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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY WITH INDEXES

(Supplement 1)

JANUARY 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7037 SEPTEMBER 1970

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 1

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced between September and December 1970 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 1988 reports, journal articles, and other documents originally announced between September and December 1970 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. NASA SP-7037 covered documents announced in *STAR* or *IAA* during the period, January–August 1970.

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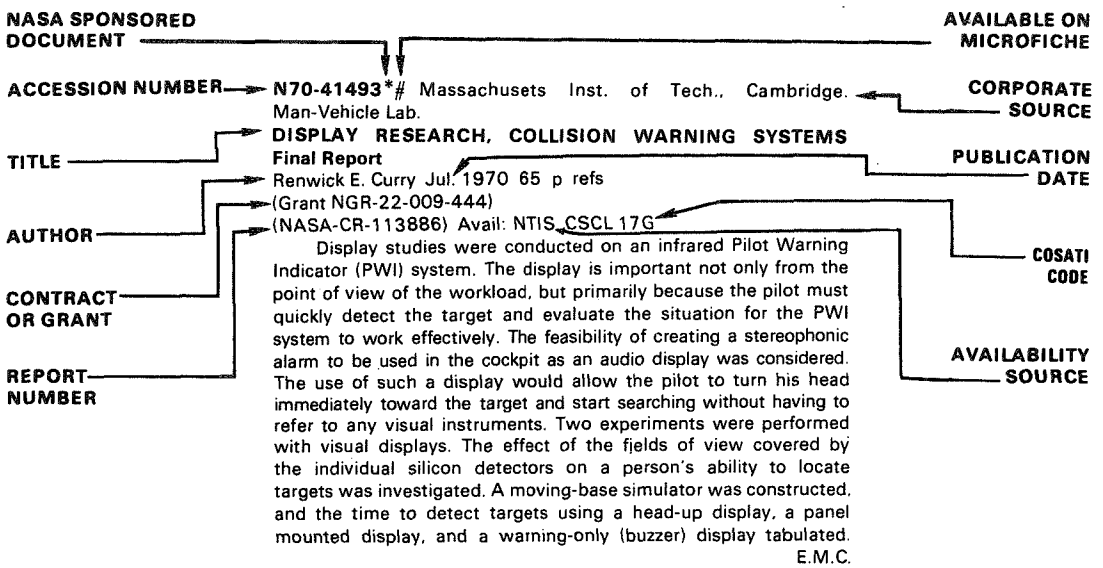
TABLE OF CONTENTS

	Page
IAA Entries	1
STAR Entries	183
Subject Index	A-1
Personal Author Index	B-1
Contract Number Index	C-1

TYPICAL CITATION AND ABSTRACT FROM *STAR*



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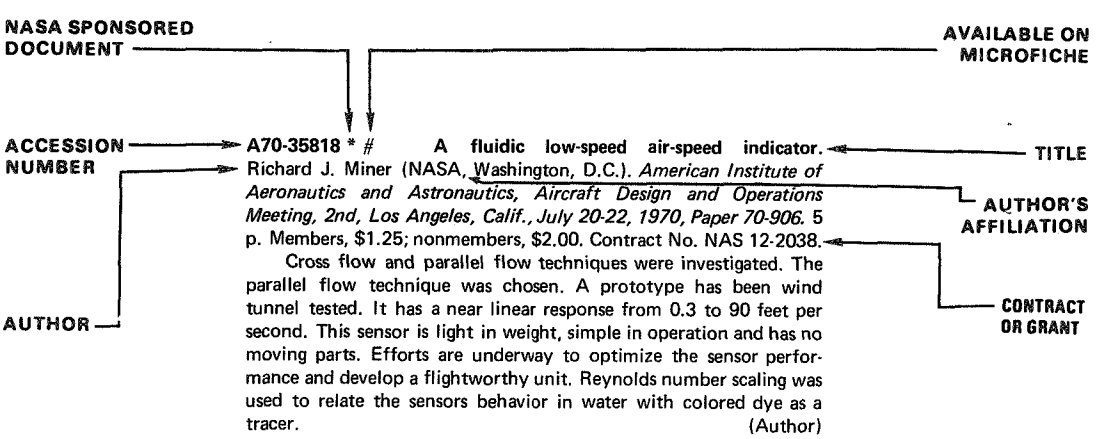

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 1) JANUARY 1971

IAA ENTRIES

A70-34351 **The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings.** Edited by R. I. Jaffee (Battelle Memorial Institute, Columbus, Ohio) and N. E. Promisel (National Academy of Sciences - National Academy of Engineering, Washington, D.C.). Oxford, Pergamon Press, Ltd., 1970. 1144 p. $48.

Contents:

Foreword. W. J. Kroll, p. xvii, xviii.

Preface. N. E. Promisel (National Academy of Sciences - National Academy of Engineering, Washington, D.C.), p. xix-xxi.

Introductory papers.

Opening address. I. Jenkins (Institute of Metals, Ipswich, Suffolk, England), p. 3, 4.

Titanium in U.S.A. T. W. Lippert, p. 5-9.

Titanium in Europe. P. Hodgkinson (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 11-17.

Processing of titanium.

Application of solidification theory to titanium alloys. H. D. Brody (Pittsburgh, University, Pittsburgh, Pa.) and S. A. David, p. 21-34. 20 refs.

Research on the quality of commercially pure titanium and Ti-6Al-4V ingots. E. DeTemple, A. Gerhardt, and W. Knorr (Fried. Krupp GmbH, Essen, West Germany), p. 35-41. 5 refs.

Chemical and structural microinhomogeneity, diffusion and mechanical properties of titanium alloys in connection with phase transformation characteristics. S. Z. Bokshtein (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Aviatsionnykh Materialov, Moscow, USSR), S. T. Kishkin (Moskovskii Aviatsionnyi Tekhnologicheskii Institut, Moscow, USSR), T. A. Emelianova, and L. M. Mirsky, p. 43-56.

Choice of vacuum-arc melting parameters to ensure ingot chemical homogeneity. V. I. Dobatkin and N. F. Anoshkin (Institute of Light Alloys, Moscow, USSR), p. 57-65.

Properties of wrought shapes formed from electroslag-melted titanium. C. E. Armantrout, J. T. Dunham, and R. A. Beall (U.S. Bureau of Mines, Albany, Ore.), p. 67-74. 5 refs.

Titanium in the U.S.S.R. S. G. Glazunov (Academy of Sciences, Scientific Council for Structural Materials, Moscow, USSR), p. 75, 76.

Forgings in titanium alloys. J. V. Scanlan and G. J. G. Chambers (High Duty Alloys, Ltd., Redditch, Worcs., England), p. 79-95.

The beta forging of titanium alloys. J. E. Coyne (Wyman-Gordon Co., Worcester, Mass.), p. 97-110. 15 refs.

The effect of beta processing on properties of titanium alloys. T. E. Green and C. D. T. Minton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 111-119.

Heavy press forging of large titanium alloy parts for aircraft and aerospace applications. T. G. Byrer and F. W. Boulger (Battelle Memorial Institute, Columbus, Ohio), p. 121-131. 7 refs.

The Mono Graf casting process. R. E. Warnock (Howmet Corp., Whitehall, Mich.), p. 133-141. 5 refs.

Precision casting of titanium. S. G. Glazunov (Academy of Sciences, Scientific Council for Structural Materials, Moscow, USSR), p. 143-147. 7 refs.

Discussion - Part A. A. D. Busby and C. D. T. Minton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 149, 150.

Discussion - Part B. H. D. Kessler (Reactive Metals, Inc., Niles, Ohio) and C. D. T. Minton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 151, 152.

Chemical and environmental behavior.

Hydriding of titanium used in chemical plant and protective measures. J. B. Cotton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England) and J. G. Hines (Imperial Chemical Industries, Wilton, Wilts., England), p. 155-170.

Anodizing of titanium equipment. F. Manton and M. E. D. Turner (Imperial Metal Industries /Kynoch/, Ltd., Billingham, England), p. 171-178.

Reaction rate of titanium and titanium alloys with titanium lower chlorides. E. K. Kleespies and T. A. Henrie (U.S. Bureau of Mines, Reno, Nev.), p. 179-188.

The oxidation of titanium films. M. J. Mindel and S. R. Pollack (Pennsylvania, University, Philadelphia, Pa.), p. 189-197. 7 refs.

Air contamination and embrittlement of titanium alloys. C. E. Shamblen and T. K. Redden (General Electric Co., Cincinnati, Ohio), p. 199-208. 8 refs.

Corrosion resistance of titanium and titanium-5% tantalum alloy in hot concentrated nitric acid. A. Takamura, K. Arakawa, and Y. Moriguchi (Kobe Steel, Ltd., Kobe, Japan), p. 209-216.

Utilization of anodic breakdown of titanium alloys as a method of characterization. T. J. Murphy (Titanium Metals Corporation of America, New York, N.Y.), p. 217-223.

Corrosion test for evaluating the corrosion resistance of titanium. S. Morioka (Tohoku University, Sendai, Japan), R. Otsuka (Institute of Physical and Chemical Research, Tokyo, Japan), and K. Nakano (Kobe Steel, Ltd., Tokyo, Japan), p. 225-232.

Titanium electrode for the manufacture of electrolytic manganese dioxide. K. Shimizu (Furukawa Electric Co., Ltd., Tokyo, Japan), p. 233-236.

Electrochemical mechanism in the stress corrosion cracking of titanium alloys. T. R. Beck (Boeing Scientific Research Laboratories, Seattle, Wash.), p. 239-245. 11 refs.

The stress corrosion cracking of alpha-titanium alloys at room temperature. D. T. Powell and J. C Scully (Leeds University, Leeds, England), p. 247-258. 33 refs.

Some characteristics of aqueous stress corrosion in titanium alloys - Summary. D. N. Fager and W. F. Spurr (Boeing Co., Seattle, Wash.), p. 259-261.

Ambient temperature stress corrosion cracking in Ti-8Al-1Mo-1V. I. S. Shaffer (U.S. Naval Material Command, Warminster, Pa.) and A. Lawley (Drexel Institute of Technology, Philadelphia, Pa.), p. 263-265.

Stress corrosion cracking in titanium and titanium alloys. J. D. Jackson and W. K. Boyd (Battelle Memorial Institute, Columbus, Ohio), p. 267-281. 31 refs.

Stress corrosion cracking of titanium and Ti-Al alloys in methanol-iodine solutions. A. J. Sedriks, J. A. S. Green, and P. W. Slattery (Martin Marietta Corp., Baltimore, Md.), p. 283-291.

Effects of halogen-containing hydrocarbons upon stressed Ti-6Al-4V alloy. K. Kamber, E. G. Kendall, and L. Raymond (Aerospace Corp. El Segundo, Calif.), p. 293-298. 8 refs.

Cracking of titanium alloys under stress during oxidation in air. U. Zwicker and E. Kalsch (Erlangen-Nürnberg, Universität, Erlangen, West Germany), p. 299-306. 7 refs.

Hot-salt stress corrosion cracking of titanium alloys. S. P. Rideout, R. S. Ondrejcin, and M. R. Louthan, Jr. (Du Pont de Nemours and Co., Inc., Aiken, S.C.), p. 307-320. 18 refs.

Discussion - Part A. J. B. Cotton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England) and U. Zwicker (Erlangen-Nürnberg, Universität, Erlangen, West Germany), p. 321-323.

Discussion - Part B. R. W. Staehle (Ohio State University, Columbus, Ohio) and U. Zwicker (Erlangen-Nürnberg, Universität, Erlangen, West Germany), p. 324-328.

Physics, thermodynamics and kinetics.

Physical properties of titanium alloys. E. W. Collings and J. C. Ho (Battelle Memorial Institute, Columbus, Ohio), p. 331-347. 24 refs.

The crystallographic structure of Ti3Al. P. C. Gehlen (Battelle Memorial Institute. Columbus, Ohio), p. 349-357. 20 refs.

Thermodynamic properties of the body-centered cubic beta-phase in the titanium-copper and the titanium-aluminum systems. M. Hoch, J. V. Hackworth, R. J. Usell (Cincinnati, University, Cincinnati, Ohio), and H. L. Gegel (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), p. 359, 360.

Calculation of regular solution phase diagrams for titanium base binary systems. L. Kaufman and H. Bernstein (ManLabs. Inc., Cambridge, Mass.), p. 361-372. 12 refs.

The single crystal elastic moduli of beta-titanium and titanium-chromium alloys. E. S. Fisher and D. Dever (Argonne National Laboratory, Argonne, Ill.), p. 373-381. 10 refs.

Computer experiments on point defect configurations and energies in Ti-M systems. J. R. Beeler, Jr. (North Carolina State University, Raleigh, N.C.). p. 383-392. 9 refs.

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Discussion. A. D. McQuillan (Birmingham, University, Birmingham, England), H. L. Gegel (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), and J. R. Beeler, Jr. (North Carolina State University, Raleigh, N.C.), p. 419-422.

Deformation and fracture.

Elastic properties of dislocations in titanium. L. J. Teutonico (Fairchild Hiller Corp., Farmingdale, N.Y.), p. 425-431. 7 refs.

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Phase transformations and heat treatment.

Some aspects of phase transformations in titanium alloys. M. J. Blackburn (Boeing Scientific Research Laboratories, Seattle, Wash.), p. 633-643. 29 refs.

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Note on the structure of the omega phase. J. M. Silcock (Central Electricity Generating Board, Leatherhead, Surrey, England), p. 731, 732.

An electron microscopy study of phase transformations in titanium-copper alloys. J. C. Williams (North American Rockwell Corp., Thousand Oaks, Calif.), D. H. Polonis, and R. Taggart (Washington, University, Seattle, Wash.), p. 733-743. 14 refs.

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Using of the Jominy test to compare the quench hardenabilities of titanium alloys Ti-6Al-4V and Ti-6Al-6V-2Sn. J. Moulin (Péchiney Group Research Centre, Voreppe, Isère, France), R. Molinier, and R. Syre (Tréfimétaux GP, Argenteuil, Val-d'Oise, France), p. 779-782.

A study of the age hardening reaction in titanium-2½% copper. P. A. Blenkinsop and R. E. Goosey (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 783-793.

Thermo-mechanical strengthening of high strength titanium alloys. H. Margolin, P. A. Farrar (New York University, New York, N.Y.), and M. A. Greenfield, p. 795-808. 15 refs.

The theoretical bases of the development of the high-strength metastable beta-alloys of titanium. N. V. Ageev and L. A. Petrova (Akademiia Nauk SSSR, Institut Metallurgii, Moscow, USSR), p. 809-814. 20 refs.

Strengthening mechanisms during the heat treatment of three titanium alloys - Ti-6Al-4V, Ti-6Al-6V-2Sn and Ti-8Al-1V-1Mo. P. J. Fopiano and C. F. Hickey, Jr. (U.S. Army, Metals Laboratory, Watertown, Mass.), p. 815, 816.

Strengthening of titanium alloys by shock deformation. M. K. Koul and J. F. Breedis (MIT, Cambridge, Mass.), p. 817-828. 12 refs.

Long time stability of Ti-679 after creep exposure for times to 15,000 hours. V. J. Erdeman and E. W. Ross (General Electric Co., West Lynn, Mass.), p. 829-837.

Effect of elevated temperature exposure on the room temperature properties of titanium alloys 8Al-1Mo-1V, 6Al-4V and 4Al-3Mo-1V. B. Turbitt and R. Geisendorfer (Boeing Co., Seattle, Wash.), p. 839-841.

The development of the structure and mechanical properties of titanium welds. I. V. Gorinin, J. B. Florinsky, and B. B. Chechukin, p. 843-846.

Discussion - Part A. M. K. McQuillan and R. T. J. Hubbard (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 847.

Discussion - Part B. E. F. Erbin (Titanium Metals Corporation of America, West Caldwell, N.J.) and R. T. J. Hubbard (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 848.

Alloying of titanium.

Titanium alloying in theory and practice. H. W. Rosenberg (Titanium Metals Corporation of America, Henderson, Nev.), p. 851-859. 16 refs.

The effect of the group III elements Al, Ga and In on the creep and stress rupture of titanium at 500 C. K. S. Jepson, L. Larke, and C. A. Stubbington (Royal Aircraft Establishment, Farnborough, Hants., England), p. 861-873. 16 refs.

Structure and creep properties of Ti7NbAl3-base alloys. F. Prinzbach and H. Winter (Battelle-Institut, Frankfurt am Main, West Germany), p. 875-878.

The influence of microstructure on the mechanical properties of forged alpha/beta titanium alloys. S. J. Ashton (High Duty Alloys, Ltd., Slough, Bucks., England) and L. H. Chambers (Magnesium Electron, Ltd., Manchester, England), p. 879-889. 6 refs.

Properties and application of Ti-5Al-2Cr-1Fe alloy (KS150B). Z. Takao, H. Kusamichi, S. Tokuda, K. Miyamoto, and Y. Fukuhara (Kobe Steel, Ltd., Kobe, Japan), p. 891-895.

Influence of carbon and oxygen on some exploratory ultra-high stregth alpha-beta titanium alloys. A. Ayvazian and R. Colton (U.S. Army, Army Materials and Mechanics Research Center, Watertown, Mass.), p. 897-899.

The effect of fabrication variables on the properties of age-hardened titanium-2½% copper. R. E. Goosey (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 901-909.

The weldability, tensile and fatigue properties of some titanium alloys. M. H. Scott and W. O. Dinsdale (Welding Institute, Cambridge, England), p. 911-922.

The fatigue properties of a high strength titanium alloy (IMI.680). R. A. Jukes (Lucas Gas Turbine Equipment, Ltd., Birmingham, England), p. 923-931.

Elasticity of titanium sheet alloys. A. Zarkades and F. R. Larson (U.S. Army, Metals Laboratory, Watertown, Mass.), p. 933-941. 11 refs.

The role of depth hardenability in the selection of high strength alloys for aircraft applications. R. M. Duncan and C. D. T. Minton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 945-957.

Metallurgical characteristics and structural properties of Ti-8Mo-8V-2Fe-3Al sheet, plate and forgings. D. B. Hunter (Titanium Metals Corporation of America, Henderson, Nev.) and S. V. Arnold (U.S. Army, Army Missiles and Mechanics Research Center,

Watertown, Mass.), p. 959-968.

High strength titanium alloys for aircraft gas turbine application. J. R. Doyle, D. L. Ruckle, and R. A. Sprague (United Aircraft Corp., East Hartford, Conn.), p. 969-978. 6 refs.

A study of the metallurgical characteristics of Ti-6Al-6V-2Sn alloy. R. Molinier, R. Syre (Titanium GP, Paris; Tréfimétaux GP, Argenteuil, Val-d'Oise, France), and J. Moulin (Péchiney Group Research Centre, Voreppe, Isère, France), p. 979-982.

The development of a superior titanium-base alloy for cryogenic applications. C. J. Kropp and A. Hurlich (General Dynamics Corp., San Diego, Calif.), p. 983-985.

Exploitation of a simple alpha titanium alloy base in the development of alloys of diverse mechanical properties. W. P. Fentiman, R. E. Goosey, R. T. J. Hubbard (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), and M. D. Smith (Cameron Iron Works, Ltd., Livingston, Scotland), p. 987-999.

Creep-resistant titanium alloys. S. R. Seagle and H. B. Bomberger (Reactive Metals, Inc., Niles, Ohio), p. 1001-1008.

Discussion - Parts A and B. H. W. Rosenberg (Titanium Metals Corporation of America, Henderson, Nev.), H. C. Child (Jessop-Saville, Ltd., Sheffield, England), and H. R. Ogden (Battelle Memorial Institute, Columbus, Ohio), p. 1009, 1010.

Applications.

Fatigue characteristics of titanium alloy forgings for rotary wing vehicles. M. Tiktinsky (Lockheed-California Co., Burbank, Calif.), p. 1013-1021. 7 refs.

High voltage electron beam welding of titanium alloys in partial vacuum. M. G. Bennett (Hawker Siddeley Dynamics, Ltd., Hatfield, Herts., England), p. 1023-1036.

Porosity in argon arc welds in titanium. E. A. Taylor, A. H. Burn, and H. R. Clarkson (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 1037-1046. 6 refs.

Submerged arc welding of titanium. R. A. Rosenberg, G. S. Irons, and K. J. Pulkonik (Mitron Research and Development Corp., Waltham, Mass.), p. 1047, 1048.

Titanium hot forming. T. O. Williams and J. C. Duerden (British Aircraft Corp., Ltd., Preston, Lancs., England), p. 1049-1051.

Forming Ti-6Al-4V sheet metal in four heat treated conditions. J. C. Chang (Rohr Corp., Chula Vista, Calif.), p. 1053-1063.

On the explosive bonding and forming of titanium. S. Inomata, A. Goto, K. Yano, M. Tsuchimoto, S. Shibata, T. Fujii (Kobe Steel, Ltd., Kobe, Japan), T. Sakurai, and M. Kanamoto (Nippon Oils and Fats Co., Ltd., Japan), p. 1065-1080.

The production and properties of some wear resistant coatings on titanium-4% molybdenum-4% aluminum-2% tin alloy (Hylite 50). J. E. Bowers, N. J. Finch, and M. G. Burberry (British Non-Ferrous Metals Research Association, London, England), p. 1081-1096. 7 refs.

Titanium in jet engines. L. P. Jahnke (General Electric Co., Cincinnati, Ohio), p. 1099-1115. 31 refs.

The application of titanium alloys in the Olympus 593 engine for the Concorde SST. A. H. Meleka (Rolls-Royce, Ltd., Bristol, England), p. 1117-1125.

Titanium metal fabrications in aero engines. A. F. Dix and R. Parkin (Rolls-Royce, Ltd., Mountsorrel, England), p. 1127-1141.

Titanium applications for supersonic airplanes. R. V. Carter (Boeing Co., Seattle, Wash.), p. 1143-1147.

Future possibilities for titanium in primary aircraft structures. A. J. Chivers (British Aircraft Corp., Ltd., Bristol, England), p. 1149-1151.

Marine applications of titanium. W. L. Williams (U.S. Navy, Naval Ship Research and Development Center, Annapolis, Md.), p. 1153-1160.

Titanium applications - U.S. Army. E. N. Kinas (U.S. Army, Army Materials and Mechanics Research Center, Watertown, Mass.), p. 1161-1167.

Titanium in the process industries today. A. O. F. Freund (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England), p. 1169-1173.

Titanium alloy pressure vessels in the manned space program. R. E. Johnson (NASA, Manned Spacecraft Center, Houston, Tex.), p. 1175-1186. 11 refs.

Discussion - Part A. N. F. Harpur and H. Brooks (Royal Aircraft Establishment, Farnborough, Hants., England), p. 1187, 1188.

Discussion - Part B. W. W. Minkler (Titanium Metals Corporation of America, West Caldwell, N.J.) and H. Brooks (Royal Aircraft Establishment, Farnborough, Hants., England), p. 1189.

Author index, p. 1191-1195.

Subject index, p. 1197-1202.

A70-34357 **Forgings in titanium alloys.** J. V. Scanlan and G. J. G. Chambers (High Duty Alloys, Ltd., Redditch, Worcs., England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 79-95.

For over 15 years titanium alloy forgings have been produced in the United Kingdom on a production basis and in this time the forging industry has been intimately associated with the growth of the titanium industry in this country. With the lack of competition from casting, as well as conventional reasons for using forgings, forging as a method of producing a shaped component was established at the outset. The bulk of the titanium alloy forgings have been manufactured for the aircraft industry where the outstanding property of high strength/weight ratio is used to advantage. In the aero engine field titanium alloys have been widely used in forged compressor discs and spacers, compressor blades and contoured flanges in bypass ducts. Titanium alloy forgings have also been built into airframe structures. (Author)

A70-34360 **Heavy press forging of large titanium alloy parts for aircraft and aerospace applications.** T. G. Byrer and F. W. Boulger (Battelle Memorial Institute, Columbus, Ohio). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 121-131. 7 refs.

Study of the forgeability of titanium alloys, for which a learning process was required before they could be successfully and consistently produced to meet rigid requirements for aircraft. One of the most critical factors is the effect of forging temperature on forging pressures. The forging behavior and mechanical properties of individual titanium alloys is influenced significantly by variations in interstitial elements. Several examples of complex titanium alloys hammer forgings are described. Calculations are presented showing the potential cost savings that can be realized by forging a 350 lb titanium alloy part to closer part definition. This can only be accomplished with higher pressures, i.e., higher press capacity. F.R.L.

A70-34427 **The influence of microstructure on the mechanical properties of forged alpha/beta titanium alloys.** S. J. Ashton (High Duty Alloys, Ltd., Slough, Bucks., England) and L. H. Chambers (Magnesium Electron, Ltd., Manchester, England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 879-889. 6 refs.

Research supported by the Ministry of Technology.

The relationship between the mechanical properties of selected forged alpha/beta titanium alloys and the various microstructures produced by heating, with or without further working, in the alpha/beta and beta regions has been investigated in a three-part programme. The initial work, concerned with thermal treatments only, shows that for IMI.314A all-Widmanstatten structures produced by cooling from the all-beta region gives the best creep resistance and the highest room temperature tensile strength with satisfactory impact and fatigue resistance, although the ductility is decreased. These behavior patterns are also applicable to IMI.318A. The next stage which involves the assessment of beta-forged IMI.679 compressor blades and flat discs concludes that although the forgeability is increased, the properties are such as to be generally unacceptable to British aero gas-turbine-engine designers. In the last section, the minimum amounts of original alpha in the microstructure and the corresponding maximum preheating temperatures, which give acceptable properties in IMI.679 and Hylite 50, are deduced. The establishment of this type of information for existing and new titanium alloys will be valuable in determining the correct forging conditions. (Author)

A70-34428 Properties and application of Ti-5Al-2Cr-1Fe alloy (KS150B). Z. Takao, H. Kusamichi, S. Tokuda, K. Miyamoto, and Y. Fukuhara (Kobe Steel, Ltd., Kobe, Japan). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 891-895.

Discussion of a titanium alloy containing 5% Al, 2% Cr and 1% Fe taking also into consideration possible industrial applications for this alloy. The tensile properties at cryogenic and elevated temperatures were investigated. A fatigue curve at elevated temperatures and a creep rupture stress versus time curve are shown. Heat treatment conditions are studied. It was found that the properties of the alloy are suitable for V/STOL jet engine parts. A new titanium alloy with good high-temperature strength was developed (5% Al, 5% Sn, 5% Zr, 2% Cr and 1% Fe). G.R.

A70-34434 The role of depth hardenability in the selection of high strength alloys for aircraft applications. R. M. Duncan and C. D. T. Minton (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 945-957.

Discussion of the reasons for variations in depth hardenability of titanium alloys Ti-11Sn-2.25Al-4Mo-0.2Si and Ti-6Al-5Zr-4Mo-1Cu-0.2Si. In addition, mechanical properties of titanium alloys with a tensile strength greater than 70 tonf/sq in. are reviewed on the basis of (1) section thicknesses in which specification strength levels are attainable, and (2) typical properties of components. Two strength ranges are considered: from 70 to 80 tonf/sq in. and above 80 tonf/sq in. Z.W.

A70-34436 High strength titanium alloys for aircraft gas turbine application. J. R. Doyle, D. L. Ruckle, and R. A. Sprague (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 969-978. 6 refs. Contract No. AF 33(657)-14903.

Determination of critical properties of the high-strength titanium alloys with specific strength/density levels from 1,050,000 to 1,200,000 in. (i.e., yield strength levels from 170 to 190 ksi) for fan blade applications at temperatures up to 400 deg F. It is found that the Ti-6Al-6V-2Sn, Ti-6Al-6V-2Sn-1Cu-1Fe-3Zr, and Ti-6Al-6V-2Sn-1Cu-1Fe-3Zr-0.1 alloys are readily forgeable into component geometries and have a uniform and predictable response to heat treatment. The basic Ti-6Al-6V-2Sn alloy has the best property balance for a high strength fan blade application. Z.W.

A70-34441 Fatigue characteristics of titanium alloy forgings for rotary wing vehicles. M. Tiktinsky (Lockheed-California Co., Burbank, Calif.). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1013-1021. 7 refs.

Survey of the fatigue characteristics of forgings made of Ti-6Al-4V and Ti-6Al-6V-2Sn alloys for rotary wing vehicles. Some results obtained are compared to those obtained for SAE 4340 steel. Topics discussed include (1) effects of welding on the fatigue strength of welded structures, (2) evaluation of welds after a duplex annealing, (3) effect of the forge reductions on fatigue properties, (4) effects of the surface finish and shot peening, and (5) physical and fatigue properties of forgings produced above the beta transus. Z.W.

A70-34444 Titanium hot forming. T. O. Williams and J. C. Duerden (British Aircraft Corp., Ltd., Preston, Lancs., England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1049-1051.

Brief discussion of the increasing use of titanium sheet as an aircraft structural material, resulting from decreasing cost of raw material and the availability of well formable alloys from which a range of properties can be obtained using short heat treatment cycles. Methods of improving the formability of titanium sheet are examined. V.P.

A70-34448 Titanium in jet engines. L. P. Jahnke (General Electric Co., Aircraft Engine Technology Div., Cincinnati, Ohio). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1099-1115. 31 refs.

Discussion of the current status and future trends of the utilization of titanium alloys in jet engines. It is shown that titanium alloys constitute 15 to 35% of the total weight of jet engines currently designed; however, titanium problems are becoming more acute, while competitive materials are establishing serious challenges. During the last quarter of the century, composite materials (both metal and plastic based) will be probably used in most jet engine applications in the low temperature regime (to 400 deg F) by offering weight and cost reductions. From 500 to 750 deg F, titanium will maintain its present advantages against heavy pressure from both metallic composites and superalloys. Above 800 deg F, superalloys will claim most engine applications by giving fewer problems and no weight or cost penalties. Above 1000 deg F, surface and structural stability handicaps will render titanium alloys useless. V.P.

A70-34449 The application of titanium alloys in the Olympus 593 engine for the Concorde SST. A. H. Meleka (Rolls-Royce, Ltd., Bristol, England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1117-1125.

Discussion of the various uses of titanium alloys in the Bristol/SNECMA Olympus 593 engine, which provide a weight saving of 1000 lb per engine as compared with the designs employing aluminum- and steel-alloy parts. The manufacturing characteristics of titanium alloys are examined, and areas of particular interest are indicated. It is shown how the mechanical properties and manipulation characteristics of titanium alloys have led to their application in the majority of components in the low-pressure compressor and a portion of the high-pressure compressor. The processes of machining, forging, forming, and welding of titanium and its alloys (now commonplace in the manufacturing procedure of gas turbine aero engines) are reviewed. V.P.

A70-34450 Titanium metal fabrications in aero engines. A. F. Dix and R. Parkin (Rolls-Royce, Ltd., Mountsorrel, England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1127-1141.

Discussion of the general aspects of the production engineering concerned with titanium metal fabrications for aircraft engines, with particular reference to metallurgical problems. The various techniques developed for the deformation of titanium and titanium-alloy sheet are described, and the peculiar behavior of titanium in deformation is noted. A discussion of fusion welding shows that the operator must be provided with well designed fixtures and equipment, without which consistent components cannot be produced. Resistance welding and heat treatment procedures which have resulted in an entirely satisfactory performance of titanium and titanium-alloy assemblies in two major Rolls-Royce engine types are examined. Research work directed to eliminate the current inability of determining on a completed component whether the fusion welds are contaminated or not is noted. V.P.

A70-34451 Titanium applications for supersonic airplanes. Roger V. Carter (Boeing Co., Commercial Airplane Div., Seattle, Wash.). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1143-1147.

Discussion of titanium applications in the airframe (60% of the airframe weight) and other components of the Boeing supersonic transport, with particular reference to the Ti-6Al-4V alloy. The characteristics of titanium alloys leading to their selection for the airframe are a strength-to-weight ratio considerably higher at pertinent temperatures than other candidate materials of suitable toughness; excellent resistance to corrosion and stress corrosion in the SST environment; good fatigue properties; excellent metallurgical stability; and good raw material availability and fabrication properties. Raw material processing techniques and manufacturing processes are examined. Several processes (in various stages of development) which could make titanium alloys even more efficient and economical are noted. V.P.

A70-34452 Future possibilities for titanium in primary aircraft structures. A. J. Chivers (British Aircraft Corp., Ltd., Bristol, England). In: The science, technology and application of titanium; Institute of Metals, Metallurgical Society of AIME, and American Society for Metals, International Conference on Titanium, London, England, May 21-24, 1968, Proceedings. Edited by R. I. Jaffee and N. E. Promisel. Oxford, Pergamon Press, Ltd., 1970, p. 1149-1151.

Discussion of project design work performed at BAC concerning the application of titanium welded construction to transport aircraft fuselages. The research work showed that weight savings on the order of 25% are possible for unit cost increases of 10 to 15% for supersonic and 30 to 35% for subsonic aircraft compared with aluminum alloy structures. Such structures would prove also very economic. The important design and manufacturing assumptions made were that extensive welding fabrication would be possible using the latest automated electron-beam and plasma-arc equipment, and that manufacturing techniques would be sufficiently well developed to construct large thin-gauge sheet structures within acceptable welding distortion limits and with consistent weld integrity. V.P.

A70-34460 * # Flow and acoustic characteristics of subsonic and supersonic jets from convergent nozzle. H. T. Nagamatsu, R. E. Sheer, Jr., and M. S. Gill (GE Research and Development Center, Schenectady, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-802.* 21 p. 27 refs. Members, $1.00; nonmembers, $1.50. Contract No. NASw-1784.

Study of the aerodynamic and acoustic characteristics of subsonic and supersonic jets on the basis of tests conducted with convergent and parallel flow nozzles and a room temperature air supply. It was found that for subsonic jets the core region extended to approximately 5 diameters from the jet exit. For a Mach number of 1.4 the sonic point was located at 13.7 diameters. For supersonic jets the sound pressure level was nearly constant over most of the angular positions. From near field measurements the overall acoustic power levels were determined and the values agreed with the far field measurements for the supersonic jets. G.R.

A70-34462 # Measurements and correlations of transition Reynolds numbers on sharp slender cones at high speeds. S. R. Pate (ARO, Inc., von Kármán Gas Dynamics Facility, Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-799.* 16 p. 39 refs. Members, $1.00; nonmembers, $1.50.

Experimental investigation of laminar boundary-layer transition on a sharp, 10-deg total angle, insulated cone at zero yaw in 12-in. and 40-in. supersonic wind tunnels at free-stream Mach numbers from 3 to 6. This research was directed toward defining the relationship between the aerodynamic noise disturbances and boundary-layer transition Reynolds numbers in high-speed wind tunnels and has extended previously published planar results to include axisymmetric models. A significant increase in transition Reynolds numbers with increasing tunnel size (similar to the planar results) is shown to exist. Sharp cone transition Reynolds numbers from ten facilities (12 to 54 in.) for free-stream Mach numbers from 3 to 14 and a unit Reynolds number per inch range from 100,000 to 1,200,000 have been correlated using aerodynamic-noise-transition parameters. A quantitative correlation of the ratio between cone and planar transition Reynolds numbers values has been developed which demonstrates a strong Mach number dependence and also indicates a variation with tunnel size and unit Reynolds number. (Author)

A70-34463 # The turbulent near wake of an axisymmetric body at subsonic speeds. Donald P. McErlean (USAF, Aero-Propulsion Laboratory, Wright-Patterson AFB, Ohio) and Christian E. G. Przirembel (Rutgers University, New Brunswick, N.J.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1,*

1970, Paper 70-797. 11 p. 26 refs. Members, $1.00; nonmembers, $1.50. Contract No. AF 44(620)-68-C-0018.

The near wake of a blunt based, right circular cylinder aligned with a uniform subsonic free stream was investigated experimentally. A low turbulence wind tunnel in conjunction with a special upstream model support system was utilized. Detailed pressure measurements were made between three model diameters upstream to six model diameters downstream of the base. Results indicate that the separation process significantly affects the approaching flow conditions for at least two model diameters. The recirculation region extends to 1.08 model diameters, and transition to the classical far wake region occurs within five model diameters. These experimental results are used to evaluate existing subsonic near wake theories. (Author)

A70-34464 # **Experimental study of axially-symmetric base flow with turbulent initial boundary layer at M sub infinity = 2.42.** Yong S. Hong (Aerospace Corp., El Segundo, Calif.) and Morris E. Childs (Washington, University, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-796.* 11 p. 10 refs. Members, $1.00; nonmembers, $1.50.

Details of the flow structure behind a blunt-based cylindrical body with a turbulent initial boundary layer have been studied experimentally in a continuous flow annular nozzle wind tunnel in which the centerbody served as the test body. Shear layer velocity profiles including the reverse flow were determined at stations downstream of the base. The approximate dividing streamline location, the location of the rear stagnation point, and the location of the position of flow separation from the body were determined. The total pressure on the dividing streamline appeared to remain relatively constant through the recompression process. The shear layer and reverse flow velocity profile could be represented satisfactorily by an error function shape for the outer part of the shear layer and a power law shape for the flow below the dividing streamline, with the two profile segments joined together smoothly at the dividing streamline. The maximum centerline velocity was almost 40 per cent of the freestream value, and the reversal of the entrained flow appeared to have started at a station about one-half of the cavity length from the base. The Pitot pressure measurements in the shear layer did not show a lip shock. Various probing techniques and methods of data analysis are discussed. (Author)

A70-34465 # **Wake stability and transition studies at Mach 4.5.** Wilhelm Behrens (California Institute of Technology, Pasadena, Calif.), John E. Lewis, and Wilmot H. Webb (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-794.* 12 p. 17 refs. Members, $1.00; nonmembers, $1.50. Research supported by the TRW Systems Independent Research and Development Program; Grant No. DA-AH-01-68-C-2086.

Results of hotwire fluctuation measurements made in the wakes of wedges (12.5- and 25 deg half-angle) including angle-of-attack and in the wake of a cylinder. The Reynolds number ranged from 1900 to 55,000. The region investigated extended to X/H = 1100. Transition location was obtained as a function of Reynolds number and wedge angle, and a lower critical Reynolds number was determined. A unit Reynolds number effect was found and explained on the basis of linear stability theory. In the transition region, spectra with a pronounced peak at a preferred frequency were observed. This peak disappeared far downstream; however, in the 'turbulent' wake a new peak in the frequency spectrum occurred. The wedge at angle-of-attack created a more unstable wake with maximum fluctuation intensity occurring on the leeward side. For cylinder wakes, at Re sub H = 14,000 transition appeared to occur twice, once in the inner wake and again, further downstream in the outer wake. (Author)

A70-34466 # **Observations on the transition process of two-dimensional supersonic wakes.** Anthony Demetriades (Philco-Ford Corp., Newport Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-793.* 11 p. 23 refs. Members $1.00; nonmembers, $1.50. Contract No. AF 04(701)-69-C-0118.

A detailed study has been made of the flow properties in the two-dimensional supersonic wake behind a heated slender flat plate. This wake exhibits a sequence of well-defined laminar, transitional and turbulent regimes. The data included the mean (average) properties, the modally-resolved fluctuations and their spectra, and the fluctuation scales. The lateral wake profiles first depart from laminar similarity at the virtual origin of turbulence and reach turbulent similarity 500 thicknesses later; a large increase in kinematic viscosity and a small decrease in Prandtl number mark the transition zone. The wideband fluctuations increase smoothly and the scales decrease greatly through transition toward magnitudes representative of turbulent wakes. However fluctuations as high as 10% of the deficits, as well as distinct scale sizes, were noted in the pretransitional wake. Spectrum analysis showed that this is due to a laminar oscillation fitting in the predictions of laminar stability theory. Evidence was gathered that this oscillation triggers transition by spectral dispersion and remains visible in the turbulent wake, perhaps as a turbulence instability. Supporting evidence from similar experiments to this effect is also presented. (Author)

A70-34467 # **A theoretical model of the near wake of a slender body in supersonic flow.** John T. Ohrenberger and Eric Baum (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-792.* 30 p. 48 refs. Members, $1.00; nonmembers, $1.50. Contract No. AF 04(701)-70-C-0152.

A steady state laminar flow theoretical model is developed which describes in detail such features as the flow approaching separation on a rounded shoulder, the expansion of the boundary layer, the development of the lip shock, shear layer, and wake shock, and the flow in the recirculation and wake neck regions. The flowfield is subdivided into an inner region, which includes the recirculating flow, that is determined by integral methods, and an outer region in which a finite difference representation of parabolic type equations is used. The solution is obtained using marching methods, in which basic flow properties are matched between the two regions on a step-by-step basis, and passage of the solution through two saddle point singularities determines uniqueness. The model is applied to a Mach 6 cold wall wedge corresponding to an experimental case of Batt, and also to a hypersonic cold wall cone at several Reynolds numbers. (Author)

A70-34475 # **Viscous interactions and flight at high Mach numbers.** Robert H. Korkegi (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-781.* 20 p. 75 refs. Members, $1.00; nonmembers, $1.50.

Viscous interactions which arise in regions of high compression on high Mach number vehicles, can result in severely high local heating and flow degradation. Regions where such strong interactions may occur on a cruise vehicle are discussed. In relation to these regions, a brief review is given of advances in our understanding of two-dimensional shock wave-boundary layer interaction and separation in compression corners, and such three-dimensional interaction problems as a blunt fin on a surface, flow in an axial corner, and shock impingement. It is concluded that much progress has been made in analytical prediction of two-dimensional laminar interactions and a promising approach advanced for the turbulent case; knowledge of departures from two-dimensional flow and three-

dimensional interactions is still largely empirical and dominantly qualitative, and even the inviscid flow field is not well known for many configurations of practical importance. (Author)

A70-34485 # An experimental investigation of the flow field around a yawed cone. R. H. Feldhuhn, A. E. Winkelmann (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.), and L. Pasiuk (U.S. Navy, Ordnance Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-766.* 20 p. 37 refs. Members, $1.00; nonmembers, $1.50. Navy-sponsored research.

An experimental investigation of the flowfield associated with a highly yawed five degree half-angle cone has been conducted in the wind tunnels at the U. S. Naval Ordnance Laboratory (NOL). The measurements, obtained for the most part at Mach 5, included surface pressure distributions, flow visualization photographs, and detailed leeward side flowfield surveys. Analysis of these results indicates that the flowfield associated with a highly yawed cone at high supersonic velocities resembles that of a circular cylinder in a supersonic crossflow. The conical inviscid flowfield on the windward side of the cone is analogous to the blunt body type flowfield established by a circular cylinder. The structure of the flowfield on the leeward side of a highly yawed circular cone is similar in appearance to that in the wake of the circular cylinder. The essential difference between these flowfields is the presence in the cone flowfield of a 'vortical singularity like' gradient which separates the flow traversing the stronger portion of the shock wave on the windward side from the flow traversing the weaker portion of the shock wave on the leeward side. (Author)

A70-34486 # Jet-interaction-induced separation of supersonic turbulent boundary layers - The two-dimensional problem. M. J. Werle (Virginia Polytechnic Institute, Blacksburg, Va.), R. T. Driftmyer, and D. G. Shaffer (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-765.* 15 p. 21 refs. Members, $1.00; nonmembers, $1.50. Navy-supported research.

An experimental study supporting the development of an analytical model for the title problem is discussed. Extensive flat-plate tests were conducted at a Mach number of four and two Reynolds numbers. Surface pressures were recorded fore and aft of the four, sonic, normal jet slots tested. Shadowgraphs, taken through glass-ported side plates, were made of both the interacting and free-jet plume characteristics. Generalized correlations showed that the entire problem scales directly with the observed shock heights and that these shock heights are predictable from free-jet considerations. (Author)

A70-34487 # Transitional flow separation upstream of a compression corner. Melvin L. Roberts (General Electric Co., Aircraft Engine Technical Div., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-764.* 10 p. 14 refs. Members, $1.00; nonmembers, $1.50. Contracts No. AF 04(694)-389; No. AF 04(694)-516; No. AF 04(694)-67-C-0035.

Experimental measurements of transitional separation, caused by a compression corner at the trailing edge of a sharp leading edge flat plate, were analyzed in an attempt to correlate the extent of separation. A previously published correlation, based on the wetted length Reynolds number at the separation point, failed when the plate length alone was changed. A reexamination of the data showed that the true correlating parameter was the free-stream unit Reynolds number. Examination of the equation of motion applicable to the dividing streamline between the boundary layer and the recirculating flow suggested that the unit Reynolds number determined the growth of turbulence in the transition region. The separated flow transition could then be related to attached-flow, boundary-layer transition on a plate, with the same external flow condition. A new correlation showed that the length of transitional separation was a function only of free-stream Mach number, inviscid flow pressure rise at the compression corner, and the length over which transition develops in an attached-flow, flat-plate boundary layer with the same external flow conditions. (Author)

A70-34488 # Physical and numerical experiments in laminar incompressible separating and reattaching flows. Thomas J. Mueller and Robert A. O'Leary (Notre Dame, University, Notre Dame, Ind.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-763.* 16 p. 11 refs. Contract No. N 00014-68-A-0152.

Laboratory and numerical experiments for the incompressible, viscous, laminar flow over the two-dimensional simple back-step, blunt base, and 45 deg symmetric V-shaped cavity are presented. The experiments were designed to duplicate as closely as possible the flow fields to be calculated. This meant that in addition to having the same boundary conditions along solid surfaces, the characteristics of the boundary layer approaching the region of interest had to be measured so that they could be used as inputs in the numerical solution. An explicit time-dependent finite difference scheme is used to obtain the numerical solution of the modelled flow field. A vorticity-stream function scheme, possessing conservative and transportive properties and utilizing upwind differencing for advection terms, yields stable solutions for Reynolds numbers ranging from 0.1 to 1500. Good qualitative and quantitative correlation is obtained between experimental and numerical results. (Author)

A70-34492 # Recent experiments in supersonic regime with electrostatic charges. M. S. Cahn, G. M. Andrew, and W. E. Anderson (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-759.* 12 p. Members, $1.00; nonmembers, $1.50.

This paper presents the results of recent experiments in airflow control by electrostatic discharges. The tests were conducted in M = 1.5 and M = 3 wind tunnels with 1.5- by 3-in. test sections. Two-dimensional full span models were used. Up to 100,000 volts at 10 milliamperes were applied to the model to produce the required gaseous discharge in the airstream. A Schlieren system provided still and motion picture data of the bow shock wave ahead of the models. Differential pressure measurements were taken across the shock waves. At M = 1.4, the shock wave moved upstream when 40 kilovolts and 70 watts are applied to the model. Other test configurations caused the shock wave to move both upstream and downstream. In one experiment, at M = 1.4, the shock wave completely disappeared from view. Areas of additional research and possible applications are presented. (Author)

A70-34496 # Laboratory simulation of the atmospheric boundary layer. J. E. Cermak (Colorado State University, Fort Collins, Colo.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-751.* 12 p. 38 refs. Members, $1.00; nonmembers, $1.50. PHS Grant No. AP-00091-01-06; NSF Grant No. G-4799; Contracts No. AF 19(604)-1706; No. DA-36-039-SC-80371; No. N-123(61756)34361ABMR; No. N 00014-68-A-0493-0001; Grants No. DA-AMC-28-043-64-G9; No. DA-AMC-28-

043-65-G20.

Similarity criteria are given for micro-, small-, and meso-scale motion of the atmospheric boundary layer. Requirements for simulation of dispersion of passive contaminants in the atmosphere are discussed. The characteristic features of a unique meteorological wind tunnel having a capability for simulating thermally stratified boundary layers are described. Mean wind speed, mean temperature and turbulence statistics measured in this laboratory facility are found to be similar to corresponding data obtained from measurements in the atmosphere. Examples of simulated dispersion over a variety of surface features including urban areas and complex topography are described. (Author)

A70-34503 # **Hypersonic flow on yawed two-dimensional wedges with leading-edge bluntness and viscous interaction.** R. C. Boger and G. F. Aiello (Avco Corp., Wilmington, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-783.* 12 p. 7 refs. Members, $1.00; nonmembers, $1.50. USAF-supported research.

A theoretical and experimental study of yawed two-dimensional bodies in a hypersonic stream, including the effects of leading edge bluntness, viscous interaction, and small angle of attack, has been carried out. It is found that the theory due to Cheng et al., which was developed for the problem without yaw, can be successfully modified to treat the yawed case. The necessary assumption for the extension of the theory is that no gradients along the span exist in the flow over the body. The results of wind tunnel tests, covering a wide range of Mach number and Reynolds number conditions at yaw angles of 60 and 70 degrees, show that this major assumption is valid and verify the modified theory. These tests include the measurement of pressure, heat transfer, and total force on the body. (Author)

A70-34509 * # **The status of thermophysics as a multidiscipline area in astronautics and aeronautics.** Gerhard B. Heller (NASA, Marshall Space Flight Center, Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 5th, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-812.* 10 p. 18 refs. Members, $1.00; nonmembers, $1.50.

Discussion of thermophysics and its relation to astronautical and aeronautical problems taking into consideration spacecraft thermal design and the thermal problems of hypervelocity vehicles. It is pointed out that thermal design should be an essential part of a system design from the very beginning. Aspects of thermal control are examined and the optical and radiative properties of thermal control coatings are discussed. Effects of the space environment on thermal control surfaces are investigated. The optical and radiation properties of natural planetary surfaces are considered and problems of remote sensing are briefly examined. G.R.

A70-34629 **USSR - The Kuznetsov NK 8-4 bypass turbojet (URSS - Le turboréacteur à double flux Kuznetsov NK 8-4).** Jacques Morisset. *Air et Cosmos,* vol. 8, July 4, 1970, p. 24, 25. In French.

Description of the NK. 8-4 bypass turbojet, which is the most powerful Soviet jet engine; it provides 10,500 kg thrust. A further development is the NK. 144, of 13,000 kg thrust, which powers the Tu-144 supersonic transport. The NK. 8-4 consists of air entry directing vanes, a 4-stage low pressure compressor, a central gear case, a 6-stage high pressure compressor, an annular combustion chamber, a simple turbine driving the high pressure compressor, and a 2-stage turbine driving the low pressure compressor. F.R.L.

A70-34672 # **Coming design options for tactical aircraft.** Terrell E. Greene (RAND Corp., Santa Monica, Calif.). *Astronautics and Aeronautics,* vol. 8, July 1970, p. 36-43. 11 refs.

Discussion of new electrooptical devices, agile weaponry, communication and navigation networks, information displays, and real-time remotely manned control systems representing design options for improving the performance of tactical aircraft in the next decade. Various concepts of facilitating takeoff, low-altitude flying, weapon delivery, and landing without visual reference to the ground are outlined. Among the advanced techniques also mentioned is the deployment of a runway reference system coupled with an airborne automatic landing system, and various radar operation modes. V.Z.

A70-34673 # **Through the central 'multiprocessor' avionics enters the computer era.** Alexander O. Williman and Cedric F. O'Donnell (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). *Astronautics and Aeronautics,* vol. 8, July 1970, p. 44-52.

Outline of the challenges facing designers and technical managers in handling the central computer of military avionics in terms of time, money and tradeoffs. Typical requirements for the memory capacity and computational speed of a near-future bomber are projected. A graph is plotted to show the increase since 1958 in speed, memory and I/O requirements for a typical group of missile and aircraft avionics computers. An example is given to show how memory capacity and speed limitations can affect computer programming costs. Projections are made as to how computer applications in avionics will expand in the future. V.Z.

A70-34675 # **Structural alloys - Favorites retain their lead.** C. M. Pierce, J. A. Hall, and T. M. Ronald (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics,* vol. 8, July 1970, p. 62-71. 26 refs.

Consideration of current trends in the field of aircraft structural alloys, noting the preference given to high-strength steels and aluminum and titanium alloys because these alloys meet well the manifold requirements of large-scale uses in aircraft frames. These requirements in hot gas ducts of V/STOL aircraft are specified as creep strength for 1000 to 3000 h, thermal fatigue resistance, oxidation/sulfidation resistance, damage tolerance, weldability and formability. The performance and characteristics of these alloys are discussed and compared. V.Z.

A70-34685 # **Certain cases of dynamic loads acting on subsonic and supersonic aircraft (Pewne dynamiczne przypadki obciążeń samolotów pod- i naddźwiękowych).** Stanisław Dubiel (Wojskowa Akademia Techniczna, Warsaw, Poland). *Technika Lotnicza i Astronautyczna,* vol. 25, Mar. 1970, p. 3-7. 8 refs. In Polish.

Analysis of dynamic aircraft loads for the case of straight flight along an inclined trajectory under conditions of variable atmospheric density, and for the case of pulling the aircraft out of this trajectory. Direct relations between the flight conditions and the loads are derived for each case. V.P.

A70-34686 # **Some problems associated with the service life of technological aviation systems. II (Niektóre zagadnienia trwałości lotniczych obiektów technicznych. II).** Mieczysław Sikorski and Henryk Tomaszek (Wojska Lotnicze, Instytut Techniczny, Warsaw, Poland). *Technika Lotnicza i Astronautyczna,* vol. 25, Mar. 1970, p. 8-11. In Polish.

Discussion of general problems associated with the design and operation of aviation systems, such as aircraft, helicopters, rockets

and their elements or subsystems. Particular attention is given to methods of determining the proper checking and maintenance intervals as a function of the time during which the system was in use. V.P.

A70-34688 # **Automation of the service process in air transportation. II (Automatyzacja procesu obslugowego w transporcie lotniczym. II).** Jan Zwierzyński. *Technika Lotnicza i Astronautyczna,* vol. 25, Mar. 1970, p. 14-19. In Polish.

Discussion of the use of automatic and computerized equipment for accelerating and simplifying airlines passenger service. Passenger name record (PNR), fare quotation (FQ), ticketing, and similar systems employed by U.S. airlines are discussed, and samples of passenger tickets, luggage tickets, and similar receipts are presented. V.P.

A70-34689 # **Profitableness of long-haul air transportation. I (Opłacalność przewozów lotniczych dalekiego zasiegu. I).** Marek Żylicz. *Technika Lotnicza i Astronautyczna,* vol. 25, Mar. 1970, p. 23-25. In Polish.

Discussion of the specific costs, which have a direct influence on airlines operation, for international flights of the Polish 'Lot' airline. A critical comparison with the worldwide economical situation of long-haul air transportation shows that the operational conditions of the Polish airlines are below average. The operational and economical aspects of an Arctic airline project are assessed. V.P.

A70-34690 # **The Wankel engine as a future power source for powered gliders and light aircraft (Silnik Wankla przyszłościowym napędem motoszybowców i samolotów slabosilnikowych).** Julian Falecki. *Technika Lotnicza i Astronautyczna,* vol. 25, Apr. 1970, p. 13-16. 14 refs. In Polish.

Discussion of the Fichtel-Sachs KM 48 rotary-piston engine developed for powered gliders by modifying an industrial Wankel engine. Due to its smooth operation, simplicity, low weight, low-noise characteristics, and facility of starting, operating, and maintenance, the engine has all the major advantages required from a powerplant for powered gliders. The KM 914 and KM 30 versions produced by the same firm for snowmobiles, and the NSU KKM 150 engine produced for motorboats are also examined. V.P.

A70-34691 # **Profitableness of long-haul air transportation (Opłacalność przewozów lotniczych dalekiego zasięgu).** Marek Żylicz. *Technika Lotnicza i Astronautyczna,* vol. 25, Apr. 1970, p. 21-23. In Polish.

Comparative computation of ton-km and passenger-km costs for the Polish 'Lot' airline and international ICAO data, on the basis of tentative conversion factors. The profitableness of foreign airlines operation under the specific conditions of Polish airlines is assessed for a fictitious airline connecting Poland with North America. V.P.

A70-34692 # **Fighting mud and water on runway surfaces (Walka z warstwą błota i wody na nawierzchniach lotniskowych).** Zdzisław Pytlewski (Wojska Lotnicze, Instytut Techniczny, Warsaw, Poland). *Technika Lotnicza i Astronautyczna,* vol. 25, Apr. 1970, p. 24-26. In Polish.

Discussion of the difficulties and dangers arising during landing and takeoff from muddy runways, and of methods coping with them at positive and negative temperatures. The increase in take-off run arising from mud layers 1.25 and 2.50 cm thick is calculated as a function of engine thrust per aircraft weight unit. V.P.

A70-34701 * **Prediction of the stability derivatives of large flexible prop/rotors by a simplified analysis.** John P. Magee and Richard R. Pruyn (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 443.* 11 p. 17 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 2-5025.

An analysis to predict the effects of blade flexibility on the static stability derivatives of large propeller/rotors in the propeller mode of flight is presented and correlated with all available test data. The analysis includes large inflow effects but has been simplified so that the calculations involved can be performed without a computer. The effects of blade flexibility are shown to be significant and these effects are shown to be predicted by the analysis with acceptable accuracy. Unknown propeller/rotor mounting flexibility and wing aerodynamic interference effects introduce some uncertainty in the pitching moment derivative correlation. An example of the use of this analysis to guide the selection of the propeller/rotor system and the selection of the blade flexibility for a tilt-rotor aircraft is included. (Author)

A70-34702 **The development of a fiberglass main rotor blade for the CH-47C helicopter.** Richard J. Spitko (Boeing Co., Vertol Div., Philadelphia, Pa.) and Harvey Young (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 450.* 9 p. 5 refs. Members, $1.25; nonmembers, $2.00. Grant No. DA-AJ-02-67-C-0072.

Brief description from the structural engineer viewpoint of a research and development program to design, fabricate, and fly advanced-geometry fiberglass rotor blades on the CH-47C helicopter. The impact of composite materials on the structural design process is summarized. M.M.

A70-34703 **The development of an advanced composite tail rotor driveshaft.** H. Zinberg (Bell Helicopter Co., Fort Worth, Tex.) and M. F. Symonds (Whittaker Corp., Advanced Structures Div., Monrovia, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 451.* 15 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Description of the development of an advanced composite tail rotor driveshaft for a next-generation helicopter. Boron-epoxy was the material chosen for the initial program, and a follow-on program to develop a carbon-epoxy driveshaft is progressing. The configuration of the advanced composite shaft was optimized, using the unsupported length of the driveshaft as the independent variable and the weight of the drive system as the dependent variable. Fabrication techniques and the results of tests of element and subsized torque-tube specimens are discussed. Two full-sized driveshafts were fabricated and subjected to static and dynamic tests. Both bending and torsional moduli were in agreement with predicted values. One shaft was tested to failure to verify the predicted torsional buckling stress. The correlation between analytical and test results was good. M.M.

A70-34704 * **Simplified procedures for estimating flapwise bending moments on helicopter rotor blades.** Anton J. Landgrebe (United Aircraft Research Laboratories, East Hartford, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 452.* 13 p. 7 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 1-7880.

Simplified procedures are described for predicting the flapwise bending moments of helicopter rotor blades. It is shown that such

moments are basically linear functions of several independent rotor parameters and can be computed by transfer function, superposition techniques. It is also shown that transfer coefficients relating independent rotor parameters to harmonics of moment can be derived and presented in the form of design charts for a wide range of blade design parameters and operating conditions of interest. The accuracy of the transfer function approach is demonstrated by several comparisons of predicted bending moments (or stresses) with experimental results and with results from a more complete numerical analysis in which chordwise and torsional degrees of freedom are included. The method is rapid in application, provides accurate results for moderate advance ratios, and is useful in gaining insight into the mechanisms by which helicopter blade flapwise moments and stresses are produced. (Author)

A70-34705 The CH-47 cruise guide indicator. W. P. Brown and H. H. Steinmann (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 453.* 7 p. Members, $1.25; nonmembers, $2.00.

Discussion of the design and operation of the Cruise Guide Indicator (CGI), a device displaying the instantaneous fatigue loading of CH-47 helicopters to their pilots. The primary function of this device is to determine the maximum acceptable airspeed limitation, using the fixed link and the pivoting actuator of the aft rotor fixed control system as fatigue loading monitors. The CGI provides a direct control over the term representing the load occurrence in the fatigue equation. It provides a higher degree of safety and broadens the operating limits of a helicopter to meet the requirements of well-designed advanced aircraft. V.Z.

A70-34706 Collection and analysis of helicopter combat flight loads data from AH-1G helicopters in Southeast Asia. F. Joseph Giessler, Joseph F. Braun (Technology, Inc., Dayton, Ohio), and William T. Alexander (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 454.* 10 p. 6 refs. Members, $1.25; nonmembers, $2.00. Grant No. DA-AJ-02-68-C-0076.

Discussion of the flight loads sustained by AH-1G helicopters operating in Vietnam as shown by an analysis of onboard oscillograph data recorded for a total of 436 flight hours during the period from June 1968, through November, 1969. The analysis covers conventional VGH data for airspeed, altitude and vertical, longitudinal and lateral accelerations, and also rotor rpm, engine torque, outside air temperature, collective pitch control stick position, and longitudinal cyclic pitch control stick position. A set of comprehensive data defining the helicopter performance in terms of ten most critical variables is obtained as a result. V.Z.

A70-34707 Power-available calculation procedure and operational aspects of a tipjet-propelled rotor system. Bruno A. Bachmann (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 460.* 14 p. 7 refs. Members, $1.25; nonmembers, $2.00.

In order to achieve an optimum pneumatically driven helicopter, the engine, duct system, and rotor have to be matched. A power-available calculation procedure using single-line engine-operating characteristics is presented. The use of the exact gas dynamic equations that describe the change of the gas conditions along a rotating rotor blade are demonstrated. An engine/rotor matching study is used to gage the influence of the important propulsion parameters on the mission performance. The control of a pneumatically driven helicopter rotor is closely tied to the dynamic response characteristics of the engines. The response characteristics of a fanjet engine/heavy-lift helicopter combination are compared with today's helicopter industry standards. Finally, the development of the pneumatic drive system is quickly reviewed historically, and some potential future improvements of the propulsion system's performance are discussed. (Author)

A70-34708 Optimization study for VTOL aircraft powerplants. W. L. McIntire and D. S. Monson (General Motors Corp., Allison Div., Indianapolis, Ind.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 461.* 10 p. Members, $1.25; nonmembers, $2.00.

Consideration of a heavy-payload short-range mission and a medium-payload long-range mission for helicopters in which the restrictions of limited 'off-shelf' powerplant inventory with a narrow range of performance and output are eliminated by adapting the aerodynamic cycle, size and configuration of the powerplant to the requirements of the mission. The engine performance and the weight characteristics used in the study correspond to the technology anticipated for the 1975 to 1980 period. Cycle pressure ratios and the effects of the turbine temperature on fuel consumption, engine weight, and helicopter gross weight are projected for that period. Operating cost rates vs cycle parameters are also investigated for an optimum helicopter propulsion system. V.Z.

A70-34709 Design optimization of a V/STOL 5000 hp engine. Thomas A. Dickey and Pierre G. Schwaar (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 462.* 10 p. Members, $1.25; nonmembers, $2.00.

Discussion of aerothermodynamic and mechanical design considerations for a modern V/STOL engine in the 5000-7000 SHP class. Details of component arrangements, rotor design, and blade cooling methods are considered and the engine fuel control is described. It is pointed out that component test and full engine experience have actually produced results within a few per cent of the original goals of the study. G.R.

A70-34710 Preliminary design and analysis of an advanced convertible fan/shaft engine for V/STOL tactical and transport aircraft. J. N. Tulino, P. C. Bosse, and W. H. Wiley (United Aircraft Corp., Pratt and Whitney Aircraft Div., West Palm Beach, Fla.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 463.* 10 p. Members, $1.25; nonmembers, $2.00.

Description of the mechanical arrangement and performance of the Pratt and Whitney Aircraft STF/S351 convertible engine, which can provide the multimode power required by V/STOL aircraft. The STF/S351 is a combined fan/shaft engine that delivers shaft power to rotors for vertical takeoff, and fan thrust for long range high speed cruise. Using a single gas generator core, fixed-geometry fan and power turbines in series, and a turbine bypass arrangement, this engine can produce full shaft power, full fan thrust, or any near-linear combination of the two. By changing the fan bypass ratio, fan pressure ratio, and turbine temperature scheduling, this engine can be tailored to meet a variety of mission requirements with the same gas generator. G.R.

A70-34711 Aerodynamic parameters that affect compressor erosion in gas turbine engines. Ronald M. Wood (General Motors Corp., Allison Div., Indianapolis, Ind.) and Robert M. Gaertner (U.S. Naval Air Systems Command, Propulsion Div.,

Washington, D.C.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 464.* 18 p. Members, $1.25; nonmembers, $2.00.

Study for relating compressor aerodynamic parameters of various gas turbine engines with the erosion characteristics of each. Erosion data were accumulated from inspections at military overhaul facilities and controlled ingestion test reports. Based on the data, a comparative ranking was made of the compressor erosion susceptibility of the various models in the study. The correlations obtained provide general design guidelines to improve sand and dust ingestion capabilities of new engine designs intended for application in contaminative environments. G.R.

A70-34712 Application of vortex visualization test techniques to rotor noise research. R. H. Spencer (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 470.* 10 p. Members, $1.25; nonmembers, $2.00.

Discussion of test methods of investigating and controlling the helicopter noise which results from a rotor blade passing near or through the vortex trailed at the trip of another blade. A concept of flow visualization by installation of a smoke generator in the tip of a rotor blade is discussed. This concept proved to be successful for documenting the tip vortex trailed from a rotor. It is found that the ability to accurately predict the intersection of a blade with a trailed vortex is paramount to the design of an acoustically acceptable rotor system. G.R.

A70-34713 Airborne flight test data acquisition and automatic data processing system for helicopter test and development programs. Frank Kreutz (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 471.* 10 p. Members, $1.25; nonmembers, $2.00.

An airborne acquisition and rapid bulk-data processing system is described. Techniques and subsystem design requirements for proper system integration are discussed which permit rapid processing of structural flight test data to a format readily acceptable to engineering analysis. This system, which is currently being used on the CH-54B Army Crane Structural Substantiation Program, was developed for structural flight testing; however, the system versatility readily permits adaptation to other types of programs. The bulk-data processing system is user-oriented so that the flight test engineer can control the data processing logic with prepared control cards. This system also provides the user with a request format to locate data in storage from a Program Data Library. (Author)

A70-34714 Qualitative report on flight test of a two-point external load suspension system. A. J. Hutto (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 473.* 11 p. Members, $1.25; nonmembers, $2.00.

Discussion of a two-point suspension system with longitudinally displaced cargo hooks for the handling of loads by helicopter. The system considered was selected as a result of wind tunnel investigations and flight tests. The flight test program substantiates the capability of a two-point longitudinally displaced suspension system to provide load restraint to enable safe transport of aerodynamically unstable loads to very impressive high speeds. Further, the system provides a quick easy hover hookup for load acquisition in minimum time. G.R.

A70-34715 A simplified study of high speed autorotation entry characteristics. H. H. McIntyre (Kaman Aerospace Corp., Bloomfield, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 440.* 8 p. Members, $1.25; nonmembers, $2.00.

Discussion of the high speed autorotation entry characteristics of four representative helicopter configurations. The results of the analysis conducted indicate that automatic autorotation entry equipment, which could detect engine failure and provide an 'early start' on the reduction of collective pitch, would greatly enhance the autorotation entry capabilities of high powered, high speed helicopters. It is pointed out that none of the configurations studied could meet the control time delay requirement of the military flying qualities specification; however, two of the configurations could meet the time delay specified in the Federal Aviation Regulations. G.R.

A70-34716 Hueycobra maneuvering investigations. Richard B. Lewis, II (U.S. Army, Aviation Systems Command, Edwards AFB, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 472.* 7 p. 14 refs. Members, $1.25; nonmembers, $2.00.

Discussion of an exploratory flight test program conducted to study the maneuvering characteristics of the AH-1G Hueycobra helicopter. Basic stability, control, performance, vibration, and structural loads characteristics of the AH-1G during controlled, steady-state maneuvers are investigated. The kinematic relationships of the aircraft during maneuvering flight are examined and potential problem areas peculiar to operational maneuvering flight, particularly in the areas of stability, vibration, loads, and total vehicle energy are discussed. G.R.

A70-34717 Combat operational flight profiles on the UH-1C, AH-1G, and UH-1H helicopters. G. L. Graham (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 455.* 12 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Determination of the frequency of occurrence of loads or stresses during the operational flight of three types of helicopters, using a special flight recorder. The data measured include airspeed, altitude, rotor speed, horsepower, load factor, weapon systems, and variation in usage. Data obtained from service are used for evaluating the accuracy of manufacturer's original estimates. Z.W.

A70-34718 Dynamic stall of helicopter blades. Lars E. Ericsson and J. Peter Reding (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 422.* 10 p. 14 refs. Members, $1.25; nonmembers, $2.00.

The dynamic stall characteristics of a helicopter blade section are analyzed. It is shown that the dominant characteristic in leading edge and trailing edge type dynamic stall is the effect of the accelerated flow generated by the nonzero pitch rate. The pitch rate induced flow acceleration delays the adversity of the pressure gradient on the leeward side, thereby causing a delay of the stall resulting in the experimentally observed large overshoot of static C sub L max. A quasi-steady theory is described in which time history effects are lumped to one discrete past-time event and the accelerated-flow effect is represented by an equivalent time lag. The theory, which uses static experimental data as an input, is found to predict experimental dynamic stall characteristics and associated torsional undamping as long as applicable static data are available. The latter requirement presently puts an upper limit on the frequency when applying the developed quasi-steady theory. (Author)

A70-34719 The application of hingeless rotors to tilting prop/rotor aircraft. David A. Richardson (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National*

Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 403. 7 p. 11 refs. Members, $1.25; nonmembers, $2.00.

This paper discusses some of the aerodynamic, dynamic, and structural considerations in the prop/rotor design for a tilt-rotor aircraft. The importance of increasing the blade loading in cruise flight is shown by the effect on aircraft weight of reducing rotor speed and the effect on blade section L/D. The upper limit of blade loading is shown by presenting some experimental model test data defining stall flutter boundaries. The results of model tests are given which show the effect of blade twist on cruise efficiency and figure of merit. The effect of blade flapping frequency on the amount of cyclic pitch required for control is given. Comments are made on hub geometry with recommended considerations. A blade design with an in-plane frequency of less than once per revolution is described. The material selection, the blade root configuration, and the transition from the root to the outer portion of the blade are discussed. (Author)

A70-34720 Miniature laser obstacle warning systems for helicopters. H. D. Eckhardt (RCA, Burlington, Mass.) and N. A. Luce (Quantel Corp., Princeton, N.J.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 433.* 15 p. Members, $1.25; nonmembers, $2.00.

Description of the use of a gallium arsenide laser ranging system for obstacle proximity warning for helicopters. The system described can reliably detect 3-in. diameter obstacles out to ranges of 100 feet and at all azimuths. The gallium arsenide obstacle warning system can consist of small lightweight units which may be mounted in various places on the helicopter. Z.W.

A70-34721 Millimeter radar for landing applications. L. H. Kosowsky and K. L. Koester (United Aircraft Corp., Norden Div., Norwalk, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 434.* 9 p. 7 refs. Members, $1.25; nonmembers, $2.00.

Investigation of the feasibility of utilizing millimeter wave radar as a high resolution landing aid. In order to obtain quantitative data for the design of landing aid radars operating at millimeter wavelengths, an experimental radar system was designed and developed to be capable of a wide range of experiments. Experiments were designed to obtain backscatter data from an airborne platform, and the experimental radar system was installed and flown in in a helicopter. Of particular interest was backscatter at shallow grazing angles from terrain, runways, and aircraft on taxiways. It was found that at millimeter wavelengths there is a large contrast between the return from terrain and the return from runways and taxiways. The backscatter cross section of aircraft and urban areas was obtained and is presented as a design parameter for future millimeter systems. Photographs of the PPI display showing runways, hangars, and other aircraft are presented to illustrate the capability of millimeter radar as a landing monitor. Z.W.

A70-34722 Stability and control considerations for a tilt-fold-proprotor aircraft. F. E. Tiller, Jr. (Bell Helicopter Co., Fort Worth, Tex.) and Robert Nicholson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 442.* 17 p. 13 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-69-C-1121.

Examination of the inherent characteristics of the tilt-fold-rotor VTOL aircraft concept and their effect on the stability and control of this aircraft. The impact that its unique characteristics - i.e., pylon tilt and rotor stop-fold - have on flying qualities is emphasized. The impact of stability and control criteria on design is evaluated. Wind tunnel test results of static and dynamic models are coupled with observations made during analytical studies to establish needed background information. Z.W.

A70-34723 Control of large crane helicopters. Leonard S. Szustak and David S. Jenney (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 441.* 19 p. 8 refs. Members, $1.25; nonmembers, $2.00.

This paper discusses several aspects of the controllability of large crane helicopters. The size of these next generation helicopters may require the development of new pilot techniques and the large range of aircraft gross weight/inertia will require a re-definition of current stability and controllability criteria. The primary mission of these large cranes, that of serving as an external cargo carrying platform, dictates the need to understand better and to account for the characteristics of slung loads and to offer more automatic assistance to the pilot in this complex job. Some specific controllability criteria are proposed here. It is shown too, that some seemingly simple external load handling problems are in fact difficult if not insoluble. Results of tests of a canted tail rotor (for better hover efficiency) show that with proper coupling added, controllability does not suffer. Finally, advances in the design of control systems - perhaps even to fly-by-wire - and in Automatic Flight Control Systems (AFCS) to permit load stabilization and precision hovering have been shown to be feasible. (Author)

A70-34724 Models for a VTOL airplane in transition. David L. Key (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 444.* 12 p. 5 refs. Members, $1.25; nonmembers, $2.00. Contract No. NOw-66-0630-c.

The purpose of this paper is to propose realistic models of a VTOL in transition. After a brief glance at the nature of transitions, the aerodynamic forces and moments are considered in some detail. A model suitable for use in parameter identification schemes is presented and its accuracy illustrated by comparing responses with responses obtained in a full digital simulation. This model has the aerodynamics represented in the form of a Taylor's series. For the aircraft studied (the X-22A), at least second-order terms will be required for studying dynamics, but only first-order terms may be sufficient for transition profile studies. Starting with nonlinear equations and the full Taylor's series representation, the model is simplified progressively until it is linear time-varying. Responses obtained using the various simplifications are shown and the simplification processes discussed. The linear time-varying model will probably be valid for studying small perturbations from the reference transition, but the time-varying form is not conducive to easy analysis. It is shown that simply considering transition as a sequence of fixed point analyses can incur a number of errors. (Author)

A70-34725 # Avionics - The key to the future of army aviation. William H. Maloney (U.S. Army, Aviation Agency, Fort Rucker, Ala.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 430.* 5 p. Members, $1.25; nonmembers, $2.00.

Discussion of the problems for solving fundamental Army Aviation requirements concerning the support of the ground soldier under any conditions in which he is able to fight. Following functional areas of the avionics are discussed: (1) communications, (2) navigation, (3) automatic flight control, (4) environment, (5) instrumentation, (6) identification/air traffic regulation, (7) ground support equipment, (8) surveillance, (9) electronics countermeasures, and (10) fire control. Z.W.

A70-34726 # Application of the Floquet transition matrix to problems of lifting rotor stability. David A. Peters (McDonnell Douglas Corp., St. Louis, Mo.) and Kurt H. Hohenemser (Washington University, St. Louis, Mo.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 412.* 10 p. 10 refs. Members, $1.25; nonmembers, $2.00.

Description of a method of stability analysis for linear systems with periodically varying parameters. This method allows an easy

computation of stability measures of blade motions in forward flight. A Floquet transition matrix which relates the values of all state variables at the beginning and at the end of one period is computed by a number of numerical timewise integrations. The complex eigenvalue of the Floquet transition matrix with the absolute largest value provides a stability measure for the least stable mode. The developed algorithm is applied to the forward flight equations of motion of a lifting rotor with rigid flapping blades with and without elastic blade root restraint and with and without tilting moment and delta-3 feedback. The derived characteristics of the damping ratio for the least damped mode show for all cases studied that an advance ratio threshold exists beyond which damping deteriorates rapidly.
M.V.E.

A70-34727 A theoretical method for rotor blade flutter in forward flight. E. R. Wood (Georgia Institute of Technology, Atlanta, Ga.) and K. W. Shipman. *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 410.* 14 p. 7 refs. Members, $1.25; nonmembers, $2.00.

Presented is a theoretical method for determining rotor blade flutter in forward flight. The theory accounts for the unsteady aerodynamic contribution of the wake below the rotor. This is made possible due to certain simplifying assumptions of the authors regarding the rotor's wake at the onset of flutter. In particular, it is assumed at the onset of flutter that oscillations begin to build up prior to the blade reaching a critical azimuth position, then decay as the blade moves beyond this point. Based upon this a wake model is postulated and the theory developed. The resulting lift deficiency function is compared with that of Loewy and Theodorsen. It is shown in limiting cases that the work presented is consistent with earlier flutter theory. The theory is applied to bending-torsion flutter for the tip segment of a rotor blade. Here, beyond a certain value of advance ratio, the influence of advance ratio on flutter speed is found to be essentially constant. (Author)

A70-34728 Helicopter structural weight prediction and evaluation - Theory versus statistics. Henry G. Smith (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 401.* 13 p. 15 refs. Members, $1.25; nonmembers, $2.00.

Critical review of the usual statistical methods for helicopter weight prediction and evaluation, and consideration of the pitfalls whose avoidance is prerequisite to the successful application of these methods. Comparable weight prediction techniques utilized in the fixed-wing industry are discussed. A more general statistical equation form is proposed for helicopter weight prediction. A number of illustrative examples in regard to techniques of helicopter weight prediction and evaluation is presented and discussed with the objective of obtaining more meaningful comparative evaluations. Fundamental concepts of weight comparison are discussed, and the use of weight evaluation parameters relating directly to vehicle efficiency, or productivity, are recommended instead of the currently standard procedures. Weight trends and weight-growth sensitivity are also considered to be important factors in any weight evaluation. Available theoretical techniques that may be utilized as aids in preliminary design weight comparisons, whether now or in the future, are presented. The effects of differences in technology levels or in the performance base can be very large and must be accounted for in any preliminary design-weight evaluation. The adverse effects of increased size and gross weight are evident, other factors being equal.
M.V.E.

A70-34729 Noise radiation from helicopter rotors operating at high tip Mach number. Roger E. A. Arndt (Pennsylvania State University, University Park, Pa.) and Dean C. Borgman (U.S. Army, Aeronautical Research Laboratory, NASA Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 402.* 13 p. 22 refs. Members, $1.25; nonmembers, $2.00.

A review of the theories currently available for predicting the intensity of helicopter rotor noise indicates that contributions from compressibility and thickness effects are not generally considered. In the current effort, classical acoustic theory is used to predict the effects of these two additional noise sources on the overall noise level from helicopter rotors. The most recent helicopter noise theory, that of Lowson and Ollerhead, considers rotational noise to be the major contributor to the overall noise level. The noise spectra generated from this theory tends to underestimate the noise level in the higher sound harmonics. The current study indicates that some of the higher harmonics of helicopter rotor noise output are due mainly to drag divergence effects when the rotor is operating at high advancing tip Mach numbers. It was found that a more realistic prediction of the helicopter noise spectrum may be obtained through a combination of the results of the present work with the previous results of Lowson and Ollerhead. Spectra are predicted for both the uniform thickness rotor blade and a tapered thickness blade. As might be expected, the tapered thickness blade shows a substantial reduction in generated noise over the uniform thickness blade when both blades are assumed to be at the same operating conditions. Experimental data obtained from full scale wind tunnel tests are available for both types of blades. Better correlation is obtained between theory and experiment when compressibility and thickness effects are added to the rotational noise effects particularly at the higher harmonics. (Author)

A70-34730 * Metropolitan air transit system. A. E. Andreoli (Stanford University, Stanford, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 400.* 10 p. Members, $1.25; nonmembers, $2.00. Contract No. NSR-05-020-151.

Description of a metropolitan air transit system design which is feasible from the technical, economic, and utility points of view. The redundancy designed into the system and the reliability of the system components assure a more than adequate safety level along with all-weather dependability necessary in a computer transportation system. The design evolved by the team satisfied all the important constraints identified in the study such as noise, rapid handling of passengers, and economic sense. The economic feasibility of the system would be enhanced if the system were to be used in a number of metropolitan areas in the country and even around the world.
M.M.

A70-34731 An investigation of the need for improved displays in heavy-lift helicopters. Archie T. Sherbert, Jr. (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 432.* 8 p. 7 refs. Members, $1.25; nonmembers, $2.00.

Discussion of the cockpit display problems of present-day heavy-lift helicopters. Helicopters designed to transport large external loads have associated with them two types of display problems: (1) cockpit display problems which are common to present-day helicopters, regardless of size or mission; and (2) display problems which are peculiar to the external load-handling operations associated with heavy-lift helicopters. A review of these problems is followed by a description of an experimental program designed to assist in quantifying these problems and identifying feasible solutions. Thus, this program is to provide a data bank which can be used by engineers and human factor analysts to gain better understanding of helicopter display problems. This data bank will be available to substitute for expensive and time-consuming flight investigation of visual cues each time such information is required. Analysis of the film accumulated on this program is expected to provide information which can be used in support of crew station trade studies. Such studies will encompass aircrew station visibility and instrument panel layout.
M.V.E.

A70-34732 Night observation and weapon fire control system. Robert J. Walker (Emerson Electric Co., St. Louis, Mo.). *American Helicopter Society, Annual National Forum, 26th,*

Washington, D.C., June 16-18, 1970, Preprint 431. 8 p. Members, $1.25; nonmembers, $2.00.

Description of an attack helicopter fire control system with detection, recognition, and kill capabilities in day or night operation. Missions of the system are to include hunter-killer, armed escort, quick reaction rescue operations, perimeter patrol, route patrol, and area surveillance. The system's proven multimode radar, aided image intensifier, and armament subsystem are described in detail as are operational uses of the complete system. Added system modes for future applications are discussed. M.V.E.

A70-34733 Airborne and ground resonance of hingeless rotors. R. T. Lytwyn, W. Miao (Boeing Co., Vertol Div., Philadelphia, Pa.), and W. Woitsch (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 414.* 9 p. Members, $1.25; nonmembers, $2.00.

A hingeless rotor helicopter, with in-plane blade frequency less than rotor speed, is analyzed for its airborne and ground resonance characteristics. The analysis, which accounts for the fundamental blade and fuselage flexible modes as well as for the rigid-airframe modes of motion, uses the quasi-steady representation of aerodynamic forces in hover to show that hingeless rotors such as that of the BO-105 helicopter are stable, even at the resonant rotor speed nearest the operating range in the airborne state, because of inherent aerodynamic damping. Although not used by the BO-105 helicopter, the effects of cyclic feedbacks proportional to the airframe attitudes are explored. The analysis reveals that, if this type of feedback control is used for aircraft flight stability, the inherent aerodynamic damping of hingeless rotors is deteriorated. (Author)

A70-34734 Analytical study of helicopter rotor stall flutter. F. O. Carta, L. M. Casellini, P. J. Arcidiacono (United Aircraft Research Laboratories, East Hartford, Conn.), and H. L. Elman (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 413.* 20 p. 16 refs. Members, $1.25; nonmembers, $2.00. Grant No. DA-AJ-02-68-0048.

Attempt at developing a method for predicting the stall flutter response of a helicopter rotor blade. For this purpose, incompressible unsteady aerodynamic data for an NACA 0012 airfoil executing pure sinusoidal pitching motions were employed. To apply such data under rotor blade operating conditions where multiharmonic motions and velocity variations exist, the data were expressed as functions of instantaneous section angle of attack, angular velocity, and angular acceleration. In addition, scaling procedures were developed in an attempt to account for the effects of compressibility. Application of the resulting analysis to define the aeroelastic characteristics of several blade designs showed that significant self-excited torsional oscillations of the stall flutter type could be predicted for certain combinations of flight conditions and blade designs. Recommendations for further studies are presented. M.V.E.

A70-34735 Recent advances in helicopter vibration control. D. L. Kidd, R. W. Balke, W. F. Wilson, and R. K. Wernicke (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 415.* 13 p. 10 refs. Members, $1.25; nonmembers, $2.00.

Review of recent progress in the development of helicopter vibration reduction techniques. New insights into vibration control, revealed by advances in computation and 'datamation,' are reported, along with the development of the passive tetrapod focal-pylon isolation system derived from the earlier bipod system. The analysis, design, and testing of two successful active antivibration devices is discussed. Significant results are: (1) a demonstrated 30-knot increase in vibration-comfort crossover speed for the two-bladed rotor and a projected 50-knot increase from improved designs of the same antivibration devices; (2) new antivibration design rules for the fuselage and pylon resulting from the use of modern structural analysis techniques and improved instrumentation methods; and (3) a better understanding of the helicopter vibration problem offering significant improvements in test methods for loads and vibration. M.V.E.

A70-34736 New insights into the design of swept-tip rotor blades. W. A. Spivey (Bell Helicopter Co., Fort Worth, Tex.) and G. G. Morehouse (U.S. Army, Aeronautical Research Laboratory, NASA Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 420.* 14 p. 8 refs. Members, $1.25; nonmembers, $2.00.

The results of an exploratory program correlating wind-tunnel data with whirl-stand data are presented. The results show that modifying the tip of a rotor can improve performance. Three tip-shapes were tested in the USAARL 7 x 10-foot wind tunnel. Lift-drag data were taken at M = 0.17, and acenaphthene flow visualization was done at M = 0.29. Tip shapes geometrically similar to the wind-tunnel models were fabricated onto UH-1 tail rotors and tested on the USAARL whirl stand. Thrust-power data were taken through a range of tip Mach numbers from 0.30 to 0.72, and acenaphthene flow visualization was done at a tip Mach number of 0.54. Forward-flight data for an AH-1G HueyCobra main rotor with swept tips is also presented. It indicates power savings and noise-level reductions compared to data for a standard-tip rotor. A technique used to calculate the effects of tip sweep on forward-flight performance is presented, and its correlation with flight-test data is shown. (Author)

A70-34737 * A study of rotor blade-vortex interaction. Barnes W. McCormick, Jr. (Pennsylvania State University, University Park, Pa.) and Makam Surendraiah. *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 421.* 12 p. 14 refs. Members, $1.25; nonmembers, $2.00. Grant No. NGR-39-009-111.

An experimental and analytical study of the rotor blade-vortex interaction problem has been conducted under the auspices of the NASA Langley Research Center. Using miniature, flush mounted pressure transducers, time-dependent surface pressures were measured on a model rotor blade as it passed through a vortex generated by a fixed wing mounted upstream of the rotor. In addition to obtaining details of the chord-wise pressure distribution, the pressures were integrated to obtain the time-wise variation of the rotor section lift coefficients. The geometry of the test setup was varied in order to study the effect of such parameters as the distance of the vortex axis from the rotor plane, the angle at which the rotor blade intersects the vortex, the vortex size and strength, and the rotor rpm. Results of an approximate quasi-steady and unsteady two-dimensional analysis are compared with the measured section lift-coefficients. The significance of the findings of this study in relation to rotor noise is discussed. A brief sound movie has been made which permits the viewer to simultaneously observe both aurally and visually the results of the rotor blade intersecting the vortex. As the rotor is moved progressively nearer the vortex, the viewer observes the development of a sharp pressure spike on an oscilloscope and hears simultaneously the developing impulsive noise produced by the interaction. (Author)

A70-34738 Model testing to establish ditching and flotation stability characteristics of helicopters. John C. Kidwell (Bell Helicopter Co., Fort Worth, Tex.) and William A. Crago (British Hovercraft Corp., Ltd., East Cowes, Isle of Wight, England). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18, 1970, Preprint 474.* 20 p. Members, $1.25; nonmembers, $2.00.

Discussion of the development of modeling techniques, test

techniques, and facilities for establishing the ditching and flotation stability characteristics of helicopters. This work has been underway in England since 1954. These model investigations have been a part of both military and civil helicopter development programs. The modeling techniques are based on the scaling laws developed by William Froude, similar to the methods used by ship model experimenters. Test results from several representative configurations are presented. Hydrostatic stability is discussed analytically, together with application of the stability testing techniques. M.M.

A70-34739 * Helicopter rotor periodic differential pressures and structural response measured in transient and steady-state maneuvers. John F. Ward (NASA, Langley Research Center, Flight Mechanics and Technology Div., Hampton, Va.). *American Helicopter Society, Annual National Forum, 26th, Washington, D.C., June 16-18. 1970, Preprint 423.* 14 p. 13 refs. Members, $1.25; nonmembers, $2.00.

This paper summarizes a detailed review and analysis of recorded rotor blade differential pressure and structural load data for five maneuver flight conditions. The objective was to identify fundamental aerodynamic and structural response characteristics, if any, that could be specifically associated with limiting maneuver flight. The paper describes the test aircraft, instrumentation, data reduction technique, and presents a sample of the significant data in time-history form. The results indicate that the probable cause of the maneuver limitations was a wake-induced, torsional degree-of-freedom forced response. Leading-edge separation aggravated the problem and appears to define the limiting maneuver condition for acceptable operation. (Author)

A70-34773 Measurements in hotshot hypersonic wind tunnels (Mesures dans les souffleries hypersoniques à rafales brèves). J.-P. Chevallier and O. Leuchter (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *ONERA, TP* no. 823, 1970. 17 p. 13 refs. In French.

Review of various aspects of methods of measurement which are appropriate for hotshot hypersonic wind tunnels. These measurements involve forces, pressure, heat flow, and means of probing the heat flow, particularly in the presence of chemical reactions. Several examples are cited which were drawn from actual experience, where precise measurements were obtained in spite of the fact that the duration of the shot was limited to 100 or 200 msec. F.R.L.

A70-34774 Recent improvements in the O.N.E.R.A. ARC2 wind tunnel. Jean-Pierre Chevallier (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Supersonic Tunnel Association, Meeting, 33rd, Los Angeles, Calif., May 7, 8, 1970.) ONERA, TP* no. 827, 1970. 8 p. 6 refs.

Discussion of the results of experiments in which the performance of a wind tunnel was improved by applying a silastene coating to the arc chamber of the tunnel. The chamber design was simplified and the gas heating efficiency was increased when this technique was used in the ARC2 wind tunnel of the ONERA. 50-msec tests at temperatures from 7,000 to 8,000 deg K, with a greatly reduced amount of metal impurities, were carried out in this tunnel with a silastene-coated chamber. V.Z.

A70-34775 Continuous-variation measurement of a parameter in wind tunnels. J. M. Christophe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Supersonic Tunnel Association, Meeting, 33rd, Los Angeles, Calif., May 7, 8, 1970.) ONERA, TP* no. 828, 1970. 12 p.

Discussion of a theoretical basis and procedure for continuous-variation measurements of wind tunnel parameters minimizing the testing time. The application of this method is demonstrated by continuous measurements of flow characteristics while continuously varying the angle of attack of a tunnel-inserted body. The limitations of this method associated with filtering, speed of travel and inertia effects are discussed. The reduction of motive power requirements provided by this method when studying large-scale wind tunnels is noted. V.Z.

A70-34808 # Moving skin boundary layer control. William H. Bond (General Dynamics Corp., Convair Div., Huntsville, Ala.). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-881.* 11 p. 24 refs. Members, $1.25; nonmembers, $2.00.

Two test programs were conducted to establish the feasibility and the characteristics of boundary layer control on an airfoil achieved by moving the wetted surface in the streamwise direction. Small-scale smoke tunnel tests verified qualitatively that a significant increase in maximum lift coefficient is attainable. Larger-scale experiments with another model indicated that significant areas of thin skin can be moved at speeds high enough to be of interest in vehicle design. The power required to move the skin appears to be acceptably small, so that the viscous external drag may be sufficient to automatically move the skin in cruising flight. Under this condition, the viscous power dissipated by the treated wing surface may be reduced by nearly one-half. (Author)

A70-34809 # Manpowered flight, its purpose and future. W. Czerwinski (Toronto, University, Toronto, Canada). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-879.* 8 p. Members, $1.25; nonmembers, $2.00.

Discussion of the theoretical and practical possibility of further improvements of manpowered aircraft to such an extent that they could be classified as practical flying bicycles for competitions and other sporting activities, similar to the extent to which gliding has progressed in the post-war years. It is noted that, in view of recent advances in the design methodology and optimization techniques, as well as better understanding of low-density structures and availability of stronger and more rigid materials, it seems to be quite safe to predict that the third generation of manpowered aircraft will become practical flying machines suitable for use as popular sports vehicles. M.M.

A70-34810 # Prospects for improvement in efficiency of flight-propulsion systems. R. M. Denning and J. A. Hooper (Rolls-Royce, Ltd., Bristol, England). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-873.* 12 p. Members, $1.25; nonmembers, $2.00.

A broad survey of aircraft gas turbine propulsion trends is attempted, identifying the critical performance characteristics and indicating probable future improvements. Particular categories of propulsion system including those for V/STOL and supersonic transport aircraft are considered in more detail. Some discussion of special and multiple function powerplants is also included. Desirable engine characteristics for types of aircraft considered are discussed and problem areas identified. The powerplants are considered from the viewpoints of thermodynamics, noise and installation. Specific engine projects relevant to the survey are discussed. (Author)

A70-34811 # **Flight efficiency trends for the S.S.T.** H. A. Goldsmith (British Aircraft Corp., Bristol, England). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-871.* 10 p. Members, $1.25; nonmembers, $2.00.

Description of two approaches to improved overall flight efficiency: (1) major new discoveries or techniques - the breakthrough method; and (2) small to medium scale improvements to existing concepts or techniques - the development method. These two methods are illustrated by reference to the aerodynamic, propulsion and structural history of the Concorde, and their general significance for an SST is analyzed. A number of possible future lines of attack are outlined. M.M.

A70-34812 # **Aircraft operating procedure development using integral-variational performance analysis methods.** J. A. Thelander and J. H. Bernert (Douglas Aircraft Co., Long Beach, Calif.). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-876.* 13 p. 9 refs. Members, $1.25; nonmembers, $2.00. Research sponsored by the McDonnell Douglas Independent Research and Development Program.

The situations considered in this paper relate to general aspects of aircraft operation, both commercial and military. There are instances in each class of operation that involve dynamic flight conditions which may significantly affect overall mission performance and efficiency. Commercial-logistic aircraft require several transitional dynamic maneuvers in the course of a single flight while the mission profiles of high-performance tactical aircraft are likely to be predominantly dynamic. Development of efficient operating procedures for such nonsteady flight conditions involves integral-variational performance analysis and optimization methods. A review of such development with some illustrative examples is presented. (Author)

A70-34813 # **Improving the airplane efficiency by use of wing maneuver load alleviation.** Roland J. White (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-877.* 9 p. 5 refs. Members, $1.25; nonmembers, $2.00.

It is shown that by deflecting the wing flight controls in response to a change in airplane load factor the maneuvering flight loads may be reduced resulting in a wing weight saving. Five different maneuver load alleviation (MLA) configurations were studied for wing bending load relief on a large 700,000 lb. transport airplane. The effect of MLA on an extended wing span design was also investigated. Results show that the airplane studied could have its wing span increased 10% for the same wing weight if MLA were used. The corresponding airplane performance improvement is a 13% (10,000 lb.) increase in airplane payload. This design approach also appears attractive for growth versions of the airplane. Design considerations which must be recognized when using MLA are discussed, along with the use of the MLA system for active gust alleviation. Future use of MLA may be expected. The resulting performance benefits may pave the way for the use of flight controls for active gust alleviation and direct lift control. None of these systems provide an attractive design unless their design is kept fundamental and simple. (Author)

A70-34814 # **Prospects for increased performance of sailplanes.** David J. Marsden (Alberta, University, Edmonton, Alberta, Canada). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-878.* 6 p. 8 refs. Members, $1.25; nonmembers, $2.00.

Variable geometry in the form of high lift flaps has been proposed as a means of increasing the overall cross-country speed of a sailplane by providing a better compromise between cruise and climb performance. This paper gives an analysis of the parameters affecting a sailplane's cross-country performance, considering the operational requirements, with particular reference to the use of high lift flaps. The results show that a substantial increase in the effective cross-country speed could be obtained without increasing the size and cost beyond that of present day sailplanes. (Author)

A70-34815 # **Improved aeronautical efficiency through packable weightless wings.** John D. Nicolaides (Notre Dame, University, Notre Dame, Ind.). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-880.* 7 p. 9 refs. Members, $1.25; nonmembers, $2.00.

New wings now exist which contain no rigid members and are made entirely of nylon cloth. They are near weightless. These wings can be packed and deployed like a parachute, but they can also glide and soft land like a bird; and they can be powered and flown like an airplane. Improved aircraft efficiency may be obtained by the air delivery of cargo along route by utilizing this deployable, gliding and controllable system. Pilot recovery and premeditated jumping in all weather and in all winds, with safe landings at distant selected locations may now be accomplished. Of particular importance is the land recovery of rocket boosters, spacecraft, and disabled aircraft or helicopters. Powered deployable flight systems for the stand-off delivery of cargo and weapons have been demonstrated and a new 'Flying Buggy' for general aviation is now designed and constructed. (Author)

A70-34816 # **Improved airplane performance through advanced flight control system design.** Lewis H. Pasley and Gerald J. Kass (Boeing Co., Wichita, Kan.). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-875.* 10 p. Members, $1.25; nonmembers, $2.00.

An assessment of the potential airplane performance improvements that are possible by application of advanced flight control technology is presented. The concept of providing a more efficient airplane by considering the flight control system during the initial design phases has been referred to as Controls Configured Vehicles (CCV) technology. This technology includes such concepts as ride quality control, flutter margin control, maneuver load control, and relaxation of inherent static stability requirements. These concepts can be utilized to decrease the weight and drag, thereby improving the vehicle performance. This paper examines the performance improvements that can be realized by application of one of the CCV concepts, relaxation of the inherent static stability requirements. By relaxing this requirement, (which usually sizes the tail surfaces) and sizing the surfaces by control considerations, the tail surfaces are smaller with resulting performance improvements. The effective static stability is provided by a stability augmentation system. A long range subsonic bomber is utilized as a basis for demonstrating the potential performance improvements. (Author)

A70-34817 # **Performance advantages offered by advanced flight control technology.** Robert P. Johannes (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in*

Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-874. 6 p. Members, $1.25; nonmembers, $2.00.

Inclusion of flight control technology early in the configuration development phase of new aircraft can result in significant reduction in structural weight and improved aerodynamic efficiency. The extension of control system functions to include inherent aircraft stability augmentation, active flutter control, maneuver load control, and active ride control, in addition to normal maneuvering control and handling qualities augmentation, can provide these advantages. In order to validate these potential benefits a series of analytical studies have been conducted applying advanced control functions to various existing and projected aircraft. The results of these efforts will be discussed in terms of weight savings which can be achieved. (Author)

A70-34818 # **Predictions of the blowing required to suppress separation from high-lift aerofoils.** I.S. Gartshore (British Columbia, University, Vancouver, Canada). *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-872.* 10 p. 13 refs. Members, $1.25; nonmembers, $2.00.

This paper gives a review of methods for predicting the streamwise development of boundary layers augmented by tangential blowing; typical results obtainable by one of these methods are presented and problems which remain to be solved are outlined. From the results it appears possible to predict the development of blown boundary layers up to separation with reasonable accuracy provided the boundary layer upstream of the blowing slot is not too large, and provided wakes are not shed from upstream sections. Calculations of the minimum power required for blowing to suppress separation show that significant savings can be made if two slots are used with correct blowing velocities from each. A simple criteria has been found which suggests when a minimum will persist in the velocity profile downstream of a blowing slot due to incomplete mixing of the upstream boundary layer with the jet fluid. (Author)

A70-34819 # **A preliminary estimate of airframe cost effectiveness in the 1980's.** Claude E. Burrell. *Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Meeting on the Prospects for Improvement in Efficiency of Flight, Toronto, Canada, July 9, 10, 1970, AIAA Paper 70-870.* 16 p. 34 refs. Members, $1.25; nonmembers, $2.00.

This paper presents an approach to the selection of new materials for cost effectiveness in future airframe applications. Projections for the 1980's are provided. Potential weight ratios are derived by using simple structural criteria in conjunction with estimated material properties. A fundamental approach to costing is outlined. Material costs are shown to be related to annual production volume. Vehicles are treated as premium-type materials. Detailed costs are estimated for several materials considered. Adjustments for year of production and of production qualities are incorporated. These data are then combined with the weights forecasts to obtain the weight-cost relationships. The materials mix is indicated. The data indicates a large growth of the use of composites. This comparative method is intended to be of assistance in selecting the elements of an R and D program. As such, it provides information prior to actual experience from which statistical estimates are derived. (Author)

A70-34915 **Aircraft development and world aviation growth (Sir Charles E. Kingford-Smith Memorial Lecture).** J. E. Steiner (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Aeronautical Journal,* vol. 74, June 1970, p. 433-443.

Survey of the development of world aviation from the viewpoint of technical progress and its influence on commercial aspects. Investment risks associated with modern aircraft development programs are examined, and factors affecting profits and costs in airline operations are evaluated. Fare histories are traced on North Atlantic and Pacific routes, and the possibility of further reductions in prices is considered. T.M.

A70-34916 **The MRCA project.** B. O. Heath (British Aircraft Corp., Ltd., Preston, Lancs., England). *Aeronautical Journal,* vol. 74, June 1970, p. 444-455; Discussion, J. R. Morgan, N. W. Boorer, and T. O. Williams (British Aircraft Corp., Ltd., Preston, Lancs., England), p. 455, 456.

Description of the background pressures which generate a need for a multirole combat aircraft (MRCA), and outline of the international factors which have influenced the development programs in Europe. Emphasis is placed on the British efforts conducted in cooperation with the French. The recent history of the development programs is outlined, including the rationalization and the accommodation of a wide range of operational requirements based on the use of variable sweep and a good thrust-to-weight ratio. Avionic versatility is considered, and attention is given to the high degree of commonality envisioned for the aircraft, the avionics, and the weapons system generally. Some formal arrangements of the official and industrial management networks which control the whole project are also illustrated. T.M.

A70-34917 **Economics of propulsion systems for air transport.** David Huddie (Rolls-Royce, Ltd., Derby, England). *Aeronautical Journal,* vol. 74, June 1970, p. 457-466; Discussion, p. 466-468.

Survey of factors affecting the financial success of research and development projects for new propulsion systems in air transportation. Reasons for new powerplants are considered along with the contributions made by powerplant efficiency and size to aircraft operating economics. Maintenance costs are analyzed covering such subsidiary aspects as parts cost, maintenance labor, overhaul, maintainability, reliability, resistance to ingestion damage, and salvage and repair. Effects of engine reliability on traffic delays are treated. T.M.

A70-34919 **The external aerodynamics of hovercraft.** E. J. Andrews (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal,* vol. 74, June 1970, p. 472-482; Discussion, R. W. Dyke and R. B. Stratton, p. 482.

Description of a research program involving external aerodynamics and its role in the handling qualities of amphibious hovercraft. The work involves the isolation of interacting aerodynamic, hydrodynamic, and air cushion effects. Test programs were conducted in three phases involving: (1) solid models affording a parametric study of the effect of hull shapes, (2) solid models with controlled air cushion efflux, and (3) hollow models and independently controlled air induction and cushion efflux systems. Some test results are presented graphically, and it is concluded that the handling problems will not be solved by refinement in configuration design. The problems will be overcome by providing the vehicle with force and moment producing devices of sufficient magnitude. T.M.

A70-34923 **A non-linear solution to a tab-aileron flutter problem.** D. L. Birdsall (Bristol, University, Bristol, England). *Aeronautical Journal,* vol. 74, June 1970, p. 509-512.

Discussion of a design problem which arose in part due to a change in the role of an aircraft which was already in production. A jet trainer was to be fitted with under wing pylons on which was to be carried a selection from a total of eleven external stores including

fuel tanks, mini-guns, rocket pods, and bombs. The problem involved a suitable choice of balance masses for ailerons and spring tabs which would ensure flutter free operation whatever the store configuration (including no stores) throughout the velocity-altitude envelope. Design solutions are outlined. T.M.

A70-34924 Cumulative damage problems in aircraft structures and materials (Second F. J. Plantema Memorial Lecture). J. Schijve (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *Aëronautical Journal,* vol. 74, June 1970, p. 517-532. 40 refs.

Discussion of the performance of fatigue tests for both design studies and for proving the fatigue quality of a new aircraft structure. Results of a recent investigation on crack propagation under flight simulation loading are presented, and fatigue damage and interaction effects are defined. These data serve as a background for understanding the empirical trends and related information from the literature. T.M.

A70-34975 # A three-dimensional hypersonic viscous interaction. F. X. Hurley (McDonnell Douglas Research Laboratories, St. Louis, Mo.). *ASME, Transactions, Series E - Journal of Applied Mechanics,* vol. 37, June 1970, p. 467-474. 20 refs.

The displacement-interacting boundary layer in the symmetry plane region of a flat hypersonic delta wing is studied through a method of control volume balances for mass, momentum, and energy. Free-parameter-bearing expressions for the velocity components, density, and boundary-layer thickness are postulated and substituted into the integral balance equations. The resulting algebraic system for the free parameters is a very complicated one, but solutions are readily extracted by means of iterative machine computations. Answers for the assumed set of flight conditions indicate that the inboard drift of boundary-layer fluid from both sides gives rise to a center-plane region which is three-dimensional in character and which exhibits increased boundary-layer thickness, elevated pressures, and reduced skin-friction and heat-transfer coefficients. (Author)

A70-34992 VAK 191 B (VAK 191 B). Hans Brenner. *Flugrevue/Flugwelt International,* July 1970, p. 32-37. In German.

Discussion of the VAK 191 B VTOL reconnaissance-fighter aircraft, the first prototype of which was completed in April 1970. The craft was developed according to the 1961 NATO Basic Military Requirements (NBMR. 3) for a low-level fighter/reconnaissance aircraft, as a further development of the Fiat G. 91 with V/STOL characteristics. The craft is cantilever shoulder-wing semimonocoque failsafe structure employing a tandem-type landing gear with single nose wheel and zero-track twin main wheels. It is powered by two Rolls-Royce MTU RB 162-81 lift jet engines and one Rolls-Royce MTU RB 193-12 engine. Specifications and illustrations of the aircraft are presented. V.P.

A70-34993 The digital computer and its use in modern aircraft. II. (Der digitale Rechner un seine Verwendung in modernen Flugzeugen). P. A. Hearne (Elliott Flight Automation, Ltd., Rochester, Kent, England). *Flugrevue/Flugwelt International* July 1970, p. 57, 58. In German.

Discussion of the impact of computer technology on the designing of advanced aircraft required to operate over an ever increasing operational spectrum. Current digital concepts and systems were discussed in Part I, with particular reference to the airborne computer. Part II compares the characteristics of distributed and lumped computer systems, and examines outer loop control, engine control, and system integrity. V.P.

A70-35034 * Hypersonic viscous flows. Arthur Henderson, Jr. (NASA, Langley Research Center, Flow Analysis Section, Hampton, Va.). In: Modern developments in gas dynamics. Edited by W. H. T. Loh. New York, Plenum Press, 1969, p. 83-129. 77 refs.

Analysis of the pressure-induced problem of the hypersonic viscous flow for a two-dimensional case. A brief consideration of the correlation parameters involved is presented. The closed-form local-similarity solutions are obtained. The parameters influencing the boundary layer transition under the hypersonic regime are reviewed. The current understanding of the boundary layer transition phenomenon is assessed. The problem concerning the turbulent boundary layer is examined including the effect of wall-temperature ratio, methods of locating the virtual origin, and transformation of the compressible boundary layer profiles. Z.W.

A70-35035 * Hypersonic gas dynamics of slender bodies. H. K. Cheng (Southern California, University, Los Angeles, Calif.). In: Modern developments in gas dynamics. Edited by W. H. T. Loh. New York, Plenum Press, 1969, p. 131-182. 68 refs. Grant No. NGL-05-018-044.

Survey of the current work on theoretical gas dynamics associated with hypersonic flow past slender bodies. The inviscid hypersonic flows and related problems are reviewed. The problem of the outer-edge singularity of a hypersonic boundary layer and its relation to external vorticity and shock-heating effects is delineated. A number of recent works on needle-like bodies in viscous hypersonic flow, and a formulation of the three-dimensional interaction problem, are reviewed. Z.W.

A70-35047 Near wakes of dihedra placed at an angle of attack in a hypersonic rarefied gas flow (Proche sillage de dièdres placés en incidence dans un écoulement hypersonique de gaz raréfié). Jean Allègre and Christian Matrand (CNRS, Laboratoire d'Aérothermique, Meudon, Hauts-de-Seine, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 270, no. 24, June 15, 1970, p. 1630-1633. In French.

Experimental study of certain flow phenomena involving dihedra placed in hypersonic rarefied gas flows. By recording base pressures and by systematic study of the wakes produced by these dihedra, both qualitative and quantitative results are obtained concerning the base flow and the near wakes of dihedra placed at an angle of attack in a hypersonic rarefied gas flow. Certain results formulated during previous studies are verified and supplemented, and the evolution of the structure of flows at lower Reynolds numbers than those previously considered is demonstrated. A.B.K.

A70-35157 # Development of a low-mass flow, high temperature, high-pressure, continuous-source hot-gas facility. Allen A. Otte (Honeywell, Inc., Minneapolis, Minn.). In: The environmental challenge of the 70's; Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., April 12-16, 1970, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1970, p. 92-95.

Discussion of a high-temperature high-pressure source of hot gas, developed for simulating turbine inlet conditions of present and future generation gas turbine engines. The source, devised for use in the development, testing, and calibration of a fluidic temperature sensor, will generate and measure accurately the temperature of hot gas over a range of temperatures between 70 and 3000 deg F and pressures ranging from 10 to 500 psig. It will also hold a set point within minutes, so that a multipoint calibration can be performed on a temperature sensor within a single working day. Design specifications of the hot-gas facility are examined. V.P.

A70-35159 # **Improved test procedure for evaluation of humidity resistance of airborne aeronautical equipment.** I. B. Blackman (General Dynamics Corp., New York, N.Y.). In: The environmental challenge of the 70's; Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., April 12-16, 1970, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1970, p. 102-107. Contract No. AF 33(657)-13403.

Discussion of the mechanics of formation and accumulation of water in airborne aeronautical equipment, resulting from operation in a moist tropical environment. The aim of this discussion is the development of a test procedure designed to assess the ability of equipment to resist exposure to such environments. It is recommended that current procedures be revised to simulate the significant conditions of actual flight in a humid tropical environment by subjecting the specimen to typical profiles of varying ambient pressure and temperature in a near-saturated atmosphere. The procedure must also provide for functional evaluation of the specimen while under stress, with no drying permitted. V.P.

A70-35177 # **Air pollution by airports.** Nevil Milford, Gerard C. McCoyd, Leonard Aronowitz, and Joseph H. Scanlon (Grumman Aerospace Corp., Bethpage, N.Y.). In: The environmental challenge of the 70's; Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., April 12-16, 1970, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1970, p. 448-460. 17 refs.

Study of the significance of air pollution produced by airports for the surrounding communities. A brief outline of airport pollution relative to total urban pollution is given. Some of the earlier studies are discussed, as well as public and legal activities. A program was initiated to develop a dispersion model for airports. This model employs data on the airport pollution sources to calculate the concentration of pollutants as a function of position relative to the airport for various meteorological conditions. As a result of these calculations, and the earlier work by others, it is possible to determine just what additional data and studies are required to provide a thorough understanding of the problem. F.R.L.

A70-35178 * # **Heave dynamics of tracked air-cushion vehicles.** Jack D. Leatherwood (NASA, Langley Research Center, Hampton, Va.). In: The environmental challenge of the 70's; Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., April 12-16, 1970, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1970, p. 461-467. 8 refs.

This paper presents the results of an analytical investigation to determine the basic heave response characteristics of a tracked air-cushion vehicle as a function of parametric variations of vehicle operating parameters. Results are also presented to demonstrate the feasibility of controlling vehicle heave response by the use of an active lip control system. Nonlinear equations describing the dynamic and thermodynamic state of the air-cushion system are derived and solved with the use of an analog computer. Results indicate that the air-cushion vehicle responses are highly nonlinear and depend upon such parameters as equilibrium hover height, air-cushion support pressure, supply flow characteristics, cushion dead volume, and input disturbance amplitudes. They further indicate that vehicle-guideway contact may readily occur for small input disturbances and that active lip control is very effective in eliminating the possibility of contact and in reducing undesirable vehicle responses. (Author)

A70-35180 # **A method for predicting forcing functions for structures being tested in a shock tube.** D. C. Bickel, W. B. Leisher, and M. G. Vigil (Sandia Laboratories, Albuquerque, N. Mex.). In: The environmental challenge of the 70's; Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., April 12-16, 1970, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1970, p. 486-490. 5 refs. AEC-supported research.

Discussion in which the aerodynamic parameters of the shock tube are related to terms allied to mechanics, thereby providing the engineer who is not familiar with shock tube terminology with a better understanding with which to approach the subject of shock tube testing. An example is given by applying the flow conditions from a specific shock tube to generalized shapes obtaining a set of functions that are directly equatable to force time histories. The method suggested could be applied to any shock tube. M.M.

A70-35183 **Repeatability of ground-test noise measurements on an aircraft engine.** Howard A. Thorpe (Rohr Corp., Chula Vista, Calif.). *Acoustical Society of America, Journal,* vol. 47, June 1970, pt. 1, p. 1485.

Review of the accuracy and repeatability of the ground-test noise measurements on a JT8D turbojet engine. These tests were performed as a part of a noise-suppression hardware development program. Some independent evidence regarding accuracy and results of repeatability measurements are presented. The principal acoustical effects of elevating the microphones and engine are discussed briefly. Also data acquisition and processing techniques are indicated. M.V.E.

A70-35184 **An IR NDT bond inspection system for rotor blade honeycomb box assemblies.** A. J. Intrieri (Boeing Co., Vertol Div., Philadelphia, Pa.). *(American Society for Nondestructive Testing, National Fall Conference, 28th, Detroit, Mich., Oct. 14-17, 1968.) Materials Evaluation,* vol. 28, July 1970, p. 153-156, 161.

Discussion of an infrared nondestructive testing system for the bond inspection of honeycomb box assemblies for helicopter rotor blades. The system, presently being used in production, is essentially a closed-circuit, slow-scan video system that provides a rapid, contamination-free method for detecting bondline voids. The system generates and displays a television-like presentation of the normally invisible IR energy emanating from the test specimen, identifying any voids as dark or cool spots. G.R.

A70-35185 **At the crossroads in air-traffic control. II.** Gordon D. Friedlander. *IEEE Spectrum,* vol. 7, July 1970, p. 69-83. 5 refs.

Discussion of various aspects of air-traffic control taking into account present systems and FAA's plans for this decade. An instrument-landing system for precision instrument approaches is discussed. Approach lighting systems, air-traffic control towers, and related facilities are considered. Transmissometer facilities for runway visual range are examined and NAVAIDS for nonprecision instrument approaches are described. Plans for collision-avoidance systems and the principles of operation of these systems are discussed. A radar microwave link system, long-range radars, and a positive-control airspace are considered and a glimpse of some ATC equipment for foreign installations is given. G.R.

A70-35190 # **Influence of the flexural deformability of wings on the longitudinal stability of a glider (Wpływ odkształcalności giętnej skrzydła na stateczność podłużna szybowca).** Jerzy Maryniak and Marwan Lostan (Warszawa, Politechnika, Warsaw, Poland). *Mechanika Teoretyczna i Stosowana,* vol. 8, no. 2, 1970, p. 137-148. 11 refs. In Polish.

Study of the influence of the flexural deformability of wings on the longitudinal stability of a glider, using small perturbation theory. The three degrees of freedom corresponding to glider motion in the vertical plane are taken into account along with supplementary degrees of freedom associated with the influence of flexural deformability. The equations of motion are given in the form of a system of second-order ordinary differential equations with constant

coefficients. Numerical calculations were conducted for a competition glider with allowance for the first flexural mode of the wings and three degrees of freedom of a rigid glider. T.M.

A70-35194 # **Applications of aerospace technology to air pollution problems.** Robert F. Sawyer (California, University, Berkeley, Calif.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 5th, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-815.* 14 p. 5 refs. Members, $1.00; nonmembers, $1.50.

A strong overlap exists between aerospace technology and aeropollution technology which suggests possible applications of aerospace technology to air pollution problems. Air pollution problems should be identified on the basis of the pollutant, the size of the air volume over which it acts, and the source. A productive and necessary area for application of aerospace technology is to the aerospace sources of air pollution. Present and potential sources are: (1) turbojet aircraft - takeoff, landing, and ground operations, (2) turbojet aircraft - high altitude operations, (3) possible use of metals in aircraft fuels, and (4) rocket emissions. Other promising areas include atmospheric modeling and applications of aerothermochemistry to combustion control. (Author)

A70-35195 # **Free-flight wind tunnel test of hypersonic decelerators.** William J. Burns (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 5th, Tullahoma, Tenn., May 18-20, 1970, Paper 70-587.* 12 p. Members, $1.00; nonmembers, $1.50. USAF-supported research.

A free-flight wind tunnel test program at Mach 6 was conducted at Arnold Engineering Development Center to determine the feasibility of deploying a hypersonic drogue on a telescopic boom into the wake of a reentry vehicle. Drag and stability data were obtained for several drogue configurations in which drogue diameter, drogue cone half-angle, drogue boundary layer bleed area, and drogue deployment distance were varied. A description of the model assemblies, model launcher, and model catcher, and a discussion of the dynamic scaling analysis are given. The data reduction technique is described, and typical test results are presented for two drogue configurations. (Author)

A70-35201 International Symposium on Space Technology and Science, 8th, Tokyo, Japan, August 25-30, 1969, Proceedings. Edited by Akira Takano. Tokyo, AGNE Publishing, Inc., 1969. 1208 p. $40.

Contents:

Foreword. A. Takano, p. i.
Opening address. T. Hayashi, p. vii, viii.

Special lecture.
Apollo - Steps to the moon. G. E. Mueller (NASA, Washington, D.C.), p. 3-18.

General lectures.
Rockets for research - A description of the use of small rockets by Langley Research Center to extend research capability. H. A. Wilson, Jr. and R. L. Wright (NASA, Langley Research Center, Hampton, Va.), p. 21-31. 7 refs.
ESRO - Organization and programme. W. J. Kleen (ESRO, Noordwijk, Netherlands), p. 33-50.
Japanese sounding rocket program 1967-1969. F. Tamaki (Tokyo, University, Tokyo, Japan), p. 41-62.
The United Kingdom National Space Programme. J. E. Twinn (Royal Aircraft Establishment, Farnborough, Hants., England) and B. G. Pressey (Science Research Council, London, England), p. 63-70.

Propellants and propulsion.
Thrust magnitude control of solid rocket motors - Characteristic analysis and small motor tests. T. Godai and Y. Yuzawa (National Aerospace Laboratory, Tokyo, Japan), p. 73-80. 13 refs.

On the combustibility of aluminum particles in the deflagration zone of ammonium perchlorate-copper chromite-aluminum pellets. K. Kishi (Daicel Co., Tokyo, Japan) and K. Yamazaki (Tokyo, University, Tokyo, Japan), p. 81-88. 7 refs.
Combustion of propellant under spin acceleration. T. Nagaoka, K. Ito, and T. Koreki (Nissan Motor Co., Ltd., Tokyo, Japan), p. 89-96. 8 refs.
Combustion phenomena in space vehicle environments. V. A. Dorr and H. R. Schreiner (Ocean Systems, Inc., Tarrytown, N.Y.), p. 97-101. 8 refs.
Survey on a ten years research work in rocket propulsion. O. P. Lutz (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany), p. 103-120. 64 refs.

The uses of a real time computer in nuclear rocket engine testing. J. B. Henshall (California, University, Los Alamos, N. Mex.), p. 121-130.
Quantum electronic space vehicle. S. Seike (Japanese Information Center of Scientific Technology, Uwajima, Japan), p. 131-137. 15 refs.
Proposed process of metallic fuels. W. Ishibashi (Iwatani and Co., Ltd., Osaka, Japan) and J. Sakurada (Iwatani Chemical Industry Co., Ltd., Osaka, Japan), p. 139-144
Micro and mm waves attenuation caused by small amount of metals with low ionization potentials in rocket exhausts. M. Taira (Japan Defense Agency, Tokyo, Japan), p. 145-152.

Effects of ammonium perchlorate filler fraction on relaxation modulus and failure mechanisms of composite propellant. T. Kunio (Keio University, Tokyo, Japan), M. Takashi (Aoyama University, Tokyo, Japan), Z. Ueno (Nissan Motor Co., Ltd., Tokyo, Japan), and K. Hara, p. 153-164. 10 refs.
156 inch diameter solid propellant rocket motors - Past, present and future. H. W. Ritchey (Thiokol Chemical Corp., Bristol, Pa.), p. 165-171. 7 refs.
Colloid thruster technology '69. E. Cohen (TRW Systems Group, Redondo Beach, Calif.), W. C. Burson, Jr., and P. C. Herren, Jr. (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), p. 173-188.
Some problems of formation of space vehicle booster control systems with parametric invariance. B. N. Petrov, N. I. Sokolov, and N. B. Sudzilovsky, p. 189-198. 7 refs.

Materials and structures.
Temperature dependency of cut growth process in viscoelastic materials. T. Kunio (Keio University, Tokyo, Japan) and M. Takashi (Aoyama-Gakuin University, Tokyo, Japan), p. 201-210. 17 refs.

A study on defect and strength of viscoelastic materials. T. Kunio (Keio University, Tokyo, Japan), M. Takashi (Aoyama University, Tokyo, Japan), T. Nagaoka, K. Shirota (Nissan Motor Co., Ltd., Tokyo, Japan), and H. Fukase, p. 211-216. 15 refs.

An analysis of adhesive debonding in case-bonded solid propellant rocket motors. T. Kunio (Keio University, Tokyo, Japan) and M. L. Williams (Utah, University, Salt Lake City, Utah), p. 217-222. 11 refs.
Response of metal and non-metals under high strain rates. R. F. Rolsten and E. G. Bodine, p. 223-244. 14 refs.

Optimum structural design based on reliability analysis. J-N. Yang, E. Heer (California Institute of Technology, Pasadena, Calif.), and M. Shinozuka, p. 245-258. 5 refs.
On the buckling loads and postbuckling behavior of curved panels under axial compression. T. Hayashii and K. Kondo (Tokyo, University, Tokyo, Japan), p. 259-268.
A simple, practical method for the experimental determination

of the end fixity of a column. W. H. Horton, J. I. Craig (Georgia Institute of Technology, Atlanta, Ga.), and D. E. Struble, p. 269-280. 9 refs.

A theoretical and experimental study of supersonic panel flutter of circular cylindrical shells. Y. Matsuzaki (National Aerospace Laboratory, Tokyo, Japan) and S. Kobayashi (Tokyo, University, Tokyo, Japan), p. 281-290. 17 refs.

Interlaminar shear stress distribution in a filament wound plate. T. Hayashi (Tokyo, University, Tokyo, Japan) and S. Sando, p. 291-302. 13 refs.

An analogy between beams supported by one-and-two elastic layers. C. Del Rio (Universidad Nacional de Ingeniería, Lima, Peru), p. 303-308.

Expandable structures for space applications. M. I. Yarymovych (USAF, Office of Assistant Secretary of the Air Force for Research and Development, Washington, D.C.) and F. W. Forbes (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), p. 309-326.

Flight dynamics and astronautics.

Minimum-impulse orbital transfer with a fixed time. N. Sannomiya and Y. Nishikawa (Kyoto University, Kyoto, Japan), p. 329-339. 9 refs.

Interplanetary low-thrust mission design via Chebychev optimization methods. D. W. Hahn, F. T. Johnson, and B. F. Itzen (Boeing Co., Seattle, Wash.), p. 341-348. 11 refs.

Some problems in astroelasticity - Dynamics and control of flexible space vehicles and spacecraft. Y-Y. Yu, p. 349-358. 13 refs.

Dual-spin satellites considered as deformable gyrostats. P. Y. Willems (California, University, La Jolla, Calif.), p. 359-369. 15 refs.

Differential correction and quasilinearization. A. D. Dayton (USAF, Applied Mathematics Div., Arlington, Va.), p. 371-375.

Aerodynamics.

Flow visualization of shock waves induced by a secondary gas injection by the use of conical lens. T. Yamanaka (National Aerospace Laboratory, Tokyo, Japan), p. 379-389. 21 refs.

Effect of nose bluntness on aerodynamic characteristics of flared body at supersonic speed. T. Tani, I. Kawamoto, S. Sakakibara, and J. Noda (National Aerospace Laboratory, Tokyo, Japan), p. 391-397. 8 refs.

High enthalpy nozzle flow with heat exchange. Y. Aihara (Tokyo, University, Tokyo, Japan) and Y. Watanabe (National Aerospace Laboratory, Tokyo, Japan), p. 399-406. 10 refs.

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Experimental study of the hypersonic rarefied gas flow past a flat plate and around a cylinder. Y. Kobayashi (Tokyo, University, Tokyo, Japan), p. 429-437. 31 refs.

Thermal decomposition of plastics with surface re-radiation. T. Fujiwara (Nagoya University, Nagoya, Japan), p. 439-446. 6 refs.

Shock tube flow of a chemically relaxing gas. M. Yasuhara, S. Taki, and T. Fujiwara (Nagoya University, Nagoya, Japan), p. 447-454. 6 refs.

Continuum normal shock structure by perturbation methods. M. B. Hammond (North American Rockwell Corp., Downey, Calif.) and P. R. Choudhury (Southern California, University, Los Angeles, Calif.), p. 455-464. 12 refs.

The structure of shear-turbulence in the presence of a transverse magnetic field. P. S. Lykoudis (Purdue University, West Lafayette, Ind.), p. 465-474. 20 refs.

Aerospace environment.

Experimental study of underexpanded jet expanding into vacuum. K. Oshima and Y. Kobayashi (Tokyo, University, Tokyo, Japan), p. 477-479.

The pumping system of the ultra-high vacuum space environmental chamber. J. Asai, T. Sasaki (Ministry of Posts and Telecommunications, Tokyo, Japan), H. Nakagawa, and R. Tsunoda (Japan Oxygen Co., Ltd., Kawasaki, Japan), p. 481-490. 6 refs.

Improved solar simulators using water-cooled 30 kw xenon arc lamps. K. Tsujimoto and Y. Nakamura (Ushio Electric, Inc., Tokyo, Japan), p. 491-498.

Nonlinear three-nodes analysis for thermal design of a spinning spherical satellite. M. Furukawa (Ministry of Posts and Telecommunications, Tokyo, Japan), p. 499-508. 7 refs.

Prediction of temperature distribution in satellite. M. Kobayashi, S. Kato, S. Aoki, K. Uzawa, and H. Ono (Nippon Electric Co., Ltd., Tokyo, Japan), p. 509-513.

Optimization of shape and coating pattern of spacecraft. K. Oshima (Tokyo, University, Tokyo, Japan) and Y. Oshima (Ochanomizu Women's University, Tokyo, Japan), p. 515-520.

Spacecraft and rockets.

Scientific mission for a helio-stationary spacecraft - Synchronous planet. T. Obayashi (Tokyo, University, Tokyo, Japan), p. 523-525.

Capabilities of M-4SS launch vehicle for future space research. R. Akiba (Tokyo, University, Tokyo, Japan), p. 527-531.

Concept of a helio-stationary spacecraft. M. Nagatomo and H. Matsuo (Tokyo, University, Tokyo, Japan), p. 533-538.

The Black Arrow launching vehicle. J. E. Twinn (Royal Aircraft Establishment, Farnborough, Hants., England), p. 539-545.

The Black Arrow X3 spacecraft. H. J. H. Sketch (Royal Aircraft Establishment, Farnborough, Hants., England), p. 547-556.

'Bora-Sond' - Upper atmosphere sounding vehicle for supersonic transport (SST) application. G. A. Partel (Centro Studi Trasporti Missilistici, Rome, Italy), p. 557-563.

The biosatellite program. M. Morton (General Electric Co., Valley Forge, Pa.), p. 565-580.

The R-4D - A multi-application rocket engine for spacecraft reaction control. D. A. Moberg (Marquardt Co., Van Nuys, Calif.), p. 581-592. 7 refs.

Titan III launch vehicles. D. S. Levine (Martin Marietta Corp., Denver, Colo.), p. 593-602.

The Delta story - Evolution of a universal space research launch vehicle. E. W. Bonnett (McDonnell Douglas Astronautics Co., Santa Monica, Calif.) and W. R. Schindler (NASA, Goddard Space Flight Center, Greenbelt, Md.), p. 603-628.

The Apollo docking system. K. A. Bloom and G. E. Campbell (North American Rockwell Corp., Downey, Calif.), p. 629-640.

Apollo ordnance systems. C. H. Lowry (North American Rockwell Corp., Downey, Calif.), p. 641-651.

Technical results of the sky-mapping experiment onboard the Orbiting Astronomical Observatory. Y. Nozawa (Smithsonian Astrophysical Observatory, Cambridge, Mass.), p. 653-660.

Space electronics.

Measurement of a weak, noise-like signal power by an intensity interferometer. N. Morinaga, H. Osawa, and T. Namekawa (Osaka University, Osaka, Japan), p. 663-672. 5 refs.

Frame synchronization in bi-orthogonal coded multiplex communication system. T. Nomura, Y. Yasuda (Tokyo, University, Tokyo, Japan), and A. Fukuda, p. 673-679.

A narrow band television system with non-mechanical shutter.

N. Niwa (Tokyo, University, Tokyo, Japan) and T. Hiruma (Hamamatsu TV Co., Ltd., Hamamatsu, Japan), p. 681-686. 5 refs.

Development in electronics - From basic materials to satellite components. P. Henninger (Siemens AG, Munich, West Germany), p. 687-700. 7 refs.

Microelectronics in space environment. E. Keonjian (Grumman Aerospace Corp., Bethpage, N.Y.), p. 701-705.

An electronically despun antenna for medium-altitude satellites. H. Uda, H. Komuro (Ministry of Posts and Telecommunications, Tokyo, Japan), S. Nobuoka, and Y. Takeichi (Mitsubishi Electric Corp., Kamakura, Japan), p. 707-710.

An evaluation on availability of frequency resources for satellite broadcasting. K. Ohmaru and Y. Masuko (Japan Broadcasting Corp., Tokyo, Japan), p. 711-718.

Some considerations on achieving optimum receiving systems for satellite broadcasting. M. Matsushita and T. Izumi (Japan Broadcasting Corp., Tokyo, Japan), p. 719-725.

Flush-mounted antennas for rockets. Y. Takeichi, T. Kawamura, and M. Ono (Mitsubishi Electric Corp., Kamakura, Japan), p. 727-734.

Large scale integrated circuits for space electronics. L. Hamiter (NASA, Marshall Space Flight Center, Huntsville, Ala.), p. 735-746. 9 refs.

Centralized command and control for INTELSAT IV. R. S. Cooperman (Cummunications Satellite Corp., Washington, D.C.), p. 747-756.

An advanced PN code command system. T. Nomura (Tokyo, University, Tokyo, Japan), K. Takahashi, H. Hara, M. Harada, and T. Takai (Nippon Electric Co., Ltd., Tokyo, Japan), p. 757-762.

Low noise solid state amplifiers for artificial satellites. K. Shirahata and D. Taketomi (Mitsubishi Electric Corp., Kamakura, Japan), p. 763-768.

On FM radiometer. K. Yamauchi, N. Morinaga, and T. Namekawa (Osaka University, Osaka, Japan), p. 769-780. 13 refs.

Flexible channel multiplier. T. Hayashi, M. Hashimoto (Tokyo, University, Tokyo, Japan), and K. Yamamoto (Matsushita Electric Industrial Co., Ltd., Osaka, Japan), p. 781-784.

On the orbit determination procedures for Doppler frequency and angular measurements of artificial satellite. S. Saito (Tokyo, University, Tokyo, Japan), T. Takenouchi (Tokyo Astronomical Observatory, Tokyo, Japan), K. Muramatsu, K. Matsumoto, R. Toriumi, T. Kimura (National Space Development Center, Tokyo, Japan), and K. Ujiie (Hitachi, Ltd., Tokyo, Japan), p. 785-792. 5 refs.

A self-optimizing distortionless filter. H. J. Rome (Dynamics Research Corp., Wilmington, Mass.) and D. W. C. Shen (Pennsylvania, University, Philadelphia, Pa.), p. 793-808. 6 refs.

Design and performance of high power travelling wave tubes for satellite communications ground stations. A. J. Prommer (Siemens AG, Munich, West Germany), p. 809-814. 9 refs.

Guidance and control.

Rocket guidance and control based on implicit measurement. A. Nara and M. Ozaki (Hitachi, Ltd., Tokyo, Japan), p. 817-824.

Guidance and control and propulsion technology. J. L. McDaniel (U.S. Army, Research and Engineering Directorate, Redstone Arsenal, Ala.), p. 835-838.

The hybrid simulation of guided and controlled flight of rocket. K. Higuchi and H. Koshiishi (National Aerospace Laboratory, Tokyo, Japan), p. 839-854. 5 refs.

Terminal guidance for a Mars softlander. R. K. Cheng (Hughes Systems Laboratories, Los Angeles, Calif.), p. 855-865.

Reorientation of a spin stabilized satellite by using magnetic dipole and geomagnetic field. M. Shigehara and S. Yasui (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan), p. 867-874.

The guidance, navigation, and control of the Apollo lunar landing. D. G. Hoag (MIT, Cambridge, Mass.), p. 875-887. 15 refs.

An optimal explicit guidance equation and its applications. K. Nitta, K. Matsushima, K. Otsubo, and T. Shiho (National Aerospace Laboratory, Tokyo, Japan), p. 889-904. 14 refs.

An algorithm for free terminal time control in trajectory optimization. T. Tanabe (Tokyo, University, Tokyo, Japan), p. 905-914. 5 refs.

Nonlinear estimation and its application to strapdown systems. T. Matsuzaki (Tokyo, University, Tokyo, Japan), p. 915-928. 13 refs.

Flight control of the Apollo lunar-landing mission. M. P. Frank (NASA, Manned Spacecraft Center, Houston, Tex.), p. 929-939.

A group representation theory application for solving flexible cosmic controlled member stabilization problems. A. I. Kukhtenko and V. V. Udilov (Akademiia Nauk Ukrainskoi SSR, Institut Kibernetiki, Kiev, Ukrainian SSR), p. 941-948. 7 refs.

Dynamic flexible artificial earth satellites and some principles of control systems' design. B. N. Petrov, V. Iu. Rutkovskii, and V. M. Sukhanov, p. 949-959. 10 refs.

The role of the Real Time Computer Complex (RTCC) in support of project Apollo. G. W. Ebker (IBM Corp., Houston, Tex.), p. 961-972.

Systems engineering.

Characteristics of three parameter space with applications to system synthesis. J. E. Cadena (Ministerio de Defensa National, Bogota, Colombia) and G. J. Thaler (U.S. Naval Postgraduate School, Monterey, Calif.), p. 975-982. 8 refs.

The system approach in resource allocation examples and some observations. L. Steg (GE Valley Forge Space Technology Center, Philadelphia, Pa.), p. 983-989.

A systems approach to comparison by emphasis. C. E. Caveness, p. 991-996. 9 refs.

Effect of parameter-variation in the learning method for system identification. A. Noda (Tokyo Institute of Technology, Tokyo, Japan), p. 997-1010.

A matrix approach to parameter analysis of dynamical systems. J. Karmarkar (Santa Clara, University, Santa Clara, Calif.) and G. J. Thaler (U.S. Naval Postgraduate School, Monterey, Calif.), p. 1011-1018. 16 refs.

Analysis of rescue success in emergency return mission. S. T. Ghu and A. R. Nagy, Jr. (Aerospace Corp., El Segundo, Calif.), p. 1019-1036. 6 refs.

Conceptional design of navigation satellite system. K. Kimura (Ministry of Transportation, Tokyo, Japan), M. Kubo, H. Kuno, and I. Yamada (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan), p. 1037-1052.

Evolution in design of the orbiting geophysical observatories. W. E. Scull (NASA, Goddard Space Flight Center, Greenbelt, Md.), p. 1053-1061.

Space science.

The Tiros solar proton monitor program. R. E. Cashion (Johns Hopkins University, Silver Spring, Md.), p. 1065-1072.

The Isis series of ionospheric satellites. C. D. Florida (Department of Communications, Ottawa, Canada), p. 1073-1087.

Tektite - From space to sea. H. M. Wittner (General Electric Co., Philadelphia, Pa.), p. 1089-1102.

Measurement of ionosphere by the gyro-plasma probe. M. Ejiri and T. Obayashi (Tokyo, University, Tokyo, Japan), p. 1103-1110.

17 refs.

Rocket observations of winter ionosphere by gyro-plasma probe. H. Oya and T. Aso (Kyoto University, Kyoto, Japan), p. 1111-1115. 14 refs.

Ionization of energetic neutral particles on a metal surface. T. Honzawa (Nagoya University, Nagoya, Japan), p. 1117-1121.

Some meteorological considerations of the frequency of shooting star shower and solar eclipse. D. Manabe (Kyushu University, Fukuoka, Japan), p. 1123-1127. 6 refs.

Lithium-doped silicon solar cells. I. Tagoshima, J. Matsuzaki (Japan Broadcasting Corp., Tokyo, Japan), and Y. Moriguchi (Nippon Electric Co., Ltd., Kawasaki, Japan), p. 1129-1133. 6 refs.

A balloon borne X-ray telescope. M. Oda, M. Matsuoka, S. Miyamoto, J. Nishimura, Y. Ogawara (Tokyo, University, Tokyo, Japan), and M. Wada (Institute of Physical and Chemical Research, Tokyo, Japan), p. 1135-1138.

A simplified hypsometer for high-altitude balloon observation. H. Hirosawa (Tokyo, University, Tokyo, Japan), p. 1139-1144.

Small swing angle detector of balloon payloads. H. Horisawa, J. Nishimura, S. Ohta, and Y. Ohtsuka (Tokyo, University, Tokyo, Japan), p. 1145-1148.

Control device of the azimuthal angle of gondola by twisting suspension rope of the balloon. J. Nishimura, H. Hirosawa, S. Ohta, Y. Ohtsuka, and Y. Nara (Tokyo, University, Tokyo, Japan), p. 1149-1152.

Reaction jet azimuth control system for balloon-borne gondola. M. Fujii, S. Ohta, and Y. Ohtsuka (Tokyo, University, Tokyo, Japan), p. 1153-1156.

On the hunting mechanism of the plastic balloon. J. Nishimura and H. Hirosawa (Tokyo, University, Tokyo, Japan), p. 1157-1161.

On a class of precessional phenomena and their stability in the sense of Liapunov, Poincaré and Lagrange. D. G. Magiros, p. 1163-1170.

Space medicine and biology.

On the biological effect of fission neutrons on epithelial cells of the cornea and intestine. V. M. Mastriukova and A. D. Strzhizhovskii, p. 1173-1182. 7 refs.

Calculation of algae cultivator for life support system. B. G. Kovrov, V. N. Belianin, and A. A. Shtohl (Akademiia Nauk SSSR, Institut Fiziki, Krasnoyarsk, USSR), p. 1183-1187.

Method and technique of wheat continuous culture as a link of life support system. G. M. Lisovskii, B. G. Kovrov, I. A. Terskov, and I. I. Gitelzon (Akademiia Nauk SSSR, Institut Fiziki, Krasnoyarsk, USSR), p. 1189-1192.

Unidirectional response of statoreceptors to vibration - A mean for artificial gravity in space flight. T. Gualierotti (Milano, Università, CNR, Milan, Italy), p. 1193-1200. 10 refs.

Fluid mechanical aspects of blood flow. R. M. Nerem (Ohio State University, Columbus, Ohio), p. 1201-1216.

Space law.

The legal status of the moon. M. Kido, p. 1219-1222.

The new tendencies in space law. M. Smirnoff (Institute of Foreign Trade, Belgrade, Yugoslavia), p. 1223-1232. 34 refs.

A70-35238 **High enthalpy nozzle flow with heat exchange.** Yasuhiko Aihara (Tokyo, University, Tokyo, Japan) and Yasuo Watanabe (National Aerospace Laboratory, Tokyo, Japan). In: International Symposium on Space Technology and Science, 8th, Tokyo, Japan, August 25-30, 1969, Proceedings. Edited by Akira Takano. Tokyo, AGNE Publishing, Inc., 1969, p. 399-406. 10 refs.

Heat transfer to the convergent-divergent axisymmetric nozzle wall from high enthalpy flow was analysed and expressed in terms of nozzle geometry. The validity of the results rests with favourable comparisons with measurements. By utilizing these discussions, optimum nozzle geometry of minimum heat transfer was obtained. Relaxation of electronic excitation temperature was measured in an expansion nozzle coupled to a continuous arc-heated wind tunnel. It was pointed out that the nonequilibrium phenomena in this flow field were also influenced by the heat exchange. (Author)

A70-35246 **Experimental study of underexpanded jet expanding into vacuum.** Koichi Oshima and Yasunori Kobayashi (Tokyo, University, Tokyo, Japan). In: International Symposium on Space Technology and Science, 8th, Tokyo, Japan, August 25-30, 1969, Proceedings. Edited by Akira Takano. Tokyo, AGNE Publishing, Inc., 1969, p. 477-479.

An experimental investigation was carried out on a carbon-dioxide free jet expanding into a low density atmosphere from conical nozzles, which is closely related to phenomena of interference of the rocket plumes with the vehicle. The plumes have the pressure ratio over 100,000 and exit Mach number of 2 to 7, and are expanded into sufficiently low pressure atmospheres cryo-pumped by liquid nitrogen. A new measuring technique named the freeze-up method is presented, which is to condensate the flowing gas molecule colliding on the cooled metal thin plate set parallel to the flow direction and to visualize them on the plate. Also, a detailed flow survey using hot-wire and Langmuir probe was carried out. (Author)

A70-35344 # ***Behavior of solutions to the equations of a*** **spatial gyrohorizon compass (Pro povedinku rozv'iazkiv rivnian' prostorovogo girogorizontkompasa).** S. P. Sosnits'kii (Akademiia Nauk Ukrains'koi RSR, Institut Matematiki, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 32, May 1970, p. 459-461. In Ukrainian.

Analysis of the equations of perturbed motion of a spatial gyrohorizon compass. The first independent integrals of these equations are obtained. It is shown that a point representing a solution of the equations moves in a conditionally periodic manner *along a two-dimensional torus.* V.P.

A70-35372 # **Oscillations of a tandem wing without an outgoing wake in a plane incompressible flow (Schwingungen eines Tandemflügels ohne abgehende Wirbelschleppe in ebener, inkompressibler Strömung).** Wilfried Gleich. Karlsruhe, Universität, Fakultät für Mathematik, Doktor der Naturwissenschaften Dissertation 1970. 140 p. 23 refs. In German.

Study of the special problem of the behavior of a system of two tandem wings, in which the front wing performs a harmonic oscillation, while the rear wing moves so that behind the wing system no wake is created. To obtain these conditions, the motion of the rear wing is investigated. Particular emphasis is placed on finding such parameters which make it possible to obtain the above conditions while the rear wing is at rest. Based on extensive numerical computations, an approximate linear relationship is derived between the wing distance, rear wing depth, and wavelength of the oscillation, which satisfies the objectives of the study. O.H.

A70-35375 # **Experimental investigations of a transonic plane flow past a wave-shaped wall in a blocked tunnel (Experimentelle Untersuchungen der schallnahen, ebenen Umströmung einer welligen Wand im blockierten Kanal).** Hans Jungbluth. Karlsruhe, Universität, Fakultät für Maschinenbau und Verfahrenstechnik, Dr.-Ing. Dissertation, 1969. 56 p. 15 refs. In German.

Experimental investigations of transonic plane flows past a wave-shaped wall in a wind tunnel, performed to check the existing theories and to obtain data for additional theoretical solutions. Theoretical solutions to linear subsonic and supersonic flows with and without a plane cross wall are first presented. In the transonic range, a solution obtained by a parabolic method is given, and some recent works dealing with the transonic flow past a wavy wall are discussed. As the experiments were conducted in a supersonic tunnel, a theoretical estimation of the tunnel wall effect for the case of an incident sonic flow is presented. To simulate the incident Mach 1 flow, the supersonic wind tunnel is operated in a blocked up condition. Interferometric density measurements were made to determine the velocity from the profile. In order to extend the results obtained in tunnel flow measurements to the case of an infinitely large flow field, measurements were carried out for three different tunnel heights. Finally, the results are compared to theoretical solutions hitherto known. O.H.

A70-35418 Fabrication and properties of tungsten-filled adiprene. Eugene Cerceo (Boeing Co., Vertol Div., Philadelphia, Pa.). *SAMPE Journal,* vol. 6, June-July 1970, p. 17-20, 41. 5 refs.

Development of a tungsten-filled urethane which can be applied to aircraft areas requiring a balancing element whose density must vary from 1 to 5 g/cc. It is found that larger tungsten particles had a lesser surface area and yielded lower viscosities, higher densities, but greater settling rates than smaller particles. Z.W.

A70-35448 Aerodynamic noise. Edited by Arnold Goldburg (Boeing Scientific Research Laboratories, Seattle, Wash.). New York, American Institute of Aeronautics and Astronautics, Inc. (AIAA Selected Reprint Series. Volume 11), 1970. 130 p. $2.50.

Contents:

Preface. A. Goldburg (Boeing Scientific Research Laboratories, Seattle, Wash.), p. 5-7.

On Sound generated aerodynamically. I - General theory. M. J. Lighthill (Royal Aircraft Establishment, Farnborough, Hants., England), p. 14-37.

The influence of solid boundaries upon aerodynamic sound. N. Curle (Manchester, University, Manchester, England), p. 38-47.

Strength distribution of noise sources along a jet. H. S. Ribner (Toronto, University, Toronto, Canada), p. 48.

Jet noise (The Wright Brothers Lecture of 1963). M. J. Lighthill (Royal Aircraft Establishment Farnborough, Hants., England), p. 49-59.

Aerodynamic sound emission as a singular perturbation problem. S. C. Crow (Boeing Scientific Research Laboratories, Seattle, Wash.), p. 60-83.

Sound generation by turbulence and surfaces in arbitrary motion. J. E. Ffowcs Williams and D. L. Hawkings (Imperial College of Science and Technology, London, England), p. 84-105.

Refraction of sound from a point source placed in an air jet. J. Atvars, L. K. Schubert, and H. S. Ribner (Toronto, University, Toronto, Canada), p. 106, 107.

Jet noise and shear flow instability seen from an experimenter's viewpoint. E. Mollo-Christensen (MIT, Cambridge, Mass.), p. 108-114.

The evolution of the engine noise problem. F. B. Greatrex and R. Bridge (Rolls-Royce, Ltd., Derby, England), p. 115-119.

Perspective of SST aircraft noise problem. G. S. Schairer, J. V. O'Keefe, and P. E. Johnson (Boeing Co., Seattle, Wash), p. 120-132.

A70-35450 # Nonlinear analysis of rotating stall. Saburo Nagano and Hiroyuki Takata (Tokyo, University, Tokyo, Japan). *Tokyo, University, Institute of Space and Aeronautical Science, Report No. 449,* vol. 35, Apr. 1970, p. 119-197. 15 refs.

Establishment of a new stall model to describe rotating stall in axial compressors, where blade rows are replaced by semiactuator disks (finite chord and infinitesimal pitch), flow fluctuations are permitted to be finite and nonsteady, and cascade characteristics are taken into consideration in both nonlinear and nonsteady forms. By numerical analysis, adopting a finite difference method, an attempt is made to clarify various aspects of rotating stall, such as the number of stall cells, the amplitude and the wave shape of the disturbance, the stall propagation velocity, and their variations with the flow rate through the compressor, and the mechanisms for establishing them. All aspects of rotating stall observed in common compressors are exemplified numerically, using a model of the present analysis.F.R.L.

A70-35476 Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn (California, University, Los Alamos, N. Mex.). Pittsburgh, Instrument Society of America, 1969. 426 p. Members, $12.; nonmembers, $15.

Contents:

Foreword. D. L. Limbacher. 1 p.

Engine testing.

Pulsed laser holography - New instrumentation for use in the investigation of liquid rocket combustion. S. Rogero (California Institute of Technology, Pasadena, Calif.), B. J. Mathews, and R. F. Wuerker (TRW Systems Group, Redondo Beach, Calif.), p. 1-9. 8 refs.

Simulated rocket engine dynamic force and pressure measurement system. V. D. Drumond (Boeing Co., Seattle, Wash.), p. 10-17.

High response pulse rocket engine thrust measurement system. A. H. Boud (USAF, Rocket Propulsion Laboratory, Edwards AFB, Calif.), p. 18-33.

Vibration monitoring as a tool for turbine engine malfunction detection. E. L. Elswood and B. B. Gish (Bell and Howell Co., Monrovia, Calif.), p. 34-47.

The role of spectrometric oil analysis instrumentation in the advance detection of aircraft engine failures. I. D. Brent, II and P. N. Dudeney (Baird-Atomic, Inc., Cambridge, Mass.), p. 48-54.

Ultra high speed measuring techniques.

Acoustic measurements in supersonic transitional boundary layers. S. R. Pate and M. D. Brown (ARO, Inc., Arnold Air Force Station, Tenn.), p. 55-64. 16 refs.

Acoustic measurement of transition on reentry vehicles. E. A. Starr (Bolt Beranek and Newman, Inc., Cambridge, Mass.) and R. H. Myers, Jr. (Avco Corp., Wilmington, Mass.), p. 65-77.

Development of a fast-response pressure transducer. F. P. Baltakis (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.), p. 78-83.

Internal rocket-engine probes for use in a combustion instability environment. S. Rogero (California Institute of Technology, Pasadena, Calif.), p. 84-88. 5 refs.

Primary calibration of pressure transducers to 10,000 Hz. J. D. Favour and R. Stewart (Boeing Co., Seattle, Wash.), p. 89-96. 9 refs.

System operational techniques.

Planning a management program for maintenance and repair of a digital data system. E. H. Henderson (North American Rockwell Corp., Canoga Park, Calif.), p. 97-102.

Undergraduate education for systems engineering. T. C. Warner, Jr. and M. D. Weiss (New Haven College, West Haven, Conn.), p. 103-113.

A hybrid computer controlled structural dynamics test system. C. S. Chang (Lockheed Missiles and Space Co., Huntsville, Ala.), p. 114-121.

Systems operation simulator. J. M. Woods (General Electric Co.,

Huntsville, Ala.), p. 122-126.

Wind tunnel.
A three-component wind-tunnel balance for measuring extremely small forces. J. G. Fowke (NASA, Langley Research Center, Hampton, Va.), p. 127-132.
Development and application of ultra-miniature pressure transducers for use in wind tunnel models. I. A. D. Kurtz (Kulite Semiconductor Products, Inc., Ridgefield, N.J.), p. 133-143.

Development and application of ultra-miniature pressure transducers for use in wind tunnel models. II. J. C. Kicks (Boeing Co., Seattle, Wash.), p. 144-149.
Low pressure data acquisition techniques in a hypersonic wind tunnel. D. H. Murray and E. S. Ojdana, Jr. (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio), p. 150-160.

An on-line final data system for V/STOL wind tunnel testing. P. Polgar (Boeing Co., Philadelphia, Pa.), p. 161-165.

Free-flight telemetry instrumentation for wind tunnels. R. G. Choate (ARO, Inc., Arnold Air Force Station, Tenn.), p. 166-179. 10 refs.

In-flight control systems.
Flight evaluation of direct lift control on the DC-8 super 63. G. R. Jansen (Douglas Aircraft Co., Long Beach, Calif.), p. 180-184.

Development of C-5A propulsion system monitoring. M. S. Edwards and A. P. Pennock (Lockheed-Georgia Co., Marietta, Ga.), p. 185-193.
DC-10 airborne flight test data system. D. D. Crompton (Douglas Aircraft Co., Long Beach, Calif.), p. 194-198.

Airborne data acquisition on high density computer tape. D. R. Reynolds and W. L. Crawford (NASA, Ames Research Center, Moffett Field, Calif.), p. 199-205.

V/STOL instrumentation.
Weight tare compensation for V/STOL wind tunnel testing. S. B. Moore (LTV Aerospace Corp., Dallas, Tex.), p. 206-210. 9 refs.

Magnetostrictive measurements of torque from high speed rotating shafts. F. Scoppe (Avco Corp., Stratford, Conn.), p. 211-216. 7 refs.
Flow-direction measurement with fixed-position probes in subsonic flow over a range of Reynolds numbers. L. N. Krause and T. J. Dudzinski (NASA, Lewis Research Center, Cleveland, Ohio), p. 217-223.

Instrumentation for the extraction of V/STOL stability derivatives. I. L. Clinkenbeard, R. W. Hill (LTV Aerospace Corp., Dallas, Tex.), and J. L. Rooker (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), p. 224-234. 10 refs.

Automation of test facilities.
Test system philosophy for automating test facilities. W. W. McGhee (American Computer Technology, Inc., Northridge, Calif.), p. 235-239.

Start Stop Dynamics. W. W. Mingus (American Computer Technology, Inc., Northridge, Calif.), p. 240-248.

Structural fatigue testing by computer control. H. T. Strandrud (Boeing Co., Seattle, Wash.), p. 249-255.
A digital data acquisition and control system for acoustic testing of large aerospace vehicles. R. E. Maly (Lockheed Missiles and Space Co., Sunnyvale, Calif.), p. 256-263.
The steps to successful application development. K. R. Harstad (Collins Radio Co., Cedar Rapids, Iowa), p. 264-269.

Real time computer operations.
Antenna positioning by digital computer. W. F. Kamsler (Martin Marietta Corp., Denver, Colo.), p. 270-273.
A digital computer technique for controlling a six degree of freedom wind tunnel separation simulator. R. G. Butler (ARO, Inc., Arnold Air Force Station, Tenn.), p. 274-280. 6 refs.

Tradeoffs for real-time computer configurations. J. Weissman (North American Rockwell Corp., Anaheim, Calif.), p. 281-285.

Use of time-sharing computer to support several large test facilities. C. W. Putt and F. N. Goldberg (NASA, Lewis Research Center, Cleveland, Ohio), p. 286-291.

Programming of variable loads by means of a semi-computer/semi-hardware method. G. R. Olbrechts (Boeing Co., Seattle, Wash.), p. 292-296.

On-line display systems.
On-line display of pulsed rocket engine performance data. G. P. Starr (TRW Systems Group, Redondo Beach, Calif.), p. 297-301.

On-line CRT display systems. R. E. Bailey and T. M. Wooster (General Dynamics Corp., San Diego, Calif.), p. 302-305.

A device for printing alphanumeric listings and digital data plots. J. W. Oglesbee (NASA, Lewis Research Center, Cleveland, Ohio), p. 306-313.

Fast response solid state display for on-line information retrieval. H. C. Borden (Hewlett-Packard Co., Palo Alto, Calif.), p. 314-317.

Maintenance and accident recording systems.
Technical approaches to aircraft data recording in civil and military aircraft. J. R. Williams (Leigh Instruments, Ltd., Carleton Place, Ontario, Canada), p. 318-323.
Maintenance recording applied to advanced aircraft. W. R. Beckman, G. A. Birdsall (Lockheed Aircraft Service Co., Ontario, Calif.), and W. Wood (Lockheed-California Co., Burbank, Calif.), p. 324-328.
Accident and maintenance recording - A European view. N. O. Matthews (College of Aeronautics, Cranfield, Beds., England), p. 329-344. 12 refs.
Crash recorder data from 'non-crash' recorders. R. C. Culpepper (USAF, Wright-Patterson AFB, Ohio), G. H. Ebel (Conrac Corp., Caldwell, N.J.), and C. G. Peckham (Technology, Inc., Dayton, Ohio), p. 345-350.

Measurement research and development. I.
Radiation backscatter ablation sensor. R. Jones, D. Gicking (General Electric Co., King of Prussia, Pa.), and R. A. Florentine, p. 351-358. 5 refs.
Hydrocarbon gas detection using a HeNe laser. B. H. Beam, D. N. Jaynes, and C. N. Burrous (NASA, Ames Research Center, Moffett Field, Calif.), p. 359-363. 7 refs.
Remote sonic monitoring system. G. N. Sawyer (General Electric Co., Bay St. Louis, Miss.), p. 364-367.

Subminiature solid state accelerometer. C. L. Gravel and A. Brosh (Kulite Semiconductor Products, Inc., Ridgefield, N.J.), p. 368-372.
Stopping rotor burst fragments with high speed film. A. A. Martino (U.S. Navy, Naval Air Propulsion Test Center, Trenton, N.J.), p. 373-379.
Measurement research and development. II.
Measuring man's environment from the air. C. N. Anderson, D. H. Bundy, H. E. Eskridge, and J. E. Hand (EG & G, Inc., Las Vegas, Nev.), p. 380-382.
A vibrating diaphragm pressure measuring system. J. Dimeff, J. W. Lane, G. J. Deboo, and R. C. Hedlund (NASA, Ames Research

Center, Moffett Field, Calif.), p. 383-389. 7 refs.

Advanced measurement techniques for automatic checkout of nonelectronic systems. H. R. Hegner and A. H. Hehn (IIT Research Institute, Chicago, Ill.), p. 390-402.

An active RC band-pass filter for the fluxgate magnetometer. W. J. Kerwin (NASA, Ames Research Center, Moffett Field, Calif.), p. 403-408. 7 refs.

Versatile vibration systems. A. N. Waldman (Gulton Industries, Inc., Metuchen, N.J.), p. 409-415.

Author index, p. 417, 418.

A70-35480 Vibration monitoring as a tool for turbine engine malfunction detection. E. L. Elswood and D. B. Gish (Bell and Howell Co., CEC/Transducer Div., Monrovia, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 34-47.

This paper describes a vibration monitor evaluation program conducted jointly by Bell and Howell CEC/Transducer Division and Pan American World Airways. Results showed that engine vibration monitoring systems, using properly placed externally mounted piezoelectric transducers and selective filtering, are excellent tools for early detection of turbine engine malfunctions. The program involved a study of engine vibration transmissibility, bearing generated vibrations, and compressor/turbine vibrations. This led to transducer placement and filter-band selection which allowed a majority of vibration related failures to be detected. Examples of bearing failures and compressor problems are presented. (Author)

A70-35481 The role of spectrometric oil analysis instrumentation in the advance detection of aircraft engine failures. I. D'Arcy Brent, II and Peter N. Dudeney (Baird-Atomic, Inc., Cambridge, Mass.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 48-54.

Spectrometric oil analysis is to the maintenance engineer what blood analysis is to the medical diagnostician. It provides information that makes possible the identification and localization of impending malfunctions. The technique is based upon quantitative and qualitative measurements of submicroscopic metal particles suspended in lubricating fluids. The magnitude of the concentration level is a measure of the wear in an oil-wetted mechanism, and the elements present identify the components that are wearing. Oil analysis technology started with the railroad industry in the early 1940's and received increasing recognition over the years until now this technology has been adopted by the military departments. Equipment development was so rapid that now the performance of current instrumentation exceeds the demands of the application. The basic premise of the technology is irrefutable, but the implementation of many oil analysis programs is open to question. Oil analysis has great potential, and its application can change the engine maintenance concept as it relates to safety, mission readiness, inventory control, and cost. To take full advantage of this potential, greater emphasis must be placed on substantiative data, fact, and logic. (Author)

A70-35484 Development of a fast-response pressure transducer. Frank P. Baltakis (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 78-83.

Description of a small (0.2 in. diam), fast-response pressure transducer developed for measuring shock interaction induced transient pressures. Transducer design incorporates the pressure bar principle to minimize disturbances from the boundaries of the sensing element and a unique orifice-cavity method to avoid disturbances which normally originate at the metal diaphragm. Calibration and wind-tunnel shock interaction data show that this type of transducer is suitable for measuring pressures of 1/20 to 100-psi magnitude and of 1 to 17-microsecond duration. Transducer performance, design and construction are described in the paper. (Author)

A70-35490 * A three-component wind-tunnel balance for measuring extremely small forces. James G. Fowke (NASA, Langley Research Center, Hampton, Va.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 127-132. NASA-supported research.

Measuring aerodynamic loads in high enthalpy wind tunnels at low free-stream dynamic pressure with 25 to 100 atm supply pressure requires special techniques. This need arises from the low forces, 0 to 0.5 lb, imposed on 1/50- to 1/25-scale models. Described herein is a highly sensitive three-component force balance developed for the NASA-Langley 4-ft hypersonic arc tunnel. An air bearing, located above the tunnel, supports the weight of the model and sting. Electromechanical feedback control systems provide restoring loads to null the model's position. Leveling requirements and an applicable load calibration method in which accuracy is not degraded by mechanical friction are discussed. (Author)

A70-35493 Low pressure data acquisition techniques in a hypersonic wind tunnel. David H. Murray and Edward S. Ojdana, Jr. (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 150-160.

This paper describes a low pressure-measuring system developed at the Aerospace Research Laboratories to make pressure measurements on aerodynamic models tested in the ARL Mach 12 to Mach 14 hypersonic wind tunnel. The system employs commercially available pressure transducers and a high-speed digital recording and data processing system. The results of evaluating the techniques employed by the system are discussed. These results show that pressures in the 0.5 to 50 mm Hg range may be measured to an accuracy of plus or minus 2% of true pressure or plus or minus 0.5% of full scale, whichever is smaller. (Author)

A70-35494 An on-line final data system for V/STOL wind tunnel testing. Peter Polgar (Boeing Co., Vertol Div., Philadelphia, Pa.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 161-165.

Discussion of the use of a on-line final data system for wind tunnel tests of complex, powered V/STOL models and for the testing of simpler models. The Boeing V/STOL Wind Tunnel Data Encoding and Evaluation System (WINDEE) provides final corrected test data on-line. Tabulations and digital plots of test data are provided as

model testing progresses. Data is also available for monitoring model and tunnel functions via 19 digital displays updated under computer control. The WINDEE system contains off-the-shelf computer and instrumentation hardware for all elements except a data-steering logic network. In a typical powered V/STOL model test, the computer makes monitor data available for both model and tunnel control functions. G.R.

A70-35496 Flight evaluation of direct lift control on the DC-8 Super 63. G. R. Jansen (Douglas Aircraft Co., Long Beach, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 180-184.

The increasing size of the next generation jet transport results in inertia characteristics which delay the aircraft's lift response to a longitudinal control input. This characteristic results in decreased capability to achieve precise glide path control and increases the altitude above the runway for initiation of the landing flare maneuver. Any degradation of lift response to control input is not compatible with the increased emphasis on all-weather operation which requires more precise glide path-control, minimum flare altitude, and minimum touchdown dispersion. Direct Lift Control (DLC), pioneered by Douglas in 1963, by-passes the large aircraft lift response problem by varying lift coefficient directly at the pilot's command. (Author)

A70-35497 Development of C-5A propulsion system monitoring. M. S. Edwards and A. P. Pennock (Lockheed-Georgia Co., Marietta, Ga.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 185-193.

The C-5A MADAR subsystem has on-board capability that provides for malfunction detection, analysis, and recording for selected subsystems, including the engine, the TF39-GE-1. Studies were made by General Electric, the engine manufacturer, to define the extent of monitoring necessary for the TF39. These studies defined a number of line replaceable units (LRU's) associated with the engine. The selected LRU's then determined the parameters to be monitored for the engines. Further studies defined the instrumentation requirements for obtaining the parameters. The utilization of the parameters for fault isolation and incipient malfunction detection has been partially defined. Further analysis to establish limits and correlation procedures is to be completed. This paper presents a synopsis of several years of effort in the definition of the C-5A propulsion subsystem monitoring program. (Author)

A70-35498 DC-10 airborne flight test data system. Dale D. Crompton (Douglas Aircraft Co., Long Beach, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 194-198.

This paper describes an airborne pulse-code-modulated (PCM) data system which, although it is being developed for the DC-10 aircraft, will have built-in versatility for adaptation to aircraft ranging from small fighters to large commercial carriers. The compact system, designed specifically for use in severe environmental conditions experienced in experimental and prototype aircraft, is capable of accepting a wide variety of inputs. System capability and on-board operating characteristics are discussed as well as the results of tests run during conversion to L-band telemetry. The airborne system will be complemented by a ground-based station having an on-line computer and displaying real-time data in engineering units on cathode ray tube graphic display consoles and strip charts. (Author)

A70-35499 * Airborne data acquisition on high density computer tape. D. R. Reynolds and W. L. Crawford (NASA, Ames Research Center, Moffett Field, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 199-205. Contract No. NAS 2-3795.

An airborne data acquisition system is described. The system is presently being used to record data for aircraft handling qualities and flight dynamics research. It digitizes 48 analog channels of information at the rate of 50 frames per second, and records these data on 800 density, gapped-format computer tape for a ground-based computer. A core memory permits high speed operation without data loss. Techniques are discussed which permit qualification of the system for the military airborne environment, and operation with intermittent failure of the aircraft electrical system. To minimize the time between completion of a flight test and the availability of the computed data, a data processing system for the large ground computer has been developed. This system is user-oriented so that the experimentor can modify his program by prepared control cards with stylized descriptive commands written in the user's terminology. The developed program also provides for the use, with a simplified data request format, of the fixed data located in permanent storage. (Author)

A70-35500 Weight tare compensation for V/STOL wind tunnel testing. S. B. Moore (LTV Aerospace Corp., Vought Aeronautics Div., Dallas, Tex.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 206-210. 9 refs.

A method of static weight tare compensation for V/STOL Wind Tunnel Models is described. The technique uses accelerometer outputs algebraically summed with each of the affected internal strain gage balance components. The accelerometers are mounted within the model with their sensitive axes oriented at a precise angle in the vertical plane of symmetry with respect to the corresponding balance component axis of sensitivity. These mounting angles are defined such that the outputs of the accelerometers, vs angle of attack over the desired pitch range, are similar to the balance weight tare outputs. Amplifier gains are adjusted so the accelerometer and corresponding balance outputs are essentially identical, resulting in significantly increased data accuracy and resolution. (Author)

A70-35502 Instrumentation for the extraction of V/STOL stability derivatives. Ivan L. Clinkenbeard, Richard W. Hill (LTV Aerospace Corp., Dallas, Tex.), and James L. Rooker (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Instrumentation in the aerospace industry. Volume 5 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 224-234. 10 refs.

This paper briefly summarizes the results of a study which identified V/STOL flight test instrumentation accuracy and development requirements necessary to extract aerodynamic coefficients from flight test data suitable for correlation purposes. The study revealed that, in general, state of the art instrumentation is adequate provided that: (1) detailed a priori knowledge of the instrumentation errors are determined, and (2) the techniques determined to be adequate for compensating the instrumentation errors are used. However, specific design and development are required for the following measurement techniques: low range airspeed, inflight direct thrust, angles of attack and sideslip, and pressure altitude. A preliminary design for a V/STOL flight test instrumentation system is recommended and installation techniques and precautions are discussed. (Author)

A70-35510 Tradeoffs for real-time computer configurations. John Weissman (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 281-285.

This discussion is tutorial and considers the main computer parameters involved in real-time systems, especially avionic systems. The restriction to general purpose real-time computers permits comparisons with data processor type computers. The present trend from serial to parallel computers and future trends are reviewed. Existing controversies over optimal word length, memory usage, and register organization are presented. Presently evolving sophisticated multicomputer and multiprocessor organizations and their associated management and software problems are introduced. (Author)

A70-35511 Programming of variable loads by means of a semi-computer/semi-hardware method. G. R. Olbrechts (Boeing Co., Seattle, Wash.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 292-296.

A system is being built which will be used to apply 100 independently variable loads to demonstrate the fatigue performance of the 747. The loads issued to each channel are approximated by a series of line-segments. A computer is used to store and issue the begin-value and slope of each straight line, while external digital circuitry generates the straight lines. The general rate at which the loads are varied is controlled by means of a programmable clock. The outputs of the digital interpolating circuitry drive digital to analog converters, which drive servo-controlled load systems. (Author)

A70-35515 Technical approaches to aircraft data recording in civil and military aircraft. James R. Williams (Leigh Instruments, Ltd., Carleton Place, Ontario, Canada). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 318-323.

The everyday use of airborne data acquisition systems, and particularly of flight data recorders, is now a reality and emcompasses both civil and military specifications. The reasons why such systems are required are discussed, together with a brief description of a typical military and civil system, including block diagrams; a comparison of the two is then drawn, resulting in definitions of 'mission fulfilment' for the military and 'preventive maintenance' for the civil. Particular unique hardware differences are highlighted, being the methods chosen for survivability and recoverability of accident data recordings. (Author)

A70-35516 Maintenance recording applied to advanced aircraft. W. R. Beckman, G. A. Birdsall (Lockheed Aircraft Service Co., Ontario, Calif.), and W. Wood (Lockheed-California Co., Burbank, Calif.). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 324-328.

Description of the use of a comprehensive on-board recording system in the design development and operation of a complex airframe system for the SR-71 program. The system's effectiveness as a maintenance tool has been quantified over a recent six-month period. During this period, over 80% of all maintenance actions were initiated as a result of malfunction detection by the system. T.M.

A70-35517 Accident and maintenance recording - A European view. N. O. Matthews (College of Aeronautics, Cranfield, Beds., England). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 329-344. 12 refs.

European national requirements for accident recording systems are reviewed. Equipment developed to meet these requirements is described and some operational aspects considered. Future developments in this field are examined. Surplus capacity on these systems has led to their use for maintenance recording purposes. These and the development of specialised maintenance recording systems has led to problems in handling the mass of data recorded. This has to be processed and presented in a form and timescale which is consistent with the airline maintenance problem. Future possibilities, including telemetry systems for the transmission of performance data in flight to the airline maintenance base, are discussed. (Author)

A70-35518 Crash recorder data from 'non-crash' recorders. Richard C. Culpepper (USAF, Wright-Patterson AFB, Ohio), George H. Ebel (Conrac Corp., Caldwell, N.J.), and Cyril G. Peckham (Technology, Inc., Dayton, Ohio). In: Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1969, p. 345-350.

Description of an improvised method of extracting and analyzing flight loads data from damaged magnetic tapes after an aircraft has crashed. The tapes were cut in many fragments making it impossible to splice and run them in a reproducing unit. Iron particles were applied to the surfaces, concentrating about the points where the magnetic state changed from a one to a zero. The particles were then transferred to transparent scotch tape, photographed, and properly aligned. The results of the extracted data are detailed, and recommendations are included for inexpensive recorders with a high probability of data recovery after crash. T.M.

A70-35549 The second generation of helicopters. C. Marchetti (Marchetti Design Co., Paris, France). *Interavia,* vol. 25, July 1970, p. 842, 843.

Consideration of second-generation helicopters, which will incorporate technical improvements insofar as technological knowledge permits. Attention is given to various types of compound helicopters, which only utilize the rotor fully during the landing and takeoff phases. When cruising, lift derives from an auxiliary wing. Another possibility is the convertible helicopter, which is a variable configuration machine. Electrically powered helicopters are considered feasible. F.R.L.

A70-35550 Developments in helicopter rotor technology. Jacques Spincourt. *Interavia,* vol. 25, July 1970, p. 883.

Review of results which have been obtained in the structural field common to the entire rotary wing aircraft range, and specifically applicable to convertible helicopters. The tendency is to use titanium and reinforced plastics as materials for rotor construction. The guiding principle is the prolongation of rotor life, which has had to undergo additional fatigue strains due to the continual increase in speeds. With reference to new rotor blade configurations, the Sikorsky Advancing Blade Concept is considered to be of great interest. An even more revolutionary concept which is discussed is the variation of the rotor diameter in flight. F.R.L.

A70-35600 Study of erosion by solid particles. J. E. Goodwin, W. Sage, and G. P. Tilly (National Gas Turbine Establishment, Farnborough, Hants., England). *Institution of Mechanical Engineers, Proceedings,* vol. 184, pt. 1, no. 15, 1969-1970, p. 279-289; Communications, p. 289-291; Author's Reply, p. 292. 19 refs.

The influences of the impacting velocity and the nature of the particles on the erosion of different materials have been studied using a vacuum whirling arm rig. The most important characteristics of natural sand were found to be the size distribution and percentage of quartz present. For artificial abrasives used in industrial processes, erosion can be related to the hardness and sharpness of the particles. Tests on steel and nylon using quartz indicate that there is a fundamental dependence on particle size whereby comparatively little damage is caused by particles up to about 5 micron but larger sizes cause successively more damage till a saturation condition is reached. This dependence is shown to be most important for the design of filter systems for helicopters and other vehicles whose engines suffer through ingestion of dust. Erosion is found to be dependent on a simple power of velocity. For small particles the exponent is 2.0, but for particles bigger than about 100 micron it is 2.3 for a wide range of conditions. The eroding particles are found to incur a substantial degree of fragmentation which is dependent upon the initial sizes and the velocity of impact. It is suggested that the extent of fragmentation of the particles as well as the properties of the target material are important in determining the erosion behaviour. (Author)

A70-35626 VFW's H3-E Sprinter. Christoph Fischer (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany). *VertiFlite,* vol. 16, July 1970, p. 4-9.

Description of the design and performance of VFW's H3-E Sprinter, a small semicompound helicopter with pneumatic rotor drive and side-mounted fans developing thrust for forward flight. The propulsion system uses an Allision engine to drive a centrifugal compressor in hover. A duct delivers the compressed air through a flexible sleeve to the air distributor around the rotor shaft. From there, it goes by flexible hoses to the roots of the fully articulated blades. At the blade tip, the hot air is expanded through flush mounted slot nozzles. An important feature is a built-in rate of climb of 1600 ft/min for the initial 280 ft. Descriptions are given of the airframe structure, vibrational characteristics, stability, control, maintenance, reliability, and costs. T.M.

A70-35646 # Model for the prediction of closed compartment fire propagation. M. Bello and A. L. Johnson (Aerospace Corp., El Segundo, Calif.). *(American Institute of Aeronautics and Astronautics, Thermophysics Conference, 4th, San Francisco, Calif., June 16-18, 1969, Paper 69-618.) Journal of Spacecraft and Rockets,* vol. 7, July 1970, p. 788-793. 6 refs.

Mathematical model of a closed compartment fire developed to analyze the effects of various combustion parameters and analytically predict the composition, pressure, and temperature histories of the atmosphere during a fire. A one-dimensional analytical model of a compartment fire was developed utilizing heat and mass balances and material combustion characteristics. A semiempirical expression is formulated to relate the average linear burning rate of the combustible materials and the flame propagation which includes the effect of convective velocity, gravity, total pressure, and oxygen partial pressure. A computer program was used to solve the equations resulting from the heat, mass, and combustion equations. Results of the analysis provide a macroscopic overview of a fire in a closed compartment. (Author)

A70-35657 # A thin strap support for the measurement of the dynamic stability characteristics of high-fineness-ratio, wind-tunnel models. W. A. Millard and W. H. Curry (Sandia Laboratories, Albuquerque, N. Mex.). *(American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 4th, Cincinnati, Ohio, Apr. 28-30, 1969, Paper 69-350.) Journal of Spacecraft and Rockets,* vol. 7, July 1970, p. 854-858. 21 refs. AEC-supported research.

A transverse support system that appears to have minimal support interference effects has been developed for use in dynamic-stability tests of high fineness ratio wind tunnel models. It consists of a thin metal strap placed in tension between the walls of the tunnel. The model is mounted on the strap in a manner which allows the model to oscillate freely in the plane of the strap. Dynamic-stability tests using the strap rig were conducted on a model of the Tomahawk rocket (fineness ratio 23.3). The tests were conducted at M = 7.3 in the Sandia, 18-in. hypersonic wind tunnel. The test results were compared with data derived from theoretical studies, from other wind tunnel programs, and from full-scale flight tests. Reasonable correlation was obtained. (Author)

A70-35661 # Hele-Shaw and porous medium flow for space fuel cells. H. A. Dwyer (California, University, Davis, Calif.) and D. Erickson (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *(American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-678.) Journal of Spacecraft and Rockets,* vol. 7, July 1970, p. 873-875.

Experimental study of the behavior of Hele-Shaw and porous medium fuel tank systems to investigate the characteristics of these types of flow systems with respect to sloshing, wetting and funnelling, and to study any new problems associated with the Hele-Shaw and porous medium tanks. The study was carried out in a simulated low-gravity environment. Results indicate that sloshing and wetting are eliminated as basic problems, while funnelling remains somewhat of a controllable problem. The major new fluid flow problem found was an interface instability between the liquid fuel and the driver gas. The experiments compared the theory of Saffman and Taylor (1958) for the stability of fluid interfaces in an infinite medium with the finite tank configurations. In all experiments the amount of fluid left in the tank was also measured. (Author)

A70-35696 # Lifting and side forces acting on a body in transonic flow (O pod'emnoi i bokovoi silakh, deistvuiushchikh na telo v transzvukovom potoke). E. D. Terent'ev. *Prikladnaia Matematika i Mekhanika,* vol. 34, Mar.-Apr. 1970, p. 324, 325. In Russian.

Determination of the distributions of the lifting force and the side force between the wake behind a body and the transonic external flow. The results are obtained by dividing the lifting and side forces into a component representing the portion of the force which derives from integrating the momentum flow density tensor over the wake area, and a component representing the portion of the force which derives from integrating the external flow function, and by establishing a relation between these components. It is shown that the distributions obtained hold for both viscous and ideal gas flows. V.P.

A70-35802 # Development of the S-3A carrier-based ASW weapons systems. Fred H. Baughman (U.S. Naval Air Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-882.* 5 p. Members, $1.25; nonmembers, $2.00.

The Navy's new carrier-based ASW aircraft, the S-3A, is now in Engineering Development. This replacement for the S-2 'Tracker' represents a giant step forward in carrier-based ASW, and is a fitting counterpart to the land based P-3C. The S-3A will carry a complex and highly integrated avionics suite to combat the anticipated submarine threat of the late 1970s. Heavy emphasis in the development program is placed upon early integration and test of key elements of this avionics system. Contract terms are aimed at reducing risk and assuring achievement of key development milestones prior to committing the government to production. (Author)

A70-35803 # **F-111 design experience - Use of high strength steel.** Urban A. Hinders (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-884.* 10 p. Members, $1.25; nonmembers, $2.00.

High strength steel (220-240,000 PSI) is used extensively as load bearing structure in the F-111 wing, fuselage, and empennage support structure. Cyclic load testing of this structure caused fatigue failures which, together with the inflight failure of a forged steel part, have been subjected to extensive analysis and review. The purpose being to evaluate the known and potential problems associated with the design of highly loaded steel parts. The major conclusion is that a coordinated engineering approach to design, fabrication and inspection procedure are required to achieve a sound design and that fracture mechanics analyses can provide this coordinated approach. (Author)

A70-35804 # **Marine Corps plans for introduction of Harrier aircraft into the close air support role.** Homer S. Hill (U.S. Marine Corps, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-885.* 6 p. Members, $1.25; nonmembers, $2.00.

The introduction of Harrier into operational units will have a twofold objective. The first is to employ Harrier within the existing, proven and highly effective Marine Tactical Air Control System, with as few changes to the system as possible. The second is to exploit the unique V/STOL capabilities of Harrier which will allow dispersed operations on land from austere, forward bases and at sea from the helicopter platforms and flight decks of amphibious shipping. Dispersed operations will reduce vulnerability to enemy attack and result in vastly increased responsiveness to requests for close air support. (Author)

A70-35805 # **747 operations - The first 100 days.** Donald E. Kinkel (Pan American World Airways, Inc., Jamaica, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-891.* 6 p. Members, $1.25; nonmembers, $2.00.

It was determined during B747 development to implement an updated flight training philosophy, emphasizing curriculum simplification, highlighting differences between this and aircraft previously operated, and limiting instruction to those systems the crew could gainfully employ. Confidence in this approach was warranted. During the first 100 days of scheduled operation, concern with size and mass diminished in favor of emphasis upon further refinement of operating techniques to obtain better performance. Improved instrumentation and a more sophisticated navigation system greatly facilitated the uneventful and orderly introduction of the B747 into scheduled operation. (Author)

A70-35806 # **Development of the initial maintenance program for the Boeing 747.** James E. Dougherty, Jr. (U.S. Department of Transportation, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-889.* 10 p. 18 refs. Members, $1.25; nonmembers, $2.00.

This paper sets forth the basis utilized by the Federal Aviation Administration to establish the initial maintenance and inspection program for the Boeing 747. It traces procedural techniques employed in cooperation with interested industry segments. It also describes the development and application of reliability programs now in common use in the field of aircraft maintenance. The relationship of the condition monitoring concept to the program is discussed. The Boeing 747 Maintainability Program is summarized as well as the applicability of such a program to forthcoming large aircraft types. (Author)

A70-35807 # **747 operations - The first 100 days - Maintenance.** B. H. Pabst (Pan American World Airways, Inc., Jamaica, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-890.* 4 p. Members, $1.25; nonmembers, $2.00.

Review of the early service experience with the JT9D engines used on the 747 aircraft. In the course of the first 100 days of operation, 24 unscheduled engine removals occurred due to eleven different causes. Faults and fixes are discussed. It is felt that the JT9D engine has not yet lived up to expectations in performance and reliability, though no doubt is entertained as to its ultimate development into a reliable efficient engine. M.V.E.

A70-35808 # **747 operations: The first 100 days - Ground operations/airport services.** G. Erskine Rice (Pan American World Airways, Inc., Kennedy International Airport, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-892.* 5 p. Members, $1.25; nonmembers, $2.00.

The introduction of the Boeing 747 provided a challenge for Pan Am's Airport Services staff which was proportional to the new aircraft's size and capacity. New concepts, such as Pan Am's computerized check-in system and the container handling system, have become an integral part of 747 operations. A new line of ground handling equipment was designed and built, new procedures written and implemented, and requisite training carried out. These efforts have enabled Pan Am to service the 747 at the airport at a level equal to or exceeding our experience with other aircraft. (Author)

A70-35809 # **The design of composite compression tubes.** D. A. Collings and F. R. Steinlein (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-898.* 7 p. 5 refs. Members, $1.25; nonmembers, $2.00.

An analytical and experimental study of the mechanical properties of axially-loaded composite tubes is described. Boron/epoxy, glass/epoxy, and graphite/epoxy tubes were evaluated for possible applications to VTOL aircraft components and comparisons made with aluminum, titanium, and beryllium design solutions. To obtain a valid comparison between each design, an optimum geometry was calculated such that, under axial compressive loading, failure occurred simultaneously by local instability of the tube wall (crippling) and a general instability of the component (column failure). Based on these criteria, expressions were developed for the optimum design of any tube in terms of its longitudinal and transverse material properties. A computer-aided design procedure was developed in which the designer interacts with the program to arrive at a near-optimum solution within given constraints. To support the analysis, experiments were performed in which cross-plied S-glass tubes were tested under axial compression. The effects of longitudinal and transverse moduli on the local instability of round tubes is discussed. A potential application of composite tubes to VTOL aircraft structural components was demonstrated by the design and fabrication of a composite tail skid brace assembly. Model studies were made of a possible redundant truss structure for the tail section of a large crane helicopter. (Author)

A70-35810 # **System engineering process for survival enhancement of military aircraft.** Walter D. Dotseth (North American Rockwell Corp., Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-893.* 10 p. Members, $1.25; nonmembers, $2.00.

Description of the system engineering process for survival enhancement of military aircraft designed to meet the more stringent survivability requirements of a general nuclear war. Elements for

design, development, validation, and evaluation of the total survivability/vulnerability system are presented and shown to be compatible with the requirements of Military Standard MIL-STD-499, 'System Engineering Management.' The process is structured to be adaptable to any type of military aircraft system. M.V.E.

A70-35811 # **The need for development of a system to achieve fastener standardization.** H. H. Cunningham, Jr. (American Airlines, Inc., Tulsa, Okla.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-894.* 11 p. 9 refs. Members, $1.25; nonmembers, $2.00.

A detailed review is made of current design practices involving fasteners as applicable to airline operation. Recommendations are given for a standardization guideline to provide for more efficient utilization. Problems are discussed associated with the myriad of redundant fastener configurations available along with ill defined installation practices. Requirements necessary to insure maintenance of fastener integrity throughout their service life are considered. Such requirements include design objectives resulting from airline operational experience. A system approach is suggested to allow standardization of an operator's fastener inventory. It is based on specific strength level requirements and wrenching configuration for applicable threaded fasteners. (Author)

A70-35812 # **Special structural design considerations for wide-body commercial jet transports.** W. M. Laurence (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-895.* 6 p. Members, $1.25; nonmembers, $2.00.

The new wide-body jetliners offer substantial improvements in operating efficiencies and passenger comfort over previous transports. This paper discusses special considerations required in the structural development of these wide bodies, and how these considerations were applied in the design of the McDonnell Douglas DC-10. The use of trade studies and their required degree of complexity in the development of the design are discussed. The dominating influence of cabin pressurization loads on a large fuselage, especially with respect to fatigue and fail-safe requirements, is emphasized. Considerations in the control of the stiffness and analyses for the stability of the shell are presented. Finally, the efficient usage of the wide-body transport for carrying both passengers and cargo is discussed. (Author)

A70-35813 # **Composite airframe design.** D. G. Whinery, K. I. Clayton (North American Rockwell Corp., Columbus, Ohio), and C. Tanis (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-896.* 7 p. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-3508.

Manufacturing methods utilizing unidirectional glass reinforcement were applied to design and fabrication of a demonstration wing section resenting the T2B airplane wing from station 115 to tip station 207.5. Design was substantiated by detail tests. Fabrication problems and solutions are discussed. Ultimate strengths of fullscale structures were 6% and 30% over the design goal with 40% less weight, 20% less estimated fabrication cost, greater bending stiffness-to-weight ratio, and greater torsional stiffness-to-weight ratio than an aluminum wing. (Author)

A70-35814 # **Acoustic fatigue design information for honeycomb panels with fiber reinforced facings.** M. J. Jacobson (Northrop Corp., Aircraft Div., Hawthorne, Calif.) and R. C. W. van der Heyde (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-897.* 9 p. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-67-C-1672.

This paper is concerned with portions of an extensive analytical and experimental program that was formulated to obtain acoustic fatigue design information for fiber reinforced structure. Fiber reinforced structure is expected to see increasing use in aircraft because of its favorable strength-weight ratio, and acoustic fatigue design information for such structure is needed. Panel design, stress data, panel lifetime, and modes of failure are reported from acoustic tests of honeycomb panels, mainly with S-glass fiber reinforced facings, but also with boron fiber reinforced facings and with aluminum alloy facings. Facing failures near the panel center predominated. When failure occurred in the facings near the panel center, the predicted panel life, based on the Rayleigh-Miner hypothesis, is compared with experimental life for panels with S-glass fiber reinforced facings. The effects of angle-plied facings, cross plied facings, and parallel-plied facings on the panel life and mode of failure are reported. In addition to providing acoustic fatigue design information, this program has demonstrated that high quality honeycomb panels with S-glass fiber and boron fiber reinforced facings can be designed and fabricated to offer greater resistance to acoustic loading than well-designed and well-fabricated aluminum honeycomb panels of comparable weight and thickness. (Author)

A70-35815 # **Air transport mission capability analysis.** W. G. Huley (United Air Lines, Inc., Chicago, Ill.) and A. P. Donow (United Air Lines, Inc., San Francisco, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-899.* 6 p. Members, $1.25; nonmembers, $2.00.

Efficient utilization of commercially operated airplanes requires the air line operator to thoroughly understand the mission capabilities of his equipment. Since payload and range performance capability are influenced by many variable factors such as environmental, geographical, regulatory, airplane design, and operational policies, it is essential that an adequate accounting be made of the many limitations imposed by these factors for a meaningful analysis. This paper deals with an evolutionary approach to mission capability analysis that attempts to establish payload and range capability and measure its suitability in terms of confidence levels and probabilities of occurrence. It also explores the variety of applications for this type of information beyond those normally associated with scheduling and routing activities. Furthermore, it discusses the many ways analyses may be processed, ranging from simple or elaborate hand-produced studies to utilization of on-line flight planning computers as well as computerized programs developed for mass production output. (Author)

A70-35816 # **Minimum equipment list - A manufacturer's and user's viewpoint.** Webster C. Heath (Douglas Aircraft Co., Long Beach, Calif.) and W. R. Paul Surbaugh (American Airlines, Inc., Flushing, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-900.* 4 p. Members, $1.25; nonmembers, $2.00.

Discussion of the history and functions of the Minimum Equipment List (MEL), and review of the manufacturer's and user's participation in it. MEL origins are shown to antedate the commercial jet age, and the development of the FAA guidelines for this list appears to have proceeded systematically and satisfactorily. The significant changes the technical development of this list has undergone during recent years are pointed out. The manufacturer's efforts in this area are shown to start very early in the design development of a new aircraft and to continue through the flight test phase and the airline operational phase, notwithstanding the fact that the MEL is normally a matter between the FAA and the airline. It is felt that the MEL should be considered during design and test in order to ensure a high degree of dispatchability for new aircraft in future years of operation. M.V.E.

A70-35817 * # **On the application of heat and force fields to the sonic boom minimization problem.** David S. Miller and Harry W. Carlson (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-903.* 9 p. 26 refs. Members, $1.25; nonmembers, $2.00.

There is much interest and some controversy concerning the possibility of sonic-boom suppression through airstream alteration by application of force or heat fields. The present paper presents a discussion of the relationship of these more exotic schemes to conventional approaches involving shaping of the aircraft itself, describes the required flow-field alteration for the more promising heat-field method, and provides a first estimate of power requirements. The results of the study indicate that finite rise-time signatures which offer substantial sonic-boom alleviation are theoretically obtainable but that severe, if not unsurmountable, problems of implementation are presented. (Author)

A70-35818 * # **A fluidic low-speed air-speed indicator.** Richard J. Miner (NASA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-906.* 5 p. Members, $1.25; nonmembers, $2.00. Contract No. NAS 12-2038.

Cross flow and parallel flow techniques were investigated. The parallel flow technique was chosen. A prototype has been wind tunnel tested. It has a near linear response from 0.3 to 90 feet per second. This sensor is light in weight, simple in operation and has no moving parts. Efforts are underway to optimize the sensor performance and develop a flightworthy unit. Reynolds number scaling was used to relate the sensors behavior in water with colored dye as a tracer. (Author)

A70-35819 # **The safety gap in flying today.** Richard L. Newman (National Association of Flight Instructors, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-907.* 9 p. 35 refs. Members, $1.25; nonmembers, $2.00.

Aviation is challenged by an awareness gap between engineers and line pilots, resulting not from ignorance of aircraft performance, but from a lack of understanding of each other's jobs on a day-to-day basis. The cause of this is threefold: the design engineer has a very idealistic view of just how his airplane will be used; the aircraft certification standards are often inappropriate; and the line pilot is often unaware of the basis for some of his procedures. Areas in which I suggest remedies are improved aircraft instrumentation, realistic certification standards, improved pilot training, and increased pilot participation in the design of the aircraft. (Author)

A70-35820 # **The case for an integrated flight management system.** J. G. Ayers and A. S. Bolthouse (IBM Electronics Systems Center, Owego, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-908.* 6 p. Members, $1.25; nonmembers, $2.00.

Four major tasks have evolved for the commercial aircraft pilot: to fly the plane; to compute or monitor operational parameters; to interface with the air traffic control system and to avoid collisions. Each new generation of aircraft increases the repetitive and routine activities that the pilots must perform. A flight management system, integrated by a central digital computer, is suggested to perform the routine procedures and free the pilot to concentrate on the primary task of flying the plane. The elements and interfaces of a flight management system for next-generation aircraft are identified and discussed. (Author)

A70-35821 # **A certificated stick force augmentation system for light STOL aircraft.** Robert L. Devine, Gustav H. Dreier, and R. Hunter Blackwell (Helio Aircraft Co., Bedford, Mass.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-909.* 5 p. Members, $1.25; nonmembers, $2.00.

A servo actuator is used on the Helio HST-550A Stallion, a single-engine turboprop STOL aircraft, to augment longitudinal stick forces at very high angles of attack. An electrical signal proportional to angle of attack is generated by a vane and modified by a small on-board signal processor. The processor electrical-current output is applied to the servo, which generates pitch-down stick forces as a function of current input. Various fail-safe features are incorporated, and the system is enabled to operate only at low airspeeds. The system is particularly applicable to STOL aircraft which can achieve very high angles of attack. (Author)

A70-35822 # **Negative G Drone aircraft surface tension fuel system.** H. W. Barber and R. Lavi (Northrop Corp., Ventura Div., Newbury Park, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-910.* 5 p. Members, $1.25; nonmembers, $2.00.

The U.S. Navy MQM-74A Target Drone employs the surface tension principle in the fuel system to prevent air inclusion in the turbojet engine fuel during negative or zero g flight maneuvers. The system consists of two surface tension filters (screens) located in the fuel tank. The surface tension fuel pickup units are interconnected to the fuel pump intake and each is covered with a negative g hood. This system has the unique feature of eliminating moving parts normally found in aircraft fuel feed systems, i.e., flapper valves, check valves, accumulators, and dual-ended boost pumps. During negative g transients, the fuel trapped by the hood maintains positive contact with the surface tension screen. The liquid film bridging the screen pores forms a liquid membrane that resists gases from going through, while allowing a free flow of liquid across the screen pores. Continuous fuel flow is thus maintained throughout the vehicle flight maneuver and during adverse g transients. The MQM-74A surface tension fuel system has met design requirements and is operational. (Author)

A70-35823 # **An advanced extensible wing flap system for modern airplanes.** W. W. Williams (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-911.* 6 p. Members, $1.25; nonmembers, $2.00.

An advanced extensible wing flap system for a modern heavy cargo airplane was designed, analyzed and compared with similar conventional systems now in production. The advanced system employs gear-driven sliding rails to support and extend the flaps and a separate set of gearboxes with linkages buried inside the flaps to control the flap angles. It uses no tracks, rollers, carriages or screwjacks and all attachments to the flaps and wing structures utilize spherical self-aligning bearings which allow the conjugate motions of the flap and the structural deflections to occur without binding or jamming the mechanism. The advanced system reduced the system weight, the system manufacturing costs, the FAA takeoff field length and increased the productivity of the airplane. It is applicable to most extensible flap arrangements fitted to most airfoils including the new 'peaky' and 'supercritical' sections. (Author)

A70-35824 # **An unusual component - The Boeing model 737 nose gear gravel deflector.** Charles E. Loughney (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-912.* 6 p. Members, $1.25; nonmembers, $2.00.

Discussion of the design, development, and testing of the Boeing Model 737 nose gear gravel deflector and engine vortex dissipator.

These two components are the main among a number of features the aircraft incorporates for making gravel runway operation safe. The deflector keeps the nose tire gravel spray from damaging the wing mounted engines, while the engine vortex dissipator prevents engine vortex action from causing undue gravel ingestion. M.V.E.

A70-35825 # SST brake control system. James E. Klansnic (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-913.* 3 p. Members, $1.25; nonmembers, $2.00.

Description of the SST electrohydraulic primary and standby brake control system. The electrical control system consists of independent normal and standby brake systems including their power supplies. Pedal force is converted into an electrical signal by a triple-channel force transducer. The transducer signals are transmitted to a mid value logic function which permits only the middle strength signal to be transmitted to a summing point for each wheel brake. The wheel speed transducer signal is processed through an electronic unit which continuously scans all wheel velocity signals to obtain a reference wheel velocity. The wheel speed transducer signal is compared to the reference, modified and summed with the pedal transducer signal and transmitted to the valve drivers which then provides a valve force to generate a brake pressure level which delivers an optimum braking effect. The standby system functions in a similar manner. The major features of the overall system are improved performance, lighter weight, and ready adaptability to all weather conditions. M.V.E.

A70-35826 # C-5A main landing gear bogie pitching control. Herman S. D. Yang (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-914.* 9 p. Members, $1.25; nonmembers, $2.00.

The C-5A six-wheel main landing gear bogie, as the result of a high flotation requirement, poses a problem for designing a wheel braking torque compensating mechanism which stabilizes bogie pitching during braking. For ground operation, the bogie is also required to pitch plus or minus 12 deg with respect to the shock strut. During retraction of the main gear, however, the bogie is required to be at right angle with the shock strut for the first 60% of the gear travel and then rotate about the pitch pivot with a defined pattern for 85 deg. To meet these requirements, avoiding weight penalty and complexity, a single braking torque link is used; and the bogie pitching control for on ground and in air operation is simplified to a two-stage pneumatic centering spring cartridge with the utilization of the torque compensating mechanism and a guiding track in the wheel well. (Author)

A70-35827 # Multiple-channel actuation system for the Boeing 2707 SST horizontal tail. Robert H. Hurlow (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-915.* 4 p. Members, $1.25; nonmembers, $2.00.

Discussion of some of the unique features of the horizontal tail actuation system of the B2707 SST, representing significant advances in control system technology. These features include: single-surface pitch control, four-channel integrated stability augmentation servos, and force 'voting' and equalization of multiple control channels to provide fail-operational/fail-safe redundancy. These features are expected to provide the necessary bridge to a fully electrically controlled commercial airplane in the foreseeable future. M.V.E.

A70-35828 # Evaluation tests of precision taxi and docking guidance systems. W. A. Browning (American Airlines, Inc., Tulsa, Okla.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-916.* 7 p. 9 refs. Members, $1.25; nonmembers, $2.00.

Two visual display systems and an automatic taxi guidance system were subjected to limited testing to determine their effectiveness at improving aircraft docking accuracy. These systems were tested because a need for improved ground guidance systems for wide-bodied aircraft was anticipated and because precision parking capability was considered as a necessary element in the development of a proposed modular loading dock. Neither visual display system, one using colored light beams and the other a Fresnel lens with a light source, offered significant improvement over the existing visual aids. The magnetic leader cable type automatic steering system was not developed sufficiently for conclusive results, but automatic steering appears to be promising and shows its greatest potential in low visibility applications. Subsequent service experience with the 747s has shown that ground maneuvering ability is better than expected and the immediate need for these systems has diminished somewhat. (Author)

A70-35829 # Advanced baggage handling and processing concepts. John Kukar (United Air Lines, Inc., Chicago, Ill.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-917.* 4 p. Members, $1.25; nonmembers, $2.00.

Due to industry growth and sprawling terminal facilities, a third generation of automated hardware has emerged and has been prototyped. When put in regular service, satisfactory operation is anticipated. However, manual code writing is required. Compelling physical and economic constraints require a completely automated system. As a first step, manual coding must be eliminated and ultimately automatic baggage dispatch to the airplanes is necessary. The ultimate objective requires total aviation community participation, i.e., airframe, hardware and controls manufacturers as well as airport operators, airlines and facilities planners. An effort of this magnitude can best be coordinated through A.I.A. (Author)

A70-35830 # Mobile lounges and airport productivity. Robert B. Wilson (Eastern Air Lines, Inc., Miami, Fla.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-918.* 6 p. Members, $1.25; nonmembers, $2.00.

Discussion of the problem of optimizing the handling of passengers from the time they enter the airport terminal until they are seated in the aircraft, and vice versa. Only existing general systems are considered, and of these only two are ultimately compared: (1) the mobile lounge, a large vehicle up to 15 feet wide by 55 feet long, transporting passengers from the waiting area to the aircraft and able to receive and deliver passengers from or to the aircraft and terminal building at the floor heights involved, sparing passengers the necessity to climb stairs; and (2) the conventional fixed facilities consisting of a loading bridge over which a passenger can walk from the terminal building into the aircraft. The results of various studies indicate that the volume of passenger traffic, the passenger amenities, the total time for his trip, and the scheduled turnaround time for aircraft at the terminal are all accommodated equally well by fixed facilities and by mobile lounges. In terms of first costs, as well as of annual expenses over the long term, including amortization and interest for capital items and the cost of operation and maintenance for buildings and equipment, there appears to be an advantage to the mobile lounge solution. Other intangible and judgmental factors which can argue for or against mobile lounges are also set forth. M.V.E.

A70-35831 # A design study of a C-5 aircraft cargo loading system for major permanent terminals. W. L. Cowart (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-919.* 9 p. Members,

$1.25; nonmembers, $2.00.

Several operational and design concepts have been proposed for cargo loading systems to permit the rapid and efficient offloading and loading of the C-5 aircraft and the transfer of cargo between the terminal buildings and the aircraft parking sites. Since the C-5 aircraft flight hours are at a premium during contingency operations, minimizing aircraft ground time is the goal of loading system design. This Air Force funded study examines four loading system concepts. Each concept is examined in sufficient depth of design detail to permit costing and to identify any development problems that might result from the approach. Quantitative and qualitative rationale for the selection are offered, and the design and operational characteristics of the selected system are detailed. (Author)

A70-35832 # **Joint-use cargo terminal planning.** John B. Parkin (Parkin Architects Engineers Planners, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-920.* 5 p. Members, $1.25; nonmembers, $2.00.

Large-capacity transports are coming into service as air cargo operations at large hubs are suffering from current problems - low profitability, shortage of airport land, airport vehicular and ramp congestion, tight money, pilfering, etc. New trends are evident - door-to-door service, off-airport cargo facilities, unitized loads, containerized shipping and faster turn-around times. Large carriers are better able to satisfy market needs by independent action than the small carriers who usually depend on the airport authority to provide joint-use of on-airport facilities. Single occupancy cargo terminals can be tailored to the carrier's operations but in joint-use cargo terminals the terminal owner's interest of long term flexibility is a major design consideration. The paper discusses the influence of large capacity transports on air cargo operations and describes the resulting planning principles as they are applied to a new joint-use cargo terminal being constructed at Los Angeles International Airport. (Author)

A70-35833 # **C-5 flight simulation program.** C. P. Moore (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-922.* 11 p. 7 refs. Members, $1.25; nonmembers, $2.00.

The C-5 flight simulation program was formulated to provide direct support to the design and development of the basic aircraft and its flight control and guidance subsystems. The aircraft handling qualities criteria that existed at the time the C-5 design studies commenced indicated that satisfactory pilot control of an aircraft of this large size, weight, and inertia would be difficult to achieve. The number of flight control surface hydraulic power servos, long control cable length, and the requirements for the artificial feel system were also a matter of concern. The aircraft mission specification required an autopilot and flight director with a large number of modes of operation and extensive pilot navigation and guidance aids including terrain following and automatic landing. These considerations dictated the extensive use of ground-based simulation commencing with the earliest preliminary design and continuing through acquisition of system hardware and flight test demonstration. This paper describes the simulation program plan, techniques used, equipment required, and compares significant results with those obtained in flight test. (Author)

A70-35834 # **Aircraft simulation application to the development of the Concorde project.** Jean Pinet (Société Nationale Industrielle Aérospatiale, Toulouse, France). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-923.* 8 p. Members, $1.25; nonmembers, $2.00.

Consideration of simulation as the required solution for study of the man-machine coexistence, particularly for handling studies where the introduction of man, as a sophisticated transfer function in the mathematical computations, is not yet at a sufficiently advanced stage. For this study, the fixed cabin simulator in Paris, the variable stability Mirage IIIB, the BAC Bristol ground based simulator, and, mainly, the Aerospatiale Toulouse ground based simulator were used. Results are described in detail. F.R.L.

A70-35835 # **Simulator development and flight validation of a perspective display as an independent landing monitor.** Donald L. Parks and David G. Tubb (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-924.* 11 p. 7 refs. Members, $1.25; nonmembers, $2.00.

Pilots performing low visibility landings will most likely require a landing monitor which is independent of current landing aids. Preliminary requirements for the monitor were derived by applying unique simulation techniques using a perspective display based on 'electronic runway lights' (e.g., microwave transmitters/radar reflectors/infra-red sources). Display evaluations consisted of quantifying pilot accuracy in (a) assessing simulated automatic approaches, (b) estimating point of aim from decision height, and (c) deciding to land or go-around. 'Aiding' symbology improved pilot accuracy and produced comparable results with head-up and head-down displays. Flight tests confirmed simulator results, justifying simulation technique, precision and realism. (Author)

A70-35836 # **In-flight evaluation of selected pilot's controllers.** D. W. Rhoads (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.), D. E. Frearson, and J. A. Townsend (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-925.* 12 p. 7 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-69-C-1023.

A comprehensive in-flight evaluation of selected large aircraft pilot's controller concepts has indicated their overall desirability as compared with the conventional column and wheel. The concepts, a dual side-arm controller, a circumferential drive wheel and column, and a combination of the latter and an integral hand controller, were evaluated using B-1 type airplane statics and dynamics in the Cornell Aeronautical Laboratory B-26 variable stability aircraft. Four subjects provided objective and subjective data for cruise, simulated terrain following and takeoff and landing flight conditions. The data, in addition to indicating the overall desirability, have pinpointed design deficiencies. (Author)

A70-35837 # **Development of a flying qualities criterion for the design of fighter flight control systems.** T. Peter Neal and Rogers E. Smith (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-927.* 13 p. 10 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-69-C-1664.

It is readily apparent that current longitudinal flying qualities criteria do not adequately account for the effects of dynamic modes introduced by today's complex flight control systems (FCS). To remedy this situation, a combined analytical and experimental investigation was recently conducted, using the USAF/CAL variable-stability T-33 airplane. Based on an extensive pilot-in-the-loop analysis of the experimental results, a design criterion was developed which is shown to be applicable to a wide range of short-period and FCS dynamics. A simplified version is also presented to provide the designer with preliminary estimates of flying qualities. (Author)

A70-35838 # **A design approach to provide satisfactory spin characteristics for a modern fighter aircraft.** G. R. Casteel (North American Rockwell Corp., Los Angeles, Calif.) and Carl J. Weyl (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-928.* 8 p. 6 refs.

Members, $1.25; nonmembers, $2.00.

The proposed program includes designing for spin resistance as well as for spin recovery. The spin-resistance criterion presented can be used by the designer to evaluate the spin resistance of a given design. Highlights and technically interesting aspects of individual design tasks include analytical spin calculations, aerodynamic data requirements, configuration sensitivity studies, model tests, and flight test. It is recommended that spin characteristics be actively investigated from the preliminary design stage through flight-test demonstration. Greater utilization of analytical spin calculations is also recommended to interpret model test results, configure the aircraft, and help plan the flight-test demonstration program. (Author)

A70-35839 # **Dynamics and control of helicopters with two-cable sling loads.** Malcolm J. Abzug (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd. Los Angeles, Calif., July 20-22, 1970, Paper 70-929.* 12 p. 6 refs. Members, $1.25; nonmembers, $2.00.

Lift helicopters carry heavy loads (on cables) that are external to the fuselage. Load motions relative to the fuselage cause stability and control problems. To study these problems requires dynamic models of the helicopter and its load. This paper expands previously published single-cable models to consider the case of two tandem cables. The two-cable model is derived from the general equations of multiple-part motion originally developed for satellite attitude control studies. Small perturbation equations of motion are presented, in two separable sets. The longitudinal motions have four-degrees of freedom; the lateral motions have six degrees of freedom. A brief closed-loop analysis is made of the impact of sling degrees of freedom on yaw damping in hover. Conventional yaw damping does not produce satisfactory stability for the modes associated with the load pendulum motions. However, combining feedback of differential transverse cable angle with yaw rate feedback produces satisfactory damping of all modes. (Author)

A70-35840 # **Determination of realistic performance trade-offs in the air-to-air role.** R. W. Gallington and D. Finkleman (U.S. Air Force Academy, Colorado Springs, Colo.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-930.* 10 p. Members, $1.25; nonmembers, $2.00.

Recent air superiority fighter studies have failed to include systematically the trade-offs between ordnance and aircraft capabilities. Compromises among performance demands must be studied along with the capabilities of current technology in order to arrive at the most effective weapons system within the state-of-the-art. The investigation to be described has led to the formulation of a realistic design philosophy which allows analysis of the interrelated demands upon armament, detection capability, thrust, speed, and load factor. (Author)

A70-35841 # **Optimal takeoff trajectories of a heavily loaded helicopter.** F. H. Schmitz. *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-931.* 13 p. 9 refs. Members, $1.25; nonmembers, $2.00. Contract No. DA-28-043-AMC-02412(E).

Optimal control theory has been applied to the STOL takeoff of a heavily loaded helicopter. The object of the analysis was to determine constrained and unconstrained extremal trajectories which maximize the terminal vertical distance for a given fixed horizontal distance. The resulting optimal trajectory consists of an initial acceleration segment followed by a decelerating segment in which most of the terminal altitude is gained. If the problem was constrained to nondecelerating flight, the resulting optimum consisted of a maximum acceleration segment followed by a constant velocity climbout segment. The slightly decreased performance of the constrained optimum was more than offset by its ease of implementation. (Author)

A70-35842 * # **Some trim drag considerations for maneuvering aircraft.** Linwood W. McKinney and Samuel M. Dollyhigh (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-932.* 11 p. 7 refs. Members, $1.25; nonmembers, $2.00.

Summary of the results of a preliminary analytical and experimental study of trim drag characteristics at maneuvering lift coefficients. The study includes aft-tail configurations at subsonic and supersonic speeds and canard configurations at subsonic speeds. It is shown that the tail load required to minimize trim drag is highly dependent on the wing-body drag-due-to-lift characteristics with examples presented for both the full and zero leading-edge suction cases. M.V.E.

A70-35843 # **Airframe-inlet integration.** Paul W. Hill (General Dynamics Corp., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-933.* 12 p. Members, $1.25; nonmembers, $2.00.

Vehicle conceptual design and performance analysis have been accomplished on eight advanced supersonic tactical fighters. Four configurations have been selected for wind tunnel tests to develop aircraft design criteria related to airframe-propulsion subsystem integration. All configurations were designed to meet requirements established for advanced supersonic tactical fighters. Wing loading and thrust loading were maintained constant for all designs and configuration changes restricted to those caused by the different inlet types and locations. Effects of the different airframe-inlet arrangements have been defined in terms of range and maneuver capability. (Author)

A70-35844 # **Close-spaced nozzles twin jet configuration.** L. W. Throndson (North American Rockwell Corp., Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-934.* 11 p. Members, $1.25; nonmembers, $2.00.

Nozzle drag of twin-jet afterburning engine-powered tactical aircraft is often a problem. As a result, podded engines or semi-isolated wide-spaced nozzles are receiving much attention. Overall aircraft drag and weight can generally be reduced via a compact configuration employing close-spaced nozzles, but the drag of the inboard boattail surfaces of adjacent nozzles is an area of concern. Examination of existing data in the literature indicated afterbody and nozzle drag could be low with adjacent exhaust nozzles. Evaluation was needed for the case of afterburning nozzles with relatively steep boattail angles at dry power; and tests were conducted by the Columbus Division at the Langley Research Center 16-Foot Wind Tunnel utilizing a model employing force balances plus extensive pressure instrumentation. Low nozzle and total afterbody drag was obtained in these tests of a close-spaced twin-jet configuration. With suitable shaping of the afterbody, higher pressure recovery was achieved on the nozzle boattail inboard surfaces than on the outboard regions at subsonic cruise conditions. (Author)

A70-35845 # **An examination of the low visibility landing problem below 200 ft and the federal regulations governing operational approval.** George L. Yingling (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-936.* 12 p. 14 refs. Members, $1.25; nonmembers, $2.00.

FAA Advisory Circular, AC No. 120-20 entitled, Criteria for Approval of Category II Landing Weather Minima is examined in the light of recent Air Force experience in flying to and below Category II minima. Findings of other authors, as presented in various papers, are also reviewed and used in the examination. Films of experimental flying in actual weather down to zero-zero (Cat IIIc) are shown to

reveal the pilot's instrument and visual cue problem in attempting to proceed under a 'see-to-land' concept. Conclusions are that such a concept should be discouraged because of lack of adequate cues, lack of means of reporting critical visibility conditions and lack of means of assuring ILS beam integrity. (Author)

A70-35846 # **Seeking a new precision approach and landing system - A test of maturity.** Siegbert B. Poritzky (Air Transport Association of America, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-937.* 8 p. Members, $1.25; nonmembers, $2.00.

Discussion of some of the problems encountered and findings made in the search for a new precision approach and landing system. The RTCA Committee's efforts to select a new approach and landing guidance system are described. The conclusions reached point at an optimized scanning fan beam system believed able to meet most of the operational requirements. Several of the most important problems facing the designers, such as frequency, data rate, and antenna requirements as they affect aircraft systems, are reviewed along with the tradeoff between demands of aircraft systems and limitations of radio systems. Special attention is given to the problem of achieving agreement on a single new system. M.V.E.

A70-35847 # **Advanced controls and displays for future commercial aircraft operations.** John D. Warner (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-938.* 9 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Study of the development of flight deck systems arising from new operational requirements. To accommodate changes expected in this decade and the next requires innovations in the role of the crew and in the hardware to assist them. The emphasis will be more on crew management than on crew actuation. Information presented to the crew will be processed and displayed in an integrated fashion to provide the best visibility of a complex situation. Display systems will employ time-sharing so as to make available the many forms of required information without adding hardware. The operational advantages of three specific systems: the Electronic Attitude Director Indicator, the Pictorial Navigation Display, and the Multifunction Display are discussed. F.R.L.

A70-35848 # **Armament selection for the air-to-air role and its effect on aircraft configuration.** V. M. Marti (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-939.* 9 p. Members, $1.25; nonmembers, $2.00.

Demonstration of how an aircraft configuration can be affected by the air-to-air armament selected. There are not short cuts in the methodology of armament selection for high performance aircraft. Armament must be considered in the initial design in order to achieve the optimum. The high performance of modern aircraft and the extreme demands made on the armament system dictate that the two be considered simultaneously to obtain a viable total system. Major attention is concentrated on air-to-air guns and medium range missiles to give some examples of the in-depth thought that must be applied before a serviceable, accurate, reliable, and safe aircraft weapon system can be selected. F.R.L.

A70-35849 # **Size effects in conventional aircraft design.** F. A. Cleveland (Lockheed Aircraft Corp., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-940.* 32 p. 27 refs. Members, $1.25; nonmembers, $2.00.

As subsonic aircraft size has increased, the useful-load/gross-weight ratio has improved despite the so-called square/cube 'law;' despite increasing requirements for such things as safety, reliability, and maintainability; and despite demands for greater comfort, speed, range, and productivity per dollar. Though future growth potential appears unlimited if adequate technology improvement time obtains, the economic advantage gain rate is flattening and further increases are likely in smaller increments. Nonetheless, one gross weight doubling, and possibly two, is predicted by 1985; nuclear power can drive the optimum weight to five or ten million pounds before the year 2000. (Author)

A70-35851 Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970. 254 p.

Contents:

Introduction. L. Taylor, p. 1-3.

Opening speech. G. Roberts, p. 4-6.

The pilot's view of the next ten years. R. Westbrook (British Air Line Pilots Association, Harlington, Middx., England), p. 7-14.

Operations and economics in the 1970's. R. Heitmeyer (International Air Transport Association, Montreal, Canada), p. 15-37.

The growth of air cargo transport. G. R. Moore (Pan American World Airways, Inc., New York, N.Y.), p. 38-48.

The expanding horizons of air transport. G. G. Kayten (NASA, Washington, D.C.), p. 49-80, 82-94.

The aircraft maintenance department and regularity. W. L. Bennett (British Overseas Airways Corp., London Airport, Hounslow, Middx., England), p. 102-117.

Technical contribution to improvement in regularity. D. J. Mayes (Smiths Industries, Ltd., Wembley, Middx., England), p. 118-137.

The air traffic dilemma and possible cures. R. W. G. Mundy (International Federation of Air Traffic Controllers Associations, East Twickhenham, Middx., England), p. 138-153.

Aircraft design as a factor affecting regularity. S. C. Caliendi (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England), p. 154-174.

The interdisciplinary approach to safety education. J. F. Detwiler (Southern California, University, Los Angeles, Calif.), p. 180-190.

Royal Aircraft Establishment research into air safety. F. A. Hufton and F. O'Hara (Royal Aircraft Establishment, Farnborough, Hants., England), p. 191-221.

An analysis of safety. P. J. Spooner (Lloyd's Aviation Department, London, England), p. 222-227.

A70-35852 # **Operations and economics in the 1970's.** Roderick Heitmeyer (International Air Transport Association, Montreal, Canada). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 15-32; Discussion, p. 33-37.

Outline of some of the more important trends and likely developments in the field of air transport in the 1970s. The economic challenge confronting the world's airlines due to costs rising faster than revenues is considered, noting especially the increase in landing fees and other user charges. The introduction of high-capacity subsonic aircraft (jumbo jets) is discussed, noting their failure to produce any significant reduction in passenger costs per seat-kilometer. The productivity of the supersonic transport is considered from the standpoint of restrictions on its operation due to the sonic boom and the likelihood that in the early stages of its

operation only first class service might be offered or else a surcharge would be levied on economy or tourist services. Some conjectures are hazarded regarding the future development of all-cargo aircraft and V/STOL aircraft. An attempt is made to predict the nature of the operations and routings prevailing toward the end of the 1970s. A.B.K.

A70-35853 # **The growth of air cargo transport.** George R. Moore (Pan American World Airways, Inc., New York, N.Y.). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 38-41; Discusion, p. 42-48.

Discussion of certain factors promoting and impeding the growth of air cargo transport. The all-important factor of profitability is stressed in getting shippers to choose air transport for their cargo in spite of the higher rates. An average annual rate of growth of air cargo transport on the North Atlantic route in the vicinity of 30% per year is predicted for the next decade, provided that time spent in on-the-ground movement of freight can be reduced and customs clearances can be simplified. The need for a new type of air cargo terminal including off-airport satellite facilities is noted. A.B.K.

A70-35854 * # **The expanding horizons of air transport.** Gerald G. Kayten (NASA, Washington, D.C.). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 49-80, 82-94.

Summary of work done by NASA with regard to improvements in the design of subsonic and supersonic aircraft. In connection with the development of new-generation subsonic aircraft, an approach based on the concept of a supercritical wing is cited where shock-induced boundary layer separation is virtually eliminated, as is the associated drag rise. It is hoped to achieve an increase in speed to Mach 1 or very close to it. The need to reduce specific fuel consumption in advanced subsonic propulsion systems is stressed, as well as the need to achieve operation at much higher turbine inlet temperatures (up to as much as 1000 F higher on current engines). The advantages accruing from the use of composite aircraft structures based on high-strength filamentary materials are considered. The development of short-haul intercity transport based on STOL or V/STOL aircraft as a means of relieving congestion at major airports is discussed. The concept of a hydrogen-fueled hypersonic aircraft as a reusable shuttle for low-cost space transportation is evaluated, and the possibility of a nuclear aircraft is briefly touched upon. A.B.K.

A70-35855 # **The aircraft maintenance department and regularity.** W. L. Bennett (British Overseas Airways Corp., London Airport, Hounslow, Middx., England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 102-110; Discussion, p. 111-117.

Description of the procedures used by a major airline to ensure regularity or punctuality of air service. The maintenance and overhaul procedures followed for the Boeing 707s and VC 10s used by this airline are outlined. Factors essential to ensuring regularity of air service after an aircraft has been overhauled are cited, showing how units not directly connected with the overhaul program can aid and support this program. The importance of good management, preferably with flight engineering training, is stressed. A.B.K.

A70-35856 # **Technical contribution to improvement in regularity.** D. J. Mayes (Smiths Industries, Ltd., Wembley, Middx., England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 118-130; Discussion, p. 131-137.

Discussion of the application of autoland hardware to the improvement of aircraft schedule regularity. The autoland system used on the BEA Trident is described; it consists of three subsystems working in parallel to achieve a high safety level by redundancy. The procedure used in designing components of autoland systems and in monitoring the reliability of such systems is outlined. The determination of the total risk for a Category II autoland approach is demonstrated. A.B.K.

A70-35857 # **The air traffic dilemma and possible cures.** R. W. G. Mundy (International Federation of Air Traffic Controllers Associations, East Twickhenham, Middx., England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 138-149; Discussion, p. 150-153.

Discussion, from the standpoint of the air traffic controller, of some of the problems which have arisen as a result of the growth of air transport. The failure of ATC systems throughout the world to keep pace with rapid advances in aircraft design and operating technique is noted. Certain aspects of automation of ATC systems are considered, including the need for coordination in the planning of ATC systems between adjacent national administrations. The inhibiting effects of noise abatement procedures on efficient ATC operations are noted. The worldwide introduction of ATC systems based on the area navigation concept is recommended. Methods of improving communications in ATC operations are suggested, and an improvement in the ATC environment through the use of a worldwide area navigational capability in conjunction with automatic flight procedures coupled with computer-driven ATC systems is recommended. A.B.K.

A70-35858 # **Aircraft design as a factor affecting regularity.** S. C. Caliendi (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 154-174.

Discussion of the methods used by the aircraft manufacturer to ensure that the probability of a delay in departure due to malfunction of equipment is reduced to a practical minimum. The role of the aircraft designer in ensuring regularity of flight departures is discussed, as well as the use of reliability testing to predict malfunctions not revealed by periodic overhauls. An example of a malfunction resolved by theoretical analysis is cited. The use of special interrogation units to reduce the time required for a maintenance crew to detect faults is discussed. The need for feedback of in-service reliability, maintainability, and availability data to the designer is stressed. The types of documentation used in monitoring aircraft design are described. A.B.K.

A70-35859 # **Royal Aircraft Establishment research into air safety.** F. A. Hufton and F. O'Hara (Royal Aircraft Establishment, Farnborough, Hants., England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings. Harlington, England, British Air Line Pilots Association, 1970, p. 191-217; Discussion, p. 218-221.

Indication of some of the areas in which research affecting air

safety is being pursued. Emphasis is placed on the way in which the results of this type of research will affect operational practices and training procedures, as well as the effect it may have on the design and construction of materials. A review is presented of some of the research being carried out with regard to gust loads affecting aircraft during thunderstorms. The use of onboard aircraft airworthiness data recording devices is discussed. Types of fatigue and fracture analysis required for SST components are described. A summary is made of the various types of human error contributing to accidents, showing that many of these errors are not so much human errors as mismatches at the man/machine interface. A.B.K.

A70-35860 # **An analysis of safety.** Peter J. Spooner (Lloyd's Aviation Department, London, England). In: Challenge of the '70s - Air transport growth with regularity and safety; British Air Line Pilots Association, Technical Symposium, 10th, London, England, November 25-27, 1969, Proceedings.
Harlington, England, British Air Line Pilots Association, 1970, p. 222-227.

Analysis of aircraft accident prevention and investigation from an insurer's point of view. It is shown how economic factors sometimes mitigate against the implementation of proper safety measures. Two accidents attributed to improperly publicized modifications on the part of the manufacturer are cited. Some key areas where economics and safety clash in their respective interests are noted. A.B.K.

A70-35879 # **Navigation aids - Evolution and trends.** H. G. Busignies (ITT, New York, N.Y.). *Electrical Communication,* vol. 45, no. 2, 1970, p. 88-91. 6 refs.

Discussion of the progress made in the field of navigation aids in the last 40 years and of future developments in this field on the basis of the new technological advances. Some of ITT's important contributions are listed. Newer developments considered include ground stations for geosynchronous communication satellites, the entire electronic communication package of Intelsat III, and methods of navigation by satellite. Systems based on a combination of the directive effect with distance measurement are listed. Further efforts to make air travel safer are examined. Anti-collision devices, navigation by satellite and the increasing employment of the computer are discussed. G.R.

A70-35880 # **Air-traffic control.** B. Grängsjö (Standard Radio och Telefon AB, Barkarby, Sweden). *Electrical Communication,* vol. 45, no. 2, 1970, p. 92-99.

Description of a nation-wide computer-based air-traffic-control system which will satisfy future requirements for air safety. The system includes a network of radars with real-time display of information in several flight-information centers. As an example, an area 1024 km by 1024 km is considered, and the minimum requirements for automation of the main area-control center are outlined. The area represents a flight-information region; the main area-control center is also referred to as a flight information center. In addition, separate local air traffic-control centers might be needed at several locations for approach and local control. To maintain integrated control over the flight-information region, it is necessary to build up, at some central point, a complete picture of the air traffic. This is the flight-information center, and to perform all its tasks rapidly and accurately it must be computer controlled. G.R.

A70-35889 A numerical method for calculating steady unsymmetrical supersonic flow past cones. Maurice Holt and D. Ejike Ndefo (California, University, Berkeley, Calif.). *(International Academy of Astronautics and Akademiia Nauk SSSR, International Colloquium on Gasdynamics of Explosions and Reacting Systems, 2nd, Novosibirsk, USSR, Aug. 24-29, 1969.) Journal of Computational Physics,* vol. 5, June 1970, p. 463-486. 45 refs.

Telenin's numerical method is adapted to the problem of steady supersonic flow past pointed conical bodies at yaw. The method is formulated for cones of circular cross-sections with the intention of determining bounded analytic solutions uniformly valid in the region between the shock and cone surfaces. Attention is focused on the nature of the entropy field and the behavior of the streamlines as influenced by variations in the free-stream conditions. (Author)

A70-35894 Supersonic flows about conical bodies. P. I. Chushkin (Akademiia Nauk SSSR, Vychislitel'nyi Tsentr, Moscow, USSR). *(International Academy of Astronautics and Akademiia Nauk SSSR, International Colloquium on Gasdynamics of Explosions and Reacting Systems, 2nd, Novosibirsk, USSR, Aug. 24-29, 1969.) Journal of Computational Physics,* vol. 5, June 1970, p. 572-586. 11 refs.

Numerical solution of three problems of supersonic flow about conical bodies at zero and nonzero angles of attack. A generalized method of integral relations is developed for calculating perfect gas flow about a cone at an angle of attack. The shock layer is subdivided into nonoverlapping strips by means of a number of rays, and approximations by trigonometric polynomials with respect to the corresponding variable are carried out. Supersonic flow about cones in the presence of an exothermal combustion reaction is analyzed. A two-component model is considered in which the kinetics is described by a single concentration of unreacted molecules. The integration of the two-dimensional approximating system in all the meridian planes of interpolation is carried out by the numerical method of characteristics with a network of inverse type. This characteristic computational scheme using two-dimensional compatibility relations is extended to the case of three-dimensional supersonic flows with nonequilibrium chemical processes, taking into account exact kinetics. The flow about blunt-nose inverted cones at an angle of attack in a supersonic stream of nonequilibrium dissociating oxygen is investigated. M.V.E.

A70-35895 Numerical methods of some transsonic aerodynamics problems. O. M. Belotserkovskii (Akademiia Nauk SSSR, Vychislitel'nyi Tsentr, Moscow, USSR). *(International Academy of Astronautics and Akademiia Nauk SSSR, International Colloquium on Gasdynamics of Explosions and Reacting Systems, 2nd, Novosibirsk, USSR, Aug. 24-29, 1969.) Journal of Computational Physics,* vol. 5, June 1970, p. 587-611. 12 refs.

Review of some numerical methods used for the determination of aerodynamic characteristics of high-speed vehicles with transonic and supersonic velocities. Following a survey of recent numerical methods, which include steady-state schemes, unsteady-state schemes, and the 'large particles' method, the problems of flow past bodies at small free-stream supersonic velocities, and of the singularities of the flow around bodies with sonic discontinuities are considered in succession. The calculations of the flow around a cylindrical body under supersonic and transonic conditions, and the three-dimensional flows are also examined. In conclusion, some properties of flows with floating shocks are studied. O.H.

A70-35923 Pressure distribution measurements on wedges in compressible flow (Druckverteilungsmessungen an Keilen bei kompressibler Strömung). Mauri Tanner (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, June 1970, p. 202-208. 16 refs. In German.

Pressure distribution measurements were performed on three different wedges in compressible flow at Mach numbers of 0.5 to 2.2. The results show the influence of wedge angle, Mach number and boundary layer thickness on the base pressure and on the pressure distribution on the flank of the wedge. Additionally it is shown how a splitter plate in the wake influences the pressure coefficients. (Author)

A70-35924 Wind tunnel investigation of the vortex system at a slender body of revolution with incidence with and without wings (Windkanaluntersuchung des Wirbelsystems an einem angestellten schlanken Rotationskörper ohne und mit Tragflügel). Friedrich-Reinhard Grosche (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, June 1970, p. 208-217. 17 refs. In German.

The flow field on the suction side of a slender body of revolution was investigated by means of a directional probe in the 3 m wind tunnel of the AVA Göttingen of the DFVLR. In one part of the measurements, which were performed in cooperation with Messrs. Messerschmitt-Bölkow-Blohm, the model was equipped with a rectangular wing. The diameter of the body of revolution was d = 0.2 m and the total length 15 d = 3 m. The free-stream Mach number was small, about 0.12. The Reynolds number based on free-stream velocity and body diameter was about 500,000. The measurements were performed in six planes perpendicular to the body axis at angles of attack between 7 and 20 deg. From the measured data, the cross-flow velocities and the isobars of the total pressure loss in the different planes were determined and plotted. Position and strength of the body vortices as well as the influence of the aerofoil on the vortex system may be seen from the diagrams. (Author)

A70-35929 # The use of jet aircraft engines to dissipate warm fog. Herbert S. Appleman and Frank G. Coons, Jr. (USAF, Directorate of Aerospace Sciences, Scott AFB, Ill.). *Journal of Applied Meteorology,* vol. 9, June 1970, p. 464-467.

Discussion of a pilot study designed to determine the feasibility of using the heat and mixing properties of a jet engine exhaust for fog evaporation on aircraft runways. The heat requirements for warm fog dissipation are calculated, showing that the total heat required for fog droplet evaporation and air warming in Project Warm Fog is about 13G cal. The heat and turbulence produced by a C-141 aircraft are shown in diagram form. Fog evaporation experiments at Travis AFB, Calif., are described briefly. It is found that visibilities can be increased from below 1000 ft to well over a mile in less than 5 min by this technique. V.Z.

A70-35954 Validation of ground based simulation. John B. Sinacori (Northrop Co., Hawthorne, Calif.). *(American Helicopter Society, Annual National Forum, 25th, Washington, D.C., May 14-16, 1969, Paper 362.) American Helicopter Society, Journal,* vol. 15, July 1970, p. 10-21.

Study of various kinds of simulators to determine their ability to produce data representative of visual flight. Five simulations of a small jet lift V/STOL aircraft using the same pilot are reported. The resulting data are compared with actual flight results using the same aircraft and pilot. The simulators used different displays, motion modes, and instrumentation, and the results are discussed in the light of the characteristics of each simulator and the aircraft. The precision hover and the lateral quick start and stop maneuver are studied in detail. B. H.

A70-35955 Measurement and evaluation of helicopter flight loads spectra data. John D. Porterfield (Kaman Aerospace Corp., Bloomfield, Conn.) and William T. Alexander (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *American Helicopter Society, Journal,* vol. 15, July 1970, p. 22-34. 18 refs. Grant No. DA-AJ-02-67-C-0055.

A comparison of available flight spectrum data for several helicopters is presented, with special emphasis given those obtained for the Army CH-47A, UB-1B, and CH-54A helicopters. Spectrum variations and comparisons with the spectrum of Civil Aeronautics Manual 6, as well as with other fatigue spectra used to establish component service lives, are discussed and evaluated. Some of the consideration and judgements which are instrumental in establishing a rational flight loads spectrum for critical components are also presented. (Author)

A70-35956 Rotor high speed performance - Theory vs test. Franklin D. Harris, Frank J. Tarzanin, Jr., and Richard K. Fisher, Jr. (Boeing Co., Vertol Div., Philadelphia, Pa.). *(U.S. Air Force Flight Dynamics Laboratory, V/STOL Technology and Planning Conference, Las Vegas, Nev., Sept. 23-25, 1969.) American Helicopter Society, Journal,* vol. 15, July 1970, p. 35-44. 16 refs.

At the higher forward speeds desired in the next generation of helicopters, regions of separated flow exist within the rotor disk. The influence of these growing regions begins to reduce significantly rotor lift-drag capability beyond an advance ratio of 0.4. As advance ratio increases, such factors as compressibility, reverse flow, three-dimensional flow, and blade stall, increase both rotor torque and blade flapping motion. To provide a suitable aerodynamic theory with which to calculate this degradation in performance, the theory must include the effects of unsteady aerodynamics, three-dimensional flow, and blade aeroelasticity. This paper illustrates the improvement to aerodynamic theory achieved after incorporating these above effects. Test and theory correlation is shown in the regions of flight associated with the next generation of turbine power helicopters. A performance theory is demonstrated that is accurate, even when the rotor is heavily stalled. Figure 1 correlates this theory with recently acquired 16-ft diam rotor data at an advance ratio of 0.4. (Author)

A70-35957 Aerofoil section characteristics in shear flows. T. Nishiyama (Tohoku University, Sendai, Japan) and K. Hirano. *Ingenieur-Archiv,* vol. 39, no. 3, 1970, p. 137-148. 8 refs.

The technique of Glauert's image method for a single source is applied to determine the image system of a single vortex in shear flows of arbitrary velocity profile. The aerofoil section characteristics are obtained analytically by the extension of the image system for a single vortex and for a single source to those for vortex and source distributions. Numerical calculations are made and the results show the effect on the aerofoil section characteristics of vorticity in flow fields which have been obtained by combining linear shear flows, by comparison with those obtained in uniform flow. (Author)

A70-35959 Investigation of the influence of cross-section deformation on the vibration behavior of a helicopter blade with hollow cross section (Untersuchung des Einflusses der Querschnittsdeformation auf das Schwingungsverhalten eines Hubschrauberblattes mit Hohlquerschnitt). R. Uhrig. *Ingenieur-Archiv,* vol. 39, no. 3, 1970, p. 159-170. 11 refs. In German.

The differential equations of a vibrating beam having deformable cross section are derived. The solution of these equations can advantageously be formulated by using numerically produced transfer matrices. Introduction of the boundary conditions yields the resulting equations of the complete system. The application of the method to a rotor blade of a helicopter rotor driven by reaction shows that the influence of the deformation of the cross section on the torsional vibration is remarkable whereas the influence on the bending vibration is negligible small. (Author)

A70-35962 Vibrational relaxation in flight and in wind tunnels (Schwingungsrelaxation im Flug und im Windkanal). K. Kraemer (Max-Planck-Institut für Strömungsforschung, Göttingen, West Germany). *Ingenieur-Archiv,* vol. 39, no. 3, 1970, p. 195-200. 10 refs. In German.

An enthalpy-temperature-diagram is used to discuss the evolution of nonequilibrium gas states in the detached front wave of a blunt body at hypersonic speed. A typical difference persists between both free flight and windtunnel flow, because of different initial conditions. (Author)

A70-35973 **Reduction of a class of stochastic control problems.** P. Whittle and P. A. Gait (Cambridge University, Cambridge, England). *Institute of Mathematics and Its Applications, Journal*, vol. 6, June 1970, p. 131-140. 6 refs.

Examination of processes with linear dynamics and quadratic control costs, but with rather general stopping rules and terminal costs. An extremal representation of the solution for the deterministic case is obtained in theorem 1, and a corresponding integral representation of the solution for the stochastic case in theorem 2. The methods are applied to the optimization of the approach path in a very simple landing problem. The essential role of the stochastic element is demonstrated, and the concept of an 'ideal approach path' examined. O.H.

A70-35976 **National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings.** Ottawa, National Research Council, 1970. 477 p. $10.00. In English and French.

Contents:

Preface. M. S. Kuhring, p. iii.

The bird strike problem 'en route' in the RNLAF. J. P. C. de Bruin (Royal Netherlands Air Force, The Hague, Netherlands), p. 15-19.

Military bird strikes in the United Kingdom. P. F. Hart (RAF, London, England), p. 21-30.

Bird strikes in the German Air Force. J. Hild (Bundesministerium der Verteidigung, Luftwaffe, Porz-Wahn, West Germany), p. 31-43.

Investigations of the bird hazard problem in the Federal Republic of Germany. W. Keil, p. 45-50.

Statistical measurement of bird hazards to aircraft. H. E. Bryant (Department of Transport, Ottawa, Canada), p. 61, 63-67.

Activities of the Federal Aviation Administration and the United States Inter-Agency Bird Hazard Committee on bird hazards to aircraft. J. T. Morse (FAA, Washington, D.C.), p. 69, 71-76.

Bird problems at Hong Kong airport. J. D. Romer (Urban Services Department, Hong Kong), p. 77, 79-86. 6 refs.

U.S. Air Force problems in bird/aircraft strikes. E. A. Seaman (USAF, Washington, D.C.), p. 87, 89-91.

Research on bird hazards to aircraft in New Zealand. T. A. Caithness (Internal Affairs Department, Wellington, New Zealand), p. 93, 95-99. 6 refs.

Bird strikes in the USSR. V. E. Iakobyi (Academy of Sciences, Moscow, USSR), p. 101, 103-109. 5 refs.

The birds as a menace to flight safety. J. D. Caldara (Flight Safety Foundation, Inc., Arlington, Va.), p. 111-119.

Military airlift command bird strike control programme. B. W. Brink (USAF, Military Airlift Command, Scott AFB, Ill.), p. 121, 123-125.

Canadian airport problems with birds. J. L. Courtney (Department of Transport, Ottawa, Canada), p. 129, 131-134.

Methods of ecological research on airfields. J. Hild (Bundesministerium der Verteidigung, Luftwaffe, Porz-Wahn, West Germany), p. 135, 137-142.

Airport design and management to reduce bird problems. V. E. F. Solman (Canadian Wildlife Service, Ottawa, Canada), p. 143, 145-147.

Bird dispersal techniques and their use in Britain. E. N. Wright (Ministry of Agriculture, Fisheries and Food Infestation Control Laboratory, Guildford, Surrey, England), p. 207, 209-214. 11 refs.

Microwaves - A potential solution to the bird hazard problem in aviation. J. A. Tanner, S. J. Davie (National Research Council, Ottawa, Canada), C. Romero-Sierra, and F. Villa (Queen's University, Kingston, Ontario, Canada), p. 215, 217-221. 8 refs.

Bird ingestion problems relating to gas turbine engines. R. S. Cox (Rolls-Royce, Ltd., Bristol, England), p. 381, 383-390.

Experimental techniques in bird ingestion research. A. J. Tudor (Rolls-Royce, Ltd., Derby, England), p. 391, 393-401.

Development of a prototype turbine engine inlet device for protection against bird ingestion. T. G. Horeff (FAA, Washington, D.C.), p. 403-411.

Work of ICAO in the field of bird hazard reduction. K. K. Wilde and H. J. Gursahaney (International Civil Aviation Organization, Montreal, Canada), p. 459-467.

A70-35977 # **The bird strike problem 'en route' in the RNLAF.** J. P. C. de Bruin (Royal Netherlands Air Force, The Hague, Netherlands). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings.
Ottawa, National Research Council, 1970, p. 15-19.

The development of more sophisticated aircraft has contributed to the increase of bird strikes, at both the military and civilian level, thus posing an international problem. Most bird strikes in the RNLAF occur 'en route', where the damage is usually much greater than with bird strikes 'on and around' the airfields. During the spring and autumn migration of birds there is a considerable increase in the number of bird strikes. Since the spring of 1967 the RNLAF has employed a bird warning system, which is based upon the registration of bird movements with the aid of a 23-cm radar. The intensity of the bird migration is determined with polaroid photographs and distributed to the air bases. A restriction system for military aircraft has been drafted, based upon an intensity scale for bird migration. Thus far the number of bird strikes 'en route' during the migration periods has decreased. (Author)

A70-35978 # **Military bird strikes in the United Kingdom.** P. F. Hart (RAF, London, England). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings.
Ottawa, National Research Council, 1970, p. 21-30.

Discussion of damage sustained by RAF aircraft due to bird strikes, and outline of preventive measures undertaken at military airfields. Investigation of bird remains has slightly increased the proportion of birds identified; a table shows numbers of bird species associated with collision incidents for yearly periods between 1964 and 1968. Gulls are the main bird strike hazard, and Yorkshire is the worst strike area. Reports do not indicate that bird migration is a severe problem in the U.K. The peak months for accidents are July and August, before the main bird movement. The excessive cost of providing adequate protection against collision limits current efforts to avoidance or scaring measures. T.M.

A70-35979 # **Bird strikes in the German Air Force.** J. Hild (Bundesministerium der Verteidigung, Luftwaffe, Porz-Wahn, West Germany). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa,

National Research Council, 1970, p. 31, 33-42; Discussion, J. P. C. de Bruin (Royal Netherlands Air Force, The Hague, Netherlands) and Emanuelson, p. 34.

Since 1966, the German Air Force experienced nearly 600 bird strikes. The bird strike maxima were always in early spring, in summer and in autumn, because of migration and inter-migration. 35 per cent of bird strikes happened at take-off and landing and during round-airfield-procedure in flight levels up to 100 ft.; 65 per cent happened in flight mostly in the northern German district. Flight levels of 500 or 800 ft seem to be highly endangered by bird strikes because of the main flight procedures of the two German jet types. During daytime most of the bird strikes happened from 08.00 to 13.00 (local time) depending on the season. On some airfields the number of bird strikes decreased, possibly because of special agricultural and technical provisions for scaring birds. Seagulls and buzzards were the bird species which caused the majority of bird strikes. (Author)

A70-35980 # **Investigations of the bird hazard problem in the Federal Republic of Germany.** W. Keil. In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 45-50.

Outline of the research activities of the German Board to Prevent Bird Hazards to aircraft. Recommendations for bird strike avoidance are given on the basis of data gained from airport investigations, in-flight bird hazard studies, and commercial airline reports. German airports utilize bird traps as well as pyro- and electroacoustic equipment; ecological studies are aimed at providing solutions in the fields of agriculture, forestry, and hunting. The use of chemical agents is under investigation. In-flight studies concern migration patterns and serve to provide data for long-term hazard forecasts. T.M.

A70-35981 # **Statistical measurement of bird hazards to aircraft.** H. E. Bryant (Department of Transport, Aeronautical Engineering Div., Ottawa, Canada). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 61, 63-67.

Discussion of some simple statistical procedures for determining the magnitude of the bird strike hazard at airports. The objective is to provide a means of orientation for viewing the problem and a level from which it can be compared at various airports. On the domestic scene, it is necessary for airport authorities in each country to take bird strike reports and relate them to aircraft movements divided by 1000 in order to produce strike rate data. Each nation must then set control limits for the strike rate at its domestic airports. At international airports, authorities should introduce strike data collection methods that avoid reliance on flight crew reports alone. Strike rate data for international airports should be submitted to an international body for publication and for evaluating an international strike rate standard. T.M.

A70-35982 # **Activities of the Federal Aviation Administration and the United States Inter-Agency Bird Hazard Committee on bird hazards to aircraft.** J. T. Morse (FAA, Washington, D. C.). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 69, 71-76.

Description of research activities conducted by the FAA since 1960 on various methods of eliminating birds on and around airports and on improving the resistance of vital aircraft components to bird impact. Ecological, biological, and migration studies have been carried out. Tests were made on the bird-impact resistance of windshields and airframes and on ingestion in turboprop and turbojet aircraft. To further the recognition of the bird hazard problem and to assure a coordinated effort, an Interagency Bird Hazard Committee was established with representatives from other interested departments and agencies. This committee's function is to exchange research reports, prepare advisory data, and make recommendations to the aviation public. T.M.

A70-35984 # **U.S. Air Force problems in bird/aircraft strikes.** E. A. Seaman (USAF, Washington, D.C.). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 87, 89-91.

With a total of 363 bird/aircraft collisions in 1968 involving damage, plus 829 collisions where no damage was sustained, the U.S. Air Force finds it necessary to continue supporting research into the bird control problem. Research now being conducted involves not only bird studies, but bats as well. Information is disseminated to pilots to alert them to bird hazards and to base civil engineers to instruct them on the latest methods of reducing birds at airfields. The problem of birds is viewed to be like the weather; one builds stronger aircraft to withstand adverse weather, and applies findings from research to modify flying to adjust to weather circumstances. (Author)

A70-35985 # **Research on bird hazards to aircraft in New Zealand.** T. A. Caithness (Internal Affairs Department, New Zealand Wildlife Service, Wellington, New Zealand). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 93, 95-99. 6 refs.

In late 1964 detailed ecological surveys began on 12 airfields. Research techniques and preventative measures implemented are outlined, with special reference to: invertebrate surveys, stomach analysis of insectivorous birds, insecticide treatments, Polystyrene models of crucified gulls for clearing traditional roosts and casual flocks, and poisoning of a breeding colony of gulls. Since research findings and recommendations have gained impetus, a reduction of 30 per cent in incidents has been achieved. On those airfields where management has been more intensive the reduction has been even greater, i.e., at Napier 46 per cent less for all species and 89 per cent for gulls. At Auckland International Airport an overall reduction of 44 per cent has been achieved. Because of difficulties experienced in implementing both major and minor ecological modifications near already established airfields, a problem probably not contained only to New Zealand, it would seem desirable that international law should not be confined to cover the technical features near airfields but should cover the biological facets as well. (Author)

A70-35986 # **Bird strikes in the USSR.** V. E. Iakobyi (Academy of Sciences, Institute of Evolutionary Morphology and Animal Ecology, Moscow, USSR). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 101, 103-108; Discussion, p. 108, 109. 5 refs.

From extrapolation of research at civil airports on the Baltic coast and in the Ukraine to the whole country, we have come to the conclusion that in the USSR more than 1500 bird strikes occur annually. The number of bird strikes in 1968 was six times higher than in 1963. Seasonal numbers of bird strikes increased from March to September and reached a maximum in September. The daily peak of the bird strikes occurred from 0800 to noon. At 150-300 km.p.h. speed, 66.2 per cent of the bird strikes are reported. In the course of

take-off there are 1.2 times more bird strikes than during landing. 68.2 per cent of the bird strikes took place at the airfield or nearby. In 44.6 per cent of the cases the engine was damaged, in 29.8 per cent - the wing, in 12.6 per cent - the windscreen. A quarter of the bird strikes took place with AN-2 aircraft. In the Air Forces almost the same rate of bird strikes was observed yearly and monthly. 62 per cent of the incidents occurred within the airfield area. More than 40 per cent of the bird strikes damaged the engines and 9.6 per cent - the windscreen. Strikes of civil and military planes by Passeres, Laridae, Accipitridae, Columbidae, Anatidae birds are the most frequent. (Author)

A70-35987 # **The birds as a menace to flight safety.** J. D. Caldara (Flight Safety Foundation, Inc., Arlington, Va.). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 111-113, 115-118; Discussion, J. Hild (Bundesministerium der Verteidigung, Porz-Wahn, West Germany), p. 119.

Discussion of damage sustained by aircraft as a result of bird impact, and survey of recent measures intended to alleviate this problem. Research on stronger windshields is outlined, and cases of impact at various speeds are used to illustrate the need for further efforts in this area. Damage to aircraft engines is considered, and the practicality of intake guards is evaluated. Protection in flight by means of a high-intensity microwave beam is described together with studies on the use of chemical agents as a bird repellant on airports. T.M.

A70-35988 # **Military airlift command bird strike control programme.** B. W. Brink (USAF, Military Airlift Command, Scott AFB, Ill.). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 121, 123-125.

Description of bird impact incidents involving the Military Airlift Command, and outline of some corrective actions intended to minimize the hazard near airfields. From 50 to 70% of the bird strikes involving transport aircraft occur less than two miles from the runway below a height of 3000 ft. These incidents can be alleviated by reducing local populations of the problem species through habitat and land use changes. This can be accomplished by proper handling or removal of sanitary fills, draining or filling duck ponds, removal of nesting sites, elimination of certain vegetation, and chemical control of insects and worms. Effective results depend upon manipulation of these factors in a specific manner at each airport. Temporary bird hazards can be minimized with scare devices, chemicals, and trapping. T.M.

A70-35989 # **Canadian airport problems with birds.** J. L. Courtney (Department of Transport, Airports and Field Operations Branch, Ottawa, Canada). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 129, 131-134.

Description of reported incidents of civil aircraft collisions with birds in Canada, and summary of Canadian efforts to alleviate this problem. In Canada, 70% of all reported bird strikes involving civil aircraft occur within the boundaries of airports. Airport operators are spending large sums of money to make airports and surrounding lands unattractive to problem bird species and to keep birds away from runways and approaches. However, the knowledge, equipment, and techniques available permit only limited and indirect control of bird presence and movements. The number of aircraft collisions with birds is rising despite best efforts. More direct and positive means of controlling bird presence and movements are needed. A major part of the available resources should in the future be concentrated on research and experimentation to find practical and positive means of preventing bird strikes. T.M.

A70-35991 # **Airport design and management to reduce bird problems.** V. E. F. Solman (Canadian Wildlife Service, Ottawa, Canada). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 143, 145-147.

Discussion of rules for planning airport location and design to minimize hazards from birds. Areas habitually used by birds should be avoided. The soil should be sandy and well drained, and a sturdy fire-resistant ground cover which is not attractive to birds should be selected. Airport buildings, structures, and landscaping should be designed to minimize attractiveness to birds. T.M.

A70-35994 # **Bird ingestion problems relating to gas turbine engines.** R. S. Cox (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 381, 383-389; Discussion, J. P. C. de Bruin (Royal Netherlands Air Force, The Hague, Netherlands), R. Griffiths (United Aircraft of Canada, Ltd., Ville Jacques Cartier, Quebec, Canada), and A. W. R. Allcock (British Embassy, Washington, D.C.), p. 389, 390.

Development of a set of design rules to minimize damage by bird strikes to vulnerable engine components. Service experience, information obtained from specific airworthiness demonstration tests, and research programs were studied. The design rules are discussed in relation to the engine compressor components. Basically, it became obvious that there were considerable differences in the damage caused by the bird and that which occurred when a piece of an engine component was released. Every effort must be made to retain the blading intact, even if twisted or nicked. Thus the engine can continue to provide adequate power. F.R.L.

A70-35995 # **Experimental techniques in bird ingestion research.** A. J. Tudor (Rolls-Royce, Ltd., Derby, England). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. Ottawa, National Research Council, 1970, p. 391, 393-401; Discussion, R. Griffiths (United Aircraft of Canada, Ltd., Ville Jacques Cartier, Quebec, Canada), p. 401.

Attempt to understand the problem of damage to gas turbine aero engines due to bird strikes, with emphasis on the importance of representative rig testing. Some experimental techniques concerned particularly with simulating damage to first stage rotor blading are described. The rig testing falls into two main categories: firing tests at fixed blades, and tests on rotating assemblies in the spinning pit. Air gun performance is discussed, together with the development of a sabot system and the use of dummy blades. For rotating tests in a vacuum spinning pit, it is possible to simulate bird strike conditions on a full row of blades, using a spinning arm with one blade. Attention is given to the usefulness of high speed cine and multiflash photography. F.R.L.

A70-35996 # **Development of a prototype turbine engine inlet device for protection against bird ingestion.** T. G. Horeff (FAA, Aircraft Development Service, Washington, D.C.). In: National Research Council, World Conference on Bird Hazards to Aircraft,

Queen's University, Kingston, Ontario, Canada, September 2-5, 1969; Proceedings. (Ottawa, National Research Council, 1970, p. 403-411. Contract No. FA-67-WA-1692.

A prototype grill device was developed for a turboprop engine inlet duct to deflect birds away from the engine to prevent engine damage and power loss. Criteria were established for a design that can be retracted when the aircraft is out of the bird hazard area. Bird impact tests were conducted on the device in an air gun facility to assure structural integrity against the impact of a 4-lb bird at 200 kt and to determine impact loads. Wind tunnel tests were performed to measure pressure recovery and inlet pressure distortion profiles in the extended position and during the retraction sequence. Flight tests were conducted with the device in the extended position to determine effects on engine performance. Protective concepts for a variety of engine inlets were devised based on these test results and 'trade-offs' were estimated for each design. A peak dynamic bird impact load of 10,000 lb was measured on the grill device inclined at 30 degrees to the horizontal at an impact velocity of 200 kt. This load was doubled at 280 kt. Inlet distortion was determined to be within the plus or minus 5 per cent allowable limit under all operating conditions. The loss in pressure recovery was less than 2 per cent with a corresponding increase in specific fuel consumption. (Author)

A70-35997 # **Work of ICAO in the field of bird hazarc reduction.** K. K. Wilde and H. J. Gursahaney (International Civi Aviation Organization, Montreal, Canada). In: National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, September 2-5, 1969, Proceedings. (Ottawa, National Research Council, 1970, p. 459-467.

Review of recent work of ICAO in the field of bird hazard reduction, which has consisted of providing states with information on discouraging birds from airports. ICAO has also initiated a worldwide program for collection of reports on bird strike incidents, and is working toward the development of airworthiness specifications to enable aircraft to withstand bird strikes. More recently, it has become involved with procedures for dissemination of bird hazard warning reports. The formation and structure of ICAO is briefly outlined, and the work of the three sections primarily concerned with the bird hazard problem is reviewed. F.R.L.

A70-35998 # **An airport bird detection radar for reducing bird hazards to aircraft.** Glen W. Schaefer. *National Research Council, World Conference on Bird Hazards to Aircraft, Queen's University, Kingston, Ontario, Canada, Sept. 2-5, 1969, Paper.* 33 p. 11 refs.

Feasibility design study for a low cost ABDE (airport bird detection equipment) radar which would display an airfield map showing the presence and magnitude of bird groups on the runway, and short vegetation in all weathers. It is concluded that a high-resolution X-band radar with an antenna at a height of 20 to 30 m would meet the requirements, except for detection in heavy rain. A PPI photograph of gulls standing on a runway illustrates that the hazard may be appreciated immediately. The use of ABDE radar with bird patrols should greatly reduce jet engine ingestions and eliminate near-disasters from multiple engine shutdowns on aircraft directed to land or take off in the presence of dense flocks. F.R.L.

A70-36127 # **Correlation between flame-out and ignition characteristics for diffusion-type fuel burnup behind a system of angled stabilizers (O korreliatsii kharakteristik sryva i zazhiganiia plameni pri diffuzionnom szhiganii topliva za sistemami ugolkovykh stabilizatorov).** V. A. Khristich and V. N. Litoshenko. *Mashinostroenie,* no. 5, 1970, p. 78-82. In Russian.

Experimental investigation of the working process of an annular combustion chamber (built into the turbine body) for preheating a gas turbine employing gaseous fuel. The results are used to derive empirical expressions correlating the ignition and flame-out characteristics for stabilizers over a wide range of stabilizer parameters (shape, width, apex angle) and chamber shadings. V.P.

A70-36129 # **Profiling plane diffuser grids for subcritical velocities of the oncoming flow (Profilirovanie ploskikh diffuzornykh reshetok pri dokriticheskikh skorostiakh natekaniia potoka).** V. S. Beknev (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR). *Mashinostroenie,* no. 5, 1970, p. 132-137. 9 refs. In Russian.

Comparison of three approaches to the generalization of wind-tunnel test data obtained for diffuser grids at subcritical flow velocities for (1) the condition of maximum efficiency of the grid profile, (2) the condition of maximum efficiency of the grid, and (3) the condition of minimum coefficient of profile losses. The results of a comparison with respect to angles of attack, trail angles, grid spacings, and losses shows that the greatest discrepancies occur for generalization with respect to angles of attack and losses. The influence of the isentropic index of the gas on the pressure distribution over the blade contour and on the grid losses is assessed. V.P.

A70-36194 # **Trailing-edge stall.** S. N. Brown and K. Stewartson (University College, London, England). *Journal of Fluid Mechanics,* vol. 42, July 9, 1970, p. 561-584. 10 refs.

Study of the laminar flow in the neighborhood of the trailing edge of an airfoil at incidence. The airfoil is replaced by a flat plate on the assumption that leading-edge stall has not taken place. Expressions for the critical order of magnitude of the angle of incidence for the occurrence of separation on one side of the plate for incompressible flow and for supersonic flow are presented. The structure of the flow is determined by the incompressible boundary-layer equations but with unconventional boundary conditions. The value of the angle of incidence for which separation occurs is the trailing-edge stall angle and an estimate is obtained from asymptotic solutions. The linearized solution yields an estimate for the viscous correction to the circulation determined by the Kutta condition. G.R.

A70-36195 # **Diffraction of shock waves by a moving thin wing.** L. Ting and M. Gunzburger (New York University, Bronx, N.Y.). *Journal of Fluid Mechanics,* vol. 42, July 9, 1970, p. 585-608. 14 refs. Contract No. AF AFOSR 1062-67.

An analytical solution is obtained for the flow field due to the impinging of a plane shock wave of arbitrary strength by a thin wing moving in the opposite direction. The planform and the thickness distribution of the wing can be arbitrary and the speed of the wing can be either supersonic or subsonic relative to the undisturbed stream ahead of the shock or to that behind the shock. The solution is a generalization of the previous solution of Ting and Ludloff for the diffraction of shock wave by a two-dimensional stationary airfoil to a three-dimensional wing moving with supersonic or subsonic speed relative to the stream ahead of or behind the shock. The solution is employed for the analysis of the changes in aerodynamic forces when an airplane encounters a blast wave or a shock wave of another airplane. It is also used to study the diffraction of a shock wave or an N-wave advancing over flat terrains. (Author)

A70-36209 **Effects of heavy jets on airport acceptance rates.** Tirey K. Vickers (James C. Buckley, Inc., New York, N.Y.). *Journal of Air Traffic Control,* vol. 12, July 1970, p. 10-13.

Study of changes in airport acceptance rates caused by the appearance of heavy jets taking into consideration three sequencing strategies. It is found that acceptance rates can be expected to decrease initially, as the percentage of heavy jets increases. The maximum decrease will occur when the percentage of heavy jets reaches 50% of the traffic mix. At this point, the acceptance rate will be slightly less than 90% of normal. As the percentage of heavy jets in the traffic mix continues to increase beyond the 50% point, the acceptance rate will start to increase again. Controllers can gain back some of the theoretical loss in capacity by grouping aircraft of the same type where possible, rather than by alternating the types of aircraft in the sequence. G.R

A70-36253 # **Influence of water ballast on glider loads (Wplyw balastu wodnego na obciążenia szybowca).** Wiesław Stafiej. *Technika Lotnicza i Astronautyczna,* vol. 25, May 1970, p. 10-13. In Polish.

Development of a concept of unifying the characteristic velocities of a glider for flights with and without water ballast, and improving simultaneously the structural safety factor. The concept derives from a thorough analysis of the influence of ballast on the loads acting on the glider wings, control surfaces, and fuselage. The loads acting on the Cobra 17 glider are tabulated. V.P.

A70-36258 # **Hypersonic flow around segmentally conical bodies at a large angle of attack (O giperzvukovom obtekanii segmental'no-konicheskikh tel pod bol'shim uglom ataki).** B. A. Zemlianskii. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1970, p. 33-39. 10 refs. In Russian.

Approximate analysis of flow near the blown (windward) plane close to the lateral surface of a blunt cone placed in hypersonic gas flow at a large angle of attack. It is assumed that the blown generatrix of the cone is inclined at a small positive angle to the flow. On the basis of hypersonic theory, the problem is reduced to a study of two-dimensional flow around an equivalent local blunted cone with a duct. Minimization of the effects of circumferential spreading of the gas and coincidence of the integral effects of nose bluntness in the initial and model flows are achieved by a corresponding choice of the local cone's tip midsection radius and the edge thickness of the duct. The resulting analog makes it possible to calculate the initially three-dimensional flow using numerical techniques developed for two-dimensional problems. The accuracy of the procedure is demonstrated by comparison with three-dimensional calculations available in the literature. Some results are included for the effects of physicochemical transformations of the air on the studied flows. T.M.

A70-36260 # **Hypersonic flow around a delta wing of finite thickness (Giperzvukovoe obtekanie treugol'nogo kryla konechnoi tolshchiny).** A. L. Gonor and N. A. Ostapenko. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1970, p. 46-55. In Russian.

Generalization of a method, previously developed by Gonor (1970) for calculating hypersonic flow around thin delta wings with supersonic leading edges, to apply to the case of delta wings of finite thickness where the flow has a qualitatively different structure. It is shown that the effect of wing thickness leads to a new flow runoff line which is no longer coincident with the symmetry plane as in the case of slender wings. Specific calculations are performed for hypersonic flow around wings with a rhomboid cross section. Shock wave separation curves are illustrated for different values of internal tip angles governing the wing thickness. T.M.

A70-36261 # **Design of an optimal stern section of a plane body at a supersonic flow rate (K postroeniiu optimal'noi kormovoi chasti ploskogo tela pri sverkhzvukovoi skorosti obtekaniia).** A. N. Kraiko and R. K. Tagirov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1970, p. 56-62. 5 refs. In Russian.

Investigation of two optimal profile shaping problems for the stern section of a plane body in supersonic flow. The problems involve (1) the determination of a profile contour exhibiting minimum drag at a given lifting force, and (2) the determination of a drag-optimal contour with allowance for friction forces. The friction is determined using boundary layer equations in integral form. T.M.

A70-36262 # **Flow in a supersonic viscous underexpanded jet (Techenie v sverkhzvukovoi viazkoi nedorasshirennoi strue).** V. S. Avduevskii, A. V. Ivanov, I. M. Karpman, V. D. Traskovskii, and M. Ia. Iudelovich. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1970, p. 63-69. 17 refs. In Russian.

Experimental investigation of flow in the initial segment of an underexpanded supersonic jet issuing into a submerged region and a slipstream with Mach numbers smaller than ten. The study is conducted for Mach numbers smaller than six at the nozzle outlet and for Reynolds numbers from 100 to 10,000,000. A strong influence of viscosity on the nature of flow in the jet is demonstrated, and the main features of the flow are described. Detailed results are given for the fundamental parameters of the initial segment of a turbulent underexpanded jet issuing into a submerged region. T.M.

A70-36280 # **Formation of a pulling force during the motion of a deformable profile (Vozniknovenie tianushchei sily pri dvizhenii deformiruemogo profilia).** V. A. Eroshin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1970, p. 179-183. 6 refs. In Russian.

Consideration of the problem of unsteady motion of a deformable profile, using the formulation proposed by Sedov. The values of the pulling force and the efficiency are determined for a flat profile along which small-amplitude sinusoidal waves are propagating, taking into account the vortices flowing off the trailing edge of the profile. The results obtained for sinusoidal deformations of the profile are generalized to the case of a profile of arbitrary shape. A.B.K.

A70-36301 # **Calculation of the characteristics of random vibrations of a panel in the acoustic field of an exhaust jet (Raschet kharakteristik sluchainykh kolebanii paneli v akusticheskom pole vykhlopnoi strui).** K. G. Valeev and V. E. Kvitka (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR). *Akusticheskii Zhurnal,* vol. 16, Apr.-June 1970, p. 219-222. In Russian.

Development of an approximate method of calculating the probability characteristics of the stresses occurring during the vibration of flat panels in the acoustic field of a jet engine exhaust. Formulas are presented for determining the acoustic pressure distribution with the aid of third-of-an-octave or octave filters. As an example, the values of the stress intensity parameters for a rectangular flat skin panel loaded by an acoustic pressure from an exhaust jet are determined. A.B.K.

A70-36319 **The birdstrike problem.** Marcus Langley. *Science Journal,* vol. 6, Aug. 1970, p. 55-60. 5 refs.

Discussion of the hazard to aircraft constituted by very large high flying birds and flocks of small ones in the immediate neighborhood of airports. Damage caused by birds may be structural, or may involve ingestion into one or more engines. The airfield problem is more severe than the lone bird hazard, and is the center of

most current antibirdstrike research. Various countermeasures such as reduction of grass cover, the broadcasting of recorded bird distress calls, and the use of high intensity microwave beams are considered. F.R.L.

A70-36339 # **Electronics and flight safety.** *Aircraft Engineering,* vol. 42, July 1970, p. 6, 7, 11.

Discussion of the Plessey philosophy of the use of data acquisition systems, with a description of their range of systems. Data integrity is an overriding consideration, and this has been applied equally to airborne and ground systems. Each system described has an expansion facility which, even for the smallest system, will accommodate the forthcoming changes in mandatory requirements and, at the same time, be capable of flight envelope and engine monitoring. Data acquisition is used as a tool to assist in the evaluation of aircraft health and, as a corollary, that of flight safety. These facilities permit both operational and maintenance staffs to observe the trends as well as the absolute values relating to a wide range of parameters. Advance warning is given of parametric failure in areas where incidents or catastrophic accidents could occur. F.R.L.

A70-36340 # **The philosophy of flight data acquisition systems.** Frank Breach (Epsylon Industries, Ltd., Feltham, Middx., England). *Aircraft Engineering,* vol. 42, July 1970, p. 8-11.

Account of the development of flight data recorders and the need for system integration. A data replay system was essential to back flight recordings. It had to output the required data quickly and at the various levels of data reduction, but first the speed and accuracy with which data was required from replay had to be decided. Workshop test equipment was defined to ensure that the airborne equipment overhaul and recertification procedure could be implemented. Aircraft test equipment was also defined so that a comprehensive check could be carried out on the completed system in the aircraft by fleet personnel. F.R.L.

A70-36341 # **Flight data recording systems.** A. R. Morcom (Sperry Rand, Ltd., Bracknell, Berks., England). *Aircraft Engineering,* vol. 42, July 1970, p. 12, 13, 16.

Brief survey of the past developments, current status, and future trends in flight recording for accident investigation and operational purposes. The intention of the original requirements was to record parameters describing the aircraft flight path. Current U.S. regulations call for the recording, with respect to time, of airspeed, altitude, vertical acceleration, and heading. The present British requirements also require pitch, and the French specify marker beacon flyover. The record must be preserved if the recorder is subjected to a crushing load of one ton, a 100 g shock, and exposure to fire at 800 C for 15 min. The Sperry Airborne Data Acquisition System (SADAS) 5000 series is described, as well as other SADAS systems. In future, it is expected that systems will be expanded to include new functions such as engine monitoring, crew proficiency monitoring, and the acquisition of operational data for the purpose of increasing operational efficiency. F.R.L.

A70-36342 # **Flight and accident data recorders.** *Aircraft Engineering,* vol. 42, July 1970, p. 17, 19.

Description of a range of accident data recorders and associated equipment developed by Fell Avionics to meet the present and future requirements for both civil and military aircraft, and which can readily be incorporated with any flight data recording system. Designed to accord with Aeronautical Radio, Inc. (ARINC) characteristics, the range of recorders incorporate the same basic design features, operating on a continuous loop principle. These recorders have sufficient expansion capability for any future mandatory requirements plus additional capacity for mission or maintenance data analysis if needed. F.R.L.

A70-36343 # **Underwater recovery of flight data recorders.** *Aircraft Engineering,* vol. 42, July 1970, p. 18, 19.

Discussion of the requirements and the value of systems for underwater recovery of flight data recorders. It is considered to be essential to retrieve the recorder in order to determine as quickly as possible the cause of the crash, and to establish whether urgent modification is required to the type of aircraft involved. It is suggested that compressed air could be used as the ejection force rather than explosive charges. F.R.L.

A70-36344 # **A simple rapid microbiological test for aircraft fuel.** E. C. Hill (University College, Cardiff, Wales). *Aircraft Engineering,* vol. 42, July 1970, p. 24, 25, 28.

Description of a recently introduced test for microbiological contamination of fuel for jet engines that may be carried out in the field. Important considerations for the test were that it could be conducted without microbiological training or aseptic manipulations, that the reagents should be stable, with a good shelf life, that it could give a meaningful result within one hour, that all major groups of organisms should be detected, and that the sensitivity should be such that the operator would receive a positive indication when proliferations of organisms had just started. The work was concentrated on the detection of phosphatases, a group of enzymes very widely distributed in microorganisms. Laboratory evaluation proved that a phosphatase assay was a useful test for microorganisms in fuel condensate. F.R.L.

A70-36345 # **Thermal insulation for the Concorde engine bays.** J. O. Collins, B. R. Yerry (Johns-Manville Products Corp.), and K. J. McGuire (Delaney Gallay, Ltd., London, England). *Aircraft Engineering,* vol. 42, July 1970, p. 29, 30.

Description of the engine bay insulation developed for the Concorde. A combination of a highly efficient, stainless steel foil, and polytetrafluorethylene film resulted in an insulation system that would protect the underside of the wing from the heat of its engines. Noise level, engine fire conditions, and penetration by globules of molten titanium were factors which had to be considered. F.R.L.

A70-36374 # **A new method for the calculation of the flow around the wing of small span width near sonic speed (Eine neue Methode zur Berechnung der schallnahen Strömung um den Flügel kleiner Spannweite).** K. Burg (Karlsruhe, Universität, Karlsruhe, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 170-T 173. In German.

Discussion of a method for the calculation of the flow around a thin wing on the basis of a linear equation of parabolic type. The mathematical relations describing the conditions at a thin wing are investigated and a wing with a small span width is considered. The velocity in the flow direction at the wing is analyzed and the behavior of the pressure in the supersonic flow is discussed. G.R.

A70-36375 # **Theoretical and experimental results regarding the effect of the 'previous history' at turbulent boundary layers (Theoretische und experimentelle Ergebnisse zum Einfluss der**

'Vorgeschichte' bei turbulenten Grenzschichten). K.-O. Felsch. *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 181, T 182. In German.

Study of the effect of the previous history on the relation of two parameters in the similar solutions of turbulent boundary layers. Experiments conducted in a small wind tunnel are discussed. Numerical investigations regarding the effect of the initial conditions on the further development at boundary layers with differing pressure distributions are reported. G.R.

A70-36376 # **Flow about the edges of tapered wings set at an angle of attack (Kantenumströmung bei angestellten kegeligen Flügeln).** A. Frohn. *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 183. In German.

Discussion of the flowfield about the leading edges of tapered wings set at an incidence angle. The flow about the tip and leading edges of a triangular plate pointed into the airflow at an angle of attack is considered by means of an equation system including the gasdynamic equation and the appropriate Monge equations. The incidence angle parameter is made to allow for the disturbance due to the elongated delta wing shape by affecting not only the velocity components, as under acoustical theory, but also the location coordinates. As independent variables, coordinates are selected by the Oswatitsch analytical method of characteristics. An approximate calculation is said to indicate that the hyperbolic region - which, for slender wing shapes, reaches out about the edges very little - expands suddenly to a considerable width when a certain wing elongation value is exceeded, and reaches then the shock wave. M.V.E.

A70-36377 # **Calculation of stress distribution on axisymmetric annular wings by means of the method of singularities (Berechnung der Druckverteilung an rotationssymmetrischen Ringtragflügeln mit Hilfe der Singularitätenmethode).** W. Geissler (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 183-T 185. In German.

Calculation of annular wings with stress distributions on the curved (axisymmetric) skeleton surface. Two principal problems are considered. First, profile contours and pressure distributions are calculated from a given distribution of singularities. Second, a calculation is made of the distribution of singularities and thus the pressure distribution for a given profile contour. The results are shown graphically and are compared to those obtained by other authors using a linearized method. O.H.

A70-36380 # **Calculation of a weak shock wave in an isobaric, inhomogeneous atmosphere (Brechung einer schwachen Stosswelle in einer isobaren, inhomogenen Atmosphäre).** W. Merzkirch (Ernst-Mach-Institut, Freiburg im Breisgau, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 195. In German.

Description of a simple analytical solution to the problem of calculation of the intensity of a supersonic boom on the ground. By assuming an isobaric atmosphere and a shock wave of small intensity, the intensity of a supersonic boom can be obtained by this method, which utilizes deviations in the standard Mach number on the ground, caused by temperature or wind variations. The results obtained are in good agreement with those achieved by numerical methods. O.H.

A70-36382 # **Compression and expansion areas in steady supersonic flows past yawing bodies of rotation (Kompressions- und Expansionsgebiete bei stationärer Überschallumströmung angestellter Rotationskörper).** P. Niederdrenk (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für theoretische Gasdynamik, Aachen, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 202-T 204. In German.

Investigation of the compression and expansion characteristics of a steady supersonic flow which passes along a slender body of rotation in a direction forming a small yaw angle with the body's axis of symmetry. By using the acoustical theory, differential equations describing the problem are linearized, and a simple expression for the relative pressure variation in the shock wave is obtained that characterizes the compression and expansion areas. O.H.

A70-36385 # **Plane profiles in a parallel and a source-shaped supersonic flow (Ebene Profile in paralleler und quellförmiger Überschallanströmung).** F. Süveges (Karlsruhe, Universität, Karlsruhe, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Aachen, West Germany, Apr. 8-12, 1969.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 50, no. 1-4, Sonderheft, 1970, p. T 211-T 216. In German.

Investigation of the effect of a source flow on pressure distribution, shock pattern, and impact wave resistance as compared to parallel flows. Flow fields around profiles in a two-dimensional parallel and in a supersonic source flow are compared, and the deviations in both flow fields in the entire supersonic range are examined. The considerations are restricted to stationary, frictionless flows only, with a calorically ideal gas as a flow medium. O.H.

A70-36390 Study of aircraft traffic on the ground at an airport - Utilization of digital simulation (Etude du trafic des avions au sol dans un aéroport - Utilisation d'une simulation numérique). Robert Davidson (Aéroport de Paris, Paris, France) and Evelyne Benejam (Compagnie Générale d'Automatisme, Nozay, Essonne, France). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings).
Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.5-6a.13. In French.

Development of a digital simulation method intended to study the problem of aircraft traffic on the ground at airports. In general, the simulation studies the influence of the constraint represented by the infrastructure of taxi tracks on traffic flow. The other constraints of this traffic are also better known, thanks to exploitation of the simulation. F.R.L.

A70-36391 A comparison of pulse techniques for surveillance of cooperative aircraft with satellites. F. P. Corr and J. E. Henrich (IBM Corp., Federal Systems Div., Gaithersburg, Md.). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Pro-

cessing, Symposium International sur la Régulation du trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings).
Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.15-6a.29.

Satellite-based systems for surveillance of aircraft must conserve satellite power and bandwidth. For a high-capacity system, the power consumed on the satellite must be compatible with the available energy source. In this paper, an attempt is made to compare three systems from the points of view of power and bandwidth. The first system comprises ground-based interrogators, and transponders in the satellites and aircraft. Each aircraft is independently addressed on a pulse-by-pulse basis. The second system is similar to the first except for the use of a common timing signal for all aircraft. Pseudo-random modulation is used to generate the signal. The third system has no interrogators. The aircraft emit pulses in a 'random' manner. (Author)

A70-36392 The application of associative processing to air traffic control. R. E. Lyons (IBM Corp., Federal Systems Div., Gaithersburg, Md.). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.31-6a.40. 7 refs.

Description of an associative processor concept suitable for use in air traffic control problems. The tracking and correlation problem is selected as a specific example of a processing requirement which lends itself to associative processing techniques. The associative processor solution to this requirement is developed in sufficient detail to obtain estimates of hardware size and processing time. An important result is that the processing time required to perform tracking is independent of load, while the time to perform correlation depends only linearly on the traffic load. The systems aspects of hybrid conventional/associative processing systems for air traffic control are discussed. F.R.L.

A70-36393 Terminal control in the U.S.A. ARTS-III. John C. Mercer (FAA, Washington, D.C.). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.41-6a.51. 5 refs.

Discussion of the application of automation as a means of solving some of the problems of aviation, with a review of current and predicted activity. By 1975, it is expected that there will be 450,000,000 passengers per year, and 200,000 civil aircraft will be operating in the U.S. A modular design for an Automated Radar Terminal System (ARTS) is described. The ARTS-III Beacon Tracking Level will provide continuous aircraft identity on the controller's radar display, a display of Mode C altitude data from equipped aircraft, and ground speed on transponder-equipped aircraft. F.R.L.

A70-36394 Statistical properties of an air-traffic control system based on a central processor. Juliusz L. Kulikowski (Polska Akademia Nauk, Instytut Automatyki, Warsaw, Poland). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings).
Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.53-6a.61.

There are considered the working conditions of a civil air-traffic control system based on a central information processor realized by an electronic computer. A formal description of the system has been given in the first part of this paper. The formulae /4/, /5/ and /6/ give some propositions of the system optimization criteria. The third part of the paper contains a discussion of the central processor working conditions. A particular attention has been paid to a problem of system informational congestion. A theorem has been proved giving some sufficient conditions of system informational stability formulated in the terms of the theory of Markov processes. Some remarks concerning the modeling of the system has been given. (Author)

A70-36395 Employment of electronical data processing systems for air traffic control. Hanns-Jörg Batzer (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 8), 1970, p. 6a.63-6a.77.

Outline of the work done by the Bundesanstalt für Flugsicherung to achieve, with the aid of data processing installations, an automation of certain auxiliary functions of air navigation systems, and thus greater performance efficiency. The hardware and the software resulting from these considerations are described. Based on the experience gained, some requirements for future data processing systems are derived which could be put into action in the field of air traffic control. The development of a higher problem-oriented programming language matched to the special requirements of air navigation is discussed. F.R.L.

A70-36396 Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 9), 1970. 62 p. In French and English.

Contents:

Central aviaschedule as a part of air traffic control system. V. M. Venevcev, I. B. Gercbach, H. B. Kordonsky, M. S. Maksim, and G. L. Popov, p. 6b.5-6b.25.

Simulation applied to the problems of air traffic control (La simulation appliquée aux problèmes de contrôle du trafic aérien). J. Nouhant (EUROCONTROL, Brétigny, Essonne, France), p. 6b.26-6b.36.

The United States National Airspace System NAS en route Stage A. G. E. Lundquist (FAA, Washington, D.C.), p. 6b.37-6b.46.

An overview of the 1980 ATC system of the continental U.S.A. L. A. Goldmuntz (U.S. Department of Transportation, Washington, D.C.), p. 6b.47-6b.64.

A70-36397 Central aviaschedule as a part of air traffic control system. V. M. Venevcev, I. B. Gercbach, H. B. Kordonsky, M. S. Maksim, and G. L. Popov. In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien;

International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 9), 1970, p. 6b.5-6b.25.

Discussion of the connection between the control schedule and air traffic control, of the requirements of the computer schedule, and peculiarities of computer solution of the problem. These involve commercial and safety requirements, optimum use of aircraft, minimization of the number of aircraft used, a common order of scheduling, and the positioning of each trip. Attention is given to the general order of computer scheduling and long-term schedule utilization for prediction of ATC service development. F.R.L.

A70-36398 Simulation applied to the problems of air traffic control (La simulation appliquée aux problèmes de contrôle du trafic aérien). Jacques Nouhant (EUROCONTROL, Centre Expérimental, Brétigny, Essonne, France). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 9), 1970, p. 6b.26-6b.36. In French.

Review of the application of simulation to air traffic control, simulation being defined as the art of drawing conclusions applicable to a real system while studying the responses of an artificial system reconstituted in the laboratory. Such a system is conceived so that its reaction to exterior influences are the same as those of the actual system. The simulation equipment at Brétigny is described in detail. Simulation exercises are divided into three successive phases: preparation, execution, and analysis of results. F.R.L.

A70-36399 The United States National Airspace System NAS en route Stage A. Gustav E. Lundquist (FAA, Washington, D.C.). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 9), 1970, p. 6b.37-6b.46.

Comprehensive review of implementation of the National Airspace System (NAS), with description of future control functions now under development. The air traffic control automation program for en route facilities has evolved in response to the continuing growth of air traffic. When completed, the system will provide automation at each of the 20 air route traffic control centers. All of these facilities will be interconnected with data transmission links, and the entire system will function as a nationwide, realtime automated system. F.R.L.

A70-36400 An overview of the 1980 ATC system of the continental U.S.A. Lawrence A. Goldmuntz (U.S. Department of Transportation, Washington, D.C.). In: Air traffic; International Federation of Automatic Control and International Federation for Information Processing, International Symposium on Traffic Control, 1st, Versailles, France, June 1-5, 1970, Proceedings (Trafic aérien; International Federation of Automatic Control and International Federation for Information Processing, Symposium International sur la Régulation du Trafic, 1st, Versailles, France, June 1-5, 1970, Proceedings). Paris, AFCET (IFAC/IFIP Preprint No. 9), 1970, p. 6b.47-6b.64.

Review of the work of the Air Traffic Control Advisory Committee, which is concentrated on the control of aircraft through the airspace from takeoff to landing. Emphasis was placed on the denser portions of the airspace. In order to understand the problems of transitioning to a new system in the 1980's, the Committee studied the performance of the Third Generation System with the projected traffic loads. It was recommended that airport, en route, and terminal capacity be increased, and that the ingredients of a Fourth Generation ATC System be determined. F.R.L.

A70-36438 # A mathematical model for a theoretical study of three-dimensional separated flows. G. I. Taganov (Akademiia Nauk SSSR, Vychislitel'nyi Tsentr, Moscow, USSR). *Archiwum Mechaniki Stosowanej,* vol. 22, no. 2, 1970, p. 193-212. 8 refs.

Description of a mathematical model for simplifying the study of three-dimensional steady and unsteady separated flows, which assimilates the flow perturbation introduced by the separated zone at a given instant to a plane doublet on the body surface, the doublet axis being tangential to the body surface. Examples are given of applications of this model to the study of a symmetrical separated flow past a delta wing of small aspect ratio at an angle of incidence (spatial self-similar problem), and a symmetrical and asymmetrical separated flow past a flat plate when the motion is started from rest with a constant velocity (plane nonself-similar problem). O.H.

A70-36441 # Development of airplane stability and control technology (1970 Von Karman Lecture). Courtland D. Perkins (Princeton University, Princeton, N.J.). *(American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 6th, Anaheim, Calif., Oct. 20-24, 1969, Paper 69-1137.) Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 290-301. 15 refs.

Review of early attempts at human flight, tracing the development of the technology of stability and control. The work of Lilienthal and the Wright brothers, of the applied mathematicians Lanchester, Bryan, Bairstow, and Jones, and of the first wind-tunnel experimenters Bairstow, Jones, and Hunsaker is discussed. Flight research, flying qualities, compressibility phenomena, and aeroelastic phenomena are considered. F.R.L.

A70-36442 * # Self-alignment techniques for strapdown inertial navigation systems with aircraft application. Kenneth R. Britting and Thorgeir Palsson (MIT, Cambridge, Mass.). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 302-307. 10 refs. Grant No. NGR-22-009-229.

One of the more critical problem areas in the application of strapdown inertial techniques to the navigation of commercial aircraft is that of initial alignment. A two-stage self-alignment scheme that appears promising in this regard is explored. The first of 'coarse' alignment stage utilizes the measurement of the gravity and earth rotation vectors to directly compute the transformation matrix relating the body frame to a reference frame. A linearized error analysis is presented. The second 'fine' alignment stage corrects the initial transformation estimate by supplying a base motion compensated angular velocity signal to the transformation computer. This correction signal is computed by using estimates of the error angles between a known reference frame and the corresponding computed frame. Kalman filtering techniques are used to implement this technique and an error analysis is presented. (Author)

A70-36443 # Application of optimal control to perfect model following. S. J. Asseo (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). (American Automatic Control Council, Joint Automatic Control Conference, 9th, University of Michigan, Ann Arbor, Mich., June 26-28, 1968, Proceedings, p. 1056-1070.) *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 308-313. 9 refs. Contract No. AF 33(615)-67-C-1157.

Derivation of the necessary and sufficient conditions for the

existence of a control law for a model-following system. A modified performance index is formulated in order to eliminate the dependence of the optimal control law on the model input and to provide "perfect" model following at any feedback gain. The system thus obtained requires high gains to reduce the sensitivity to plant-parameter variations. By formulating an "ideal" type-one system the steady-state error between the plant and model outputs is made zero for all operating conditions, in addition to providing perfect dynamic model following at the nominal operating condition. The necessary conditions for the existence of feed-forward gains for perfect model following are investigated and the theory is applied to a second-order example and to an aircraft control problem. M.G.

A70-36444 # **A regression analysis of pilot-induced oscillation ratings.** Jay Eichler (Israel Aircraft Industries, Lod, Israel). *Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 314-319.

Pilot-induced oscillation (PIO) has been studied by fitting a regression surface to flight test data published by the Air Force Flight Dynamics Laboratory. The independent variables, characteristics of the pitch rate step-response, include time to first-peak, effective time delay, slope after first peak, and stick force per g. These were selected mainly from theoretical considerations and partially from their fit in the regression analysis. These variables were correlated to the PIO numerical ratings, and least-square regression surfaces were calculated. Various models were considered, including logarithmic, linear, and second-order models. The results of this study are set of parameters that can be measured on the time history of the pitch rate step response, and an ordering of these parameters according to their relative importance (correlation) to PIO ratings. On the basis of this analysis, a complete simulation study is planned to investigate further the connection of these parameters with pilot ratings. (Author)

A70-36445 # **Flutter induced by aerodynamic interference between wing and tail.** O. Sensburg (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany) and B. Laschka (Vereinigte Flugtechnische Werke-Fokker GmbH, Munich, West Germany). (American Institute of Aeronautics and Astronautics, Structural Dynamics and Aeroelasticity Specialist Conference, New Orleans, La., April 16, 17, 1969, Proceedings, p. 219-227.) *Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 319-324. 11 refs.

Study of the flutter behavior of a variable-geometry aircraft for the most critical case, where the wing has a leading edge sweep of 70°, taking interference effects into account. Theoretical analysis indicates a destructive flutter case resulting entirely from aerodynamic interaction which could not be predicted by only applying conventional three-dimensional aerodynamic coefficients to wind and horizontal tail separately. A previously reported (Topp et al., 1966) experimentally studied flutter case could thus be verified. The result is considered to be of interest, since before this investigation the question was raised as to whether flutter was caused by the interference based on potential flow, or rather by the high-energy leading-edge vortices which are connected with highly swept wings and which cannot be predicted by linearized theory. The influence of the vertical and streamwise position of the tail was studied. The calculated results show a decrease in critical speed with increasing aft position of the tail. The calculated damping characteristics showed that by including aerodynamic interference a moderate flutter case was changed into an explosive one. This corresponds to observations made during wind-tunnel tests. F.R.L.

A70-36446 * # **Flutter design charts for biaxially loaded isotropic panels.** Charles P. Shore (NASA, Langley Research Center, Hampton, Va.). (American Institute of Aeronautics and Astronautics, Structural Dynamics and Aeroelasticity Specialist Conference, New Orleans, La., April 16, 17, 1969, Proceedings, p. 296-301.) *Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 325-329. 21 refs.

Until recently, correlation between theory and experiment for the flutter of panels stressed to the verge of buckling has not been achieved because of the theoretical prediction of anomalous zero dynamic pressure flutter points. However, a recent linear flutter analysis which includes hysteretic structural damping on the bending terms of the flutter equation eliminates the anomalous zero dynamic pressure flutter points and yields good agreement with experiment. Thus, it appears that empirical flutter envelopes now used in design can be replaced by design procedures with a more rigorous analytical basis. This work develops and presents design charts for isotropic panels on the verge of buckling for typical values of structural damping. Use of these charts permits conservative panel design for wide ranges of panel length-width ratio, in-plane stress ratio, and edge rotational restraint. (Author)

A70-36449 # **Analysis of parachute opening dynamics with supporting wind-tunnel experiments.** H. G. Heinrich and R. A. Noreen (Minnesota, University, Minneapolis, Minn.). *(American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, El Centro, Calif., Sept. 23-25, 1968, Paper 68-924.) Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 341-347. 12 refs. Contract No. AF 33(615)-67-C-1010.

The study is concerned with identification of significant terms in the process of parachute inflation. For finite mass cases, the equations of motion for parachutes inflating in free air and in wind-tunnel experiments are established and organized in view of the nonsteady terms of canopy size, systems velocity, included and apparent masses, and the time derivatives of these terms. Wind-tunnel experiments are described, the results of which yield graphical and numerical time functions for the significant terms of the equation of motion and the force-time histories. The wind-tunnel results are compared with full-size test information, and certain identities are shown. The significant terms are combined to functions unique for the test conditions and substituted in the equation of motion. Force-time functions so derived compare satisfactorily with measured force histories, and the contributions of the individual terms to the instantaneous parachute force can be seen. (Author)

A70-36450 # **Cooled radial turbine for high power-to-weight applications.** Ulo Okapuu (United Aircraft of Canada, Ltd., Montreal, Canada) and Glenn S. Calvert (United Aircraft Corp., Pratt and Whitney Aircraft Div., West Palm Beach, Fla.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-524.) Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 348-354. Research supported by the Defence Research Board of Canada and the U.S. Army.

Design of a high-temperature, high-work radial turbine for advanced small gas turbine engines. This turbine is designed to produce nearly 220 Btu/lb gas flow at 87.5% efficiency, with a 5:1 stage pressure ratio. Turbine inlet gas conditions are 17.5 atm and 2300°F. The resulting turbine configuration includes an air-cooled 12-bladed rotor designed for 67,000 rpm, and a 20-vaned, air-cooled nozzle section of a reflex (supersonic) design. Both parts are IN 100 (PWA 658) investment castings. Results of aerodynamic, structural, and thermal analyses are discussed, as is a fabrication study, which indicated that a casting development effort would be required to produce adequate material properties. This effort is currently underway and consists of both an integral centrifugal-casting approach and a bicasting technique. The test rig to be used for the turbine tests is described. (Author)

A70-36451 # **Some development aspects of the YF-12A interceptor aircraft.** Clarence L. Johnson (Lockheed Aircraft Corp., Burbank, Calif.). *(American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-757.) Journal of Aircraft*, vol. 7, July-Aug. 1970, p. 355-359.

Problems encountered in the development and testing of the

Lockheed-USAF Mach 3 interceptor aircraft are discussed. The application of high-strength titanium alloys, some system development aspects, and a number of aerodynamic and thermodynamic problems are briefly reviewed. Flight tests at very high speeds and altitudes involved development of new escape systems, and cooling and navigation equipment, among many others. (Author)

A70-36452 # **Effect of constraints on optimum approach and departure paths for VTOL terminal operations.** Walter M. Hollister (MIT, Cambridge, Mass.) and John R. Leet. *(American Institute of Aeronautics and Astronautics and American Helicopter Society, VTOL Research, Design, and Operations Meeting, Georgia Institute of Technology, Atlanta, Ga., Feb. 17-19, 1969, AIAA Paper 69-209.) Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 360-365. 10 refs.

Study of the approach and departure paths for VTOL aircraft under various constraints, using a hybrid computer simulation of the aircraft as a point mass moving in a vertical plane acted upon by thrust, gravity, lift, and drag. The pilot has control over angle of attack, thrust magnitude, and thrust direction. Fuel consumption is taken to be proportional to the time integral of the thrust. Constraints are placed on the approach path plus the maximum value of velocity, acceleration, and angle of attack. Data are presented to show how the fuel cost varies as a function of the constraints imposed. The most significant consideration for fuel economy is minimization of the time during which the aircraft flies below conventional stall speed. In general, the steeper the approach or departure path, the greater the fuel cost. Fuel-optimum approaches call for high descent rates at low altitude. When the rate of descent is constrained, the fuel increases but loses its sensitivity to the approach angle. Automatic velocity control is necessary to maintain the glide path during steep approaches. M.M.

A70-36453 # **Computerized air combat simulation - A digital approach and its application.** R. J. Wenham (General Dynamics Corp., Fort Worth, Tex.). *(American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-811.) Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 366-370.

Study emphasizing the immediate need to develop and apply methods to evaluate fighter aircraft in the air-to-air combat situation. The two major computerized approaches—analog simulators and digital simulations—are compared. A currently operating three-dimensional digital program, ATAC/FW (Air to Air Combat/Fort Worth) is briefly outlined, and the utility of this program is demonstrated in four example studies, one of which establishes the credibility of the program. (Author)

A70-36454 # **Impulsive motion of a cylinder and viscous cross flow.** F. J. Marshall (Purdue University, Lafayette, Ind.). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 371-373. 7 refs.

Consideration of the problem of an impulsive start of a circular cylinder at Reynolds numbers involving viscous effects. A theoretical two-dimensional time-dependent solution for this problem is obtained and is tested as a description of the viscous cross flow for large fineness ratio bodies approximating circular cylinders at moderate angles of attack. Some agreement is obtained, although empirical procedures are still required and the region of applicability is narrow. M.V.E.

A70-36455 # **Parametric shimmy of a nosegear.** F. H. Ho and J. L. Lai (B. F. Goodrich Research Center, Brecksville, Ohio). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 373-375. 5 refs.

Study of the effect of large wheel and tire imperfections on nose gear stability. It is shown that nose gear instability can result from such wheel and tire imperfections. The phenomenon of this self-excited instability (shimmy) is found to be similar to that of parametric resonance, but different from the ordinary resonance caused by an external periodic force in that the major instability occurs when the wheel rotation frequency is equal to the double of any natural frequency of the system. For the simplified nose gear system studied, it is found that this parametric shimmy of the landing gear is determined completely by the instability character of an associated Mathieu equation. M.V.E.

A70-36456 # **Lower bounds for sonic boom considering the negative overpressure region.** James S. Petty (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 375-377. 7 refs.

Attempt to obtain configurations with lower boom overpressures from nonasymptotic theory, considering both the positive and negative parts of the overpressure signature. The techniques of Whitham (1952), those of Walkden (1958), and those of Jones (1961) are used in the analysis. The obtained results indicate that, although it may be necessary to consider the negative overpressure region in configuration tailoring for sonic boom, the penalty incurred in doing so should not be large. M.V.E.

A70-36459 # **Thermal effects on aircraft elastic mode shapes.** Robert L. Swaim (Purdue University, Lafayette, Ind.). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 379. 8 refs.

Recommendation for an early investigation of the effects of nonuniform temperature distributions on the normal vibration mode shapes of complex aerospace vehicle structures and their structural components. Total-airframe orthogonal vibration modes with undamped natural frequencies of the same order of magnitude as the rigid-body short-period frequency, as well as thermally induced stresses in the structure and reduction in the elastic moduli, will characterize the highly flexible aircraft that will be flying at high supersonic and hypersonic speeds within the atmosphere before the end of this century. It is urged that sponsoring agencies give attention and support to filling the serious existing gap in knowledge and analytical methods in order to have the analysis and design tools at hand when the application arises, as it most certainly will in the not too distant future. M.V.E.

A70-36460 # **Subsonic flow visualization using steam.** C. J. Prentice and F. X. Hurley (McDonnell Douglas Corp., St. Louis, Mo.). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 380. Research supported by the McDonnell Douglas Independent Research and Development Program.

Description of a simple technique of streamline tracing for flowfield study above 200 fps requiring no special chemical or mechanical or heating equipment. The technique uses a mixture of steam and cold nitrogen gas and produces a streamline-tracing fog which is persistently visible. Normal tunnel lighting can be used, and photography requires no special film or time exposure. M.V.E.

A70-36461 # **Test section for a V/STOL wind tunnel.** Ching-Fang Lo (ARO, Inc., Arnold Air Force Station, Tenn.). *Journal of Aircraft,* vol. 7, July-Aug. 1970, p. 380-382. USAF-sponsored research.

Study of a V/STOL testing wind tunnel section having solid vertical walls and different porosities for the top and bottom walls. This configuration has been found to give nearly zero interference at the model position for every wake angle. Interferences are eliminated in the streamwise and spanwise direction simultaneously for all wake skew angles. M.V.E.

A70-36507 **Aerodynamics (Aerodinamika).** A. M. Mkhitarian. Moscow, Izdatel'stvo Mashinostroenie, 1970. 429 p. 71 refs. In Russian.

The fundamentals of aerodynamics as applied to passenger aircraft systems are presented in a study text for engineering students of civil aviation. The laws describing motions of gases and immersed bodies are explained, including gas flow similarity laws and the fundamentals of boundary layer theory and finite-span wing theory. The characteristics of the earth's atmosphere are outlined, and topics examined include potential flows, vortex motion, isentropic flows, small disturbances, and shock waves. Aerodynamic characteristics are described for wing profiles, wings and surfaces of different shapes, bodies of revolution, and the aircraft as a whole. Special chapters are devoted to aerodynamic features at hypersonic velocities and to the fundamentals of tractor and rotor propeller theory. T.M.

A70-36508 **The method used in France for flutter forestalling of aircraft and missiles (La méthode utilisée en France pour la prévention du flottement des avions et des missiles).** R. Mazet (Paris, Université, Faculté des Sciences, Orsay, Essonne, France). *(Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace and Deutsche Gesellschaft für Luft- und Raumfahrt, Journée, 10th, Braunschweig, West Germany, Nov. 28, 1969.) L'Aéronautique et l'Astronautique,* no. 21, 1970, p. 4-10. In French.

The method applied in France to prevent accidents with planes of a new type, which are attributed to aeroelastic flutter, is characterized by the importance given to the vibration test on ground. This test does not only allow the establishment of the vibration natural frequencies, but also of the corresponding deformations of the appertaining conservative system (eigenforms), the inertial coefficients or 'generalized masses' of these forms and the internal damping conditions. It requires the proper adaptation of the harmonic excitation to each eigenform. The technique applied to discovering the causes of a possible flutter and to seeking for relief is based on the concept of energy transfer from one eigenform to the other under the effect of the aerodynamic couplings. Simple rules allow to detect on the ground the forms concerned in the phenomenon; generally, their number is not high. (Author)

A70-36509 **The basic problems posed by the development of the European Airbus (Les problèmes fondamentaux posés par la réalisation de l'Airbus Européen).** Roger Beteille (Société Nationale Industrielle Aérospatiale, Paris, France). *L'Aéronautique et l'Astronautique,* no. 21, 1970, p. 11-15; Discussion, H. Ziegler and P. Satre, p. 15, 16. In French.

Review of the European A-300-B Airbus program, which is characterized by its magnitude, its strictly commercial aspect, and the numerous industries involved. The efforts made by the constructor to solve the major technical and economic problems which have arisen in the course of development are described. F.R.L.

A70-36513 **Area navigation systems for STOL operation.** James D. Wheeler (American Airlines, Inc., New York, N.Y.). *Shell Aviation News,* no. 384, 1970, p. 8-15.

Results of a three-month flight test of area navigation systems for STOL operation, using the McDonnell-Douglas version of the Brequet four-engine STOL turboprop. The Butler-National Vector Analog Computer and Ascent-Descent Director, the Decca Omnitrac IIB System, and the Litton Inertial Navigation System are described and evaluated. It is considered that each of the three systems exhibited excessive workload, and was not considered suitable for STOL or conventional aircraft. It is felt that it would be highly desirable to automate the programming and controls in future area/vertical navigation equipment. F.R.L.

A70-36550 # **Some aspects of the quality control of turbojet fuels (Unele aspecte privitoare la controlul calităţii combustibililor pentru turboreactoare de avion).** Nicolae Ioanesi (Ministerul Petrolului, Bucharest, Rumania) and Pascal Popescu. *Revista Transporturilor,* vol. 17, Apr. 1970, p. 151-156. In Rumanian.

Discussion of the principal criteria to be taken into account in checking aircraft fuels. The aspects treated are those of chemical composition, physical properties, and the steps to be taken when storing, handling, filtering, and restocking such fuels in order to meet quality requirements in compliance with national and international standards. M.M.

A70-36647 # **Pure-impulse, high-camber, high-solidity axial compressors.** Bolesław Szczeniowski (Montréal, Université, Ecole Polytechnique, Montreal, Canada). *Archiwum Budowy Maszyn,* vol. 17, no. 2, 1970, p. 151-174. 11 refs.

Investigation of prospects for the application of the pure-impulse principle to impellers of axial compressors having high-solidity and high-camber blades which ensure considerable overlapping. Very high compression ratios were obtained in a single stage by using very high subsonic relative velocities and two diffusers - one supersonic, annular, and bladeless, and the other conventional subsonic. Such compressors can be very advantageous in turbines with isothermal burners. T.M.

A70-36656 # **Mass air transport.** Keith Legg (Loughborough University of Technology, Loughborough, Leics., England). *Istituto Internazionale delle Comunicazioni, 17th, Genoa, Italy, Oct. 8-12, 1969, Paper.* 65 p. 33 refs.

Brief discussion of disciplines and the interaction of the many subsystems involved in problems presented by mass air transport. It is pointed out that mass air transport is already upon us and that future potential traffic growth indicates massive development. The vehicles heralding this rapid development will come into service during the 1970's and it will be vital to provide suitable infrastructures in appropriate time scales. The essential requirement is to increase the low rates within the entire system process. M.M.

A70-36661 # **Juridical problems of sub-orbital space transports (Problemi giuridici dei trasporti spaziali suborbitali).** Ludovico M. Bentivoglio (Università Cattolica del Sacro Cuore, Milan, Italy). *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 17th, Genoa, Italy, Oct. 8-12, 1969, Paper.* 23 p. 28 refs. In Italian.

Discussion of various criteria and legal definitions of the basic concepts of the various forms of general and air transportation, with particular reference to Italian legislation on the subject. The various technical concepts of the various forms of air navigation are classified, and the concept of mutual responsibility by the States in the use of the avenues of space is stressed. M.M.

A70-36663 # **Sub-orbital space transports (I trasporti spaziali sub-orbitali).** Cesare Cremona (Consiglio Superiore dell'Aviazione Civile, Rome, Italy). *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 17th, Genoa, Italy, Oct. 8-12, 1969, Paper.* 13 p. In Italian.

Discussion of the implications of the recent theoretical exceeding of the sonic velocity by the Concorde 001. It is pointed out that, whatever the recoverable devices (either missiles or aircraft) used for injecting into space flight a fuselage containing a payload, the class of jet-orbital or jet-assisted aircraft makes possible the rapid, economical and safe solution of the transport problem. M.M.

A70-36665 # **Some considerations on the introduction of the Concorde in intercontinental airlines (Alcune considerazioni sull'introduzione del 'Concorde' sulle linee intercontinentali).**

Vincenzo Correnti. *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 17th, Genoa, Italy, Oct. 8-12, 1969, Paper.* 31 p. 7 refs. In Italian.

Foreword to an investigation of the consequences of the delay in introducing supersonic aircraft in civil airlines. It is pointed out that, in spite of the delayed construction of the U.S.A. SST, the design limitations of the Concorde do not warrant excessive optimism concerning its widespread commercial success. M.M.

A70-36674 **S-band cw power module for phased arrays.** E. Belohoubek, A. Presser, D. M. Stevenson, A. Rosen, and D. Zieger (RCA, Electronic Components, Princeton, N.J.). *Microwave Journal,* vol. 13, July 1970, p. 29, 30, 32, 34. Contracts No. AF 33(615)-69-C-1156; No. AF 33(615)-69-C-1488.

Discussion of improved versions of individual components of a high-power module design intended for the application in airborne equipment. The major performance goals of the power module are a cw power output above 10 W and a dc-to-rf efficiency in excess of 10% over the frequency range from 2.8 to 3.2 GHz, with operation at a case temperature of up to 80 C. A combination of class C amplifiers and varactor doublers is selected to achieve this power level. The power-input requirements for the module are set at 100 mW at a center frequency of 1.5 GHz. V.Z.

A70-36681 # ***Transition dynamics of VTOL aircraft.*** Rudrapatna V. Ramnath (Electronic Associates, Inc., Princeton, N.J.). *(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 7th, New York, N.Y., Jan. 20-22, 1969, Paper 69-130.) AIAA Journal,* vol. 8, July 1970, p. 1214-1221. 14 refs. Contract No. AF 33(615)-3657.

Asymptotic approximations using multiple time scales are developed for the longitudinal dynamics of VTOL vehicles during the hover forward-flight transition. After reviewing the method briefly, the transitional equations of motion whose coefficients vary with flight velocity, are studied. Rapid and slow motions of the vehicle are extracted individually and combined to yield a composite solution. The time scales are necessarily nonlinear functions and complex quantities to describe nonautonomous phenomena. The present method thus generalizes earlier time scale analyses. The technique is applied to VTOL vehicles exhibiting typical stability derivative variations, first to the two-degree-of-freedom case and then the three-degree-of-freedom case. The asymptotic approximations are compared with exact numerical integrals. An analytical description of the aircraft motion is thus obtained. The problem of transition points is outlined. (Author)

A70-36691 # **Three-dimensional vortex theory for axial compressor blade rows at subsonic and transonic speeds.** Olufemi Okurounmu and James E. McCune (MIT, Cambridge, Mass.). *AIAA Journal,* vol. 8, July 1970, p. 1275-1283. 7 refs.

The three-dimensional, inviscid, small-perturbation, compressible flow past a lifting axial compressor rotor is analyzed. Because of its three-dimensional nature the solution applies for transonic as well as subsonic relative speeds. A potential solution is constructed, representing B lifting blades each with bound vorticity of total strength Gamma(r). If Gamma(r) is nonuniform, vorticity is shed downstream, which in turn induces a modified flowfield at the rotor. In addition, for supersonic relative tip Mach numbers, acoustic radiation occurs. Both of these effects introduce drag at the blades. Given Gamma(r), or the mean change in circumferential velocity, the first-order static and total pressure rise, axial velocity change, etc., are determined. A second-order calculation yields the power required, including the effects of induced and wave-drag. An ideal efficiency is defined which indicates the penalty associated with departure from constant work design, as well as with losses due to acoustic radiation. For a 20% variation of Gamma across the blade span, the combination of both types of losses for a typical, but lightly-loaded, transonic rotor are of the order of 0.5%. (Author)

A70-36709 # **Critical height phenomenon for vertical jets mounted in flat surfaces.** William G. Sherling and Walter S. Woltosz (Auburn, University, Auburn, Ala.). *AIAA Journal,* vol. 8, July 1970, p. 1357, 1358.

Experimental investigation into the effects of a cold flow between two flat, parallel surfaces simulating aircraft surfaces, where the flow originated from a nozzle in one of the surfaces exhausting normal to the other surface. Data obtained in the experiment were nondimensionalized in a different manner resulting in the discovery of the so-called critical height phenomenon. It is shown that only the vehicle surface area has an effect on the value of the critical height, and therefore that nondimensionalizing the critical height with respect to the area gives the same value for all configurations. O.H.

A70-36758 **New visions in electronic packaging in the 70's; Institute of Electrical and Electronics Engineers, Eastern Electronics Packaging Conference, Massachusetts Institute of Technology, Cambridge, Mass., June 8, 9, 1970, Proceedings.** New York, Institute of Electrical and Electronics Engineers, Inc., 1970. 114 p. $15.

Contents:

Multi-chip hybrid microcircuits for low cost reliability. D. A. Graybill (General Dynamics Corp., San Diego, Calif.), p. 2.2.1-2.2.7.

Hybrid integrated microwave power amplifiers. H. Sobol (RCA, Somerville, N.J.), p. 2.4.1-2.4.5.

The impact of LSI packaging technology on system physical design. J. H. Martin (MIT, Cambridge, Mass.), p. 2.5.1-2.5.10.

Packaging and mechanical design of LM-Apollo rendezvous radar and transponder electronic assemblies. J. I. Herzlinger (RCA, Burlington, Mass.), p. 5.1.1-5.1.6.

A survey of cooling techniques for aircraft electronic equipment. S. A. Casazza and R. J. Joachim (Raytheon Co., Bedford, Mass.), p. 5.2.1-5.2.14.

A70-36763 **A survey of cooling techniques for aircraft electronic equipment.** S. A. Casazza and R. J. Joachim (Raytheon Co., Bedford, Mass.). In: New visions in electronic packaging in the 70's; Institute of Electrical and Electronics Engineers, Eastern Electronics Packaging Conference, Massachusetts Institute of Technology, Cambridge, Mass., June 8, 9, 1970, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 5.2.1-5.2.14.

Discussion of avionics cooling techniques based on the heat transfer mechanisms of natural convection, forced convection, phase change (boiling and heat of fusion), and heat pipes. Present and near future aircraft electronics are processing more power than ever before. Equivalent or shrinking space allocations require greater packaging density resulting in increased heat flux for components such as microelectronics, large-scale integrated circuits, and other solid-state devices. Hot spot power densities of 100 to 1000 watts per cubic inch have become commonplace in advanced electronics. As a result, the heat removal process and temperature control techniques have become challenging design problems. Current avionics cooling systems and some state-of-the-art concepts that may have future application are discussed with the intent to examine the range of thermal design approaches available to the designer. M.V.E.

A70-36796 **A systems approach to air transportation.** Robert W. Simpson (MIT, Cambridge, Mass.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700337.* 9 p. Members, $1.00; nonmembers, $1.50.

An attempt is made to describe a systems approach to planning

the development of national transportation systems. A transportation systems development process is defined as made up of activities such as policy making, planning, and systems analysis and actions comprising decisions and implementation programs. It is concluded that the present process of transportation development is far from rational or systematic and that major changes are required. (Author)

A70-36797 The case for V/STOL aircraft in short-haul transportation. D. G. Brown (Hawker Siddeley Aviation, Ltd., Hatfield, England). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700333.* 15 p. Members, $1.00; nonmembers, $1.50.

Discussion of the merits of a VTOL transport system for short-haul transportation. The use of fast, low-noise, fan lift V/STOL aircraft under circumstances similar to European requirements is considered. Four benefits are expected: (1) passenger and airline appeal due to competitive fares, convenience, and time saving; (2) community acceptance thanks to reduced noise and reduced proliferation of large airports; (3) such operational advantages as flexibility, enhanced all weather operation, safety, and ATC; and (4) reduced total investment. The fan lift formula is seen to lead to a wide range of V/STOL aircraft apt to meet worldwide STOL, V/STOL, and VTOL requirements, with good long-term development prospects.
M.V.E.

A70-36798 A cooperative airline program to evaluate engine parts aging effects on a current turbofan engine model. B. R. Arnold (American Airlines, Inc., New York, N.Y.) and J. R. Gast (Trans World Airlines, Inc., Kansas City, Mo.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700329.* 11 p. Members, $1.00; nonmembers, $1.50.

The contribution that aged hardware makes to performance deterioration is of interest to operators of JT3D turbofan powered aircraft since a significant percentage of these engines have exceeded 20,000 hr of operation. Recent studies involving numerous engine disassemblies, rebuild, and test cell runs reveal the most significant effects of aged hardware are the loss in high and/or low compressor stall margin; and, that a large number of parts must be replaced to realize a significant improvement in fuel consumption, with the exception of the reduction that can be obtained by controlling turbine seal clearances. (Author)

A70-36799 The effects of nonlinear asymmetric supports on turbine engine rotor stability. Rozell Williams, Jr. and Ronald Trent (General Motors Corp., Allison Div., Indianapolis, Ind.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700320.* 12 p. Members, $1.00; nonmembers, $1.50.

A rotor-shaft system supported at one end by a spline coupling, and at the other end by a flexible bearing support having asymmetric and nonlinear characteristics is analyzed. The effects of nonlinearity and asymmetry in the flexible support, on the response to excitation from sliding friction in the spline coupling and rotor unbalance are investigated. The spline friction is represented as coulomb friction. As a result of the sliding friction excitation, a bounded non-synchronous whirl is shown to occur at rotational speeds above the undamped natural frequency of the system. (Author)

A70-36800 Bearings and dampers for advanced jet engines. Paul F. Brown (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700318.* 13 p. 14 refs. Members, $1.00; nonmembers, $1.50.

Sophisticated mainshaft support systems must be developed because present jet engines demand long life and the next generation of engines will require higher levels of performance and higher thrust to weight ratios. Consequently, the bearings in these support systems must operate at higher speeds and for longer periods of time than ever before. To achieve this performance three of the factors considered in the design are surface finish and waviness control, duplexing vs single ball thrust bearings, and lubrication and cooling systems. In addition, oil film dampers mounted integral with or immediately surrounding the outer race of these bearings provide significant reductions in vibration amplitudes transmitted to the engine supporting structure and in static structure stresses, and can prolong life or provide the option of reducing structural weight without increasing stress. (Author)

A70-36801 Some historical highlights of turbine engine condition monitoring using flight data. P. D. Doran (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700314.* 10 p. 20 refs. Members, $1.00; nonmembers, $1.50.

This paper outlines highlights of the history of developments in the techniques of turbine engine performance monitoring using flight data. The steadily increasing importance of economic considerations in commercial air transport is expected to bring about extended usage of such engine performance monitoring practices in the future as the current equipment builds up time. In any case, the introduction into service of more complex and costly new aircraft is expected to dictate requirements for future continuing development of increasingly sophisticated techniques using flight data to monitor the performance of the advanced engines and associated systems installed in such aircraft. It is, therefore, intended that this paper will help serve those who seek a general perspective on how flight data performance monitoring of turbine engines began, what major steps took place in its development, the extent to which it is in use today, and its prospects for the future. (Author)

A70-36803 Solid state multiplexed electrical power distribution system. H. L. Ernst (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700301.* 10 p. Members, $1.00; nonmembers, $1.50.

This paper presents an Advanced Electric Distribution System (AEDS) for future generations of military and commercial airplanes. Based on development activities over the past two years, and complemented by various suppliers, Air Force and Navy development programs, it has become evident that a 'Solid State Multiplexed Electrical Power Distribution System' is the direction that should be pursued. This presentation emphasizes the system application, rather than the specific system or equipment design. It is considered that significant benefits will accrue to future airplane development programs by use of AEDS and associated application of Remote Power Controllers (RPCs) provided that they are incorporated early in the development and applied within their 'application limits' as compared to being used as a 'direct replacement' for the existing conventional distribution system with associated thermal circuit breakers. These benefits will include such items as wire weight reduction, crew work load reduction, reduced panel space requirements in the flight deck, and automatic load management functions. (Author)

A70-36804 Development of the Rolls-Royce RB.211 turbofan for airline operation. J. M. S. Keen (Rolls-Royce, Ltd., Derby, England). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700292.* 15 p. Members, $1.00; nonmembers, $1.50.

This paper briefly reviews the basic design concepts of the RB.211-22 high bypass turbofan engine. It summarises the facilities

available for developing the engine. It concludes with a status report of the engine development programme, including comments on the fan blade, combustion development and smoke levels, the H.P. turbine blade, oil sealing, structural rig testing, the three-shaft configuration, modular build, borescope inspection, achieved performance and noise levels. (Author)

A70-36805 Olympus 593 - Concorde development report. M. H. Beanland (Rolls-Royce, Ltd., Bristol, England). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700291.* 14 p. Members, $1.00; nonmembers, $1.50.

Discussion of the development status of the Olympus 593 engine designed to meet the performance qualifications of the Concorde aircraft. Design and development programs are discussed in detail and the particular objectives, present and future, are examined from the viewpoints of reliability, maintainability, and operational capability. Special attention is given to the techniques applied to expediting the development by safely continuing test runs of bench machines known to have mechanical defects. By the time the Olympus 593 enters service in the Concorde, more than 30,000 hr of bench and flight testing will have been completed. It is expected that the final design of the engine will meet the demands of the Concorde. M.V.E.

A70-36806 Testing results of comprehensive program for high bypass aircraft engines. R. B. Ingraham (General Electric Co., Aircraft Engine Technical Div., Cincinnati, Ohio). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700290.* 12 p. Members, $1.00; nonmembers, $1.50.

Discussion of the program of factory, flight, and operational suitability testing that has accompanied the development of the TF39-CF6 high-bypass-ratio turbofan engines. Some of the test results of performance, mechanical durability, and handling characteristics under environmental and operational extremes are given in tables and diagrams and compared with those of earlier models to indicate the accomplished progress. M.V.E.

A70-36807 JT9D engine operating experience. H. Alden Jackson and Horst O. Pohlmann (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700288.* 8 p. Members, $1.00; nonmembers, $1.50.

Discussion of the advanced design features of the JT9D engine and of the observations made about its performance in the course of its initial operating experience. The engine design is shown to have been aimed at achieving increased performance with reduced mechanical complexity, good thrust to weight ratio, improved maintenance capability through modular construction, and superior capability for condition monitoring. Improvements were to result in the main from the selection of an arrangement where each of two rotors is simply supported by two main bearings rather than the six or more in use in current engines. Experience to date has proven the judiciousness of the JTD9 engine design. Difficulties encountered have been quickly resolved. M.V.E.

A70-36808 Performance of Static Charge Reducer. W. L. Bulkley and I. Ginsburgh (American Oil Co., Chicago, Ill.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700277.* 7 p. 10 refs. Members, $1.00; nonmembers, $1.50.

The Static Charge Reducer, a device to reduce static charges in distillate fuels to safe levels during loading or fueling operations, has been in commercial service for over five years and is now being used in several hundred installations. The field experience and laboratory tests accumulated over this time have now been analyzed to show how operation is affected by such variables as the dimensions of the reducer, the flow rate and electrical characteristics of the fuel, and the configuration of the tankage. To date, the principal applications involve the use of 4 or 6 in. diameter Reducers for the loading of distillate fuels into commercial tank trucks at flow rates of 400-800 gpm. However, available data for Reducers up to 12 in. in diameter, for flow rates up to 2000 gpm, and for various tank sizes are sufficient to indicate how the Reducer will perform under a wide variety of conditions. (Author)

A70-36809 Terminal airspace utilization. Charles E. Dowling, Jr. (FAA, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700281.* 9 p. 11 refs. Members, $1.00; nonmembers, $1.50.

This paper discusses several of the most important operational aspects of terminal airspace utilization from an air traffic control viewpoint. Considerations include the work accomplished by the Department of Transportation's Air Traffic Control Advisory Committee, their FAA staff and industry representatives, as well as other selected efforts in analytical and dynamic simulation. Each of the subsystems which are involved in and therefore affect terminal/transition airspace use and capacity such as the airport, approach and landing, navigation, data acquisition, communications and air traffic control are discussed in terms of their relationship and interaction with capacity. The anticipated effect of increased automation in both the terminal and en route ATC systems and their interface is described. Possible tradeoffs between safety and expeditiousness are briefly examined. It is concluded that the expected increase in traffic will require major increase in system capability as well as changes in technique and philosophy only possible through extensive automation. In addition, new and improved National Airspace System elements will be required to cope with the resultant demand for capacity and safety. (Author)

A70-36810 CRC evaluation of aviation emission-measurement techniques. T. O. Wagner (American Oil Co., Whiting, Ind.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700338.* 21 p. Members, $1.00; nonmembers, $1.50.

Evaluation of methods for sampling, handling, and measuring emissions of particulates, hydrocarbons, carbon monoxide, carbon dioxide, oxides of nitrogen, and oxygenated compounds in the exhaust of aircraft turbine engines. Nondispersive infrared (NDIR) instruments and a Fisher chromatographic partitioner were both well suited for measuring carbon monoxide and carbon dioxide. Available flame ionization detector (FID) analyzers performed satisfactorily in measuring hydrocarbons in the range of 200 to 300 ppm C, such as prevailed at idle rpm, but they were not reliable in measuring hydrocarbons in the range of 10 ppm or less such as prevailed at high rpm. In handling samples for hydrocarbon measurements, short, hot Teflon lines with high flow rates appear to be optimum. F.R.L.

A70-36811 Aircraft electrical system multiplexing. Olin B. King and V. B. Ramsey (SCI Electronics, Inc.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700303.* 11 p. Members, $1.00; nonmembers, $1.50.

The application of multiplexing to civilian and military aircraft electrical systems provides substantial improvements in cost, weight reduction, flexibility, reliability and maintainability over conventional hard-wired systems. Relay logic and dedicated wires throughout a typical aircraft are replaced with remote data terminals, a twisted-shielded pair data bus, and a programmable central control unit. System reliability and maintainability is enhanced by the use of dual redundancy, built-in-test and automatic fault isolation and

redundant switchover features. The system operation is stable when subjected to electromagnetic interference and electrical system transients. Current developments include a Data Handling System for SOSTEL II, device technology in solid state power controllers, and remotely resettable circuit breakers. A review of future aircraft electrical systems indicates that integrating the multiplex data terminals with other elements of the electrical systems will provide even further reductions in aircraft wiring. (Author)

A70-36812 Expected technical and economic characteristics of 1975 STOL systems. Marvin D. Marks, R. K. Schaefer, Jr., and J. P. Caldwell (McDonnell Douglas Corp., St. Louis, Mo.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700311.* 8 p. Members, $1.00; nonmembers, $1.50.

The expected technical and economic characteristics of 1975 STOL systems are discussed in terms of the requirements of the passenger market, the aircraft, ground terminal facilities, and separate STOL ATC capability. An evolutionary approach is recommended utilizing existing, proven technology to establish a first generation operational system to develop the STOL concept and provide the data base for planning second generation vehicle development. A timetable for evolutionary development is presented with significant development milestones identified. (Author)

A70-36813 Basic principles of digital interior communication systems. M. S. Osborn and D. C. Fox (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700302.* 12 p. Members, $1.00; nonmembers, $1.50.

The increase in the amount of complex communication equipment in aircraft systems has caused problems which conventional approaches to interconnection of independent subsystems can no longer solve. Using point-to-point wiring penalizes aircraft performance in terms of space usage, weight, cost, and reliability. This paper presents multiplexing techniques in conjunction with solid state technology and systems integration as proposed methods which will provide a cost effective solution to aircraft interior communication problems. Two basic systems reviewed are time division and frequency division multiplexing. The proposed use of a digital interior communication system for the SST, and the criteria that no single failure in a common element would cause loss of a signal, led to development of four multiplex systems which are dual redundant. Other features of this system are weight/cost advantages, flexibility, maintainability, and redundancy which ensures high operational reliability and flight safety. In conclusion, it is felt the state-of-the-art is capable of implementing the digital communication system and these techniques will significantly improve the operation of current and future aircraft. (Author)

A70-36814 The corporate/executive market for helicopters. Dwayne K. Jose (Bell Helicopter Co., Fort Worth, Tex.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700285.* 33 p. Members, $1.00; nonmembers, $1.50.

This paper will discuss a brief history of corporate aviation, identify the primary advantages of aviation to the business community, will identify several current trends having a profound effect upon business transportation, and will discuss the impact of aviation upon corporate transportation, including the influence of the jet age. It will identify the problems and constraints confronting fixed-wing corporate air transportation and will identify which of these problems are amenable to solution by rotorcraft, and review the growth of the corporate/executive market in use of aircraft and rotorcraft. General characteristics of some of the most commonly used business helicopters are reviewed, including those expected to be in use in the period 1970-1975. (Author)

A70-36815 Relationship between WSIM ratings and filter/separator performance. L. Gardner (National Research Council, Ottawa, Canada). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700279.* 7 p. 6 refs. Members, $1.00; nonmembers, $1.50.

The Water Separation Index, Modified, has been accepted as the standard procedure for assessing the water separating characteristics of a fuel. The significance of this test in relation to filter/separator performance and life, however, has not been well established. An evaluation of the WSIM test has been made in an attempt to establish this significance. This evaluation has shown that the test is sensitive to the presence of surface active materials in a fuel. The response to such materials is reasonably quantitative, although all materials do not respond in the same manner. Filtration tests confirm the sensitivity and indicate that a WSIM rating of less than 100, possibly as low as 75, can be considered acceptable. (Author)

A70-36816 The 747 fuel system. E. D. Ayson, R. R. Dhanani, and G. A. Parker (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700276.* 10 p. Members, $1.00; nonmembers, $1.50.

The fuel system installed in the Boeing Model 747 airplane is described in general, and the pressure fueling system treated in detail. The general treatment includes description of fuel tanks, engine fuel feed system, fuel jettison system, defueling system, fuel quantity indicating system, and fueling system. The component parts of the pressure fueling system are described, and performance of the system is evaluated. In the design of the 747 airplane, surge pressures and static electrification, possible problem areas associated with refueling large airplanes, have been minimized. The fuel system of the 747 meets applicable Federal Aviation Regulations and customer requirements. (Author)

A70-36817 Consideration of performance and cost in future military aircraft engines. R. B. Dyson and R. F. O'Donnell (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700272.* 8 p. Members, $1.00; nonmembers, $1.50.

Discussion of effort application areas likely to offer opportunities for reduction in costs of military aircraft engines. It is felt that development of methods for reducing engine costs may offer better opportunities for improving the cost effectiveness of future military aircraft than do projected engine performance improvements. A technique for evaluating the worth of both cost and performance parameters is described and a review given of methods currently used for optimizing these parameters during the engine design process. Several areas where development effort may offer considerable potential for cost reduction are identified. M.V.E.

A70-36818 Cost estimating techniques for advanced technology engines. T. J. Brennan, R. N. Taylor (U.S. Naval Material Command, Naval Air Development Center, Johnsville, Pa.), and A. G.

Steinert (U.S. Naval Air Systems Command, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700271.* 9 p. Members, $1.00; nonmembers, $1.50.

Discussion of the impact of technological progress over the past two decades in materials and performance on costs and cost estimating techniques. By applying the rationale that the type and amount of raw materials used in the manufacture of an engine do affect significantly its cost, correlations between engine cost and a factor defining a weighted material content were determined. Investigations of other physical, thermodynamic, and metallurgical engine characteristics are discussed to provide a costing method for predicting future engine production costs. M.V.E.

A70-36819 Propulsion system impact on military/commercial STOL transport commonality. J. P. Stalder (North American Rockwell Corp., El Segundo, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700269.* 10 p. Members, $1.00; nonmembers, $1.50.

A STOL medium tactical transport featuring 1000 ft takeoff distance performance has been established utilizing the powered-lift wing to achieve STOL capability. Two powered-lift wing concepts, the augmented jet flap and the externally blown flap, are presented as optimum for a minimum thrust-to-weight ratio configuration. Interconnecting the propulsion system with engine cross ducting minimizes the unsymmetrical lift resulting from an engine failure. A commercial counterpart to the military transport is discussed. (Author)

A70-36820 Advanced military transport engines. James N. Krebs and Peter G. Kappus (General Electric Co., Aircraft Engine Technical Div., Cincinnati, Ohio). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700267.* 15 p. Members, $1.00; nonmembers, $1.50.

Examination of the propulsion system requirements of military and commercial transports, reviewing their impact upon design and development decisions. Trends of convergence or divergence of requirements in future transports systems are discussed. Two transport systems are considered: the first generation of high bypass turbofan transport propulsion systems represented by General Electric's TF39 and CF6 engines, and the most likely next generation of advanced technology transport powerplants of STOL, VTOL, and CTOL medium transports expected to be operational in the post-1976 period. F.R.L.

A70-36821 The use of launching and arrestment to reduce land area requirements for airports. Donald B. Doolittle (All American Engineering Co., Wilmington, Del.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700264.* 13 p. 12 refs. Members, $1.00; nonmembers, $1.50.

Improvement of landing and takeoff safety, with the use of runway launching and arresting systems is discussed. Navy aircraft carrier experience is the basis of projecting the safety of runway operations with commercial aircraft. Significant saving in takeoff runway length, and all weather landing in lengths now required for dry runways is projected. Conventional and STOL airports using launching and arresting gear are discussed. (Author)

A70-36822 Studies for and application of mechanical systems at Paris-Nord airport. F. L. Clinckx and J. P. Marcellin. *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700261.* 18 p. Members, $1.00; nonmembers, $1.50.

This paper is intended to describe the electromechanical baggage handling and sorting systems with which the ROISSY-en-FRANCE Terminal 1 will be equipped when it goes into service in 1973. Since the terminal will accommodate 9 million passengers each year, the problems of handling a heavy load of baggage traffic merited extensive planning of facilities and careful choice of equipment. Therefore special project and development studies on these systems were conducted by the Equipment Department of the Paris Airport Authority Engineering Division. This work and the systems evolving from it are meticulously reported here. (Author)

A70-36823 Morphology of deposits in aircraft and engine fuel systems. R. M. Schirmer (Phillips Petroleum Co., Newport, Tenn.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700258.* 15 p. 15 refs. Members, $1.00; nonmembers, $1.50.

Deposits produced in a wide variety of fuel system simulators and fuel test rigs were found to be remarkably consistent in their microstructure. The deposits were built from soft particles measuring about 1000 Angstrom units in diameter. These microspheres form random three-dimensional structures on the deposit face, which become more closely packed in the deposit substrate, and undergo fusion on heated surfaces. It is postulated that thermal stressing generates micelles in the fuel, and that deposits are formed by the collection of these particles from the fuel. Therefore, it is proposed that a standard method of test for fuel quality control should evaluate the deposit potential of fuels, free from the collection efficiency of physical systems. The 5 ml Bomb Procedure, which is based on the decrease in light transmittance through the fuel when thermally stressed, appears to be suitable for this purpose. (Author)

A70-36824 New techniques for measurement of jet fuel system deposits. H. T. Henderson and A. C. Nixon (Shell Development Co., Emeryville, Calif.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700257.* 8 p. 8 refs. Members, $1.00; nonmembers, $1.50.

Evaluation of some of the possible methods for the quantitative measurement of jet fuel system deposits, and discussion of the results obtained. Estimation of the extent of fouling by fuel deposits has relied upon visual examination of the coker tube, but the usefulness of this procedure has long been questioned. Other possible ways of rating the deposits on coker tubes are considered, including such techniques as removal with solvents, combustion with O2, combustion with ozone/O2, heat transfer effects, beta-ray backscattering, electron absorption, X-ray scattering, and infrared absorption. Experimental results indicate that O2 combustion and beta-ray backscattering ratings are more reliable than is visual appraisal for evaluating deposits formed by jet fuels. M.V.E.

A70-36825 Fuel tank deposits in an SST environment. G. E. Hays (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700256.* 9 p. 14 refs. Members, $1.00; nonmembers, $1.50.

Fuel temperatures resulting from the SST environment may cause Jet A kerosene to form solids which can adhere to fuel tank surfaces in localized areas. The environmental conditions influencing the formation and accumulation of deposits within the SST fuel tanks are examined and the potential problems with these deposits assessed. Methods of reducing the accumulation of deposits are investigated. The results of these investigations with the proposed SST fuel tank structure have led to the conclusion that the accumulation of deposits with Jet A kerosene fuel would not be excessive. (Author)

A70-36826 Environmental considerations and the metropolitan airport system. Dorn C. McGrath, Jr. (George Washington University, Washington, D.C.). *Society of Automotive Engineers, National Air Transportation Meeting, New York, N.Y., Apr. 20-23, 1970, Paper 700253.* 7 p. 10 refs. Members, $1.00; nonmembers, $1.50.

This paper examines the nature of the environmental challenge that airports face in the context of metropolitan area systems planning. The greatest problem is aircraft noise. This type of noise, which is immune from public regulation under traditional local powers, is not recognized adequately in planning for airports or nearby communities. Its effect on education is described, as is the question of housing development and industrial construction adjacent to airports. (Author)

A70-36829 # Some experimental results of two-dimensional compressor cascades at supersonic inlet velocities. H. Starken and H. J. Lightfuss (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Porz-Wahn, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-7.* 8 p. 14 refs. Members, $1.00; nonmembers, $2.00.

Investigation of two-dimensional compressor cascades in transonic and supersonic wind tunnels. The upstream Mach number range is 1.0 to 1.4. Tests have been carried out with three different blade shapes; these are double-circular-arc and wedge profiles. The influence of solidity on the performance of these cascades has been investigated. A detailed analysis and calculation of the shock losses shows the great influence of profile shape on the total pressure loss coefficient. The profile losses are roughly constant in the investigated Mach number range. In addition, some measurements for different back pressures are presented. These results are analyzed with the aid of a simple calculation, which shows that the axial velocity-density ratio has to be considered as an important parameter in supersonic cascade measurements. (Author)

A70-36830 # Simulation of gas turbine dynamic performance. H. I. H. Saravanamuttoo (Bristol, University, Bristol, England) and A. J. Fawke. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-23.* 9 p. Members, $1.00; nonmembers, $2.00. Research supported by the Science Research Council and Rolls-Royce.

This paper discusses the application of both analog and digital computer methods of simulation gas turbine dynamic performance. The problem is approached from the viewpoint of engineering thermodynamics, using the normal compressor and turbine characteristics. The simulation techniques were found to be extremely flexible and permitted operation over the entire running range. The simulation of an advanced twin-spool variable nozzle turbojet currently under development is described. Particular emphasis is placed on the transient operating paths on the two compressor characteristics, and their importance on surge avoidance. Procedures for improving the response rate are suggested. (Author)

A70-36831 # Nickel alloys - The heart of gas turbine engines. C. T. Sims (GE Materials and Process Laboratory, Schenectady, N.Y.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-24.* 13 p. 21 refs. Members, $1.00; nonmembers, $2.00.

Gas turbines create such a provocative high-temperature materials development challenge that metallurgists who work in this field usually consider themselves select and fortunate. Their response to the challenge has resulted in a constant issue of new iron, cobalt, and nickel superalloy compositions; of these, nickel-base superalloys are the most complex, the most widely used for the hottest parts, and to some the most fascinating. Due to the chemical and structural complexity of nickel alloys, engineers who are not metallurgists have understandable difficulty in familiarizing with their technology - and those metallurgists who understand nickel alloys reasonable well never admit it. This paper is an attempt to explain at least some of the mystery of these alloys for the engineers and designers who use their properties, and perhaps present a few unique points of view of metallurgists. However, little attempt will be made to discuss properties in detail; they are a matter of common record. Also, the alloys will be discussed only in a general sense; individual alloys will be used only for examples. Rather, emphasis will be on fundamental principles common to most nickel superalloy systems. (Author)

A70-36832 # The attitude control system as an integral part of the V/STOL propulsion system installation. J. P. Stalder (North American Rockwell Corp., International Airport, Los Angeles, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-31.* 9 p. Members, $1.00; nonmembers, $2.00.

The analytical techniques for evaluating the design and weight penalties associated with the V/STOL attitude control system are presented. A comparison is made between a V/STOL 200-passenger transport which uses thrust modulation of the lift engines for attitude control in the roll mode versus an alternate configuration which uses roll control fan driven by individual gas generators. The configuration using lift engine thrust modulation for roll control shows a 4729-lb weight advantage. (Author)

A70-36833 # History of the development of light weight lift jets. M. J. Bland (Rolls-Royce, Ltd., Derby, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-32.* 8 p. Members, $1.00; nonmembers, $2.00.

The growing interest in V/STOL aircraft will increase the pressure for efficient powerplants including lift jets and lift fans. The paper describes the progress that has been made in the development of lift jet engines and their design philosophy. Some of the problems encountered in the development of the RB 162 are discussed. (Author)

A70-36835 # Governing and monitoring of gas turbine engine for helicopters. J. Grandcoing (Société Nationale Industrielle Aérospatiale, Marseille, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-37.* 10 p. Members, $1.00; nonmembers, $2.00.

Pilots of modern aircraft have had to be provided with minimal operations in engine handling and controlling in order to devote themselves mainly to aircraft handling. Helicopter design has increasingly used the turbine engine governing system not only to control engine operation, but also to maintain a constant rotor speed, to pre-set the maximum power available in case of need, and to protect the rotating assemblies against overspeeding. This paper reviews the general requirements to be met by the helicopter engine governor system in multi- and single-engined craft with turbo-shaft or free-turbine engines (with the engine governor in the free-turbine model either controlled by the rotor speed governor or used to control rotor speed. Since the governor system has come to be considered an essential component of the helicopter and no longer as an engine component, the system must participate in general operation of the helicopter, allowing maximum performance over the entire flight envelope while requiring only minimal action and monitoring by the pilot. (Author)

A70-36836 # **Flight evaluation of helicopter gas turbine engines.** J. F. Bortkiewicz (Rolls-Royce, Ltd., Small Engines Div., Watford, Herts., England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-38.* 11 p. Members, $1.00; nonmembers, $2.00.

Five distinct phases of flight testing are outlined: initial flight evaluation, engine-helicopter integration, intensive flying, environmental tests and continuation development after introduction of engines into service. Areas of evaluation are listed and ultimate objectives specified. Since many areas of flight evaluation are common with fixed wing subsonic aircraft, emphasis is laid primarily on matching of the engine characteristics to the helicopter dynamic system. The paper is concluded with a statement of prerequisites of 'ideal' engines and their control systems for helicopter. (Author)

A70-36838 **The buzz-saw noise generated by a high duty transonic compressor.** M. G. Philpot (National Gas Turbine Establishment, Farnborough, Hants., England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-54.* 6 p. 8 refs. Members, $1.00; nonmembers, $2.00.

The buzz-saw noise made by a two-stage transonic research compressor has been investigated experimentally over a range of tip relative Mach numbers up to 1.56. The results show that the phenomenon is due to the propagation at supersonic relative tip speeds of the steady rotating pressure field associated with the first-stage rotor blades. The flow entering the tip section of the rotor has been analyzed theoretically and the circumferential pressure fluctuations computed, with good agreement with near-field measurements. The analysis leads to a clearer understanding of the dependence of the noise on inlet Mach number and three-dimensional effects and indicates the types of rotor irregularity which will most influence the harmonic content. (Author)

A70-36839 # **The transpiration-cooled gas turbine.** F. J. Bayley (Sussex, University, Brighton, England) and A. B. Turner. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-56.* 8 p. 16 refs. Members, $1.00; nonmembers, $2.00. Research supported by the Ministry of Technology.

This paper describes a program of experimental and analytical research designed to evaluate the aerodynamic and thermodynamic performance of transpiration-cooled porous surfaces in the high-temperature gas turbine. The aerodynamic penalties of effusing coolant through a set of nozzle blades are shown to be small, particularly when compared with the thermodynamic advantages which accrue from the effective cooling obtained. Although the effusing coolant can in certain circumstances increase gas to blade heat transfer rates by destabilizing a laminar boundary layer, in the turbulent boundary layers which predominate in turbine practice there is inevitably a reduction in heat transfer which can be satisfactorily predicted theoretically. In the combustion system of the gas turbine, transpiration cooling appears also to be very attractive, but much work remains to be done on heat transfer rates in the flame-tube. (Author)

A70-36840 # **Optimum cycle parameters for turbofan engines.** W. C. Moffatt (Royal Military College of Canada, Kingston, Ontario, Canada). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-65.* 8 p. Members, $1.00; nonmembers, $2.00. Defence Research Board of Canada Grant No. 9550-26.

This paper presents closed-form solutions for optimum compressor pressure ratio, bypass ratio and fan pressure ratio, given the turbine inlet temperature, component efficiencies and flight Mach number for a turbofan engine. In addition a simple procedure is outlined for obtaining the optimum combination of these quantities and a sample calculation is included. The optimum condition is defined as that which maximizes the specific thrust (thrust per pound per second of air flow through the gasifier) of the engine. The effects of differing gas properties in different portions of the engine are included in the analysis. (Author)

A70-36841 # **A rational determination of permitted usable lives for gas turbine engine components.** T. L. Salt. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-66.* 6 p. 6 refs. Members, $1.00; nonmembers, $2.00.

Description of the SMILE (Statistical, Maintenance, Inspection, and Life Evaluation) computer program designed to aid in the determination of the permitted usable lives, or the so-called 'life limits,' the FAA requires for critical aviation gas turbine rotating components in commercial use. The program embodies a rational approach to the determination of maintenance and retirement intervals, and compares, on the basis of estimated risk, alternative choices of life limits by including all the principal parameters involved. An example makes a comparison of a component with early crack initiation and substantial propagation before failure with an alternative design having late crack initiation but virtually infinitely fast propagation. It shows how a life limit may be considered redundant but necessary in the first case and essential in the second. The alternative risks with specified permitted usable lives are estimated for each design. The application of the SMILE program can produce a superior appreciation of design acceptability and management evaluation of business manufacturing costs and logistics. M.V.E.

A70-36842 # **Engine rotor matching for tip propulsion of large helicopters.** K. B. Amer and R. J. Sullivan (Hughes Tool Co., Culver City, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-68.* 12 p. Members, $1.00; nonmembers, $2.00.

This paper presents the results of engine/rotor matching studies for a pressure-jet tip-propulsion system for a large helicopter. When matching engine/airplane characteristics, it is standard practice to study the effects of cycle pressure ratio, turbine temperature, and fan bypass ratio. For a helicopter pressure-jet tip-propulsion system, in addition to engine cycle studies a more sophisticated matching analysis must be conducted because of the interacting effects of rotor characteristics (radius, chord, tip speed, airfoil thickness ratio) on propulsive efficiency as well as on weight and aerodynamic efficiency. The results of the study are compared with results for conventional shaft-drive propulsion systems for a short-range heavy-lift helicopter mission. (Author)

A70-36843 # **Environment problems affecting helicopter engine operation.** J. C. Arribat (Société Nationale Industrielle Aérospatiale, Marseille, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-96.* 7 p. Members, $1.00; nonmembers, $2.00.

One of the advantages of the helicopter is to be able to undertake in roles, which for other vehicles would prove to be difficult and even impractical. When performing flying crane duties, rescue flights or military operations, it has to fly very close to the ground or the sea, land on unprepared field and this, in open country, in the mountains or in the desert. It is relative to the fixed wing aircraft, what the 'Jeep' is to a passenger car, and due to this, it has more acute environment problems than other types of aircraft. The engines, being one of the more vulnerable components, must be protected against the attack of the environment. This subject being very large, it will be limited to three environment problems which are

the most important for helicopter engines: salt spray, dust and ice. The solutions - adopted by Sud Aviation, in close collaboration with Turbomeca, for its helicopters - are presented. The case of piston engines, we shall deal with gas turbine engines only. (Author)

A70-36844 # **CH-54A engine air particle separator - 3½ years of successful operation.** C. D. Stephenson (U.S. Army, Project Manager's Office, St. Louis, Mo.). *American Society of Mechanical Engineers, Gas Turbine Conferehce and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-97.* 7 p. Members, $1.00; nonmembers, $2.00.

The CH-54A EAPS - the first effective, operational engine air particle separator - has been in field service in Southeast Asia for 3½ years. In that time, engine times between removal for erosion have increased from approximately 80 hr to over 800 hr. Due to the availability of EAPS, engine TBO has increased from 400 to 800 hr. This paper reviews EAPS operational experience to date. The environment at operational sites is reviewed, engine removal history is summarized, and the various design improvements developed during this period are discussed. Recommendations for future systems design and development are included. (Author)

A70-36845 # **Experimental performance in annular cascade of variable trailing-edge flap, axial-flow compressor inlet guide vanes.** T. H. Okiishi, G. H. Junkhan, and G. K. Serovy (Iowa State University of Science and Technology, Ames, Iowa). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-106.* 8 p. 7 refs. Members, $1.00; nonmembers, $2.00.

Aerodynamic performance of a variable-geometry axial-flow compressor inlet guide vane configuration for a gas turbine unit was determined in a series of annular cascade tests. The variable-geometry vanes used uncambered, symmetrical airfoil sections as the basic blade profile with the rear 70 percent of the vane profile movable as a trailing-edge flap. Vane flap mechanical setting angles of 0 to 50 deg measured from the axial direction were possible, and performance parameters were determined over this range of angles. Turning angles followed a general trend obtained with Carter's rule for accelerating cascades with the presently measured values tending to be lower than those obtained with Carter's rule at higher setting angles. For large camber angles (greater than 35 deg) zero-incidence blade element total-pressure loss coefficients for the 50 percent passage location of the flapped vanes tested were higher than those that might have been obtained with a continuously cambered vane row of the same solidity and camber. (Author)

A70-36846 * # **Utilization of cascade data in axial-flow compressor design and analysis - A critical review.** G. K. Serovy (Iowa State University of Science and Technology, Ames, Iowa). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-108.* 12 p. 57 refs. Members, $1.00; nonmembers, $2.00. Research supported by the Iowa State University of Science and Technology; Grant No. NGL-16-002-005.

Data from experimental research in plane and annular cascade facilities have been and are currently used extensively in aerodynamic design and analysis of axial-flow compressors. The information required and available for this application is reviewed and existing general correlations of data are discussed. A significant number of cascade test facilities are currently in operation, but most recent experiments have been limited in scope and have investigated either a proposed blade section profile over a small range of cascade configuration geometry, or a specific compressor flow phenomenon. Typical programs are discussed and evaluated. Although the future role of cascade experimentation is not clear, areas are noted which might be productive in development of advanced axial-flow compressor units with improved performance. The primary value of stationary cascade studies in improvement of understanding of flow in compressors is emphasized. (Author)

A70-36847 # **Aircraft fire protection developments by the Federal Aviation Administration (1940-1970).** H. L. Hansberry (FAA, Atlantic City, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-109.* 13 p. 90 refs. Members, $1.00; nonmembers, $2.00.

Aircraft fire protection studies conducted by CAA/FAA from the DC-3 problems of 1940 to the most recent studies of the Boeing 720 and the Lockheed Jetstar are reviewed. The reasons for the changing emphasis from concern over powerplant fires in flight to concern over post-crash fires are discussed. Current studies of controlled flammability fuels, development of protection against burner-can burn-throughs, identification of interior materials of increased fire resistance and development of improved methods of crash firefighting are outlined. (Author)

A70-36848 # **Use of supersonic cascades made of blades of simple geometric shapes for cascade wind tunnel performance evaluation.** J. Fabri, J. Paulon, and G. Janssens (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-110.* 8 p. Members, $1.00; nonmembers, $2.00.

Use of blades of simple geometric shape for supersonic compressor cascade tests gives easy means to check the validity of wind tunnel tests, since comparison of experimental and theoretical shock and flow patterns as well as pressure distributions is simplified due to the fact that there exists only a limited number of discrete shock waves or expansion fans. A supersonic compressor blade cascade wind tunnel performances are evaluated according to this technique. (Author)

A70-36849 # **Surface integrity of electrochemical machining.** Guy Bellows (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-111.* 17 p. 38 refs. Members, $1.00; nonmembers, $2.00.

Review of the various types of electrochemical machining (ECM) effects on the surface integrity of machined components. Elements of surface integrity are shown to range from surface roughness, pits, cracks, and intergranular attack, to heat affected zones and metallurgical transformations. ECM makes possible the avoidance of all of these negative effects, though it can be plagued by any of them. These effects on some of the materials used in jet engines are illustrated. Guidelines are discussed for avoiding the detrimental effects and enhancing the desirable ones. It is shown that properly applied and controlled ECM can result in unblemished, superb surface integrity. M.V.E.

A70-36850 # **A review of the design practice and technology of radial compressor diffusers.** V. J. Smith. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-116.* 15 p. Members, $1.00; nonmembers, $2.00.

Radial diffuser design for centrifugal compressors is characterized by empiricism, scaling, unchecked hypotheses, numerous configurations and prejudice. The detailed behavior of new designs is almost unpredictable. Published test data from different investigators are not more than superficially comparable due to different methods of presentation. No orderly avenues of research and development are foreseen. This situation need not continue, and must not continue if other than accidental progress is to be made. The basic requirement is a system of correlation of geometry and performance between radial and axial diffusers. Without favor to either channel or cascade concepts, it is proposed that conformal transformation techniques can provide a base from which a true technology can develop. (Author)

A70-36851 # **Advanced composites - A state-of-the-art assessment.** G. P. Peterson (USAF, Air Force Materials Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-120.* 11 p. Members, $1.00; nonmembers, $2.00.

There have been truly significant advances made in the development of advanced composite materials during the decade of the 1960s. These advances have been specially noteworthy since they have occurred in an environment which has not been conducive to either the rapid development or the early operational weapon system usage of new technology. We have seen, however, advanced composite technology literally emerge from the boron filament laboratory apparatus stage in 1961 to the point where boron composite primary aircraft structure production commitment was proposed in 1967 on Air Force aircraft and production commitment on horizontal stabilizer structure was made in 1968 by Grumman Aircraft and the Navy on F-14 aircraft. The success achieved warrants a brief look at the background and developmental approaches which are substantially different from those involved with the development of titanium. (Author)

A70-36853 # **American Airlines' data reduction experience with electronic maintenance recorders.** Steve Pauliny (American Airlines, Inc., Tulsa, Okla.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-127.* 13 p. Members, $1.00; nonmembers, $2.00.

This paper describes American Airlines' data reduction experience in a program in which electronic engine maintenance recorders were installed in 15 BAC 1-11 aircraft. The maintenance recorder system is briefly outlined. Elements of the data and its reduction through software programs leading to computer fault analysis are portrayed. Significant electronic maintenance recorder experience is summarized and some economic projections on the Jumbo Jets are made, based on this experience. (Author)

A70-36854 # **The use of fire tunnel test techniques in the design of Concorde powerplant.** J. E. Talbot (British Aircraft Corp., Ltd., Filton Div., Bristol, England) and A. Slater (British Aircraft Corp., Ltd., Mechanical Test Dept., Preston, Lancs., England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-128.* 10 p. Members, $1.00; nonmembers, $2.00.

In the very early design phases of Concorde powerplant it was realized that the high airflows passing through the engine bay would pose significant problems in terms of the precautions necessary to withstand and extinguish fires within the powerplant. A better understanding of the conditions existing in the bay during fires would produce a rational approach to the problem for both the designer and the certifying authority. In order to obtain extensive coverage of all flight conditions it was necessary to depart from current practice and to construct a simulation of the engine and its environment thereby allowing a large number of tests to be carried out. Using this rig it has been possible, not only to prove the means of detection and extinguishing throughout the flight plan, but to obtain a considerable amount of generalized data for use in component design specifications. (Author)

A70-36857 # **Electronic diagnostic techniques for analyzing gas turbine performance.** D. Autorino and H. J. Moses (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-131.* 12 p. Members, $1.00; nonmembers, $2.00.

This paper reviews the common goals of contemporary gas turbine diagnostic systems and then explains in some detail original concepts and implementation techniques to fulfill these goals. Pertinent engine parameters are delineated and purposes of the analysis system explained. System elements are functionally described and feasibility tradeoffs suggested indicating optimal combinations of elements to flexibly provide for various system requirements. It is shown that air-borne digital data acquisition computers can be powerfully utilized for on-board data analysis, flight line diagnosis, and long-term trend extraction. An operating advanced digital computerized system incorporating many novel features is explained and other variations suggested. Pertinent future trends are summarized. (Author)

A70-36858 # **Advanced control system considerations for small shaft-type aircraft gas turbines.** D. A. Prue and T. L. Soule (United Aircraft Corp., Hamilton Stanford Div., Windsor Locks, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-132.* 14 p. Members, $1.00; nonmembers, $2.00. Grant No. DA-AJ-02-68-C-0041.

The next generation of free-turbine engines in the 2 to 5-lb/sec airflow class will undergo vast improvements in performance and efficiency. The improvements will be achieved concurrent with overall reductions in size and weight. Effort is required at optimization and miniaturization of the engine control system to keep pace with these improvements. This paper describes a conceptual design of an advanced engine control system for this class of engine. It provides gas generator and power turbine control with torque, temperature, load sharing and overspeed limiting functions. The control system was concepted to accommodate, with minimum hardware changes, such variants as regenerative cycle and/or variable power turbine geometry. In addition, considerations for closed and open loop modes of control and fluidic, electronic and hydromechanical technologies were studied to best meet a defined specification and a weighted set of evaluation criteria. (Author)

A70-36863 # **Loss and flow path studies on centrifugal compressors. II.** O. E. Baljé. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-12-b.* 14 p. 15 refs. Members, $1.00; nonmembers, $2.00.

The flow conditions in a mixed flow rotor are investigated for a 'pressure balanced' flow path design. Boundary layer arguments are applied to calculate the losses in the rotor as well as in the subsequent diffuser section. The resulting efficiency data imply a comparatively high efficiency potential for mixed flow compressors with multiple cascaded components, designed on the premise of a 'pressure balanced' rotor flow path. (Author)

A70-36864 # **Loss and flow path studies on centrifugal compressors. I.** O. E. Baljé. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-12-a.* 12 p. 21 refs. Members, $1.00; nonmembers, $2.00.

Relations are derived for the boundary layer momentum thickness growth in channels with adverse pressure gradients and for the maximum allowable momentum thickness to avoid flow separation. These data are obtained by integrating the Truckenbrodt equation stepwise and by extending the Gruschwitz-Schmidbauer separation criterion. Fair agreement between calculated data and test information is demonstrated. (Author)

A70-36868 # **Aerodynamic stability of branched diffusers.** F. F. Ehrich (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-27.* 5 p. 5 refs. Members, $1.00; nonmembers, $2.00.

A systematic analysis is made of the potential instability of branched diffuser systems such as are inherent to the annular combustor systems of gas turbine engines. The system is modeled to include diffusion in each branch with pressure recovery characteristics which are a simple function of the fraction of total flow into the branch. Also included in each branch is a volume (i.e., an accumulator) and a resistance representing the combustor shells before the two branched streams rejoin. Analysis of the system equations is carried out in two perspectives. First, the equations are linearized and simple generalized criteria for stability are derived. Then the full nonlinear equations are programmed for digital computation in a form where they can be integrated with respect to time, and the full dynamic behavior of flows and pressure described. The computation is carried out several times for system variations of shell resistance, accumulator volumes, and diffuser characteristics, so that general conclusions may be drawn of the effects of these parameters on the frequency, wave form, and amplitudes of the systems' oscillations. (Author)

A70-36869 * # **Intra-stator transport of rotor wakes and its effect on compressor performance.** J. L. Kerrebrock (MIT, Cambridge, Mass.) and A. A. Mikolajczak (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-39.* 10 p. 7 refs. Members, $1.00; nonmembers, $2.00. Contract No. NAS 3-10482.

The stagnation temperature profiles which have been observed recently downstream of the stators in high Mach number compressor stages are shown to be due to transport of the rotor wakes across the main streamlines during their passage through the stator. The rotor wake fluid has energy in excess of the inviscid flow, and it is collected by the pressure side of the stator. A wake transport theory is presented, which connects the temperature profile to the rotor blade loss factor, and so provides a new method for determination of the losses in a rotor under actual operating conditions. The theory compares favorably with a special helium-tracer experiment designed to check it, as well as with temperature measurements in two high Mach number stages. (Author)

A70-36870 # **Digital computer control of gas turbine engines.** E. S. Eccles and A. G. Shutler (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-40.* 8 p. 12 refs. Members, $1.00; nonmembers, $2.00. Research supported by the Ministry of Technology.

The use of digital computer methods to control aero gas turbines is comparatively new. The paper attempts to cover their background and essential features in broad outline. It discusses the special properties of digital computer control systems in relation to hydromechanical and electric analog arrangements and the special problems of design and safety involved. Some results of practical tests on a large complex engine are presented and discussed, special emphasis being given to those techniques which are particular to digital systems. The paper finally suggests the directions in which future developments of these systems might move. (Author)

A70-36872 # **A method for predicting compressor cascade total pressure losses when the inlet relative Mach number is greater than unity.** R. L. Balzer (Boeing Co., Commercial Airplane Div., Seattle, Wash.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-57.* 6 p. 9 refs. Members, $1.00; nonmembers, $2.00.

Description of a method for predicting the total pressure losses from viscous effects for axial flow compressor cascades in compressors with subsonic axial and supersonic relative velocities. The method is similar to previous ones in that the shock system is approximated by a single normal shock located within the cascade and the total pressure loss is composed of a subsonic and a supersonic portion. The main difference is the use of the relative fluid turning angle in place of the suction surface chamber for predicting the losses. Another difference consists in the use of two-dimensional channel flow rather than Prandtl-Meyer turning for estimating the Mach number at which the shock occurs. It is felt that the method affords superior prediction accuracy for the Mach number range 1.0-1.4 and pressure ratio range 1.15-2.00. M.V.E.

A70-36873 # **Sound transmission and suppression in turbomachinery ducts.** M. J. Benzakein and J. W. Zwick (General Electric Co., Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-58.* 11 p. 11 refs. Members, $1.00; nonmembers, $2.00.

Analysis of the transmission and radiation of turbomachinery-generated noise in fans and compressor ducts. Based on a numerical solution of the three-dimensional wave equation in a homogeneous medium flowing in ducts of arbitrary shape, the analysis is an extension of previous analytical treatment of noise generation in turbomachinery. The theoretical noise transmission model permits the evaluation of fan-compressor noise suppressor (acoustic treatment) configurations in the presence of spinning modes in a moving medium. Results of barometric calculations are presented for a stationary medium. Experimental verifications of the analysis are included, and the effects of turbomachinery duct lengths and shapes on the transmission of sound are discussed. Also presented are the results of parametric studies on the effects of liner material location on sound suppression. The results indicate that optimum sound suppression can be achieved with the basic knowledge of the duct wave propagation phenomena. M.V.E.

A70-36875 # **Performance prediction for high turning low aspect ratio stator cascades in the transonic regime.** H. F. L. Griepentrog (Von Kármán Institute, Rhode-Saint-Genèse, Belgium). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-63.* 9 p. 20 refs. Members, $1.00; nonmembers, $2.00. USAF-sponsored research.

This paper describes a method for the prediction of the transonic flow field in a high solidity, high turning cascade, suitable for use as stator of a shock-in-rotor supersonic compressor stage. Effects of shock boundary layer interaction is taken into account by empirical correlation, valid for blade aspect ratios below unity. Use of partial slots for reduction of the secondary flows is briefly discussed and a correlation on slot efficiency is presented. (Author)

A70-36876 # **Vibration characteristics of low aspect ratio compressor blades.** Ralph Petricone (Applied Technology Associates, Emerson, N.J.) and Fernando Sisto (Stevens Institute of Technology, Hoboken, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-94.* 10 p. 15 refs. Members, $1.00; nonmembers, $2.00.

This paper presents the results of a study of the vibration characteristics of low aspect ratio compressor blades. The treatment is based on thin shell theory and the Rayleigh-Ritz method is used to obtain the eigenvectors and eigenvalues. The object is to elucidate those characteristics which are inaccessible using beam theory.

Results are presented which show the variation of the natural frequencies and mode shapes with angle of twist, aspect ratio, and angle of inclination of the base of the blade. A three-dimensional plot of the bending mode frequencies vs aspect ratio and twist angle is presented. Although the surfaces describing the variation of frequencies for specific modes do not intersect, there is a point of contact. This contact point is significant in the transition of mode shapes along the frequency surfaces. It is demonstrated that the 'stiff-direction' or 'in-plane' vibration of the untwisted plate evolves into coupled bending modes as the twist angle increases from zero and that the character of these modes changes in the vicinity of the contact point. (Author)

A70-36877 # **An investigation of annulus wall boundary layers in axial flow turbomachines.** D. G. Gregory-Smith (Cambridge University, Cambridge, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-92.* 8 p. 13 refs. Members, $1.00; nonmembers, $2.00. Research supported by Rolls-Royce.

In the calculation of the flow in a turbomachine, empirical correction factors have previously been used to allow for the effect of the annulus wall boundary layers. A calculation method has been produced which includes the estimation of the growth of the boundary layers and the associated secondary flows. The results from an experimental investigation of the flows past a row of inlet guide vanes and an isolated rotor row are compared with the theoretical predictions. The agreement is good except for the growth of the boundary layer where the swirl is high. (Author)

A70-36879 # **Boundary layer optimization for the design of high turning axial flow compressor blades.** K. D. Papailiou (Von Kármán Institute, Rhode-Saint-Genèse, Belgium). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-88.* 8 p. 9 refs. Members, $1.00; nonmembers, $2.00.

An optimization method, based on Le Foll's boundary layer theory and on Goldstein's conformal mapping method is described. The parameters of optimization are circulation per blade and absolute losses. The problem is treated as an inverse problem (i.e., the best blading is found starting from the flow conditions imposed). The performance of a highly loaded compressor cascade, designed according to the method presented and tested in a low speed wind tunnel, is compared with the theoretical predictions. Some discrepancies exist which are due to the influence of flow convergence and blade curvature. A modification of the method to take into account these effects is discussed. (Author)

A70-36880 # **Design of cascades for incompressible plane potential flows with prescribed velocity distribution.** W. Schwering (Reinisch-Westfälische Technische Hochschule, Aachen, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-87.* 11 p. 14 refs. Members, $1.00; nonmembers, $2.00.

A method of calculation in designing two-dimensional cascades with given velocity distribution is described. An iterative method of the solution for the integral equation to determine the coordinate function for the blade profile is presented. A parametric formulation for the surface velocity distribution is developed. Some design examples for deceleration cascades with given flow angles and prescribed velocity distribution are discussed. Calculations of the boundary layers along the surfaces of the airfoil and cascade loss coefficients are made in order to obtain information on the quality of cascades designed by this method. Proceeding from the results of boundary layer calculations, it should be possible to further improve the parametric formulation for the surface velocity distribution and in this way prescribe better or even 'optimum' velocity distributions. (Author)

A70-36881 # **Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions.** William J. Kelnhofer (Catholic University of America, Washington, D.C.) and Charles T. Derick (U.S. Army, Washington, D.C.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-86.* 5 p. 16 refs. Members, $1.00; nonmembers, $2.00.

Straight-walled diffuser-tailpipe systems with fully developed inlet conditions as encountered with gas turbine exhaust ducting systems have been tested. For constant length diffusers with varying tailpipe lengths, an increase in recovery and a slight increase in area ratio occurs at maximum performance condition. Test conditions included ratios of diffuser wall length to diffuser inlet width from 5.33 to 15.33. Maximum ratio of tailpipe length to diffuser inlet width was 10.47. (Author)

A70-36883 # **The role of chemistry in gas turbine emissions.** E. S. Starkman, R. F. Sawyer, D. P. Teixeira (California, University, Berkeley, Calif.), and Y. Mizutani (Osaka University, Osaka, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-81.* 12 p. 22 refs. Members, $1.00; nonmembers, $2.00. PHS Grant No. AP-385-04.

Extension of previous work probing the inside of a laboratory model combustor for the composition of unburned fuel and burned gas. A comprehensive analysis of previously collected data is performed, in order to better assess the influence of thermochemical and chemical kinetic factors in the formation and suppression of potential air pollutants. Application of observations of studies of a similar kind, incorporating the influence of chemical reaction rates and chemical stoichiometry, is expected to result in engines which produce minimal quantities of carbon monoxide, oxides of nitrogen, and unburned hydrocarbons. M.V.E.

A70-36884 # **An axial compressor end-wall boundary layer theory.** G. L. Mellor (Princeton University, Princeton, N.J.) and G. M. Wood (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-80.* 15 p. 14 refs. Members, $1.00; nonmembers, $2.00.

The essential ingredient missing in existing prediction methods for the performance of multistage axial compressors is that which would account for the effect of end-wall boundary layers. It is, in fact, believed that end-wall boundary layers play a major role in compressor performance and the absence of an adequate theory represents a handicap to turbomachinery designers that might be likened to the handicap that designers of wings, for example, would face if Prandtl had not introduced the idea of a boundary layer. In this paper a new theory is developed which retains all elements of classical boundary layer theory; for example, we discuss variables such as momentum thickness and wall shear stress. However, the present theory introduces new concepts such as axial and tangential defect force thickness, a rotor exit-stator inlet 'jump condition' and the importance of these concepts is demonstrated. Inherent in the derivation is an identification of the role of secondary flow and tip clearance flow. A proper means of matching the boundary layer calculations to conventional main stream calculations is suggested. Independent of empirical parametrization it appears that the theory is capable of correctly modeling boundary layer blockage, losses, and end-wall stall. Near stall, the main stream-boundary layer interaction is very strong. (Author)

A70-36885 # **Comparison of performance of supersonic blading in cascade and in compressor rotors.** A. A. Mikolajczak, A. L. Morris, and B. V. Johnson (United Aircraft Corp., East Hartford,

Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-79.* 7 p. 10 refs. Members, $1.00; nonmembers, $2.00.

Investigation of the usefulness of cascade testing as an aid in the design of highly efficient supersonic compressor rotor blading toward the primary goal of reducing jet engine weight and specific fuel consumptions. It is shown that good correspondence exists between cascade and compressor tests and that meaningful evaluation of new blade geometries is conveniently obtainable from supersonic cascade tests. The performance of three airfoil shapes tested in cascade is briefly discussed and compared to the performance of similar airfoils tested in a rotor. A description of a supersonic tunnel is given, and precautions necessary for obtaining meaningful data are stressed.
M.V.E.

A70-36886 # **Theoretical and experimental determination of pressure losses in a single-stage axial flow compressor.** Y. Le Bot, J. Paulon, and P. Belaygue (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-78.* 8 p. 7 refs. Members, $1.00; nonmembers, $2.00.

A single, isolated, test axial compressor rotor in a constant section annular duct is used for determination of off-design pressure losses. The results obtained are interpreted by means of loss coefficients and description of the flow field is deduced from a simplified actuator theory that takes into account pressure losses. Rotor stall limit is interpreted as that limit mass flow rate for which no continuous solution of the equations can be obtained. Unstable operations that take place for mass flow rates smaller than the stall limit are shown to be either rotating stall or wall separation, according to the shape of the downstream pressure profile. Experiments on the rotor confirm validity of these assumptions. (Author)

A70-36888 # **Surface integrity in conventional machining.** W. P. Koster and L. J. Fritz (Metcut Research Associates, Inc., Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-100.* 14 p. 9 refs. Members, $1.00; nonmembers, $2.00.

Review of some of the types of surface alterations produced by both conventional and the so-called nonconventional machining processes. The effect of variables in milling and grinding is reviewed. Photomicrographs illustrating surface alterations produced in martensitic steels, titanium, and nickel alloys are presented, as well as microhardness data illustrating the types of hardness changes found in these surfaces. Data on residual stresses produced in some of these materials as a function of machining variables are given. The fatigue characteristics of these alloys, as affected by conventional metal removal process variables, are summarized and explained. It is concluded that the method of machining and the variables chosen for a particular machining method are significant in relation to the mechanical performance of finished parts, and that methods must, therefore, be carefully evaluated in their relation to the performance of highly stressed components subjected to hostile environments.
M.V.E.

A70-36889 # **The application of ceramics to the small gas turbine.** A. F. McLean (Ford Motor Co., Product Development Group, Dearborn, Mich.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-105.* 10 p. 15 refs. Members, $1.00; nonmembers, $2.00.

Review of the limitations imposed by today's superalloys on the realization of the potential of the gas turbine engine, and discussion of the ways and means for overcoming these limitations. Ceramic materials are suggested as a means of achieving lower cost and higher turbine inlet temperature in small gas turbine engines. Ceramic materials and processing techniques are introduced, and silicon nitride, silicon carbide, and lithium-alumina-silicate are identified as promising materials for high temperature turbine engine components.
M.V.E.

A70-36890 # **Gas turbines-dust-air cleaners - Experience and trends.** M. G. Mund (Donaldson Co., Inc., Minneapolis, Minn.) and Hanspeter Guhne (Donaldson Co., S.A., Brussels, Belgium). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-104.* 27 p. 78 refs. Members, $1.00; nonmembers, $2.00.

The object of this paper is to present in one place most of the documented experience that shows the interrelationship of gas turbines, dust and air cleaners; and to compare opinions on what an air cleaner must do to prevent a gas turbine from failing because of air-borne contaminants. This experience covers three types of gas turbine air cleaners in both the laboratory and the field, on wheeled and tracked vehicles, and on helicopters and air cushion vehicles. The consensus is that gas turbines do need air cleaners if they are going to compete with piston engines in their environment. The information is presented so that a person specifying a gas turbine air cleaner knows what factors he must consider, and can determine the relative importance of the features of the air cleaner that would best suit his needs. (Author)

A70-36891 # **Fire detection technology for turbine-powered transportation.** T. M. Trumble (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Brussels, Belgium, May 24-28, 1970, Paper 70-GT-125.* 9 p. Members, $1.00; nonmembers, $2.00.

Attempt to provide an engineering basis for the design of a fire-detection system compatible with the requirements of newly developed turbine-powered vehicles. A method for evaluating and designing overheat and fire detection systems is presented. Advanced concepts and technologies such as optical redundancy and high temperature ultraviolet sensors are discussed. The performance of overheat and fire detection systems based on this approach is expected to provide maximum safety for vehicle occupants. M.V.E.

A70-36948 **SATRAM - Multiple trajectory landing system (LE SATRAM - Système d'atterrissage à trajectoires multiples).** P. Fombonne (Thomson-CSF, Paris, France). *Navigation* (Paris), vol. 18, July 1970, p. 245-253. In French.

Description of the SATRAM multiple trajectory landing system, which is very flexible, and can accurately indicate the position of an aircraft within a large airspace. From the beginning, SATRAM was conceived as a cooperative system, using the principle of beating beams to reduce the influence of reflections of atmospherics in the transmission of the site and the bearing, and including a distance measuring system which is completely independent of the angular guidance system. F.R.L.

A70-36950 **New aspect of long-range flights - 'The inertial flying carpet' Air France Paris-Rio (B-707) (Nouvel aspect des vols long-courriers - 'Le tapis volant inertiel' Air-France Paris-Rio /B-707/).** *Navigation* (Paris), vol. 18, July 1970, p. 278-291. In French.

Outline of the inertial navigation technique now utilized on the Air France Boeing 707s, and later to be used on their 747s. The navigational work is performed by the LTN 51 inertial platform system. Equipment which has been tested and developed on a large

scale, and which conforms to the FAA-established ARINC 561 system, is described. The navigation is controlled by two independent inertial platforms which pass commands through a computer to the automatic pilot. The LTN 51 equipment consists of a placarding group and a control display unit, the inertial navigation unit, and the mode selection unit. F.R.L.

A70-37025 # Analytical methods of designing wing structures (Analiticheskie metody proektirovaniia konstruktsii kryl'ev). I. S. Golubev. Moscow, Izdatel'stvo Mashinostroenie, 1970. 289 p. 142 refs. In Russian.

Analytical methods are described for designing thin supersonic wing structures with correlation to overall aircraft structural design problems. The optimal distributions of material in the wing structure are determined with the aid of nonlinear programming. By replacing the variable function with a set of discrete parameters, relationships (criterial functions, coupling conditions, and restrictions) are obtained which correspond to numerical and analytical solutions of the design problem. Simple examples, involving single load systems, absence of heating, and isotropic structures, are used to derive general relationships accounting for the influence of aerodynamic heating, the load spectrum, and compliance of the wing mounting. The transition from calculations to the design and selection of a practically optimal variant is demonstrated by analysis of supplementary considerations involving the stability of the structural elements, reliability, production factors, and conditions of eventual operation. Attention is given to the problem of determining aerodynamic forces for elastic lifting surfaces, and the topic of aerothermoelasticity is discussed. Design restrictions arising from flutter, reversal, and divergence are examined. T.M.

A70-37208 # Wind tunnel flow visualizations with electron beam (Visualisations d'écoulements en soufflerie à l'aide d'un faisceau d'électrons). Serge Lévy. *La Recherche Aérospatiale,* May-June 1970, p. 155-166. 54 refs. In French.

An ONERA low-pressure wind tunnel has been equipped with an electron beam probing device. This equipment has first been used to visualize flows with too weak a density for the usual optical methods to be used. Its operation is particularly simple and straightforward. Moreover the processes are stable and easily reproducible. In this article the theoretical bases of the method are outlined, the experimental set-up is described, and the results obtained are presented. (Author)

A70-37228 # Method of characteristics for calculating supersonic gas flows with foreign particles in plane and axisymmetric nozzles (Metod kharakteristik dlia rascheta sverkhzvukovykh techenii gaza s inorodnymi chastitsami v plostikh i osesimmetrichnykh soplakh). L. P. Vereshchaka, A. N. Kraiko, and L. E. Sternin. Moscow, Vychislitel'nyi Tsentr AN SSSR (Soobshcheniia po Prikladnoi Matematike, No. 1), 1969. 47 p. 16 refs. In Russian.

Summary of experience gained in the use of the method of characteristics in calculating two-dimensional steady supersonic gas flows with foreign particles in nozzles. The investigation in question was based on a two-velocity model in which the real flow is replaced by the mutually interpenetrating flow of two interacting continuous media - namely, the gas proper and the particle 'gas.' The required difference schemes are presented, and a description is given of the order of solution of the elementary problems - i.e., problems concerning the determination of the parameters at various characteristic points. Then a description is given of a general scheme for calculating a two-velocity supersonic nozzle flow, and examples of the calculation are presented. The results of the calculation by the method of characteristics are compared with similar results obtained on the basis of a one-dimensional approximation. A.B.K.

A70-37229 Theory and calculation of vibrations in flight vehicle engines (Teoriia i raschet kolebanii v dvigateliakh letatel'nykh apparatov). D. V. Khronin. Moscow, Izdatel'stvo Mashinostroenie, 1970. 412 p. 47 refs. In Russian.

Fundamentals of vibration theory for linear and nonlinear systems are set forth in this textbook and are applied to the calculations of vibrations in components, units, and systems of flight vehicle engines. The linear vibrations of multimass systems, rods, and beams under various operational conditions are discussed in detail, with special attention to the fast-rotating shafts and rotors of turboengines and their blades, circular plates and disks. Also covered are the nonlinear vibrations of mechanical systems and methods are described for determining the stability of their periodic oscillations. Further topics discussed in the book include advanced computer methods of vibration analysis such as the initial parameter method, the dynamic rigidity method, the discrete model method, and the integral method. The book contains lectures given by the author at the Moscow Aviation Institute and is intended for students specializing in aircraft engine dynamics and strength analysis. V.Z.

A70-37233 # Principles of VTOL design (Osnovy proektirovaniia samoletov s vertikal'nym vzletom i posadkoi). F. P. Kurochkin. Moscow, Izdatel'stvo Mashinostroenie, 1970. 353 p. 59 refs.

Study of the design of a type of aircraft which possesses the takeoff and landing features of helicopters plus certain other flight characteristics normally found in fixed-wing aircraft. The special features of their aerodynamic circuits, their main parameters, their weight characteristics, and their design with turboprop and turbojet power plants are considered. The use of turboprop and turbojet engines as cruising and lift engines and as engines combining both functions at the same time is discussed. Methods of calculating the flight regimes typical of VTOLs - e.g., the transition from vertical flight to horizontal flight and vice versa - are outlined. A.B.K.

A70-37237 # Vibration and balancing of aircraft engine rotors (Vibratsiia i uravnoveshivanie rotorov aviadvigatelei). M. E. Levit and V. P. Roizman. Moscow, Izdatel'stvo Mashinostroenie, 1970. 172 p. 14 refs. In Russian.

Modern methods of balancing the rotors of aircraft engines are surveyed, and the factors affecting engine vibration levels are analyzed. Emphasis is on rotor balancing techniques at revolution ranges where structural deformation can arise; the balance quality is evaluated on the basis of suspension vibrations, the resulting forces, and deflections of the rotor itself. One of the main causes of vibration is shown to be the loss of balancing in elastically deformable rotors at near critical revolution speeds. Simplified balancing procedures are described which can be used to significant advantage with existing industrial equipment. Special consideration is given to complex studies of engine dynamics which must precede the choice of an appropriate balancing procedure. Results of vibration studies with full-scale turbine engines and compressors are cited. Problems of automatization of the balancing procedures are discussed, and possible new developments are outlined. T.M.

A70-37238 # Current state and development prospects of aviation gas turbines (Sovremennoe sostoianie i perspektivy razvitiia aviatsionnykhh gazovykh turbin). B. Kh. Abiants. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 5-16. In Russian.

Survey of current trends in the development of aviation gas turbines as related to specific features of modern aircraft engines. The selection of gasdynamic and structural parameters is discussed for single-loop and bypass turbojet engines. Some gasdynamic problems are analyzed, and cooling procedures are evaluated. The strength of turbine blades is examined, and possibilities of further reductions in turbine weight are treated. Improvements in efficiency are briefly investigated. T.M.

A70-37241 # Optimization of engine parts adjustment by linear programming techniques (Optimizatsiia otladki dvigatelei metodami lineinogo programmirovaniia). Iu. V. Kozhevnikov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 52-59. In Russian.

Description of the use of linear programming techniques to improve the effectiveness of engine adjustment procedures during test-bed operation. Optimization of the adjustment process is examined for a two-state turbine engine with a given speed control program for the high-pressure stage and only one control lever. The choice of adjustment optimality criteria is examined in terms of the most precise fuel consumption or thrust controls for given constraints imposed on the rotation speed, temperature, thrust, or fuel consumption. T.M.

A70-37242 # Nonstationary supersonic flow around a profile (Nestatsionarnoe obtekanie profilia sverkhzvukovym potokom). B. E. Loktev. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 60-68. 6 refs. In Russian.

Solution of the plane nonstationary problem of the supersonic flow of a perfect and dissociating gas around a sharp profile of finite thickness. The solution in dissociating gas is given for the case of equilibrium dissociation. The shock waves are assumed to be attached at the profile, and the kinematic parameters of motion vary according to a harmonic law. The known method of linearization with respect to dimensionless kinematic parameters is applied, and equations for the unsteady part of the motion are solved by the method of characteristics. In the case of flow around a wedge, the solution is obtained in the form of a series with respect to the Strouhal number. T.M.

A70-37244 # Calculation of low aspect ratio wings under conditions of creep (Raschet kryl'ev malogo udlineniia v usloviiakh polzuchesti). A. P. Galkina and V. L. Prisekin. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 76-82. In Russian.

Investigation of the use of the method of strains for calculating a low aspect ratio wing under conditions of creep. A system of differential equations is derived for the residual strains of spars and ribs. Nonlinear viscous-flow equations are used to determine the complex stress state of panels comprising the wing cells. The sidewalls of the wing cells are assumed to be absolutely rigid for shear, and the residual shear strains of the cell panels are kinematically associated with displacements of the cell joints. A brief description of the computational procedure is given together with results obtained for a wing model. It is shown that allowance for creep leads to equalization of the strains in the main structural elements, accompanied by intense accumulation of residual deflections. T.M.

A70-37246 # Fuel burnout mechanism and heat yield in the secondary air flow injection zone of turbine engine combustion chambers with various frontal devices (Mekhanizm vygoraniia topliva i teplovydelenie v zone vtekaniia strui vtorichnogo vozdukha v kamerakh GTD s razlichnymi frontovymi ustroistvanmi). G. M. Gorbunov and I. L. Khristoforov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 88-96. 5 refs. In Russian.

Experimental investigation of the combustion process in secondary air injection regions as a function of fuel combustion efficiency along the length of the exhaust pipes. The study is conducted for different methods of secondary air injection in a combustion chamber whose head section has a zone of heterogenous mixture flow followed by a combustion zone and finally by combustion products. A dimensionless expression is given for the ratio of the maximum attained combustion efficiency (with a given method of secondary air injection) to the length (expressed in calibers of the exhaust pipe) at which this efficiency was achieved. T.M.

A70-37247 # Influence of injector characteristics, temperature, and the fuel's physicochemical properties on the combustion efficiency in the combustion chamber of a gas turbine engine (Vliianie kharakteristik forsunki, temperatury i fiziko-khimicheskikh svoistv topliva na polnotu sgoraniia v kamere GTD). N. F. Dubovkin and A. P. Gorshenin. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 97-104. 6 refs. In Russian.

Study of the combustion efficiency in gas turbine engine chambers as a function of injection quality, temperature, vaporization, viscosity, chemical composition, and other fuel characteristics. The study is based mainly on experimental data obtained with full-scale turbine engines. Graphs show fuel combustion efficiency plotted against the specific surface area of fuel droplets, the excess air ratio, single-nozzle and bypass fuel injection systems, and fuel temperature. It is demonstrated that combustion efficiency depends mainly on the fractional composition, degree of atomization, and fuel vaporization. These factors cannot be neglected, particularly in adverse conditions of low pressure and high flow rates in the chamber. In practice, combustion efficiency can be improved and differences in fuel properties can be minimized by varying the injection and atomization. T.M.

A70-37248 # Effect of air-mechanical fuel injection on certain indices of the working process of a gas turbine engine combustion chamber (Vliianie vozdushno-mekhanicheskogo raspylivaniia topliva na nekotorye pokazateli rabochego protsessa kamery sgoraniia GTD). I. N. Diatlov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 105-112. In Russian.

Results of experimental studies of the coefficient of heat generation and the coefficient of nonuniformity of the temperature field in mechanical and air-mechanical fuel injection. It is established that, owing to an improvement in the working process, air-mechanical fuel injection makes it possible to increase the combustion efficiency and to reduce the nonuniformity of the temperature field. A.B.K.

A70-37249 # Aftereffect momentum of liquid-fuel jet engines (Impul's posledeistviia zhidkostnykh reaktivnykh dvigatelei). V. A. Makhin and V. F. Prisniakov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 113-120. 12 refs. In Russian.

Investigation of the transient process of switching off a liquid-fuel jet engine. A detailed study is made of the physical picture of the process occurring in the engine after the command to switch it off has been received, and the main components of the thrust aftereffect momentum are determined. A system of equations which describes the process of switching off the engine in the most general case is derived, and certain particular cases of solution of this system of equations are considered. A.B.K.

A70-37250 # Experimental investigation of turbine stages with long blades (Eksperimental'noe issledovanie turbinnykh stupenei s dlinnymi lopatkami). M. K. Maksutova, V. N. Tarasov, G. A. Vavilov, and R. Kh. Garifov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 121-126. In Russian.

Results of an experimental study of three turbine stages with long narrow blades differing with respect to type of blade twist. It is found that the internal efficiency of stages with twisted blades exceeds by an average of 5% the efficiency of a stage with untwisted blades. The velocity coefficient of stages with twisted blades is about 5% greater than that of a stage with untwisted blades. A stage with a reverse blade twist is less sensitive to changes in the radial gap than a stage with a forward twist. A.B.K.

A70-37252 # Determination of the efficiency of an axial-flow compressor stage under conditions of rotary separation (Opredelenie koeffitsienta poleznogo deistviia stupeni osevogo kompressora v oblasti rezhima vrashchaiushchegosia sryva). A. F. Brekhov, V. N. Ershov, and V. E. Tovkanets. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 134-137. In Russian.

Solution of the problem of determining the efficiency of an

axial-flow compressor stage in a situation where the compressor is operating at a low rpm, leading to the formation of a separation region in this stage. The solution obtained is applied in a comparison of the calculated and experimental dependences of the efficiency on the flow rate in the separation region in the case of 20 fan and compressor stages. The satisfactory agreement between the calculated and experimental results attests to the possibility of using the proposed solution to determine the efficiency in a region where conditions of rotary separation prevail. A.B.K.

A70-37254 # **Certain problems of normalization of the mechanical properties of components related to an increase in the weight efficiency and reliability of aircraft engines (Nekotorye voprosy normirovaniia mekhanicheskikh svoistv detalei, sviazannye s povysheniem vesovoi otdachi i nadezhnosti aviadvigatelei).** E. N. Davchinov. *Aviatsionnaia Tekhnika,* vol. 13, no. 1, 1970, p. 147-152. In Russian.

Development of a method of eliminating an indeterminateness in the operative norms governing the mechanical properties of components which leads to a loss of weight efficiency and reliability on the part of aircraft engines. An approach to the normalization of the mechanical characteristics of these components is proposed, which eliminates this indeterminateness by taking into account the statistical dispersion laws, the conditions of applicability, and the standardization requirements. A.B.K.

A70-37370 Thermostatic examination of glass fiber reinforced composite plastic materials subjected to solar irradiation and surrounding warm air (Thermostatische Prüfung von GFK bei Sonneneinstrahlung und umgebender warmer Luft). Fritz Herzberger. *Flugrevue/Flugwelt International,* Aug. 1970, p. 39, 40. In German.

Discussion of the thermostatic properties of gliders made of glass fiber reinforced plastics and subjected to solar irradiation and warm air during their operation. A brief general review of mechanical properties of composite plastic materials in relation to temperature is given. The three phenomena responsible for heat exchange - i.e., thermal conduction, emission, and radiation - are considered, the latter being discussed in detail and calculated. The results giving the shearing modulus of resins, permissible compressive loads, and surface temperature are plotted graphically and analyzed. O.H.

A70-37371 A four-seat STOL passenger aircraft - A new German design (Viersitziges STOL-Reiseflugzeug - Neuer deutscher Entwurf). Josef Schaich. *Flugrevue/Flugwelt International,* Aug. 1970, p. 54, 56. In German.

Description of the design of a new German four-seat two-engined propeller passenger and sports aircraft. The principal features of the body as well as the two 200 hp engines are presented, and the overall aircraft performance and comfort is discussed. Technical data of the aircraft are tabulated. O.H.

A70-37388 Travel, commuter and acrobatics aircraft MBB Bo-209 Monsun (Reise-, Arbeits- und Kunstflugzeug MBB Bo-209 Monsun). Plasa. *Deutscher Aerokurier,* vol. 14, July 1970, p. 484, 485, 487. In German.

Discussion of the final (series-production) version of the MBB Bo-209 two-seater, derived from results of extensive flight testing. The characteristics of the cabin, tail unit, landing gear, wings, landing flaps, aileron, and instrument panel are described. The specifications of the aircraft are presented and its flight, takeoff, climb, and landing characteristics are outlined. The aircraft is available with a 160 HP Lycoming (with carburation) motor and a variable-pitch propeller, and also with a 150 HP Lycoming motor (with fuel-injection) and a fixed-pitch (McCauley) propeller. V.P.

A70-37390 # **Helicopter aerodynamics (Aerodinamika vertoletov).** D. I. Bazov. Moscow, Izdatel'stvo Transport, 1969. 196 p. 8 refs. In Russian.

Review of the principles of helicopter flight under various conditions, giving special attention to the operation of the main rotor. A brief history of helicopter development is presented, together with a summary of the main components of a helicopter and a classification of the various types of helicopters. The characteristics of the main rotor and its operation during autorotation and during axial and oblique flow are considered. Also considered are vertical and horizontal flight, altitude gain and descent, takeoff and landing, and equilibrium, stability, and controllability, taking into account the aerodynamic forces acting on the helicopter during the various maneuvers. A.B.K.

A70-37391 # **The operational and environmental aspects of airports with relation to the total environment.** James M. Nissen. *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-887.* 5 p. Members, $1.25; nonmembers, $2.00.

Public outcry relative to aircraft noise has reached politically unacceptable proportions. The jet airplane is unacceptable in the environment in which it must operate. It is the culmination of the evolution of transport aircraft that were designed independently and not as part of a total system. Aircraft noise pollution is not limited to the airport vicinity, but affects the majority of the people in the U.S. The system approach must be used in making the aircraft environmentally acceptable when operating from existing airports. If this is not accomplished, air transportation will not be permitted to realize its otherwise bright future. (Author)

A70-37392 # **Effect of wing leading edge geometry on maneuvering boundaries and stall departure.** W. R. Burris and D. E. Hutchins (U.S. Naval Air Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-904.* 8 p. 7 refs. Members, $1.25; nonmembers, $2.00.

This paper summarizes recent efforts to improve high angle of attack aerodynamic characteristics of three current swept wing transonic/supersonic Navy tactical aircraft designs through the use of wing L.E. (leading edge) modifications. These modifications were arrived at independently through efforts to improve buffet free maneuverability and/or to reduce the propensity toward stall departure/spin entry. Wind tunnel tests of these aircraft designs have shown that aerodynamic treatment of the wing L.E. can produce marked improvement in high angle-of-attack lateral-directional stability, delay the onset of stall buffet and improve drag characteristics. Analysis of data from these tests show the aerodynamic mechanisms by which L.E. geometry favorably affects flying qualities. Some flight tests have been conducted and show good correlation with wind tunnel results. The data presented are not intended to provide a thorough treatise on the subject but to focus attention on the benefits derived from these independent efforts in hopes of encouraging further studies and design consideration for future airplanes. (Author)

A70-37393 # **Computerized airborne integrated data systems.** Howard J. Moses (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-935.* 12 p. Members, $1.25; nonmembers, $2.00.

Commercial flight tests of an advanced aircraft operational performance data gathering and analysis system are now in progress. This system incorporates a special purpose digital computer to achieve selective data recording of appropriate information. Hardware operation and software programs are described. The total system involves airborne and ground elements and the interface between them. Analysis of the data obtained indicates considerable

progress towards achieving operational feasibility. This system is considered in conjunction with FAA mandatory data recording requirements. Several functional combinations are possible utilizing the basic building blocks now being flown. (Author)

A70-37394 # **Case studies of Short Haul Air Transportation in the Western Region.** E. R. Hinz, R. E. Finney, Jr., and H. L. Solomon (Aerospace Corp., El Segundo, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-888.* 11 p. 10 refs. Members, $1.25; nonmembers, $2.00.

The Western Region Short Haul Air Transportation Program proposes a series of feasibility demonstrations to assess the public acceptance and economic viability of new concepts of air service. Case studies have been made of potential metropolitan and rural demonstration arenas, two of which are presented in this paper, i.e., the Seattle-Portland corridor and the Palmdale jetport air feeder. Travel demand in each of these arenas was established by a modal split analysis which included consideration of the transportation mode door-to-door time and cost, and the traveler's self imposed time value. Demonstration service was then defined which would satisfy the predicted demand and which would clarify the requirements for aircraft equipment, ground facilities, and avionics necessary to provide dependable transportation service. (Author)

A70-37395 # **An assessment of the interfacing problems with CCV design concepts.** Jerry E. Jenkins, Don C. Eckholdt, and Bruce T. Kujawski (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-926.* 11 p. 10 refs.

Preliminary results are presented of a study into the benefits and consequence of relaxing static stability requirements and incorporating additional wing control devices to alleviate wing root bending moments. The analysis was performed using a large subsonic bomber configuration and considers the requirements due to the dynamics of maneuvering flight as well as considerations of trimmed equilibrium flight. Modern control theory provides a basis for a quantative comparison of the different configuration changes investigated. The results show that a reduction in stability leads to a less responsive aircraft which implies that stability augmentation system design considerations and/or control power requirements may establish the limit to which stability can be reduced. In particular, the model of the aircraft was found to be extremely sensitive to center of gravity changes as inherent stability approaches zero. The wing control devices used to alleviate root bending, induced additional pitching moments and sizeable drag penalties. A consequence of the trim change is a requirement for an elevator/wing-device interconnect. Some benefits are shown for these concepts, however the need for further studies is indicated. (Author)

A70-37396 * # **Model tests of concepts to reduce hot gas ingestion in VTOL lift engines.** Gordon R. Hall (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-905.* 56 p. 13 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 3-10498.

An investigation was performed to determine the relative effectiveness of various exhaust gas ingestion suppression concepts for application to VTOL aircraft. The test model used in the investigation was a small-scale simulated VTOL lift engine pod containing two 'engines.' Ingestion suppression concepts included: (1) shielding devices integral with the engine pod which act to deflect the reflected upwash gases away from the inlets; (2) concepts designed to alter the issuing exhaust jets (such as exhaust vectoring and jet suppression nozzles); and (3) ground plane platforms which alter the impingement process of the exhaust jets on the ground so that the potential upwash is laterally removed from the engine proximity. Effectiveness of the various ingestion suppression concepts was based on comprehensive measurements of the inlet thermal environment as well as upon the effect the concept had in altering the structure of the near flow field. The majority of concepts evaluated were found to be effective, in varying degrees, in reducing exhaust gas ingestion. (Author)

A70-37403 # **Statistical methods of designing control systems (Statisticheskie metody proektirovaniia sistem upravleniia).** I. E. Kazakov. Moscow, Izdatel'stvo Mashinostroenie, 1969. 263 p. 33 refs. In Russian.

Description of engineering methods of statistical calculation used in the design of linear and nonlinear, steady and unsteady automatic aircraft control systems. The methods discussed are based on the correlation theory of stochastic processes. The use of these methods in choosing the parameters of control systems in such a way as to minimize the rms error is described. Methods of synthesizing linear correcting circuits in linear and nonlinear automatic control systems by solving problems of the statistical theory of optimal linear systems are also considered. Particular attention is devoted to a consideration of engineering examples and to the solution of specific problems concerning aircraft control systems. Reference material required for carrying out the calculations by the methods described is included in the book. A.B.K.

A70-37405 # **Assembling and testing aircraft electrical and radio systems (Montazh i ispytanie elektroradiooborudovaniia samoletov).** D. N. Sapiro. Moscow, Izdatel'stvo Mashinostroenie, 1969. 284 p. 7 refs. In Russian.

The technological aspects of assembling and testing aircraft electrical and radio systems are examined. Manufacturing and preliminary assembly methods of structural and conducting elements are outlined and their effectiveness is analyzed. Various automatic and non-automatic facilities used for this purpose are described. A standardization of mounting, fitting, and assembly processes is proposed. Much attention is given to methods of checking and testing electrical and radio systems. Intended as a textbook, it should be valuable also to engineers and technicians of the field. V.P.

A70-37529 # **Laser planogram measurements of turbulent mixing statistics in the near wake of a supersonic cone.** A. M. Schneiderman and G. W. Sutton (Avco Everett Research Laboratory, Everett, Mass.). *Physics of Fluids,* vol. 13, July 1970, p. 1679-1682. 11 refs. Contract No. AF 04(701)-69-C-0122.

Description of the laser planogram technique for studying turbulent mixing. This method utilizes a pulsed laser and a particulate tracer to determine the spatial mixing field of tagged and untagged fluids. The laser planogram technique is described along with design considerations. As an example of its implementation, laser planogram measurements have been obtained and analyzed to provide turbulent mixing statistics in the wake of a cone at a Mach number of 2.5 and a Reynolds number of 3,000,000. The mean radial concentration profile of tagged material is shown to be a Gaussian in agreement with theory. A k to the minus 513 spectral dependence on wave number is observed, which is characteristic of highly turbulent Reynolds number flows. Experimental limitations prevent the resolution of the turbulent scale lengths in the present experiment, although the integral scale should be easily resolved with increased data length. (Author)

A70-37561 **Liability for damages caused by supersonic flights (Haftung für Schäden durch Überschallflüge).** I. H. Ph. Diederiks-Verschoor (Utrecht, Rijksuniversiteit, Utrecht, Netherlands). *Zeitschrift für Luftrecht und Weltraumrechtsfragen,* vol. 19, July 1, 1970, p. 235-240. 29 refs. In German. (Translation).

Examination of the extent of protection of residents, particularly in the vicinity of airports, against damages caused by supersonic flights, in the light of the present-time Dutch law. In considering this problem, the international and national Dutch law is examined and interpreted. For common damages, no liability is shown to exist at present time. For the future, several legislative measures are proposed. O.H.

A70-37562 Divergent conceptions in the interpretation of Article 3 of the Warsaw convention and the Hague protocol (Die abweichenden Auffassungen bei der Auslegung des Artikels 3 des Warschauer Abkommens und des Haager Protokolls). Mark Kohn (Köln, Universität, Cologne, West Germany). *Zeitschrift für Luftrecht und Weltraumrechtsfragen,* vol. 19, July 1, 1970, p. 241-247. 8 refs. In German.

Review of the divergent conceptions of the limitation of liabilities in the international air law, resulting from a divergent interpretation of the amended Article 3 of the Warsaw convention. Several aspects of the air freight carriers' obligation to issue air tickets to paying and nonpaying passengers in international air travel, as well as the resulting liabilities on the part of the air freight carriers, are discussed, and the diverging views of courts and law specialists on this subject in various countries are compared. O.H.

A70-37597 Thin aerofoil theory in magnetoaerodynamics. Isao Imai (Tokyo, University, Tokyo, Japan). In: Classical and relativistic magnetohydrodynamics; Centre National de la Recherche Scientifique, International Conference, Lille, France, June 16-20, 1969, Transactions (La magnétohydrodynamique classique et relativiste; Centre National de la Recherche Scientifique, Colloque International, Lille, France, June 16-20, 1969, Actes).

Paris, Centre National de la Recherche Scientifique (Colloques Internationaux, No. 184), 1970, p. 263-279. 5 refs.

Thin aerofoil theory in magnetoaerodynamics is presented in a systematic way comparable to that for ordinary fluid dynamics. The steady two-dimensional flow of a compressible, perfectly conducting, inviscid fluid past a thin aerofoil in the presence of a uniform magnetic field with arbitrary direction is considered. Explicit expressions for the velocity and magnetic fields as well as for the lift, drag and moment of the aerofoil are obtained for the general case of oblique fields. As examples of application of the theory, special consideration is given to the flow past an inclined flat plate and a circular arc aerofoil at zero incidence. The remarkable feature of the transition from 'hyper-liptic' to 'hyperbolic' flow condition is explained for the case of an inclined flat plate. (Author)

A70-37599 The flow of fluids with a conductivity tensor in the presence of a thin section (Sur l'écoulement des fluides a tenseur de conductivité en présence d'un profil mince). L. Dragos (Bucureşti, Universitatea, Bucharest, Rumania). In: Classical and relativistic magnetohydrodynamics; Centre National de la Recherche Scientifique, International Conference, Lille, France, June 16-20, 1969, Transactions (La magnétohydrodynamique classique et relativiste; Centre National de la Recherche Scientifique, Colloque International, Lille, France, June 16-20, 1969, Actes).

Paris, Centre National de la Recherche Scientifique (Colloques Internationaux, No. 184), 1970, p. 297-309. 24 refs. In French.

General study of the flow of compressible fluids with a conductivity tensor in the presence of a thin wing within the hypothesis of orthogonal fields. The solution is represented by Fourier integrals which are determined with the help of an integral equation resulting from boundary conditions. The core of this equation is a distribution. Using the results of distribution theory, the integral equation reduces to a Fredholm equation for both the supersonic and subsonic flows, the cores of which are expressed by convergent integrals. The results obtained in the absence of the Hall effect, as well as those of classical aerodynamics, are recovered as particular cases. F.R.L.

A70-37605 # The hybrid boost bearing - A method of obtaining long life in rolling contact bearing applications. D. F. Wilcock and L. W. Winn (Mechanical Technology, Inc., Latham, N.Y.). *(American Society of Lubrication Engineers and American Society of Mechanical Engineers, Joint Lubrication Conference, Houston, Tex., Oct. 13-16, 1969, ASME Paper 69-Lub-16.) ASME, Transactions, Series F - Journal of Lubrication Technology,* vol. 92, July 1970, p. 406-412; Discussion, W. J. Anderson (NASA, Lewis Research Center, Cleveland, Ohio), C. C. Moore (General Electric Co., Evendale, Ohio), F. A. Shen (North American Rockwell Corp., Canoga Park, Calif.), and R. P. Shevchenko (United Aircraft Corp., East Hartford, Conn.), p. 412, 413; Authors' Closure, p. 413, 414. 6 refs. Contract No. N 00019-68-C-0269.

A new bearing concept is described which offers the almost unlimited life of the fluid film bearing combined with the free starting, stopping, and oil system failure characteristics of the rolling element bearing. This new bearing type is termed the Hybrid Boost Bearing. It is envisioned as having application in jet engines to extend bearing life, and in land turbine equipment as a means of providing high overload capacity. (Author)

A70-37606 # Rigid-body rotor dynamics - Dynamic unbalance and lubricant temperature changes. R. H. Badgley (Mechanical Technology, Inc., Latham, N.Y.) and J. F. Booker (Cornell University, Ithaca, N.Y.). *(American Society of Lubrication Engineers and American Society of Mechanical Engineers, Joint Lubrication Conference, Houston, Tex., Oct. 13-16, 1969, ASME Paper 69-Lub-14.) ASME, Transactions, Series F - Journal of Lubrication Technology,* vol. 92, July 1970, p. 415-421; Discussion, E. R. Maki (GM Research Laboratories, Warren, Mich.), p. 421; Authors' Closure, p. 421-424. 14 refs. NSF-supported research.

Investigation of a symmetric rotor supported on two identical, rigidly mounted, self-aligning, finite-length fluid-film journal bearings. Rotor position is described by two translation coordinates in a plane perpendicular to the bearing line of centers, and by three Euler angles. Introduction of various amounts of dynamic unbalance via the inertia tensor off-diagonal terms (products of inertia) allows determination of angular velocity and static eccentricity ratio combinations leading to bearing "failure" defined for arbitrary maximum allowable eccentricity ratios. Instability hysteresis is considered by means of the above model. Equations and methods developed for the unbalance investigation are adapted to a variable-speed analysis. With both constant and variable mean bearing temperatures, variable-speed simulations terminating at constant speed are observed to be stable when the terminating point is below the instability threshold curve on the angular velocity-static eccentricity ratio parameter plane and unstable when above. The slope of the threshold curve and the shape of the equilibrium-condition path on the parameter plane (single-line path for constant temperature, closed curve for variable temperature) apparently combine to produce hysteresis in the variable temperature case and none at constant temperature. (Author)

A70-37647 Study of the motion of a sphere in a laminar flow - Determination of the lifting force (Etude du mouvement d'une sphère dans un écoulement laminaire - Détermination de la force de portance). Jean Gruat and Michel Laquerbe (Ecole Nationale Supérieure d'Electrotechnique, d'Electronique et d'Hydraulique, Toulouse, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 271, no. 1, July 6, 1970, p. 50-52. In French.

Consideration of a particle placed in a laminar flow and thus subjected to forces of lift and drag. A spherical particle placed in a finite medium in a cylindrical tube is studied. A series of experiments made for various positions of a ball very near the wall demonstrated a phenomenon of instability of the particle (a sort of hysteresis phenomenon) which shows that, for one and the same flow, a particle can occupy two positions in the tube. F.R.L.

A70-37748 # International challenge to airports. Kenneth K. Wilde (International Civil Aviation Organization, Montreal, Canada). *(American Society of Civil Engineers, National Meeting on Transportation Engineering, Washington, D.C., July 21-25, 1969.) ASCE, Transportation Engineering Journal,* vol. 96, Aug. 1970, p. 269-281.

Discussion of the various aspects resulting from the continuous growth of international civil aviation. The formation, organization,

and objectives of the International Civil Aviation Organization (ICAO) are briefly touched, and the importance of civil aviation is emphasized. A statistical review is presented of the development of international aviation showing that there is a great challenge in the world to provide adequate facilities for aviation. The role of ICAO in meeting the challenge for providing airport facilities throughout the world is outlined. Finally, the technical challenge in meeting new requirements in international aviation faced by both developed and developing countries all over the world is considered. Several projects by ICAO providing active help in solving a number of technical problems facing airports are reviewed. O.H.

A70-37749 # **Application of computers to airport planning and design.** Rufus C. Phillips, III (Airways Engineering Corp., Washington, D.C.). *(American Society of Civil Engineers, National Meeting on Transportation Engineering, Washington, D.C., July 21-25, 1969.) ASCE, Transportation Engineering Journal,* vol. 96, Aug. 1970, p. 341-348. 5 refs.

Discussion of various computer applications in airport planning and design either already in use or suggested for future use. Following some general considerations of the need for better planning of airports and the possible role of computers in solving this problem, various approaches to improved planning and design are reviewed. They include airspace and airport capacity analysis, analysis of alternative sites, wind data processing, plotting obstruction plans and noise contours, choice of optimum layout of airfields, development of space derivation programs for different terminal systems, analysis of passenger and baggage flows, designing of airport buildings, computation of earthwork quantities in airfield designs, etc. O.H.

A70-37750 # **Design of Hamburg's new airport terminal.** Joseph Treiterer (Ohio State University, Columbus, Ohio). *(American Society of Civil Engineers, Annual and Environmental Engineering Meeting, Chicago, Ill., Oct. 13-17, 1969.) ASCE, Transportation Engineering Journal,* vol. 96, Aug. 1970, p. 403-419. 7 refs.

Description of the principal features of an extensive study of a new Hamburg airport terminal. The study provides a system of circular planets which, due to the planet design ensures optimum conditions for operating large aircraft under their own power, as well as the ability of the airport to accommodate the changing mix of aircraft types. Efficient intermodal transfer facilities were also developed. O.H.

A70-37864 Current ferrite phase shifter technology for array antennas. William G. Spaulding (U.S. Army, Advanced Sensors Laboratory, Redstone Arsenal, Ala.). In: Engineering for the 70's; Institute of Electrical and Electronics Engineers, Annual Region III Convention, 8th, Huntsville, Ala., November 19-21, 1969, Proceedings. Edited by S. Kastorff. Huntsville, Ala., Institute of Electrical and Electronics Engineers, Inc., 1969, p. 359-361. 9 refs.

Discussion of current design trends and approaches to the production of ferrite phase shifters generally classified as digital, latching, and nonreciprocal. The applications and significance of the ferrite phase shifter are examined, and attention is given to the required performance characteristics. The present state of development is reviewed, and possible future developments are evaluated. T.M.

A70-37873 Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn (California, University, Los Alamos, N. Mex.). Pittsburgh, Instrument Society of America, 1970. 453 p. $17.50.

Contents:

Simulation concepts and applications.

A new concept for computer-aided laboratory testing of flight vehicles incorporating real environmental conditions. G. C. Chang (U.S. Naval Academy, Annapolis, Md.), p. 1-3. 7 refs.

Man-machine interface simulation considerations in advanced instrumentation systems. J. L. Eberle and R. E. Leader (Boeing Co., Seattle, Wash.), p. 4-13.

Laser instrumentation applications.

A new dual scatter, laser, Doppler shift velocity measuring technique. D. B. Brayton and W. H. Goethert (ARO, Inc., Arnold Air Force Station, Tenn.), p. 14-26. 8 refs.

Laser-aided analysis of a test-chamber vibration problem. A. A. Olsen (Ball Brothers Research Corp., Boulder, Colo.), p. 27-33. 5 refs.

Optical communications in space. A. R. Kraemer and C. R. Cooke (Sylvania Electric Products, Inc., Mountain View, Calif.), p. 34-42. 10 refs.

Design of instruments utilizing laser beam deflection. V. J. Fowler (General Telephone and Electronics Laboratories, Inc., New York, N.Y.), p. 43-50. 12 refs.

Iterative technique using a laser for alignment of the Mach-Zehnder interferometer. C. S. Chen (Virginia, University, Charlottesville, Va.) and J. D. Bird, III, p. 51-54. 6 refs.

Advances in measurement techniques. I.

New advancements in propulsion instrumentation. E. G. Johnson (Honeywell, Inc., Minneapolis, Minn.), p. 55-65.

Thermal recovery and the accuracy of air total temperature sensors. T. M. Stickney and M. Dutt (Rosemount Engineering Co., Minneapolis, Minn.), p. 66-77. 18 refs.

Discovery development and use of a cryogenic linear temperature sensor. J. C. Telinde (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.), p. 78-86. 7 refs.

Plastic wave detection and measurement by diffraction. W. L. Bingham, R. A. Douglas (North Carolina State University, Raleigh, N.C.), and W. L. Liddell, p. 87-95. 7 refs.

A new mass flow measuring system applicable to aircraft speed measurement including V/STOL. E. J. Durbin and G. Born (Princeton University, Princeton, N.J.), p. 96-104. 7 refs.

Holography.

Pulsed laser holography applications. A. D. Jacobson (Hughes Research Laboratories, Malibu, Calif.), p. 105-107. 5 refs.

Instrumentation of acoustical holography. A. F. Metherell (Douglas Advanced Research Laboratories, Huntington Beach, Calif.), p. 108-110. 12 refs.

Holographic flow and sound visualization. D. Cain, E. Sammartino, L. A. Cavanaugh, and W. G. Alwang (United Aircraft Corp., East Hartford, Conn.), p. 111-125. 25 refs.

Some aspects of bandlimiting in coherent optical matched filtering. T. H. Gee (Tennessee, University, Tullahoma, Tenn.) and W. Linton, Jr. (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio), p. 126-130. 5 refs.

An inexpensive precision displacement device to investigate holographic interferometry. G. E. Maddux (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), J. A. Wilson (USAF, Air University, Wright-Patterson AFB, Ohio), and G. H. Ratner, p. 131-141. 12 refs.

Maintenance data systems and AIDS.

Non-avionics integrated data system for an advanced high performance aircraft. W. Brenner (Grumman Aerospace Corp., Bethpage, N.Y.), p. 142-147.

A history of the development of the ARINC 573 digital flight data recording specification. K. R. Morrison (Douglas Aircraft Co., Long Beach, Calif.), p. 148-151.

Expansion of crash recording systems to AIDS. K. R. Bartholic

(AiResearch Manufacturing Co., Los Angeles, Calif.), p. 152-163.

AIDS: Benefits and costs to users - Why use it. F. D. Wise (American Airlines, Inc., Tulsa, Okla.), p. 164-169.

AIDS installation and design criteria. J. Balazic (Boeing Co., Seattle, Wash.), p. 170-175.

Advances in measurement techniques. II.

A hydrogen flame ionization detector for Martian/lunar life detection experiments. D. P. Lucero, P. H. Smith (Analog Technology Corp., Pasadena, Calif.), and R. D. Johnson (NASA, Ames Research Center, Moffett Field, Calif.), p. 176-186. 15 refs.

Dynamic calibration of pressure measuring systems. J. P. Simpson (McDonnell Aircraft Co., St. Louis, Mo.) and W. S. Gatley (Missouri, University, Rolla, Mo.), p. 187-194.

Engine vibration monitoring on the Boeing 747 aircraft. C. A. Bowes (Endevco Corp., Pasadena, Calif.), p. 195-205.

Signal conditioner for expanded range pressure measurements from reentry vehicles. E. A. Starr and B. E. Blanchard (Bolt Beranek and Newman, Inc., Cambridge, Mass.), p. 206-211.

Telemetry. I.

Computer controlled data acquisition and processing system for ECM aircraft testing. E. W. Conroy (Grumman Aerospace Corp., Bethpage, N.Y.), p. 212-219.

S-band telemetry antenna with electronic tracking and polarity diversity. C. M. Redman (U.S. Army, Instrumentation Div., White Sands Missile Range, N. Mex.), p. 220-226.

Automatic calibration verification of subcarrier telemetry discriminators. J. C. McDonald (Vidar Corp., Mountain View, Calif.), p. 227-233.

L-1011 flight test PCM/FM ground data processor. B. L. Barton and E. R. Moller (EMR-Telemetry, Sarasota, Fla.), p. 234-241.

Telemetry. II.

Considerations for high bit rate PCM. J. Gray, p. 242-251. 8 refs.

Dedicated telemetry preprocessor. L. A. Pownall (Martin Marietta Corp., Denver, Colo.), p. 252-258.

Applications of various PCM code formats and their spectral distributions. G. J. Martin, p. 259-261.

Error analysis of FET analog multiplexers. W. B. Holbrook (Radiation, Inc., Melbourne, Fla.), p. 262-267.

Aircraft noise measurement.

Critical review of methods for evaluating aircraft noise. J. C. McCann (United Aircraft Corp., East Hartford, Conn.), p. 268-279. 6 refs.

A sound monitoring system for measuring aircraft noise in the vicinity of airports. J. Colaruotolo, p. 280-287. 5 refs.

A computerized aircraft noise monitoring system - Some experience and results by the example of Stuttgart Airport. W. Glietsch, p. 288-293.

Development of a true RMS acoustic analysis capability. R. L. Borchard and D. Eslinger (Boeing Co., Wichita, Kan.), p. 294-308.

Flight deck/air traffic control instrumentation.

Electronic attitude director development for the supersonic transport. G. Annin (Boeing Co., Seattle, Wash.), p. 309-315.

ILS glide slope calibration by an optical projection method. S. W. Jorgensen and P. M. Johnson (Sanders Associates, Inc., Nashua, N.H.), p. 316-321.

Increasing airport capacity and terminal area safety by means of the scanning beam instrument landing system. G. W. Cherry, D. MacKinnon, and B. DeWolf (MIT, Cambridge, Mass.), p. 322-337. 12 refs.

Automation in air traffic control. K. P. Gray and J. W. Rabb (FAA, Washington, D.C.), p. 338-347.

Data processing and display.

CAGE - An 'intelligence system' for automatic checkout. W. F. Kamsler (Martin Marietta Corp., Denver, Colo.), p. 348-353.

Technology for the handling and presentation of dynamic data. R. A. Redding, R. D. Wesley, and T. C. Smith (Aerojet-General Corp., El Monte, Calif.), p. 354-368. 7 refs.

Operational experience with the C-5A flight test computer controlled data processing system. E. A. Reed, Jr. (Lockheed-Georgia Co., Marietta, Ga.), p. 369-375.

Computer generated graphic display applied to environmental testing of spacecraft structures. A. C. Jolly and D. J. Bozich (Wyle Laboratories, Inc., Huntsville, Ala.), p. 376-383.

Computer controlled testing and data acquisition.

Automatic gain ranging amplifier. R. L. Douglas (General Electric Co., Bay Saint Louis, Miss.), p. 384-389.

Digital control systems for electrodynamic vibration exciters. A. G. Ratz (MB Electronics, Inc., New Haven, Conn.), p. 390-402. 11 refs.

Pros and cons of computer systems. E. K. Merewether (B & F Instruments, Inc., Cornwells Heights, Pa.), p. 403-408.

Data management system development methodology for test facilities. D. J. Bozich, R. A. Arone (Wyle Laboratories, Inc., Huntsville, Ala.), and P. Brock (Wyle Laboratories, Inc., El Segundo, Calif.), p. 409-420.

A digital data acquisition, processing and operations control system for the LTV high speed wind tunnel. J. A. Wolfe (LTV Aerospace Corp., Dallas, Tex.), p. 421-443.

A70-37878 **Optical communications in space.** A. R. Kraemer and C. R. Cooke (Sylvania Electric Products, Inc., Sylvania Electronic Systems Div., Mountain View, Calif.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 34-42. 10 refs.

Discussion of the unique characteristics of optical communications and the applicability of this technology to solve important communications problems. A sample system design of a 10-channel, 10-megabit multiple-access low earth orbit (LEO)-to-synchronous and a 100-megabit synchronous-to-synchronous link is presented, with size, weight, and power estimates. The problem of acquisition and autotracking is discussed, and it was concluded that the links can be reliably established without any special platform stabilization being required. F.R.L.

A70-37881 **New advancements in propulsion instrumentation.** Elmer G. Johnson (Honeywell, Inc., Minneapolis, Minn.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 55-65.

Review of the rapid advancements in the design, materials, and applications of gas turbines for industrial and military uses, which are having an effect on associated control fields. There is a growing demand for accurate and responsive sensors which allow more direct

measurement and control of critical engine parameters. Generally, these sensors must withstand more severe environments than ever before, and they must have transducers for conversion to useful output signals. Several new sensors which have been developed to meet the criteria are described. F.R.L.

A70-37882 Thermal recovery and the accuracy of air total temperature sensors. T. M. Stickney and Mohan Dutt (Rosemount Engineering Co., Minneapolis, Minn.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 66-77. 18 refs.

Examination of modern jet-powered aircraft, which require very accurate measurements of air total temperature. The thermal recovery theory, which includes the mathematical origins of the recovery factor parameter, is discussed. Subsonic and supersonic wind tunnel data defining the thermal recovery characteristics for a number of total sensor designs is included, along with a discussion of sensor performance during icing conditions. An error analysis shows that it is quite probable that overall errors of several percent in magnitude will be generated if thermal recovery effects are either ignored or treated loosely. F.R.L.

A70-37885 A new mass flow measuring system applicable to aircraft speed measurement including V/STOL. E. J. Durbin and G. Born (Princeton University, Princeton, N.J.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. (Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 96-104. 7 refs.

A new mass flow measuring principle has been devised by the author and his colleagues. The principle utilizes an ion trajectory monitoring technique which provides a bi-directional linear output having extraordinary sensitivity. The output is a perfect integration of mass flow through the sensor system. Among many applications, the principle has been used in the development of an airspeed sensor suitable for use in optimizing V/STOL take-off performance. (Author)

A70-37891 Non-avionics integrated data system for an advanced high performance aircraft. W. Brenner (Grumman Aerospace Corp., Bethpage, N.Y.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 142-147.

Description of a diagnostic system that provides the basis for determining performance condition and minimum maintenance duties of aircraft nonavionic systems. The highlights of the selected parameter list (engine, fuel system, environmental controls, and mechanical systems) are outlined. Instruments expected to be tested that require further development to prove their design concept and merit before they may be specified as flight hardware are discussed. The rationale and concept behind the use of an on-board checkout (OBC) computer to handle and analyze, when possible, the data acquired in flight for detection, diagnosis, and prognosis of equipment failure is defined. F.R.L.

A70-37892 A history of the development of the ARINC 573 digital flight data recording specification. Kenneth R. Morrison (Douglas Aircraft Co., Long Beach, Calif.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 148-151.

Discussion of current and near-future flight recording requirements and the role played by industry in establishing and meeting these requirements. Brief attention is given to possible configurations for data recording in the future. AIDS (Aircraft Integrated Data Systems) and the ARINC (Aeronautical Radio Incorporated) 573 document are studied. F.R.L.

A70-37893 Expansion of crash recording systems to AIDS. Kent R. Bartholic (AiResearch Manufacturing Co., Los Angeles, Calif.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 152-163.

Evaluation of the expansion of a flight data (crash) recording system (FDRS) to an aircraft integrated data system (AIDS). It is concluded that the expansion of an FDRS into an AIDS can be readily accomplished at minimum expense to the airline operator by the modular addition of AIDS units. The result is a cost effective data system that can significantly offset the investment incurred by the airline to install the mandatory FDRS. The technical, operational, and economic factors relative to the FDRS expansion into AIDS strongly favor AIDS implementation by airline operators. Z.W.

A70-37894 AIDS: Benefits and costs to users - Why use it. F. D. Wise (American Airlines, Inc., Tulsa, Okla.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 164-169.

Description of one airline's experience and conclusions with regard to the application of airborne recording. It is concluded that there is definite economic payback for the larger airlines in the application of airborne recording to both operational aircraft performance monitoring and engine analysis. This is also true to a lesser degree for smaller airlines depending on technical depth within the airline and engine overhaul support structure. Savings can be substantial and, for new fleets, may offer a means of recovering the cost of the newly required expanded flight recording system. Application of this type of system to older fleets can be marginal with economic payback to some extent depending on engine behavior and fleet size. Z.W.

A70-37898 Engine vibration monitoring on the Boeing 747 aircraft. C. A. Bowes (Endevco Corp., Pasadena, Calif.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 195-205.

Discussion of the characteristics and features of the engine vibration monitoring system used as standard equipment on board the Boeing 747 aircraft. The measurement objectives, the operational and environmental constraints presented by the aircraft, and the system concepts used to meet the objectives within the constraint limits are outlined. Included is a discussion of a rugged piezoelectric transducer capable of reliable operation for long periods of time at temperatures up to 900 F, a unique hardline cable assembly for transmission of the transducer signals from the hot section of the engine to the firewall connector, and a state-of-the-art differential charge converter which was the key to overcoming many of the operational difficulties formerly associated with piezoelectric systems in this application. (Author)

A70-37907 Critical review of methods for evaluating aircraft noise. John C. McCann (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 268-279. 6 refs.

Review of the aircraft noise characteristics and major measurement and analysis problems. It is stated that several widely different noise measurement requirements exist. The variety of measurement and analysis techniques which are available can create uniformity problems, making it difficult to compare data from various organizations. The nonuniformity problem, however, can be controlled through standards. Incomplete standards were noted for some measurement requirements, notably static engine demonstration testing. In the case of noise certification, where uniform application of the noise rule to the products of several manufacturers is required, relatively complete standards were established by the FAA. Z.W.

A70-37908 A sound monitoring system for measuring aircraft noise in the vicinity of airports. Joseph Colaruotolo. In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 280-287. 5 refs.

Discussion of sound monitoring systems which have been in operation in airports for nearly 6 years without deterioration of performance or accuracy. A low level of maintenance is required to keep the system operational. The system is completely automatic and therefore it does not require the attendance of an operator. The interpretation of the data is a simple task that can be performed by personnel with a minimum of training. G.R.

A70-37909 A computerized aircraft noise monitoring system - Some experience and results by the example of Stuttgart Airport. Wolfgang Glietsch. In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 288-293.

Discussion of a computer-controlled system for monitoring aircraft noise at Stuttgart Airport in West Germany. This system was installed in March 1969, and since that time has been in continuous operation 24 hr a day. The basic objectives of the system and the parameters monitored are discussed and a brief account of design aspects of the system is given. The data obtained are considered. It is found that such an automatic noise monitoring system is an excellent tool to reduce the actual noise around an airport by helping in the development of flight regulations and enforcing their observance. G.R.

A70-37910 Development of a true RMS acoustic analysis capability. Richard L. Borchard and David Eslinger (Boeing Co., Wichita, Kan.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 294-308.

Discussion of the need, design, and development of a true root mean square spectrum analysis system for processing large quantities of wide band acoustic data. The system has been designed, developed, built, and operated in a period of approximately eight months. Since it first went into operation in June 1968, over 100,000 acoustic spectra have been processed through the system, 90% of which required 30-second data samples. The system uses analog methods, and the final output is converted to digital format. M.V.E.

A70-37911 Electronic attitude director development for the supersonic transport. Gordon Annin (Boeing Co., Seattle, Wash.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 309-315.

Discussion of the objectives, development history, and present design status of the electronic attitude director indicator (EADI). Experimental displays employing CRT stroke writing were developed and evaluated on the SST simulator. Television capability in a head-down concept was added to the basic symbol format so that the pilot could use flightpath information superimposed on an image of approach terrain. All-weather sensors, such as microvision, have been incorporated on an experimental basis. Engineering prototype EADIs now flying employ techniques whereby the signals are generated during the raster scan. Additional research work is needed to develop the EADI into a truly all-weather flight control and monitoring display. Techniques for roll-out guidance after landing are likely to be developed in the near future. M.V.E.

A70-37912 ILS glide slope calibration by an optical projection method. Stig W. Jorgensen and Philip M. Johnson (Sanders Associates, Inc., Nashua, N.H.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 316-321.

Application of optically projected digital codes as a calibration reference for the glide slope function of an ILS installation. The technique provides a continuous and automatic measurement of the elevation of an aircraft with respect to a horizontal ground plane, and the data are offered in real time at the calibrating aircraft without the use of a telemetry link. M.V.E.

A70-37913 Increasing airport capacity and terminal area safety by means of the scanning beam instrument landing system. George W. Cherry, Duncan MacKinnon, and Barton DeWolf (MIT, Cambridge, Mass.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 322-337. 12 refs.

Discussion of the growing congestion problem in the terminal areas, and review of the technology which can solve the problem. The scanning beam ILS, automatic control, and new digital computer, and digital communication link technology promise to help increase terminal-area capacity and safety while reducing airport noise, system weather dependence, and pilot and controller workload. In order to take advantage of this new technology, new procedures and a new system concept are required. It is suggested that the new system concept should include the use of automatic guidance and control systems in the aircraft to allow approaches along steep-descent corridors in time-specified slots. This system concept is seen to have advantages in terms of noise abatement, reduced midair collision hazard, accommodation of general aviation, and automation. On the basis of current results, it appears feasible to design a control system that achieves acceptable four-dimensional accuracy on a complicated terminal-area trajectory. M.V.E.

A70-37914 **Automation in air traffic control.** Kenneth P. Gray and J. W. Rabb (FAA, Washington, D.C.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 338-347.

Discussion of the air traffic control automation program for en route and terminal facilities, designed in response to the continuing growth of air traffic. When completed, the combined system will provide automation at each of the twenty air route traffic control centers and those terminals where automation is warranted. All these facilities will be interconnected with data transmission links, and the entire system will function as a nationwide real-time automated system to provide increased capacity and safety to the existing air traffic control system. It is, in particular, the en route portion of the automation program, which has been termed 'NAS (National Airspace System) En Route Stage A,' that is dealt with in detail. This portion of the program is in a sense only the beginning of system modernization. It is a modularly expandable system to which additional automation features can be subsequently added. Examples of such features are: conflict prediction and resolution, flow control techniques, sequencing, and data link. M.V.E.

A70-37917 **Operational experience with the C-5A flight test computer controlled data processing system.** E. A. Reed, Jr. (Lockheed-Georgia Co., Marietta, Ga.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 369-375.

Discussion of the experience gained in the operation of the C-5A engineering flight test (EFT) computer controlled data processing system over a two and one-half year period. The facts presented illustrate the capability, performance, limitations, and the problems encountered in the routine operation of the equipment. Highlighted features include personnel requirements, maintenance requirements, hardware and software problems, and possibilities of new applications. The batch processing activity of the output digital tapes is discussed. A general sizing of the central computer support effort is shown as a means of giving an idea of the total complexity of the C-5A data processing job. The inherent capability and flexibility of the system are demonstrated also by the fact that two other EFT programs were identified, aircraft tested, and then data processed prior to the first flight of the C-5A. M.V.E.

A70-37920 **Digital control systems for electrodynamic vibration exciters.** Alfred G. Ratz (MB Electronics, Inc., New Haven, Conn.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 390-402. 11 refs.

Description of systems for controlling electrodynamic vibration exciters used in environmental test facilities associated with the design, development, and proof-testing of aircraft, missiles, and satellites. These control systems differ completely from the conventional analog types, in that they are digital in nature, and are built around small digital computers. The technical problems inherent in developing all-digital vibration control, are outlined. Approaches to the solution of these problems are listed, and the optimum choices are outlined. Practical control systems, developed for sinusoidal, random, and shock-spectrum testing, are discussed, showing how the technical and cost compromises can be worked out. Operation of the sine and random systems is explained in detail and illustrated by test results. Freedom from operator error, flexibility and ease of setup, ease and accuracy of control, increased safety and protection, minimum system downtime to change test parameters, are among the advantages indicated. M.V.E.

A70-37923 **A digital data acquisition, processing and operations control system for the LTV high speed wind tunnel.** J. A. Wolfe (LTV Aerospace Corp., Gas Dynamics Laboratories, Dallas, Tex.). In: Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings. Edited by B. Washburn. Pittsburgh, Instrument Society of America, 1970, p. 421-443.

Description of an operational digital computer system for the acquisition and processing of wind tunnel data and the controlling of wind tunnel operations and testing systems. Operational experience, design and selection considerations, and the system's specifications are presented and discussed. The system can record data from 80 channels, with capability to expand to 256. The data consist of both contact closures and high level analog signals. The data are stored on magnetic tape and computed after a tunnel run. The system collects data at analog rates up to 24,000 conversions per second and at digital rates up to 100,000 samples per second. Provision is also made for flexible scanning rates and patterns through random or sequential multiplexer addressing during a test. M.V.E.

A70-37925 **The frequency of low visual ranges and ceilings at German civil airports (Zur Häufigkeit geringer Sichtweiten und Wolkenhöhen an deutschen Verkehrsflughäfen).** R. Lamp. *Meteorologische Rundschau,* vol. 23, July-Aug. 1970, p. 102-104. In German.

Examination of the frequency and duration of runway visual ranges less than 800 m and ceilings less than 60 m at German civil airports. Based on observations carried out at German airports during the 1949-1967 period, statistical data concerning this problem are tabulated and analyzed for various German airports. It is shown that the occurrence of the visual ranges and ceilings examined is relatively scarce and its duration usually does not exceed two hours. O.H.

A70-37975 # **Air conditioning in aircraft.** W. D. Sanders. *Tech Air,* vol. 26, Aug. 1970, p. 2-6.

Discussion of the requirements for typical aircraft air conditioning systems. Following a brief review of general design parameters, taking into account both external and internal conditions, optimum approaches to system development are considered. They include both the temperature and moisture control and the design of cooling systems for subsonic and supersonic aircraft. Diagrams of some effective cooling systems are presented. O.H.

A70-38019 # **A technique for phase speed measurements in turbulent flow.** G. R. Stegen (Colorado State University, Fort Collins, Colo.) and C. W. Van Atta (California, University, La Jolla, Calif.). *Journal of Fluid Mechanics,* vol. 42, July 30, 1970, p. 689-699. 15 refs. DOD-supported research; Contracts No. AF 44(620)-68-C-0010; No. N 0014-68-A-0493-0001.

A technique is described for measuring the local phase speed in a turbulent flow. The technique has been used to measure the phase speed of the Fourier components of the longitudinal velocity fluctuations in grid turbulence. These measurements are unique in that the probe spacing is only twice the Kolmogoroff length scale. The velocity fluctuations were measured with linearized constant-temperature hot-wire anemometers, the outputs of which were digitally sampled and recorded in real time. Digital Fourier analysis techniques were then used to calculate the cross-spectral density of the two velocity measurements. From this, the phase, phase speed, and coherence were calculated. The coherence has been used to estimate the variance of these measurements. (Author)

A70-38161 # **Algorithm and general principles of information processing in a civil aviation traffic system (Zasady ogólne i algorytm przetwarzania informacji w systemie cywilnego ruchu lotniczego).** Marek Libura and Stanisław Walukiewicz. *Polska Akademia Nauk, Instytut Automatyki, Prace,* no. 83, 1969. 25 p. In Polish.

Description of steps involved in flight planning and control of

flight plan completion required for a complete air traffic control system at airports. The proposed concept of flight control automation is characterized by the use of a closed ATC-air traffic-ATC system, where ATC has feedback on control quality which allows the introduction of changes required with time. The study features mathematical descriptions which can serve as a basis for detailed theoretical and practical investigations. T.M.

A70-38164 Contribution to the calculation method of subsonic wing theory (Ein Beitrag zu den Rechenverfahren der Unterschall-Tragflügeltheorie). Claus Oehler (Berlin, Technische Universität, Berlin, West Germany). *VDI-Z Fortschritt-Berichte, Reihe 7 - Strömungstechnik,* no. 17, Apr. 1970. 29 p. 7 refs. In German.

Description of a modification of Multhopp's (1938) quadrature method in which the reference points are equidistantly distributed over the wing span. This makes it possible to put the reference points simultaneously for several positions of the angle of attack. The special advantage of this method consists in the possibility of obtaining close solutions for constants of the integral expression for the downward air currents. Numerical expressions are presented for illustrating the applicability of this method. Z.W.

A70-38179 Interference characteristics of streamer discharges. George C. Huang (Washington, University, Seattle, Wash.), Reuben Goldman, and Richard B. Schulz (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *IEEE Transactions on Electromagnetic Compatibility,* vol. EMC-12, May 1970, p. 54-63. 5 refs. Contract No. AF 33(615)-68-C-1720.

This paper discusses analytical and experimental results of a study on streamer formation, discharge waveforms, and RF noise levels. Measurements disclose typical pulse parameters as follows: rise time = 20 ns, discharge time = 80 ns, and pulsewidth less than 600 ns (dependent upon test sample). A mathematical model is developed to represent electric field strength in the vicinity of the streamer with supporting measured values. (Author)

A70-38222 # Characteristics and flow conditions of a forced-vortex impeller of an axial flow fan. Tomio Ida (Kanagawa University, Yokohama, Japan). *JSME, Bulletin,* vol. 13, June 1970, p. 773-780. 20 refs.

Experimental study of a forced-vortex impeller in an axial flow fan without inlet vanes. The impeller is so designed as to have a forced-vortex flow at the impeller outlet on the assumption that the axial velocity component is uniformly distributed from hub to tip. Lift and drag coefficients of each blade section, theoretical head, loss of head, and mean effective radius of the impeller are presented, along with up- and downstream velocity profiles. M.V.E.

A70-38224 # The boundary layer on a rotating thin blade. Tomitaro Toyokura (Yokohama National University, Yokohama, Japan) and Kiyoshi Harada (Tokyo Shibaura Electric Co., Ltd., Tokyo, Japan). *JSME, Bulletin,* vol. 13, June 1970, p. 791-801. 12 refs.

Experimental and theoretical study of the velocity distribution in the boundary layer on a rotating blade. Measurements of the characteristics of the boundary layer of a rotating blade of an impeller driven at the outlet of a wind tunnel indicated at a given moment the presence of turbulence. The momentum equations of the boundary layer for turbulent and laminar flows are solved, and the results are compared with the experimental data obtained. The experimental study was extended to blade positions at an angle of attack. The outcome of the study includes the following results: (1) the measured boundary layer thickness is in good agreement with theoretical predictions; and (2) the radial flow in the boundary layer on the blade at an angle of attack increases considerably in the pressure side. M.V.E.

A70-38226 Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970. 220 p. Members, $10.00; nonmembers, $15.

Contents:

Introduction. A. B. Winick, p. i-iii.

Air traffic control system needs and concepts.

Air traffic control in the 70's. J. F. Taylor, Jr. (Aeronautical Radio, Inc., Annapolis, Md.), p. 3-10.

Conceptual questions in air traffic control design. G. R. Marner (Collins Radio Co., Cedar Rapids, Iowa), p. 11-18. 8 refs.

Air force ATC requirements. E. F. Walsh, Jr. (USAF, Communications Service, Scott AFB, Ill.), p. 19-25.

The impact of helicopter operations on air traffic control in the 1970's. J. G. McFadden (U.S. Army, Office of the Director of Defense Research and Engineering, Washington, D.C.), p. 27-39.

Area navigation and cartography.

Area navigation charting. J. M. Sarto, p. 53-72.

Military Airlift Command's proposed operational procedures for area navigation. L. L. Undercoffer (USAF, Military Airlift Command, Scott AFB, Ill.), p. 73-80.

Airline area navigation in continental U.S. T. G. Angelos (United Air Lines, Inc., Chicago, Ill.), p. 81-100.

Navigation displays for the 1970's. S. N. Roscoe (Illinois, University, Savoy, Ill.), p. 101-115.

Terminal area capacity.

Analysis of a capacity concept for runway and final-approach path airspace. A. J. Goldman (National Bureau of Standards, Washington, D.C.), p. 119-131. 8 refs.

Analysis tools for airport capacity. F. C. Holland (Mitre Corp., McLean, Va.), p. 133-162. 18 refs.

Time-synchronized approach control. R. L. Erwin, Jr. (Boeing Co., Renton, Wash.), p. 163-173.

STOL terminal area operations. M. D. Marks and J. E. Hosford (McDonnell Douglas Corp., St. Louis, Mo.), p. 175-181.

CAS.

Avoiding collisions in a timely manner. R. E. Perkinson (McDonnell Douglas Astronautics Co., St. Louis, Mo.), p. 185-198. 7 refs.

Results of the ATA CAS flight test program. M. J. Borrok and D. C. Rider (McDonnell Douglas Aircraft Co., St. Louis, Mo.), p. 199-213.

Application of CAS theory to parallel runway separation. J. M. Holt (Collins Radio Co., Cedar Rapids, Iowa), p. 215-226.

Satellite-based collision avoidance system concepts. D. D. Otten (TRW Systems Group, Redondo Beach, Calif.), p. 227-235. 6 refs.

A70-38227 # Air traffic control in the 70's. J. Francis Taylor, Jr. (Aeronautical Radio, Inc., Annapolis, Md.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. (A70-38226 19-21) Washington, D.C., Institute of Navigation, 1970, p. 3-10.

Discussion of the upgrading of the Third Generation System for ATC. The development programs that would lead, with low technical risk, to three functional system capabilities, are listed. The program 1 objective calls for the increase in airport capacity, while program 2 objective calls for the increase in the en route and terminal airspace capacity of the third generation ATC system to accommodate traffic

up to the 1980's. The program 3 objective calls for testing of the feasibility of major innovations in the ATC system that might be key ingredients of a fourth generation system. M.M.

A70-38228 # **Conceptual questions in air traffic control design.** Gene R. Marner (Collins Radio Co., Cedar Rapids, Iowa). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 11-18. 8 refs.

ATC system organization is discussed with regard to safety, capacity and delay. The derivation of explicit relations between these is believed possible. This could form a framework for system improvement studies. Adoption of quantitative safety goals would be helpful. Improvements in runway capacity and terminal operations and determination of minimum spacing between parallel runways are discussed. The overall system is viewed as a lightly coupled but heavily loaded system. Tighter coupling to shift delays to the ground and to decrease airborne delays due to occasional en route saturation is reluctantly viewed as necessary. Expansion of terminal capacity is urgently needed to reduce total delay and to reduce need for overall system coupling. Various analyses are needed to understand the organic functioning of the system and to properly frame conceptual questions which need resolution. (Author)

A70-38229 # **Air Force ATC requirements.** Edward F. Walsh, Jr. (USAF, Communications Service, Scott AFB, Ill.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 19-25.

The Air Force Communications Service paper discusses a number of USAF operations which are unique to the military and which have little or no parallel in general aviation. Among these operations are undergraduate pilot training, air combat tactics training, war zone training environment, low level high speed operations, terrain following radar navigation, air refueling, and problems associated with SR-71, YF-12, and F-111 aircraft. The thrust of this paper is that if the air traffic control system is to be responsive to the needs of national defense, it must be able to accommodate the unique military operations. (Author)

A70-38230 # **The impact of helicopter operations on air traffic control in the 1970's.** James G. McFadden (U.S. Army, Office of the Director of Defense Research and Engineering, Washington, D.C.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 27-39.

The integration of helicopter operations into the civil air traffic system has been initiated. The quantitative impact in the next decade is difficult to forecast but it appears that in total numbers, helicopters will not create particularly great problems in air traffic control. They will, however, require special systems and procedures, particularly in terminal areas. Their slow operating speeds make them generally incompatible with fixed wing operations. Further, from the standpoint of operational efficiency, their VTOL capabilities and high maneuverability must be exploited in air traffic management. Military experience in Viet Nam provides valuable insight into operation of helicopters in mixed fixed and rotary wing terminal environments. (Author)

A70-38231 # **Area navigation charting.** Joseph M. Sarto. In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 53-72.

Discussion of area navigation and the impact it will make on flight information publications as the area navigation system becomes an integral part of the National Airspace System. It is pointed out that the area navigation system represents a new challenge to the producers of flight information publications. But, just as the Low Frequency/Medium Frequency (LF/MF) and the present vhf en-route systems found their way into flight information publications, this new concept will surely follow the path of its predecessors and take its place in the family of charts. M.M.

A70-38232 # **Military Airlift Command's proposed operational procedures for area navigation.** Larue L. Undercoffer (USAF, Military Airlift Command, Scott AFB, Ill.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 73-80.

Discussion of operational procedures for implementing area navigation for the fast, high altitude jet aircraft of the Military Airlift Command (MAC). Suitable methods for area navigation are considered. It is found that area navigation routes, defined by coordinates, to permit Great Circle computerized flight director steering would be the most expeditious means of implementing an area navigation system. The nature of MAC equipment would require a navigator to be on board the C-141 and C-5 when these aircraft use the area navigation routes. On the VC-137 and VC-140 aircraft the LTN-51 computer controls are accessible to the pilot in flight. G.R.

A70-38233 # **Airline area navigation in continental U.S.** Thomas G. Angelos (United Air Lines, Inc., Chicago, Ill.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 81-100.

This paper summarizes the broad benefits to be gained from area navigation in the National Airspace System and the implementation status of airline area navigation. Specific system capabilities and utilization in terms of basic applications and operational benefits are addressed. A special attempt is made to delineate the unique applications of pictorial displays as contrasted to basic area navigation instrumentation alone. Area navigation charting needs are described from the viewpoint of minimum requirements and standards with emphasis on moving map display characteristics. Samples of charts developed for airline evaluation and application are presented including computer generated chart symbology for future CRT displays. (Author)

A70-38234 # **Navigation displays for the 1970's.** Stanley N. Roscoe (Illinois, University, Savoy, Ill.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 101-115.

The Federal Aviation Administration's recent Advisory Circular AC 90-45, concerned with area navigation, also discusses pilotage error. One possible way to reduce such error is to combine the symbolic with the pictorial methods of display to take advantage of the best features of both. For symbolic display, these features are highly precise short-term navigation control and capability for guidance beyond the instantaneous field of view. For pictorial display, the desirable features are improved long-term navigation control and flight control, waypoint definition and confirmation by visual chart reference, easier impromptu planning, and instantaneous and continuous orientation. (Author)

A70-38235 # **Analysis of a capacity concept for runway and final-approach path airspace.** A. J. Goldman (National Bureau of Standards, Washington, D.C.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 119-131. 8 refs.

This paper describes some highlights of a short-term analytical

study leading: (a) to a 'maximum throughput-rate' capacity concept in the context of a service facility handling a stream of customers of various types, and (b) to the specialization of this concept to a stream of IFR landings at a runway. The specialization is shown to be representable by a simple mathematical formula, of potential value (for example) in connection with cost-effectiveness analyses of proposed changes in ATC equipment or procedures. Directions for further research are identified, and the paper concludes with some general remarks on conceptual difficulties associated with the notion of 'capacity.' (Author)

A70-38236 # **Analysis tools for airport capacity.** Frederick C. Holland (Mitre Corp., McLean, Va.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings.
Washington, D.C., Institute of Navigation, 1970, p. 133-162. 18 refs.

The paper provides an overview of airport capacity analysis including the types of runway capacities, factors influencing runway capacity, and the most likely means of improvement. The bulk of the paper is an outline of the alternative analytical tools that can be applied to terminal area studies, and a description of the applications and limitations of each tool. An example illustrates the use of simulation in studying alternative strategies for parallel runway operation. Finally, the paper recommends the most effective and efficient tool to be applied to specific study areas. (Author)

A70-38237 # **Time-synchronized approach control.** Ralph L. Erwin, Jr. (Boeing Co., Renton, Wash.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings.
Washington, D.C., Institute of Navigation, 1970, p. 163-173.

Time-synchronized approach control is a concept that takes advantage of available aircraft precision navigation and guidance capabilities. It combines these with advanced ATC equipment to provide an improved method of air traffic control. The basic concept is for ATC to assign each aircraft a three-dimensional approach path and schedule that the aircraft must then maintain with an error that is small compared to the allowable longitudinal spacing between approaches. The advantages of reduced control workload and increased control precision are used as a basis for computing potential benefits in terms of increasing peak-hour operations without increasing delay. This paper describes the concept, the airborne and ground-based equipment capabilities, the expected performance, and the potential benefits. (Author)

A70-38238 # **STOL terminal area operations.** Marvin D. Marks and John E. Hosford (McDonnell Douglas Corp., St. Louis, Mo.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 175-181.

The technical and operational feasibility of STOL air transportation has now been demonstrated in joint airline-manufacturer-government evaluation programs. Advanced avionics installed in aircraft with short takeoff and landing and slow speed, steep gradient capabilities can provide new terminal area operational capabilities in a congested air traffic environment. (Author)

A70-38239 # **Avoiding collisions in a timely manner.** Robert E. Perkinson (McDonnell Douglas Astronautics Co., St. Louis, Mo.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 185-198. 7 refs.

The Air Transport Association Collision Avoidance System is in its final stages, and a number of programs have been conducted over the last year to verify and confirm assumptions made in the system. The results of these programs are discussed in this paper, and the verification of system concepts and times is discussed based on: (1) a computer simulation program to verify the system parameters, accuracies, and maneuver times; (2) a program to verify pilot capability to observe and react to the CAS displays under instrument flight load conditions in airline cockpit simulators; (3) the work done by NAFEC in analyzing probability of alarm under real-life conditions; and (4) the final proof-of-the-pudding flight test that was conducted last fall on the CAS systems supplied by three electronics companies. (Author)

A70-38240 # **Results of the ATA CAS flight test program.** Martin J. Borrok and David C. Rider (McDonnell Douglas Aircraft Co., St. Louis, Mo.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 199-213.

The Collision Avoidance System Flight Test and Evaluation Program was conducted by the Martin Marietta, Baltimore Division, under contract with the Air Transport Association of America. The purpose of the test program was to evaluate the compatibility and effectiveness of the Collision Avoidance System as set forth in the airline industry CAS specification, ANTC Report No. 117. CAS equipments designed and built by three companies, Bendix Avionics, McDonnell Douglas and joint team of Sierra Research Corporation and Wilcox Electric Company, were furnished for this test and evaluation program. A total of 124 CAS test flights (greater than 300 flight hours) were flown from 6 June 1969 to 19 November 1969. From the total 124 flights, 75 flights (210 flight hours) yielded sufficient quantitative data for adequate analysis of the CAS. Approximately 260 intercepts, the majority involving two aircraft encounters, were flown. Test results from this program show that CAS operating normally in the synchronized mode, per ANTC 117 specification, provide the proper pilot command in adequate time to perform the evasive action to prevent a potential midair collision. (Author)

A70-38241 # **Application of CAS theory to parallel runway separation.** John M. Holt (Collins Radio Co., Cedar Rapids, Iowa). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 215-226.

When airways are closely spaced and weather does not permit see-and-avoid tactics, the ATC surveillance, communication, and control system must act as a CAS when a blunder or failure occurs in any aircraft. This paper shows how the techniques of hazard detection and escape maneuver selection developed for airborne CAS can be applied to this case. A program is recommended for determining minimum parallel runway separation, and a first iteration through the required steps is given. (Author)

A70-38242 # **Satellite-based collision avoidance system concepts.** David D. Otten (TRW Systems Group, Redondo Beach, Calif.). In: Institute of Navigation, National Air Meeting on Air Traffic Control in the 1970's, St. Louis, Mo., April 14-16, 1970, Proceedings. Washington, D.C., Institute of Navigation, 1970, p. 227-235. 6 refs.

Qualitative description of two basic techniques for application of satellite technology as a means of avoiding air collisions: ground-initiated and cockpit-initiated collision avoidance commands. In the first case, satellites are used to provide accurate, three-dimensional surveillance of all airborne aircraft. Possible collision situations are computed on the ground and evasive maneuvers are commanded. In the second case, the use of multiple satellites to provide time and three-dimensional position and velocity data to each using aircraft is discussed. Interchange of this information between cooperating aircraft permits gating out of nonthreat aircraft and simple computation of relative position and velocity (in three dimensions) of possible threat aircraft. F.R.L.

A70-38243 # **Performance of conical jet nozzles in terms of discharge coefficient.** K. Sheshagiri Hebbar, K. Sridhara, and P. A. Paranjpe (National Aeronautical Laboratory, Bangalore, India). *Aeronautical Society of India, Journal,* vol. 22, Feb. 1970, p. 3-9.

An attempt is made to obtain a simple, explicit and analytical expression for the discharge coefficient of conical convergent nozzles operating under varying pressure ratios. The theoretical results based on this approach have been compared with discharge coefficient of conical jet nozzles determined experimentally covering a range of pressure ratio up to 3.25. The theory predicts the correct trend of the variation of discharge coefficient with respect to nozzle pressure ratio and nozzle convergence angle. Satisfactory quantitative agreement with the experimental results is possible by applying a suitable correction factor for the boundary layer growth which is dependent on Reynolds number. (Author)

A70-38244 # **On revealing the mechanism of flutter.** John D. C. Crisp (Monash University, Clayton, Victoria, Australia). *Aeronautical Society of India, Journal,* vol. 22, Feb. 1970, p. 10-18. 13 refs.

Demonstration that for a system of n degrees of freedom there are a total of 3(n + 1) criteria of ultimate stability with respect to flutter, based on total and modal energy balance on both an average and an instantaneous basis. It is possible to isolate simple graphical criteria which depend only on the reduced frequency, only on the air speed, on both, or on neither. The implications in understanding the basic mechanisms, in assessing the effects of parametric changes, in system analysis, and in system synthesis are outlined in terms of the binary system. (Author)

A70-38245 # **Complicated nodal patterns on a thin elastic circular plate vibrating in flexure.** K. S. R. K. Prasad (Indian Institute of Science, Bangalore, India) and P. N. Murthy (Indian Institute of Technology, Kanpur, India). *Aeronautical Society of India, Journal,* vol. 22, Feb. 1970, p. 19-22. 8 refs.

Earlier experimental investigations on thin plates brought out compounded modes involving complicated nodal patterns in addition to those obtained by thin plate theory. An analytical treatment for Waller's postulation of compounding of natural modes with nearly equal frequencies, is proposed to account for the compounded modes. Some of the intricate nodal patterns observed experimentally on free circular plate, are obtained analytically. The agreement between theory and experiment is good. (Author)

A70-38248 # **Investigation of three-dimensional flow through the rotor of an axial fan.** Girishwar Nath (Indian Institute of Science, Bangalore, India). *Aeronautical Society of India, Journal,* vol. 22, Feb. 1970, p. 45-52. 14 refs.

In the present investigation, isolated aerofoil method has been employed to design a low pressure rise, non-free vortex flow fan with small hub-tip ratio for prescribed blade loading. The fan consists of rotor only. Such fans are used in cooling towers of power plants. It is assumed that the finite number of blades is replaced by infinite number of blades such that the total circulation is the same as that of finite number of blades. The fluid is considered to be steady, incompressible, non-viscous and without heat transfer. The velocity components have been obtained in closed form. All the results are obtained in non-dimensional form and they are in close agreement with the author's previous results (1966), where the number of blades is assumed to be finite. With proper choice of design parameters, the static efficiency can be increased and the various losses associated with the non-free vortex flow can be kept as small as possible. (Author)

A70-38249 # **Technical evaluation of future generation of aircraft.** K. G. Appusamy (Air-India, Bombay, India). *(Aeronautical Society of India, Annual General Meeting, 21st, Madras, India, Apr. 4, 5, 1969.) Aeronautical Society of India, Journal,* vol. 22, Feb. 1970, p. 53-65. 6 refs.

Evaluation of future aircraft, which offer the advantages of increased comfort and speed and greater operating economy. Apart from the improved system concepts in the aircraft as a whole, a large part of the success of new generation aircraft can be attributed to major developments in power plant technology. F.R.L.

A70-38304 **Hypersonic airfoils of maximum lift-to-drag ratio.** D. G. Hull (Texas, University, Austin, Tex.) and R. A. Thompson. *Journal of Optimization Theory and Applications,* vol. 5, June 1970, p. 432-448. 11 refs. Grant No. AF AFOSR 69-1744.

The problem of determining the slender, hypersonic airfoil shape which produces the maximum lift-to-drag ratio for a given profile area, chord, and free-stream conditions is considered. For the estimation of the lift and the drag, the pressure distribution on a surface which sees the flow is approximated by the tangent-wedge relation. On the other hand, for surfaces which do not see the flow, the Prandtl-Meyer relation is used. Finally, base drag is neglected, while the skin-friction coefficient is assumed to be a constant, average value. The method used to determine the optimum upper and lower surfaces is the calculus of variations. Depending on the value of the governing parameter, the optimum airfoil shapes are found to be of three types. For low values of the governing parameter, the optimum shape is a flat plate at an angle of attack followed by slightly concave upper and lower surfaces. The next type of solution has a finite thickness over the entire chord with the upper surface inclined so that the flow is an expansion. Finally, for the last type of solution, the upper surface begins with a portion which sees the flow and is followed by an inclined portion similar to that above. For all of these solutions, the lower surface sees the flow. Results are presented for the optimum dimensionless airfoil shape, its dimensions and the maximum lift-to-drag ratio. To calculate an actual airfoil shape requires an iteration procedure due to the assumption on the skin-friction coefficient. However, simple results can be obtained by assuming an approximate value for the skin-friction coefficient. (Author)

A70-38342 * **Aeroelastic stability of plates and cylinders.** William J. Anderson (Michigan, University, Ann Arbor, Mich.). In: *Developments in theoretical and applied mechanics.* Volume 4 - Proceedings of the Fourth Southeastern Conference on Theoretical and Applied Mechanics, Tulane University, New Orleans, La., February 29-March 1, 1968. Conference sponsored by Tulane University. Edited by Daniel Frederick and E. H. Harris. Oxford and New York, Pergamon Press, 1970, p. 319-328. Grant No. NGR-23-005-166.

Linear stability criteria are presented for the panel flutter of thin plates and thin-walled cylinders. These structures are exposed to fluid flow passing parallel to an outer surface. The expression for fluid pressure is simplified in order to emphasize the dynamic properties of the systems. The pressures are derived from steady flow relations (frequency effects are ignored). An arbitrary spatial phase angle is included in the pressure expression. As this phase angle is varied in a continuous manner, the fluid flow passes from subsonic (or slender body) character to supersonic character. The results are useful in classifying several types of instability and discussing several pathological cases, which are usually treated separately. The analysis is intended to serve as an aid to understanding the mechanism of panel flutter; however, it can be applied directly to several physical problems. It is accurate for the static divergence and 'coupled mode' flutter of flat panels in supersonic flow, and for other divergence problems where experimental measurements can supply the values for the necessary aerodynamic parameters. One result is to point out the importance of static instability for flat panels in a transonic viscous flow. A second result is to illustrate that the asymmetric divergence of cylindrical shells is very sensitive to small changes in the pressure distribution. (Author)

A70-38350 **On the generation of a two-dimensional shear flow.** N. Galanis and J. F. Barrows (Cornell University, Ithaca, N.Y.). In: Developments in theoretical and applied mechanics. Volume 4 - Proceedings of the Fourth Southeastern Conference on Theoretical and Applied Mechanics, Tulane University, New Orleans, La., February 29-March 1, 1968. Conference sponsored by Tulane University. Edited by Daniel Frederick and E. H. Harris. Oxford and New York, Pergamon Press, 1970, p. 465-474. 10 refs.

A solution is developed for the modification of a steady, two-dimensional flow of an incompressible fluid, by an arbitrarily graded resistance distributed in a plane normal to the axis of a duct of constant cross-section. The solution consists of a numerical method and makes possible the calculation of any one of the three parameters (the two velocity profiles, upstream and downstream of the resistance, and the resistance distribution) if two of them are known. The solution is verified experimentally in an air tunnel in the case of a linear resistance distribution. The generated velocity profile is nearly linear with a slope of 15 fps/in. while the mean velocity of the flow is 75 fps. (Author)

A70-38365 # **Guidance and control philosophy for all-weather landing.** S. S. D. Jones (Royal Aircraft Establishment, Farnborough, Hants., England). *Institute of Navigation, Journal,* vol. 23, July 1970, p. 277-291; Discussion, p. 291-301. 7 refs.

Discussion of a range of philosophical implications which result from the interaction of guidance and control systems in the context of all-weather landing of fixed-wing aircraft. An attempt is made to deduce the considerations which must be contained in an approach to the engineering solution of the guidance and control problem. The fundamental differences between the approach and landing characteristics of fixed-wing and VTOL aircraft are surveyed. It is concluded that in the case of the former simplicity and integrity are more important than flexibility and that these criteria can be met by exploring the inherent constraints of the approach path of such aircraft by restricting the goal to provision of a single straight line defined in space. In the case of VTOL aircraft, the inherent operational flexibility may have to be matched by flexibility in the guidance system; the constraint to a single path is not acceptable. T.M.

A70-38399 # **Measuring maintenance effectiveness.** M. J. Kirby and R. L. Klein (Sperry Rand Corp., Great Neck, N.Y.). *Logistics Spectrum,* vol. 3, Winter 1969, p. 7-11. 26 refs.

Discussion of problems of maintenance, symptom diagnosis, and verification of repairs, whose complexity grows with the complexity of avionics systems. The SPOT (Symptom Pattern Observation Technique) technique for the analysis of flight data is described. The technique identifies in-flight symptoms which are caused by: (1) failures in system modules, (2) repeats left in aircraft for more than one flight, (3) shop inserted failures, (4) operator errors, and (5) malfunctions in other systems, wiring problems, and the like. M.M.

A70-38425 **Development of graphite/polyimide composites.** Mike Varlas (General Dynamics Corp., Convair Div., San Diego, Calif.). *SAMPE Quarterly,* vol. 1, July 1970, p. 52-62.

Description of the development of advanced state-of-the-art graphite/polyimide composites using commercially available raw materials. Preliminary mechanical strength properties of graphite/polyimide laminates determined at room temperature and 550 F show potential use of this material in advanced aircraft or aerospace vehicles. Tensile strength properties equivalent to those measured for graphite/epoxy laminates have been measured in graphite/polyimide laminates currently under development, and I-beams, stiffened panels, and sandwiched spar beams have been fabricated as advanced process demonstration articles. (Author)

A70-38431 **Investigation of the endurance of aluminum alloy AMg6M sheet at frequencies of 2500, 7500, and 12,500 Hz.** P. F. Kul'bashnyi (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR). (*Problemy Prochnosti,* vol. 1, July 1969, p. 38-41.) *Strength of Materials,* July 1969, p. 35-38. 6 refs. Translation.

Results of high-frequency endurance tests of annealed specimens of an aluminum sheet alloy widely used in welded aircraft structural components. Endurance curves are plotted for specimens subjected to various heat-treatment procedures. The endurance was highest at 2500 Hz in untreated specimens and at 7500 Hz in heat-treated specimens. V.Z.

A70-38459 **Fatigue strength testing of turbine blade simulators in a gas flow.** B. N. Sinaiskii (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR). (*Problemy Prochnosti,* vol. 1, Aug. 1969, p. 13-17.) *Strength of Materials,* Aug. 1969, p. 125-129. Translation.

Examination of the fatigue strength and durability of model gas turbine engine blades subjected to stress conditions simulating actual operating conditions. A study is made of model gas turbine engine blades made of ZhS6-K alloy steel, making it possible to reproduce, during fatigue strength tests, the tensile stresses from centrifugal loads in the model cross section. The testing procedure is described in detail. It consists in subjecting two groups of model blades heated to temperatures up to 900 deg C by a gas stream or in an electric furnace and subjected simultaneously to an asymmetric load cycle, the mean tensile strength of which is equal to 20 kgf/sq mm. The results obtained are discussed. O.H.

A70-38469 **Typical cases of failure and formation of defects in gas turbine discs.** T. K. Bragina (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR). (*Problemy Prochnosti,* vol. 1, Aug. 1969, p. 78-82.) *Strength of Materials,* Aug. 1969, p. 196-199. Translation.

Review of typical causes of failure of gas turbine disks made of alloys EI437B, EI437BU, EI437BUVD, and EI481 steel. A statistical analysis of the causes of failure is presented for the years 1961 to 1964. The effect of improved methods of fabrication on the reliability of gas turbine disks is stressed. Z.W.

A70-38474 **Flow noises (Strömungsgeräusche).** Manfred Heckl. *VDI-Z Fortschritt-Berichte, Reihe 7 - Strömungstechnik,* no. 20, Oct. 1969. 224 p. 170 refs. In German.

Review of the various mechanisms of occurrence and forms of manifestation of flow noises. Among the noises considered are discharge noises; propeller, ventilator, jet engine, boundary layer, and water pipe noises; and the noise generated by supersonic aircraft. Insofar as possible an attempt is made to present empirical formulas for the noise outputs and frequencies to be expected. Theoretical aspects of flow noises are treated, making extensive use of the Fourier transform method starting from the basic hydrodynamic equations. This method is shown to be very suitable for the calculation of noise energies and outputs and works very well in cases where sonic excitation of plane elastic structures (plates) is to be determined. With the aid of this method the sonic excitation can be determined, without too much difficulty, in terms of simple stationary or moving sound sources. The behavior of resonators in the vicinity of sound sources is also discussed. A.B.K.

A70-38475 **Calibration tests in the ILTUB transonic wind tunnel (Eichversuche im ILTUB-Transonic-Windkanal).** Uwe Ganzer (Berlin, Technische Universität, Berlin, West Germany). *VDI-Z Fortschritt-Berichte, Reihe 7 - Strömungstechnik,* no. 22, Mar. 1970. 49 p. 11 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

Description of calibration measurements performed in the

ILTUB (Institut für Luftfahrzeugbau der Technischen Universität Berlin) transonic wind tunnel in the Mach number range from 0.35 to 1.40 with two- and four-sided perforation of the measurement section. The pressure distributions along the surface of a 20-deg spherical cylindrical model were measured for six different Mach numbers, and the results are compared with interference-free values. Three-component measurements were carried out with two calibration models with choke ratios of 0.7 and 1.6%, respectively. Additional three-component measurements were carried out with five intact symmetrical wings characterized by rectangular, trapezoidal, sweptback, delta, and parabolic planforms, and the results are compared with experimental measurements obtained elsewhere for the same models and with theoretical values. A.B.K.

A70-38484 # **Linear theory of sonic booms (Liniowa teoria wybuchów dźwiękowych).** Andrzej Biestek. *Postępy Astronautyki,* vol. 4, no. 1, 1970, p. 39-54. 16 refs. In Polish.

Analysis of shock wave propagation in the case where the shock waves intersect each other. Equations describing the intensity of sonic booms caused by aircraft are derived in simplified form, together with equations for the intensity of interferential sonic booms. The attenuation of sonic boom intensity in the course of propagation is examined. T.M.

A70-38498 Shot peening wing panels for the 747. John Straub (Wheelabrator Corp., Buffalo, N.Y.). *Manufacturing Engineering and Management,* vol. 64, June 1970, p. 27-29.

Description of the shot peening process used to stress the surfaces of the Boeing 747's skin panels while simultaneously inducing curvature in some of the panels. The design and construction of the shot peening machine are described. As principal reasons for shot peening, increased resistance to fatigue failure and corrosion cracking are indicated. Special attention is given to process control techniques and operational requirements. Z.W.

A70-38500 Cooling it - The light aircraft, that is. Richard N. Aarons. *Business and Commercial Aviation,* vol. 26, June 1970, p. 66-69.

Discussion of some ideas and devices for installing air conditioning in piston-powered aircraft. The types of the vapor-cycle air conditioners used in light aircraft are reviewed. New cryogenic systems using supercold liquid nitrogen are indicated as a possible answer to weight and power drawbacks of vapor-cycle coolers. Z.W.

A70-38514 International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970. 320 p. $16.80.

Contents:

Flight test data systems.

A rational approach to the acquisition of flight data. P. L. Lewis (Aeroplane and Armament Experimental Establishment, Boscombe Down, Wilts., England), p. 1.1-1.5.

The influence of new techniques and components on the design of instrumentation recorders. M. A. Perry, H. M. Harrison, and L. H. Barrett (S.E. Laboratories, Ltd., Wells, Somerset, England), p. 2.1-2.11. 5 refs.

Recovery and processing of flight test and other airborne data. F. Goatcher (Plessey Co., Ltd., Havant, Hants., England), p. 3.1.

Developments in airborne crash recorders. C. Vatinelle (Société d'Instrumentation Schlumberger, Paris, France), p. 4.1-4.22.

Transducer developments (A).

Pressure measurements for launch and re-entry vehicles. E. J. Angelo (Dynasciences Corp., Chatsworth, Calif.), p. 5.1-5.5.

Solid state digital type pressure transducer. J. Intraub and E. H. Kahn (Kollsman Instrument Corp., Elmhurst, N.Y.), p. 6.1-6.12.

Design of a Piezoresistive silicon pressure transducer for air data computing. D. B. Pegg (Smiths Industries, Ltd., Aviation Div., Cheltenham, Glos., England) and W. Thorp (Ferranti, Ltd., Manchester, England), p. 7.1-7.5.

A calibrator for heat flowmeters. P. E. Burry (Royal Aircraft Establishment, Farnborough, Hants., England), p. 8.1-8.5.

Development and refinement of an ultraminiature pressure transducer and application to airplane model and airplane subsystem testing in wind tunnels. J. C. Kicks (Boeing Co., Seattle, Wash.), p. 9.1-9.18.

Flight vibration recording and analysis.

Functions and composition of data processing system used for analysis of random processes registered during flight tests. Z. A. Pavlova (Russian Flight Test Institute, USSR) and V. N. Iakovlev, p. 10.1-10.9.

The requirements for a vibration monitoring system. A. R. Jones (Ultra Electronics, Ltd., London, England), p. 11.1-11.7.

A new system for vibration signals analysis. F. R. C. Murtin (Société Industrielle d'Electronique et d'Informatique, Paris, France), p. 12.1-12.9.

A reliable high temperature transducer for engine vibration measurement. R. Hatschek (Vibro-Meter, S.A., Fribourg, Switzerland) and G. Schofield (Vibro-Meter, Ltd., Manchester, England), p. 13.1-13.6. 5 refs.

Modern methods of real time analysis of vibration data. J. P. Millward (A.E.P. International, Ltd., Staines, Middx., England), p. 14.1-14.6.

Signal conditioning with differential data amplifiers. C. J. Brown (Dana Electronics, Ltd., Luton, Beds., England), p. 15.1-15.9.

American flight test data systems.

The American approach to the solution of current flight test problems. S. C. Roberts and L. J. Mertaugh (Mississippi State University, State College, Miss.), p. 16.1-16.4.

The 747 flight test data system. W. J. Irwin (Boeing Co., Seattle, Wash.), p. 17.1-17.13.

Digital data acquisition system for CF-5A testing. R. J. Turfus (Canadian Armed Forces, Ottawa, Canada), p. 18.1-18.6.

Catapult analogue data acquisition system complete and portable. E. Lynn (U.S. Naval Air Engineering Center, Scientific Measurements Office, Philadelphia, Pa.) and D. Johnson (Datacraft, Inc., Gardena, Calif.), p. 19.1-19.5.

The Anglo-French Jaguar instrumentation data system by S.E.P.E.C.A.T.

The Jaguar. D. R. H. Dickinson (British Aircraft Corp., Ltd., Preston, Lancs., England), p. 20.1, 20.2.

Flight tests instrumentation of the Anglo-French aircraft Jaguar - SEPECAT. J. P. Bussenot (Breguet Aviation, Velizy-Villacoublay, Yvelines, France), p. 21.1-21.8.

The Anglo-French Jaguar flight test data processing systems. S. Allcock and M. L. Henney (British Aircraft Corp., Ltd., Preston, Lancs., England), p. 22.1-22.7.

Evolution of the test installation and the systems of data treatment of Jaguar. B. J. Sigaud (Dassault-Breguet, France), p. 23.1-23.5.

Transducer developments (B).

Further developments in transducers for instrumentation systems. F. E. Duffield (Ether Engineering, Ltd., Bushey, Herts., England), p. 24.1-24.11. 11 refs.

Multi-axis clusters of single-axis accelerometers with coincident centers of angular motion insensitivity. V. B. Corey (United Control Corp., Redmond, Wash.), p. 25.1-25.17.

Development and testing of a triaxial angular accelerometer for high-performance aerospace vehicles. R. D. Evans, Jr. (NASA, Flight Research Center, Edwards, Calif.), p. 26.1-26.11.

Flight-testing the high-sensitivity ONERA accelerometer. M. Delattre and J. Bouttes (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 27.1-27.12.

Automatic test equipment.

The systems approach in automatic test equipment. K. Brewster (Elliott Flight Automation, Ltd., Rochester, Kent, England), p. 28.1-28.6.

Automatic testing of complex aircraft. A. G. Hayes (British Aircraft Corp., Ltd., Stevenage, Herts., England), p. 30.1-30.7.

Testing avionic systems automatically - The economics scope and essentials. A. H. Parker (Hawker Siddeley Dynamics, Ltd., Hatfield, Herts., England), p. 31.1-31.8.

European flight test data systems.

Concorde flight test instrumentation. T. T. Walters (British Aircraft Corp., Ltd., Filton, Bristol, England), p. 32.1-32.22.

The data collection system for the prototype flight tests of the Fokker F-28 Fellowship. A. Pool (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands), p. 33.1-33.10.

The Emmanuel airborne magnetic recording system. A. Klopfstein (Centre d'Essais en Vol, Brétigny-sur-Orge, Essonne, France), p. 34.1-34.8.

Aeroelastic test equipment for the 'Concorde' S.S.T. G. Piazzoli (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 35.1-35.8.

The digital magnetic tape instrumentation system used for flight development of the Hawker Siddeley Harrier. I - The aircraft installation. P. D. Betteridge (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England), p. 36.1-36.8.

The digital magnetic tape instrumentation system used for flight development of the Hawker Siddeley Harrier. II - Ground station. P. W. Wreford-Bush (Hawker Siddeley Aviation, Ltd., Dunsfold Aerodrome, Surrey, England), p. 36.9-36.14.

A70-38518 **Developments in airborne crash recorders.** Claude Vatinelle (Société d'Instrumentation Schlumberger, Paris, France). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society, and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 4.1-4.22.

Discussion of airborne crash recorders taking into consideration their objectives, design, and special features introduced in order to ensure the crash survival of the recordings. Accident recorder design is discussed and the magnetic tapes used are considered. New advances regarding digital flight recorders are examined. The design of a maintenance recorder is described and some details concerning recorder applications are described. G.R.

A70-38523 **Development and refinement of an ultra-miniature pressure transducer and application to airplane model and airplane subsystem testing in wind tunnels.** J. C. Kicks (Boeing Co., Seattle, Wash.). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 9.1-9.18.

The Electrodynamics Technology/Instrumentation Unit of The Boeing Company's Commercial Airplane Group and Kulite Semiconductor Products, Incorporated, have developed and refined an ultraminiature pressure transducer for airplane model and airplane subsystems (particularly the inlet/engine subsystem), testing from 1967 to 1970. This effort included design, calibration, environmental investigation, modification to basic units, protective devices, and application of instruments to significant tests. (Author)

A70-38525 **The requirements for a vibration monitoring system.** A. R. Jones (Ultra Electronics, Ltd., London, England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, Mar 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 11.1-11.7.

Discussion of the vibration monitor, a comparative newcomer to the flight deck instrumentation of modern airliners. The onset of a relatively small primary failure in an engine can often be sensed as a positive increase in the vibration level at a suitably located transducer well before the crew are alerted by other parameter changes or actual physical vibration is noticed. Generally two transducers, either velocity coil or piezoelectric, are required for compressor and turbine area monitoring, but installations with only one centrally mounted transducer are proving quite successful in detecting blade failure in both areas, and a variety of miscellaneous defects of isolated nature. With all systems it is essential to eliminate, as far as possible, all spurious signals from noise sources such as earth loop currents, bulkhead connectors, and electric and magnetic fields. F.R.L.

A70-38527 **A reliable high temperature transducer for engine vibration measurement.** R. Hatschek (Vibro-Meter, S.A., Fribourg, Switzerland) and G. Schofield (Vibro-Meter, Ltd., Manchester, England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 13.1-13.6. 5 refs.

The technical and physical possibilities in creating a reliable high temperature transducer for engine vibration monitoring are discussed, for example: The mechanical design problems of piezoelectric accelerometers. The crystallographic considerations for evaluating a suitable piezoelectric material for the difficult environment of modern jet engines. The performance of the transducer resulting from this research work is described. (Author)

A70-38528 **Modern methods of real time analysis of vibration data.** J. P. Millward (A.E.P. International, Ltd., Staines, Middx., England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 14.1-14.6.

A description of the techniques used to obtain real time narrow band spectrum analysis and the expansion of these techniques to

perform auto and cross correlation, PSD, auto and cross PSD, system transfer function, etc. Also covers some of the many applications of this equipment in flight testing, failure prediction, and wind tunnel testing. (Author)

A70-38530 The American approach to the solution of current flight test problems. Sean C. Roberts and Larry J. Mertaugh (Mississippi State University, State College, Miss.). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 16.1-16.4.

Discussion of the management, instrumentation, flight test techniques, and data analysis of flight tests. It is concluded that flight test program time compression can be achieved by the use of extensive management techniques to effectively manage a multiaircraft flight test program in a number of locations, simultaneously. Program length and costs are the primary criteria with time being most important for commercial transports, and cost the most important factor for research flight testing and general aviation aircraft certification. Z.W.

A70-38531 The 747 flight test data system. Ward J. Irwin (Boeing Co., Seattle, Wash.). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 17.1-17.13.

The data system used by Boeing to flight test the 747 transport airplane is presented. General system characteristics are outlined briefly, followed by a more detailed discussion of the recording media, the major PCM and FM tape systems, and a number of special purpose airborne systems. Features of the airborne equipment which allow monitoring of the data for assurance of validity and for test management purposes are explained. The ground station, which includes quick look facilities and digitizing equipment to format data for computer entry, is described. The large computer which processes the final flight test data and performs several filekeeping functions also is discussed. Figures illustrate the size of the system, the relationships among various components, and the operation of major portions of the airborne recording system and ground station. (Author)

A70-38532 Digital data acquisition system for CF-5A testing. R. J. Turfus (Canadian Armed Forces, Ottawa, Canada). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 18.1-18.6.

The Avionics Development Section of the Aerospace Engineering Test Establishment (AETE) has designed and constructed a Digital Data Acquisition System for the CF-5A Flight Test Program. Experience with the first system has led to a design of a succeeding unit to overcome the difficulties and restrictions encountered initially. The second system is being designed as the recording system for almost all flight test projects at our Establishment. This presentation will outline the design and development of the first recording system, indicating the problem areas and the things to be changed or added in the second version. (Author)

A70-38533 Catapult analogue data acquisition system complete and portable. Edward Lynn (U.S. Naval Air Engineering Center, Scientific Measurements Office, Philadelphia, Pa.) and Dick Johnson (Datacraft, Inc., Gardena, Calif.). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 19.1-19.5.

Description of a portable analogue instrumentation data acquisition system employed for accomplishing catapult and arresting gear test investigations aboard aircraft carriers and at land-based facilities. This system has 18 channels, minimum size and weight, utilizes integrated circuitry, and is suitably packaged for aircraft shipment. Z.W.

A70-38534 The Jaguar. D. R. H. Dickinson (British Aircraft Corp., Ltd., Preston, Lancs., England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 20.1, 20.2.

As a prelude to the papers on the instrumentation methods used for the Jaguar flight trials, a résumé is given of the origins of this Anglo-French project, and the manner in which the tasks involved are divided between the two participating countries. An outline is given of the aircraft itself and the flight development arrangements. (Author)

A70-38535 Flight test instrumentation of the Anglo-French aircraft Jaguar - SEPECAT. J. P. Bussenot (Breguet Aviation, Velizy-Villacoublay, Yvelines, France). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society, and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 21.1-21.8.

Description of the characteristics of the airborne magnetic recording flight test instrumentation system of the Anglo-French Jaguar aircraft. Detailed features are presented of the design, development, and operation of the SFIM-Damien recording system which receives and stores on magnetic tapes, in digital form, the data obtained during the flight with a view to subsequent analysis on computer. A brief description of the characteristics of a digital crash recorder which complements the instrumentation of the aircraft is also presented. Finally, some modifications of the Damien system necessitated by the British prototype of Jaguar aircraft are outlined. O.H.

A70-38536 The Anglo French Jaguar flight test data processing systems. S. Allcock and M. L. Henney (British Aircraft Corp., Ltd., Preston, Lancs., England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 22.1-22.7.

The Flight Test Data Processing organization employed during the Anglo-French Jaguar Programme is outlined, and the systems employed in the United Kingdom are briefly described. The application of a small general purpose digital computer to Flight Test digital data processing is detailed and discussed. This paper is one of a series about Jaguar Flight Test to be presented by S.E.P.E.C.A.T. at the 6th International Aerospace Instrumentation Symposium, Cranfield, in 1970. The reader is particularly referred to other papers in the series for descriptions of the airborne instrumentation. (Author)

A70-38537 Evolution of the test installation and the systems of data treatment of Jaguar. B. J. Sigaud (Dassault-Breguet, France). In: International Aerospace Instrumentation Symposium,

6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 23.1-23.5.

Description of the development and operation of the SFIM digital magnetic tape recording system for flight tests of the Jaguar aircraft. Following a review of the system objectives, the principles of data treatment are explained in detail. In addition, several reflections, inspired by the development and handling of this system, are proposed. It is demonstrated that the system gives the satisfactory results that were to be expected. O.H.

A70-38543 Automatic testing of complex aircraft. A. G. Hayes (British Aircraft Corp., Ltd., Stevenage, Herts., England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 30.1-30.7.

After a decade of application in the avionics industry, Automatic Test Technology can now be applied to most of the avionics systems carried by modern aircraft and many descriptions are available of the different equipments available. The present paper is concerned with the 'why' rather than the 'how' of automatic testing. It looks at the justification for using ATE and how the advantages resulting from its use need to be weighed against the total costs involved. It concludes that significant reductions in the overall costs of testing can often be achieved. (Author)

A70-38544 Testing avionic systems automatically - The economics scope and essentials. A. H. Parker (Hawker Siddeley Dynamics, Ltd., Hatfield, Herts., England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society, and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 31.1-31.8.

Continued expansion in the use and complexity of avionic equipment imposes an ever increasing problem of testing and maintenance on both the manufacturer and the user of such equipment. Automatic means for testing can to a large degree solve this problem by increasing the speed and reliability of the testing method thereby reducing the cost of maintenance. The majority of work in the automatic testing field has to date been concentrated in areas of application in which the devices to be tested are complex and expensive, the primary field of applications and endeavour being military and civil avionics. The next two years are considered to be of vital importance to the automatic testing field in general. While equipments which have been introduced into operational service in the past have shown significant cost benefits, the industry depends heavily on suppliers and customers recognizing certain practical difficulties which have been exposed by previous applications. Steps have to be taken to prevent the recurrence of these difficulties if the full benefits of automatic testing are to be fully realized in the coming years. (Author)

A70-38545 Concorde flight test instrumentation. T. T. Walters (British Aircraft Corp., Ltd., Filton, Bristol, England). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 32.1-32.22.

The paper describes the equipment used for flight data recording in the Concorde prototype 002. It makes particular reference to the digital system which is used for the recording of quasi-static parameters. The major developments in the instrumentation for the preproduction aircraft are also described. (Author)

A70-38546 The data collection system for the prototype flight tests of the Fokker F-28 Fellowship. A. Pool (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings.
Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 33.1-33.10.

After a short history on the application of digital recording for flight testing in the Netherlands and a short description of the first digital system (used in a DC-8 aircraft of KLM) the data collection system for the Fokker F-28 prototype is described. Some details on the data processing are also given. (Author)

A70-38547 The Emmanuel airborne magnetic recording system. Alain Klopfstein (Centre d'Essais en Vol, Brétigny-sur-Orge, Essonne, France). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 34.1-34.8.

Description of the present state of development of the Emmanuel magnetic recording system to be used for in-flight tests of aeroplanes and systems and, more especially, airborne digital computers. The system is characterized by a wide variety of input parameters, an extreme precision in analogue data coding, and a considerable flexibility of use due to its programmable structure. After a general description of the system and its programming support, the problems of implementation are considered, and conclusions are drawn from its first use. O.H.

A70-38548 Aeroelastic test equipment for the 'Concorde' S.S.T. G. Piazzoli (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: International Aerospace Instrumentation Symposium, 6th, Cranfield, Beds., England, March 23-26, 1970, Proceedings. Symposium sponsored by the Cranfield Institute of Technology, the Royal Aeronautical Society, and the Instrument Society of America. Stevenage, Herts., England, Peter Peregrinus, Ltd., 1970, p. 35.1-35.8.

For the fixed parts of the structure the harmonic method has been chosen. 19 seismic electromagnetic shakers, of four different types, are located in various parts of the aircraft. The appropriation in flight of the vibratory modes is programmed, as well as the sequence of the test phases. For the control surfaces the impulse excitation method has been preferred. 10 impulse generators, of 4000 to 6000 newton thrust and of adapted burning duration, are installed within fairings, in the plane of the control servodynes. The safety and reliability constraints have led to qualify all the equipment on a test bench and on a dynamic balance, with a thorough simulation of the structure elastic characteristics and of the most severe environment to be encountered. The data are processed in the laboratory from magnetic recordings thanks to an automatic analogue equipment. (Author)

A70-38594 Assurance of integrity in modern adhesive bonded structures. M. G. Rumbaugh, R. D. Lawrence, R. E. Clemens, and E. G. Brewster (Northrop Corp., Hawthorne, Calif.). In: The expanding world of reliability; American Society for Quality Control, Annual West Coast Symposium, 11th, Los Angeles, Calif., May 15, 1970, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1970, p. 1-19. 5 refs.

Description of the methods and requirements for establishing

and controlling the manufacture of adhesive bonded aircraft structures. Preproduction control activity is reviewed including design consideration, material selection and qualification, process parameters, inspection requirements, and training and certification of personnel. The development of NDT techniques and requirements is examined. Special attention is given to the prototype development, periodic requalification, and evaluation of deficient product. Z.W.

A70-38610 Some objectives and problems associated with model testing. I. A. Simons (Westland Helicopters, Ltd., Yeovil, Somerset, England). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, July 1970, p. 539-548. 18 refs.

Discussion of model testing for helicopters taking into consideration model scaling, ditching tests and rotor testing. Scaling factors for important parameters are investigated and model rotors for wake investigations are considered. The testing of rotor performance is discussed and rotor blade aerofoil section characteristics are examined. Graphs showing aerofoil section operating conditions are presented. G.R.

A70-38611 The use of a runway vehicle for testing lifting rotors in simulated forward flight. M. C. G. Smith (National Gas Turbine Establishment, Farnborough, Hants., England). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, July 1970, p. 548-559.

Study of the feasibility of using a runway test vehicle for measuring the performance of a lifting rotor in simulated forward flight taking into consideration some disadvantages compared to wind tunnel testing. The feasibility of using a runway test vehicle for these investigations has been demonstrated. It is possible to cover a reasonably wide range of forward speeds, right down to hover, and a runway bump isolation system has facilitated a full range of measurements including rotor transients. It is found that in most cases the rate of production of test point data is less than with a wind tunnel, but this is offset to a considerable extent by reduced operating costs, since the capital investment in a vehicle is only a small fraction of that in a modern wind tunnel. G.R.

A70-38612 Structural testing, testing philosophy and loads prediction for rotary wing vehicle components. Lee C. Cowgill (Lockheed-California Co., Burbank, Calif.). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, July 1970, p. 559-572. 11 refs.

Discussion of some facets of the structural testing methods and philosophy along with some aspects of the loads prediction procedures used at the Lockheed-California Company during the development of the AH-56A Cheyenne Compound Helicopter for the U.S. Army. Aspects of service life assurance are discussed taking into consideration mission analysis, condition lists, and probability distributions. Condition selection, detail loads calculation, and spectra determination are considered in connection with loads prediction. Test selection criteria and truncation practices are examined and load schedule, loading sequences, and test equipment are discussed. Reduction factors, aspects of comparison with past practice, and equivalent test life are considered in an interpretation of test results. G.R.

A70-38613 The role of flight recording in aircraft accident investigation and accident prevention. R. G. Feltham (Board of Trade, Civil Aviation Div., London, England). *Aeronautical Journal,* vol. 74, July 1970, p. 573-576.

Summary of the present role of the flight recorder in relation to the investigation of aircraft accidents giving briefly attention to the future role of the flight recorder and to its potential for flight safety monitoring. Aspects of the development of flight recording are considered and the need for accident data recording is investigated. The importance of performance monitoring to provide data which may assist in accident prevention and improve flight safety is discussed. G.R.

A70-38614 Shock-wave radiation from a supersonic ducted rotor. C. L. Morfey and M. J. Fisher (Southampton, University, Southampton, England). *Aeronautical Journal,* vol. 74, July 1970, p. 579-585. 10 refs.

Analysis of the rotor pressure field and sound power output under supersonic conditions giving attention to the blade-passing harmonic content of the frequency spectrum. The rotor blades are assumed to be identical and equally spaced. Three-dimensional effects are neglected and the rotor with its duct is replaced by a two-dimensional model. The equivalent two-dimensional rotor is arranged so that its pressure field propagates under the same conditions as the pressure field of the actual rotor. G.R.

A70-38615 Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings giving low lift-dependent drag. G. W. Shaw (Belfast, Queen's University, Belfast, Northern Ireland). *Aeronautical Journal,* vol. 74, July 1970, p. 586-589.

Investigation of the aerodynamic effects at low speeds of the addition of thickness to one surface of a cropped delta plate giving particular attention to effects on the growth of the leading-edge vortex and on drag. The thickness distributions have been chosen so that large benefits might be obtained from this all-wing airbus, which must have low profile drag and low lift-dependent drag in order to compete economically with an aircraft of orthodox layout. G.R.

A70-38616 An improved blade root design for axial flow compressors (and turbines). H. Shaw (National Gas Turbine Establishment, Engine R & D Branch, London, England). *Aeronautical Journal,* vol. 74, July 1970, p. 589-594.

Discussion of a logical procedure whereby severe concentrations of tensile stress can be avoided both in the root fixing of a high duty compressor blade and in the inner sections of the aerofoil itself. A useful additional benefit is that the elasticity of the combined blade and root has been arranged to oppose aerodynamic flutter. Any increment of blade bending deflection is accompanied by a negative increment of blade incidence so that a work input cycle operates to oppose any vibratory motion of the blades. A compressor blade which incorporates these features in its root design has been running successfully. G.R.

A70-38618 Military aircraft market research. Janet Gulland (British Aircraft Corp., Ltd., London, England). *(Royal Aeronautical Society, All-Day Symposium on Value for Money, London, England, Apr. 1, 1968.) Aeronautical Journal,* vol. 74, July 1970, p. 603-607.

Discussion of approaches to determine the export market for military aircraft giving attention to the difficulties inherent in military aircraft market research. The division of the air forces of the world into roughly three groups is considered and selling conditions to countries of each of these groups are examined. Export figures for a number of aircraft types are examined. An individual approach is discussed, in which each country is studied separately in terms of its economic growth, defense and air force budgets, replacement timescales, likely military commitments, and known requirements. G.R.

A70-38621 Development of the Bendix/Air Equipment RDR-IDM radar as an approach aid for helicopters. R. J. van der Harten (KLM Noordzee Helikopters N.V., Amsterdam, Netherlands). *Aeronautical Journal,* vol. 74, July 1970, p. 618-621.

Discussion of the development of a radar approach aid for KLM Noordzee Helikopters which exists primarily to serve North Sea oil

rigs. The approach procedure was developed as a shared responsibility between Captain and first officer. Approaching an oil rig the primary identification is made by reference of radar pattern to ADF/Decca, and rig position information. The various steps in the approach procedure are described. G.R.

A70-38629 Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970. 349 p.

Contents:

Opening address. L.-E. Nordström, p. 1-3.

General aspects on ATC.

Some remarks on the work within ICAO on ATS development. J. O. Olsson (Swedish Board of Civil Aviation, Bromma, Sweden), p. 4-10.

IATA policy on the future development of ATS. K. E. Karwath (Deutsche Lufthansa AG, Hamburg, West Germany), p. 11-18.

ATC and general aviation. J. B. Hartranft, Jr. (International Council of Aircraft Owner and Pilot Associations, Washington, D.C.), p. 19-25, 27-29.

The development of IFALPA's views on air traffic services, with special reference to what we have learned from the North Atlantic airways. W. Masland (International Federation of Air Line Pilots Associations, London, England), p. 31-41.

Some national ATC-systems.

ATC integration of the SST. J. M. Del Balzo (FAA, Brussels, Belgium), p. 43-53.

The United Kingdom National Control Services. D. P. J. Smith (National Air Traffic Control Services, Uxbridge, Middx., England), p. 55-69, 71-73.

ATC-automation in France from stage II to stage III - The method of the filters. J. Villiers, p. 75-99, 100-104.

Practical experience of civil/military coordination in air traffic control. C.-A. Johansson (Swedish Board of Civil Aviation, Bromma, Sweden), p. 105, 106.

ATC systems design and development.

Airport capacity - Consideration of some of the factors which determine the capacity of an airport and their effect on the layout of a high capacity airport. G. A. Champniss (British Airports Authority, London, England), p. 107-119, 121-124.

Operational analysis and the use of fast-time simulation models in ATC system development. P. Holden and R. J. Burford (General Precision Systems /ATM/, Ltd., London, England), p. 125-145, 147-153.

Simulation methods and techniques used at Brétigny. J. Nouhant (EUROCONTROL, Bretigny, France), p. 155-182.

System design and development of the EUROCONTROL Maastricht Upper Area Control Centre. H. F. von Villiez (EUROCONTROL, Brussels, Belgium), p. 183-199, 201-208.

Navigation and communications.

The operational aspects of airborne navigation systems in air traffic control. W. E. J. Groves (Decca Navigator Co., Ltd., London, England), p. 209-233. 7 refs.

EUROCONTROL's evaluation of navigation systems. D. D. Lipman (EUROCONTROL, Bretigny, France), p. 235-249.

Some thoughts on errors of navigation and air traffic control. N. R. Lord (Cranfield Institute of Technology, Cranfield, Beds., England), p. 251-261, 263-266.

On the feasibility of self-navigation in a future mass flow of air traffic. C. O. Olsson (Oltronix AB, Stockholm, Sweden), p. 267-272.

ATC technology.

Digital extraction of primary and secondary radar data. J. Seseman (Standard Radio and Telefon AB, Stockholm, Sweden), p. 273-289.

Displays in air traffic control. W. F. Ashton (Royal Radar Establishment, Malvern, Worcs., England), p. 291-300.

Technology of data handling and display for planning control. E. Priebee and C. van den Tweel (Hollandse Signaalapparaten, Hengelo, Netherlands), p. 301-313, 315-319.

Operational aspects of new ATC technology.

Management factors in reducing air traffic controller stress. A. M. Waldin (FAA, Brussels, Belgium), p. 321-328.

Human factors in ATC. V. D. Hopkin (RAF, Institute of Aviation Medicine, Farnborough, Hants., England), p. 329-339, 341-344.

The air traffic controller in the future air traffic system. G. Atterholm (International Federation of Air Traffic Controllers Associations, East Twickhenham, Middx., England), p. 345-350.

Training of ATC personnel for the new era. J. Wachtel (Air Traffic Controllers Association of Israel, Lod Airport, Israel), p. 351-356.

A70-38630 # IATA policy on the future development of ATS. K. E. Karwath (Deutsche Lufthansa AG, Hamburg, West Germany). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 11-18.

Discussion of the views of the IATA regarding improvements of the ATC system to handle expeditiously the increased air traffic of the future. It is believed that the prime requirement for a safe and expeditious ATC system is provision of controlled air space in which controllers can exercise the requisite jurisdiction for providing safety. This controlled air space should encompass the whole of the flight path from takeoff through the transition area to the top of climb, cover the cruising phase and the transition to the final approach path and naturally also the final landing maneuver. Methods and devices for implementing these aims are discussed. G.R.

A70-38631 # ATC and general aviation. J. B. Hartranft, Jr. (International Council of Aircraft Owner and Pilot Associations, Washington, D.C.). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 19-25, 27-29.

Discussion of the explosive growth of general aviation and of the ATC system which will cope with the demand. The increase in general aviation operations to almost triple expansion in the time from 1960 to 1968 is discussed and critical aspects of the ATC system in coping with the air traffic are examined. Additional runways and a 'quiet' engine are proposed for increasing airport capacity. It is believed that only a very small fraction of the potential capacity of the airspace is presently used, and the assignment of a 1000 foot stratum of air only 1-½ miles long by ½ mile wide for an aircraft is considered. Systems of ATC requiring full scale area navigation airborne equipment are discussed. Installation of a computer in the cockpit and better radars are predicted and a National Airspace System is described. G.R.

A70-38632 # The development of IFALPA's views on air traffic services, with special reference to what we have learned from the North Atlantic airways. W. Masland (International Federation of Air Line Pilots Associations, London, England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 31-41.

Discussion of present ATC systems and of recommendations for their improvement giving special attention to air traffic over the North Atlantic. The dimensions of air space reserved for an aircraft over the North Atlantic and the reasons for these dimensions are considered. A system of staggered tracks and an area cover navigational system with pictorial representation in the cockpit requiring less reserved air space for an aircraft are discussed. The occurrence of navigational errors is examined and recommendations for introducing a system which is highly accurate, reliable, simple to use and free from invitations to blunder are made. G.R.

A70-38633 # ATC integration of the SST. J. M. Del Balzo (FAA, Brussels, Belgium). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 43-53.

Discussion of new developments in ATC leading to an integrated, automated, and computerized system which is well equipped for handling the greatly increased air traffic of the future involving supersonic and subsonic flights. It is pointed out that the national airspace system of the next decade is being designed in two separate compatible modular programmable packages, an en route system and a terminal area project. The main features of the present ATC system, which is essentially a manual system, are examined. An initial major program intends to modernize this system by introducing a semiautomatic method. A fully automated system which will display data blocks of flight information on the controller's radar screen is discussed also taking into consideration an automatic handoff feature. A modular automation system to provide ATC facilities in the terminal areas is considered. The New York Common Instrument Flight Rules Room complex is described, advanced flow control procedures are examined, and ultra high ATC sectors are discussed. G.R.

A70-38634 # The United Kingdom National Control Services. D. P. J. Smith (National Air Traffic Control Services, Uxbridge, Middx., England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 55-69, 71-73.

Discussion of ATC services in the UK taking into consideration operational responsibilities, facilities, and personnel. The organization of ATC services in the UK is examined and operational responsibilities for the lower airspace, the middle airspace, and the upper airspace are considered. Aspects of the aerodrome traffic zone penetration service are investigated. The priorities of radar service, radar service classifications, and control facilities are discussed. The recruiting, training, and operational examining of personnel is considered. G.R.

A70-38635 # ATC-automation in France from stage II to stage III - The method of the filters. Jacques Villiers. In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 75-99, 100-104.

Discussion of ATC-automation in France taking into consideration an analysis regarding the most suitable method for solving the problems of ATC. The salient features of the present ATC system in France and aspects of its transition to more advanced systems are examined. Basic objectives of ATC are considered in order to obtain a basis for designing an ATC system which will be essentially characterized by the choice of the optimum processing method for the information stored in the computer. A method is proposed called the 'method of the filters' which is characterized by a successive filtering of the traffic in a first filter, a 'procedural filter,' a 'radar filter,' and an 'accident filter.' G.R.

A70-38636 # Airport capacity - Consideration of some of the factors which determine the capacity of an airport and their effect on the layout of a high capacity airport. G. A. Champniss (British Airports Authority, London, England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 107-119, 121-124.

Discussion of various factors which determine the capacity of an airport taking into consideration approaches for increasing airport capacity to cope with steadily increasing air traffic. The increase in air traffic is considered and problems arising from airport congestion are discussed. Airport runway capacity is investigated taking into consideration the necessity to reduce the period of runway occupancy to a minimum, and requirements for the taxiway system are investigated. The use of a mathematical model and computer simulation as a promising method of determining the capacity and the associated delay factors of an airport is proposed. Elements of surface access are examined and aspects of aircraft development in their relation to airport use considered. G.R.

A70-38637 # Operational analysis and the use of fast-time simulation models in ATC system development. P. Holden and R. J. Burford (General Precision Systems /ATM/, Ltd., London, England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 125-145, 147-153.

Discussion of simulation techniques for ATC system evaluation purposes and of analysis programs and simulation models in ATC system development. Four main ways for evaluating system performance are briefly considered. Real-time simulation and fast-time simulation are discussed. An air movement simulation model of a multiple airport TMA is described and the fundamental stages in the planning of the simulation study are investigated. A computer model and a critical event simulation program are considered. System demand analysis, height distribution analysis, spatial analysis, ATC analysis and conflict analysis are discussed, and the Hong Kong Runway Model, the Hong Kong Oceanic Control Model, the EUROCONTROL Upper Airspace Model, and the TMA and En-Route Airways Model are considered. G.R.

A70-38638 # Simulation methods and techniques used at Brétigny. J. Nouhant (EUROCONTROL, Experimental Centre, Bretigny, France). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 155-182.

Discussion of the use of simulation techniques for studying possible improvements of an ATC center and for ascertaining, a priori, the validity of long term plans taking into consideration work done at the EUROCONTROL Experimental Center at Brétigny. The

basic objectives of simulation are briefly considered and the Dynamic Air Traffic Simulator at Brétigny is described. The design and the functions of an Experimental Data Processor and Display System are considered. Preparation and conduct of exercises with the equipment are discussed. G.R.

A70-38639 # **System design and development of the EUROCONTROL Maastricht Upper Area Control Centre.** Hansjürgen Frhr. von Villiez (EUROCONTROL, Data Processing Div., Brussels, Belgium). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 183-199, 201-208.

Discussion of the operational objectives and the technical design criteria for the EUROCONTROL Upper Area Control Center Maastricht. The reasons for the creation of the new control center for the upper airspace in the Benelux-FRG region are discussed and the plans for meeting the requirements for optimum air traffic services are considered. The technical means to implement the operational concept are described taking also into account the design considerations for telecommunications. G.R.

A70-38640 # **The operational aspects of airborne navigation systems in air traffic control.** W. E. J. Groves (Decca Navigator Co., Ltd., London, England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 209-233. 7 refs.

Review of the operational aspects of airborne navigation systems, following an examination of the component parts of a modern navigational system and their functions. These components fall into the categories of navigational aids or sensors, a digital computer (the central data processor), and the cockpit displays and controls. The Omnitrac navigation system, the pictorial display design, and the functions of the Omnitrac computer are described. Attention is given to way-point selection, autopilot coupling, slant range and profile navigation, and malfunction checks. The Omnitrac systems design philosophy is discussed. The role of navigation in ATC, ATC system concepts, and existing ATC system trends are studied. The practical applications of area navigation are outlined, and a number of practical examples are cited. Economic benefits to the administrations responsible for the deployment of ground navigation facilities, and benefits to airlines in terms of savings in direct operating costs resulting from use of area navigation are considered. F.R.L.

A70-38641 # **EUROCONTROL's evaluation of navigation systems.** D. D. Lipman (EUROCONTROL, Experimental Centre, Bretigny, France). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 235-249.

Description of the preliminary evaluation of the performance of two new navigational aid systems for Air Traffic Control. In response to the provisional specification issued in 1961 by EUROCONTROL for the development of a new, improved navigational system for ATC, two new systems were proposed by the industry: the HARCO (Hyperbolic Area Coverage) system, giving hyperbolic basic information, and the VORDAC (VOR-DME for Area Coverage) system, giving basic information by azimuth and distance. To determine the accuracy and overall system reliability, a series of extensive preliminary tests of both systems was carried out by EUROCONTROL Agency. The tests are described and discussed in detail. An illustration of the type and order of the results achieved which, however, should not be regarded as definitive in any way, is also presented. O.H.

A70-38642 # **Some thoughts on errors of navigation and air traffic control.** R. N. Lord (Cranfield Institute of Technology, Cranfield, Beds., England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 251-261, 263-266.

Outline of the possibility of wholly strategic or wholly tactical ATC systems, and examination of the existing ATC complex as a feedback control system which depends for its success on the accuracy of navigational information. Attention is drawn to the fact that it depends on old information from which it must predict future positions. The time delays in this prediction decision-making technique are highlighted, and the dependence of ATC system design on knowledge of navigational errors is emphasized. The navigation error is analyzed to show that it comprises a positional (fixing) error onto which a dynamic error must be added, this latter error being time dependent and due to errors in heading, ground speed, etc. Data gathering, error analysis, and dangers of a mixed sample of observations which could mislead one into the wrong assumption of an error distribution pattern are discussed. The philosophy of the work on error synthesis currently being undertaken at the College of Aeronautics is outlined. Error distribution curves are discussed, together with observations as to the reason the Gaussian distribution appears to be falling into disrepute. The importance of the blunder in both error analysis and synthesis is demonstrated. M.M.

A70-38643 # **On the feasibility of self-navigation in a future mass flow of air traffic.** C. O. Olsson (Oltronix AB, Stockholm, Sweden). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 267-272.

Discussion of the aspects of abandoning the present-time rigid flow control of air traffic by replacing it by self-navigation. It is shown that the present Air Traffic Control system uses a surprising number of man hours on the ground in relation to the hours flown due to the concept that each airplane has to be controlled individually through an intermediary. As a result, a communication system may become stagnant or crippled unless long-range alternatives are found. It is suggested that, like in automobile and naval operations, individual control of each vehicle will have to be abandoned in favor of new techniques that would return separation control and much of the routing control to the pilot, while the controller's task would be raised to a higher level of flow control and 'management by exception.' O.H.

A70-38644 # **Digital extraction of primary and secondary radar data.** Jorg Seseman (Standard Radio and Telefon AB, Stockholm, Sweden). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings.
Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 273-289.

Suggestion that the air traffic control problem be solved by taking full advantage of modern data handling and computing techniques, and by introducing automatic equipment for the routine work, thus freeing the operators for special surveillance and control tasks. An equipment is described (the plot extractor) which converts the analog primary radar signals to digital form, detects the secondary surveillance radar (SSR) codes, and processes the radar signal information. The aim of this processing is to eliminate noise,

clutter, fruits (unsynchronous SSR replies caused by interrogations from another interrogator), and signal redundancy, and to extract target position information. The extractor output is suitable for direct input to a computer, a narrow-band transmission link, a PPI, or a recorder. F.R.L.

A70-38645 # **Displays in air traffic control.** W. F. Ashton (Royal Radar Establishment, Malvern, Worcs., England). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 291-300.

Discussion of the need for technological improvements in the design of strokes in a character to provide an ATC display which presents all the required information adequately within the limits of known technology. Some more general points on display requirements are dealt with, together with techniques being investigated to provide better, more flexible and hopefully cheaper displays. M.M.

A70-38646 # **Technology of data handling and display for planning control.** Erik Priebee and Cornelis van den Tweel (Hollandse Signaalapparaten, Hengelo, Netherlands). In: Swedish Society of Aeronautics and Astronautics, International Symposium on Air Traffic Control, Stockholm, Sweden, March 12-14, 1969, Proceedings. Stockholm, Swedish Society of Aeronautics and Astronautics, 1970, p. 301-313, 315-319.

Explanation of the Signaal Automatic Air Traffic Control System (SATCO) in use at Schiphol airport, considered to be a typical sample of a true-system design for flight plan processing. It is said to be possible to fulfill modern requirements by a multiprocessing, general-purpose, real-time micromin computer, the design of which includes the possibility of polymorphic operation with radar extractor primary and secondary radar application, micromin high speed electronic displays, and extensive software facilities. F.R.L.

A70-38651 **Physics of aerodynamic noise.** Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969. 151 p. $1.20.

Contents:

Foreword. A. V. Rimskii-Korsakov, p. 2, 3.

Study of the discrete components in the noise spectrum of an axial compressor. D. V. Bazhenov, L. A. Bazhenova, and A. V. Rimskii-Korsakov, p. 4-20. 6 refs.

The influence of air-intake wall design in an axial compressor on the propagation of sound. D. V. Bazhenov, L. A. Bazhenova, Iu. B. Kravchenko, and A. V. Rimskii-Korsakov, p. 21-45. 14 refs.

Experimental study of the effect of the surface roughness of a rod on the intensity and frequency of eddying sound. D. V. Bazhenov, L. A. Bazhenova, and A. V. Rimskii-Korsakov, p. 46-59.

The propagation of sound in a cylindrical tube with impedance walls in the presence of a flow. A. V. Rimskii-Korsakov and P. G. Kolev, p. 60-64.

The effect of the reaction of the medium on the operation of a radiator in a waveguide. A. D. Lapin and Iu. P. Lysanov, p. 65-72.

The radiation of a non-uniform elastic wall in a moving medium. A. D. Lapin, p. 73-83. 6 refs.

The pulsation of colliding axisymmetric oxidant and fuel gas jets. V. I. Kondrat'ev, p. 84-87.

The frequency characteristics of gas-jet stem radiators. Iu. Ia. Borisov and N. M. Glynkina, p. 88-99. 6 refs.

The supersonic air jet as a source of sound. V. M. Mainin and A. V. Rimskii-Korsakov, p. 100-107.

The noise frequency spectrum of a supersonic jet. T. Kh. Sedel'nikov, p. 108-113. 5 refs.

The discrete components of the noise frequency spectrum of a free supersonic jet. T. Kh. Sedel'nikov, p. 114-129. 7 refs.

The dispersion equation of a 2-dimensional ejector. L. I. Nazarova and T. Kh. Sedel'nikov, p. 130-137.

Dispersion equations for multi-layered jets and several jets. T. Kh. Sedel'nikov, p. 138-143.

A70-38652 # **Study of the discrete components in the noise spectrum of an axial compressor.** D. V. Bazhenov, L. A. Bazhenova, and A. V. Rimskii-Korsakov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 4-20. 6 refs.

The article examines the mechanism of formation of discrete components in the noise spectrum of the intake of an axial turbocompressor. It demonstrates the intrinsic dependence of the intensity of this noise on the relation between the numbers of blades of the guide vanes and the rotor disk. It shows that it is possible to reduce this noise by altering the distance between the disks and the inclination of the blades. (Author)

A70-38653 # **The influence of air-intake wall design in an axial compressor on the propagation of sound.** D. V. Bazhenov, L. A. Bazhenova, Iu. B. Kravchenko, and A. V. Rimskii-Korsakov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 21-45. 14 refs.

This article examines methods of simulating under laboratory conditions sound sources, which from their parameters are similar to sources existing in axial turbocompressors with guide vanes. Then it considers the propagation of such sound along a coaxial waveguide, similar according to its parameters to the air-intake of a turbocompressor. It studies the effect of resonators and active absorbent cladding on the attenuation of sound propagated along a waveguide. (Author)

A70-38654 # **Experimental study of the effect of the surface roughness of a rod on the intensity and frequency of eddying sound.** D. V. Bazhenov, L. A. Bazhenova, and A. V. Rimskii-Korsakov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 46-59.

The article considers the effect of different types of rough surface of a rod on the frequency and intensity of eddying sound, radiated by it when moving in air, and on its aerodynamic resistance. It describes tests on smooth cylindrical rods, covered with brass meshes or perforated brass tubing, as well as on rods with fluting milled on the surfaces (the rods were rotated by means of a 'club propeller' or 'squirrel cage'). (Author)

A70-38657 # **The radiation of a non-uniform elastic wall in a moving medium.** A. D. Lapin. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 73-83. 6 refs.

This article examines the sound field produced in the uniform moving stream of an ideal fluid by a nonuniform elastic wall, which is made to oscillate under the action of random forces. It is assumed that the properties of the wall are altered periodically. An investigation is made of the laws governing the variation in field characteristics as a function of the wall parameters, the motion of the medium and the properties of the statistical forces. (Author)

A70-38658 # **The frequency characteristics of gas-jet stem radiators.** Iu. Ia. Borisov and N. M. Glynkina. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 88-99. 6 refs.

The results are given in this article of an experimental study of the relation between the internal structure of a jet and the frequency of the sound vibrations generated by a generator depending on the geometric dimensions of its several basic elements: diameter of stem and jet, size of resonator, etc. (Author)

A70-38659 # **The supersonic air jet as a source of sound.** V. M. Mainin and A. V. Rimskii-Korsakov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 100-107.

Study of supersonic jet noise on the basis of tests with two nozzles which are different in size but have geometrically similar dimensions. The phenomena observed at the discharges from the large and the small nozzle were completely similar. The jet noise spectrum at various pressures is investigated. It is found that a supersonic jet from a nozzle is a source of sonic radiation of three different types. G.R.

A70-38660 # **The noise frequency spectrum of a supersonic jet.** T. Kh. Sedel'nikov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 108-113. 5 refs.

In this article a theoretical explanation is put forward for some peculiarities of the noise spectrum of supersonic jets. It is shown that it is possible to obtain the frequency of the maximum in the noise frequency spectrum of a hot supersonic jet by using the linearized equations of the acoustics of a moving medium. (Author)

A70-38661 # **The discrete components of the noise frequency spectrum of a free supersonic jet.** T. Kh. Sedel'nikov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 114-129. 7 refs.

In this article a theoretical explanation is put forward for the appearance of discrete components in the noise frequency spectrum of a jet. On the basis of analyzing the instability of the fluctuations of a plane and an axi-symmetric jet, the possibility is indicated of predicting the discrete components of the noise spectrum of a jet. (Author)

A70-38662 # **The dispersion equation of a 2-dimensional ejector.** L. I. Nazarova and T. Kh. Sedel'nikov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 130-137.

In the article a theoretical investigation is made into the question of the stability of the boundary of a 2-dimensional jet in a 2-dimensional ejector. A theoretical explanation is given of some peculiarities of the noise spectrum of a jet, flowing from a nozzle with an ejector. (Author)

A70-38663 # **Dispersion equations for multi-layered jets and several jets.** T. Kh. Sedel'nikov. In: Physics of aerodynamic noise. Edited by A. V. Rimskii-Korsakov. (Translation of Fizika Aerodinamicheskikh Shumov, Moscow, Izdatel'stvo Nauka, 1967.) Boston Spa, Yorks., England, National Lending Library for Science and Technology, 1969, p. 138-143.

Discussion of dispersion equations for determining the stability of the boundaries of multi-layered jets and several jets. A two-layered cylindrical infinite supersonic jet is considered, and the dispersion equations are derived. The case of an annular jet is investigated and the dispersion equation for a 3-layered jet is obtained. The dispersion equation for an infinite cylindrical jet and for two identical parallel jets is studied. G.R.

A70-38700 **Future polymer applications.** G. B. Gechele (Bologna, Università, Bologna, Italy) and F. Coccioli (Montecatini Edison S.p.A., Milan, Italy). *Contemporary Physics,* vol. 11, July 1970, p. 387-402.

Discussion of the principal features of polymers in the light of the recent advances in their development, and the fields of their future industrial application. After dealing with the main structure-to-property relations for plastic materials, the most important lines of development for polymers are outlined. As illustrations of this concept, several examples of short-range application are given, subdivided into different industrial sectors. They include applications as new textiles, building materials, furniture parts, in aviation, in the automobile industry, and in packaging. In addition, a brief review of working and forming plastics is presented. O.H.

A70-38722 **Radiation of sound and excitation of sound in solid bodies by vortices (Schallabstrahlung und Körperschallanregung durch Wirbel).** B. Stüber (Müller-BBN, Munich, West Germany). *Acustica,* vol. 23, no. 2, 1970, p. 82-92. 10 refs. In German. Research supported by the Bundesministerium der Verteidigung.

The present work describes a method which allows the investigation of radiation from simple flow fields produced by vortices and also the calculation of the sound waves excited in a plane, infinite plate which is situated near the flow field. The knowledge of the trajectory and 'life-history' of the vortices is necessary for this method. Quantitative calculations have been made for the single two-dimensional vortex filament, for a pair of two-dimensional, spinning vortices, for the collision of two straight lines of parallel vortex filaments with a wall and for the bound vortices which appear on the wings of a propeller together with the hub and tip vortices. (Author)

A70-38800 # **Electrization of aircraft in clouds and precipitations (Elektrizatsiia samoletov v oblakakh i osadkakh).** I. M. Imianitov. Leningrad, Gidrometeoizdat, 1970. 212 p. 123 refs. In Russian.

Meteorological conditions accompanying the electrization of aircraft in clouds and precipitation are examined for subsonic flight velocities. The text is based mainly on laboratory research concerning the electrical properties of the free atmosphere. The physical processes leading to the onset of an electrical charge on the aircraft are analyzed, and the pattern of static electrization for bodies immersed in a flow of particles is explained. A relation is established between the electrical charge on the aircraft and the parameters of clouds. Experimental data are given for charge levels under various meteorological conditions. Problems which arise due to electrization are surveyed, including the disturbances in flight measurements and communication, danger of lightning strikes, and adverse effects on

flight dynamics. The electrical currents acting on the aircraft are classified according to source, effects, and discharge mechanisms. Methods of reducing the charge and the associated disturbances are briefly outlined. T.M.

A70-38805 Bearing retainer material for modern jet engines. Paul F. Brown (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Lubrication Engineers, Annual Meeting, 25th, Chicago, Ill., May 4-8, 1970, Preprint 70 AM 2D-1.* 12 p. Members, $0.75; nonmembers, $1.50.

Modern jet engines require bearing retainers that can provide reliable service under stringent and unusual conditions. In current commercial transports, these engines commonly operate at 1.5 x 10 to the 6th power DN for 12000 hours or more between overhauls, and in military applications, the cage and bearings are required to retain its integrity when the oil is lost for up to one minute while at full power. Standard bronze retainers with lead plate over silver plate have proven inadequate to meet these requirements. To find a more suitable retainer, candidate cage materials and coatings were evaluated in a test rig simulating engine conditions. A silver plate AMS 6415 cage material was found capable of surviving a program which comprised 50, one minute, oil cutoff cycles. An additional program was conducted to optimize the Ag-plate coating thickness which was established as being 0.001 to 0.002-inches thick. Subsequent engine evaluation of this silver plated steel retainer verified the rig test results. This material combination is now used in production engines in both commercial and military aircraft.(Author)

A70-38815 Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970. 687 p. Members, $25.; nonmembers, $35.

Contents:

A routine Bayesian assessment and modification of prediction. T. L. Salt (General Electric Co., Cincinnati, Ohio), p. 20-28.

On the use of prior distributions in acceptance sampling. R. G. Easterling (Sandia Laboratories, Albuquerque, N. Mex.), p. 31-35.

A risk analysis procedure for calculating failure rates vs time. D. G. Ebeling (General Electric Co., New York, N.Y.), p. 36-45.

Mariner '69 testing and flight results. M. T. Goldfine (California Institute of Technology, Pasadena, Calif.), p. 48-62.

Skylab test program - Management and requirements. H. P. Wong (NASA, Washington, D.C.) and J. B. Meyer (General Electric Co., New York, N.Y.), p. 63-74.

All-weather automatic landing system development and testing. D. R. Clifford (Boeing Co., Seattle, Wash.), p. 75-81.

Interpretation of test data by design margin techniques. H. Hecht (Aerospace Corp., El Segundo, Calif.), p. 107-111.

S-65-200 Commercial Compound Aircraft design for maintenance. A. C. Veca (United Aircraft Corp., Stratford, Conn.), p. 113-122.

Design of helicopter transmission for 'on-condition' maintenance. D. G. Harding and J. C. Mack (Boeing Co., Morton, Pa.), p. 123-135.

The use of U.S. Army rotary wing mishap experience to assure improved product effectiveness. J. T. Darrah, Jr. and J. L. Haley, Jr. (U.S. Army, Board for Aviation Accident Research, Fort Rucker, Ala.), p. 136-148. 5 refs.

Utilization of Army aviation experiences via RAMMIT (Reliability and Maintainability Management Improvement Techniques). L. L. Bishop (U.S. Army, Aviation Systems Command), p. 149-159.

The Huey/Cobra M&R Field Program results and significance. J. E. Gean and G. E. Knudsen (Bell Helicopter Co., Fort Worth, Tex.), p. 160-173. 5 refs.

Impact on engine maintainability of gaseous radioactive penetrant inspections. W. C. Eddy, Jr. (Industrial Nucleonics Corp., Columbus, Ohio), p. 205-210.

Ultrasonic holography in nondestructive testing. L. E. Goodwin and R. S. Lovett (Holotron Corp.), p. 211-220.

Nondestructive testing - A condition monitored maintenance tool. W. J. Weldon (American Airlines, Inc., Tulsa, Okla.), p. 221-227.

Methodology to define, monitor and control life-limited components during storage. J. C. DuBuisson (Martin Marietta Corp., Friendship International Airport, Md.), p. 245-254. 26 refs.

An eclectic approach to long life reliability measurement. T. J. Breen (General Electric Co., Philadelphia, Pa.), p. 255-263. 9 refs.

The analysis of the effective reliability of a system. J. J. Hadel and B. Krogull (McDonnell Douglas Corp., St. Louis, Mo.), p. 264-278.

System for utilization of remote equipment for failure investigation and reliability evaluation (SUREFIRE). A. S. Kamp and J. J. Lyndon (General Electric Co., Philadelphia, Pa.), p. 279-289.

Maintenance and Reliability Simulation modeling for airfreighters. H. D. Hall and W. G. Ness (Lockheed-Georgia Co., Marietta, Ga.), p. 354-361.

Needed - Space maintenance tools. R. M. Belless, Jr. and L. R. Anderson (Martin Marietta Corp., Friendship International Airport, Md.), p. 362-374. 18 refs.

A method for assessing a system's operational effectiveness. E. Selig (Litton Industries, Inc., Beverly Hills, Calif.), p. 375-382.

A Mission Success model for unmanned space exploration. M. J. Shumaker and R. C. Cary (Martin Marietta Corp., Denver, Colo.), p. 385-396.

Hazard functions, renewal rates and peril rates. H. Ascher, p. 414-426. 12 refs.

Acceptance criteria for demonstrating system safety requirement. H. H. Moon, Jr. and W. E. Knowles (General Dynamics Corp., Fort Worth, Tex.), p. 440-444.

The economics of reliability. R. H. Dudley, K. K. Hekimian, and H. Laitin (Southern California, University, Los Angeles, Calif.), p. 451-470. 9 refs.

Reliability enforcement in design - Using gyroscopes as an example. W. G. Denhard (MIT, Cambridge, Mass.), p. 471-479.

Airborne electronic equipment guarantees. R. H. Myers, C. M. DeWitt, III (Hughes Aircraft Co., Culver City, Calif.), and A. J. Feduccia (USAF, Rome Air Development Center, Griffiss AFB, N.Y.), p. 480-505. 9 refs.

The application of an integrated structural analysis to the prediction of reliability. K. W. Bills, Jr. and J. H. Wiegand (Aerojet Solid Propulsion Co.), p. 514-526. 17 refs.

An approach to reliability determination of a rotating component subjected to complex fatigue. V. R. Lalli (NASA, Lewis Research Center, Cleveland, Ohio) and D. B. Kececioglu (Arizona, University, Tucson, Ariz.), p. 534-548. 22 refs.

Reliability prediction models for microcircuits. D. C. Porter and W. A. Finke (Boeing Co., Seattle, Wash.), p. 564-575. 6 refs.

MOS reliability prediction model. M. F. Adam and D. M. Aaron (North American Rockwell Corp., Anaheim, Calif.), p. 576-586.

Evaluation of a safety program. P. H. Bolger (NASA,

Washington, D.C.), p. 614-621. 7 refs.

Extended reliability basis of structural design under uncertainties. A. H.-S. Ang (Illinois, University, Urbana, Ill.), p. 642-649. 10 refs.

Statistical evaluation of load factors in structural design. H. C. Shah (Stanford University, Stanford, Calif.) and W. H. Tang (Illinois, University, Urbana, Ill.), p. 650-658. 10 refs.

Distributions of strength in simple fatigue and the associated reliabilities. D. B. Kececioglu (Arizona, University, Tucson, Ariz.), R. E. Smith (Sandia Laboratories, Albuquerque, N. Mex.), and E. A. Felsted (U.S. Army, Rock Island Arsenal, Rock Island, Ill.), p. 659-672. 17 refs.

A70-38816 A routine Bayesian assessment and modification of prediction. Trevor L. Salt (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 20-28.

Discussion of the development of a computer program for the routine assessment and modification of belief. Previous ideas regarding the modification of mechanical component life predictions by utilization of Bayes Theorem in its discrete formulation as proposed by Salt (1969) are extended, and a computer program BAMBI (Bayesian, Analysis Modified By Inspection) is discussed. It is found that a computer program such as BAMBI can be extremely useful for evaluating an original design intent in the light of subsequent test and field experience. G.R.

A70-38821 All-weather automatic landing system development and testing. D. R. Clifford (Boeing Co., Seattle, Wash.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 75-81.

Summary of the testing done to date on an Autoland control system employing inertial smoothing in the Boeing jet transport prototype. Such a system can compensate for ground beam anomalies. It is concluded on the basis of the test results that satisfactory fail-operational automatic control systems for approach and landing can be designed, built, and used on commercial transport aircraft. At least triple redundancy is required. When such a degree of redundancy is employed, digital technology, as exemplified by the GE prototype automatic flight control system used in the -80 all-weather landing system development and testing, provides substantially more troublefree operation and improved fault detection and isolation capability. G.R.

A70-38823 S-65-200 Commercial Compound Aircraft design for maintenance. Angelo C. Veca (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 113-122.

In the design of the S-65-200 Commercial Compound Aircraft - a 230 knot, 86 passenger transport - maximum consideration was given to meeting a high dispatch reliability goal and to ease of performing maintenance. This paper describes how maintenance and reliability of this compound helicopter is enhanced by use of new and improved technology. Use of built-in test equipment reduces electronic component maintenance by approximately 43%. An airborne integrated data system reduces line level maintenance by approximately 16% and provides trend information for detection of incipient malfunctions. A newly developed rotor head bifilar vibration absorber reduced aircraft vibration levels, thereby reducing airframe and structure maintenance by almost 15%. A modularized engine allows for minimum disassembly at intermediate levels of maintenance. New and high grade materials, such as composites and vacuum-melt steels, improve life characteristics of structure and dynamic components. The ability to inspect subsystems is increased, and all components are readily removable. Almost 95% of all maintenance actions are performed from outside the aircraft. The cumulative result of these features of the S-65-200 Commercial Compound Aircraft is a predicted 0.98 dispatch reliability. Direct maintenance is estimated at 9.3 maintenance manhours per flight hour for all levels of aircraft maintenance. (Author)

A70-38824 Design of helicopter transmission for 'on-condition' maintenance. D. G. Harding and J. C. Mack (Boeing Co., Vertol Div., Morton, Pa.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 123-135.

Discussion of the reduction of helicopter 'cost of ownership' by the process of reducing the frequency of transmission overhaul. Reasons for time scheduled overhauls and their validity to helicopter transmissions are explored. Failure functions for several transmissions are shown and individual failure modes explored for indications of failure function trends beyond the current operating regime. The conclusion is reached that significant cost savings are possible with on-condition maintenance. G.R.

A70-38825 The use of U.S. Army rotary wing mishap experience to assure improved product effectiveness. James T. Darrah, Jr. and J. L. Haley, Jr. (U.S. Army, Board for Aviation Accident Research, Fort Rucker, Ala.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 136-148. 5 refs.

U.S. Army Board for Aviation Accident Research (USABAAR) data are reviewed to define the general trends in rotary wing mishap experience. Factors which have caused aviation accidents are identified and compared to further define the accident prevention problem. The cause factors of materiel failure, malfunction and design deficiency are selected for further examination through a discussion of several examples taken from accident case histories. While component modification has long been employed to correct materiel deficiencies, it is shown that this approach has often fallen short of truly eliminating the problem. The application of the system safety concept in the elimination of materiel related accident cause factors in existing rotary wing aircraft is outlined. The close interrelationship of all assurance sciences is discussed as an essential element of risk management at any point in the life cycle of a system. The adaptability of this approach in military systems to civilian products is shown. (Author)

A70-38826 Utilization of Army aviation experiences via RAMMIT (Reliability and Maintainability Management Improvement Techniques). Lawrence Leonard Bishop (U.S. Army, Aviation

Systems Command). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 149-159.

Discussion of a system for processing maintenance data and other data relevant to the operations and support of Army aircraft. The system called RAMMIT is to present the data as useful information in an easily interpreted format. To accomplish these objectives, the system was designed basically to validate and utilize the data reported through the TAERS (The Army Equipment Record System)/TAMMS (The Army Maintenance Management System) system. However, RAMMIT is also designed to integrate the TAERS/TAMMS data with other sources of usage, maintenance, and field experience data to enable the U.S. Army Aviation Systems Command to provide improved logistics support to Army aircraft and support equipment. G.R.

A70-38827 The Huey/Cobra M&R Field Program results and significance. James E. Gean and George E. Knudsen (Bell Helicopter Co., Fort Worth, Tex.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 160-173. 5 refs.

The UH-1/AH-1 Maintainability and Reliability Program has been in operation for six years. This paper briefly reviews the concepts on which the program is based, and outlines the history of the program as background for the main theme of the paper - review and evaluation of the program to determine its validity for use in the future. The data and analysis output of the program are evaluated in terms of their quality, quantity, and usefulness in making decisions which are significant in Army management of the UH-1/AH-1 production and logistics programs. Statistical tables and plots showing how pertinent factors have varied with time are used to demonstrate the degree to which the program has achieved its objectives of early identification and correction of reliability and maintainability problems. Each M&R Program task is examined and the lessons learned from experience and the conclusions drawn are presented. This includes, in addition to the contract work statement tasks, the management functions of organization, staffing, training, and channels for decision making. The scope of the program is evaluated, and the factors limiting it are discussed. The possibility of including additional tasks is considered and some possibilities are suggested. Conclusions drawn throughout the paper are summarized and recommendations are made for improving future M&R Field Programs for the next generation of Army helicopters. (Author)

A70-38828 Impact on engine maintainability of gaseous radioactive penetrant inspections. William C. Eddy, Jr. (Industrial Nucleonics Corp., Columbus, Ohio). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 205-210.

Discussion of a method for measuring microscopic defects such as are present in early low cycle fatigue in aircraft materials. The process used takes advantage of the fact that all materials have surface-absorbed gases which can be replaced with radioactive gases. The concentrations of these gases in cracks and porosity are readily detectable using conventional film autoradiography or electronic scanning. The process apparently can measure clean cracks in stainless steel having dimensions of 1 to 5 millionths of an inch and depths of less than 1 mil. Cracks of this size are generally created in low cycle fatigue at about 40% of service life. G.R.

A70-38830 Nondestructive testing - A condition monitored maintenance tool. Warren J. Weldon (American Airlines, Inc., Maintenance and Engineering Center, Tulsa, Okla.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970.
Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 221-227.

Discussion of a maintenance program known as Condition Monitored Maintenance for turbine engines which results in the elimination of total overhaul at a specified time. The application of NDT plays a most vital role in the success of the program by permitting critical areas to be monitored with relatively minor open-up to permit access to perform the inspection. The engine inspections are performed 'on the wing,' that is, with the engine still installed on the aircraft. A similar plan is being applied to the airframe, components and accessories of the aircraft. G.R.

A70-38833 The analysis of the effective reliability of a system. J. J. Hadel and B. Krogull (McDonnell Douglas Corp., St. Louis, Mo.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 264-278.

The purpose of this paper is to present an analytical technique which expands the classical definition of weapon system mission success probability to encompass degraded mode operation. The approach evaluates the effects upon system capability arising from each degraded state. The normalized sum of the capabilities in all system states, weighted by their probability of occurrence, is interpreted as the 'Effective Reliability' of the system. The paper describes the technique of degraded mode evaluation and introduces a deterministic computer program to calculate system state probabilities. A demonstration of the application of the method is provided in the analysis of a fighter bomber system. (Author)

A70-38835 Maintenance and Reliability Simulation modeling for airfreighters. H. D. Hall and W. G. Ness (Lockheed-Georgia Co., Marietta, Ga.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 354-361.

A Maintenance and Reliability Simulation Model has been developed which can be used to evaluate and optimize the Maintainability and Reliability characteristics of an aircraft and the maintenance and logistic resources required to support the aircraft. The model is programmed to simulate any aircraft type or series. Its uniqueness to a specific design arises by virtue of the input data supplied to the 'aircraft characteristics' segment of the model. The validity and accuracy of the model logic have been verified by simulating the maintenance operations of a fleet of aircraft being operated in scheduled service and comparing the model output with actual inservice reported data. (Author)

A70-38837 **A method for assessing a system's operational effectiveness.** Eugene Selig (Litton Industries, Inc., Beverly Hills, Calif.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 375-382.

Description of a method for assessing the operational effectiveness of avionics hardware when formal means do not exist for supplier and user accumulation and evaluation of field data. The equipment selected for consideration was developed in 1962 and nearly 3500 systems have been delivered. The data provided are based on an evaluation of 76,000 flights, 150,000 flight hours, and 268,000 system operating hours, and confirm good system performance in the field. The importance of understanding the differences between various performance parameters is emphasized, and problems which may be experienced in the absence of such knowledge are discussed. M.M.

A70-38840 **Acceptance criteria for demonstrating system safety requirement.** H. Harvey Moon, Jr. and Walter E. Knowles (General Dynamics Corp., Fort Worth, Tex.). In: Annals of reliability and maintainability. Volume 9 - Assurance technology spinoffs; Proceedings of the Ninth Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970. (. Conference sponsored by the Society of Automotive Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Mechanical Engineers. New York, Society of Automotive Engineers, Inc., 1970, p. 440-444.

System safety requirements for the two most recent USAF aircraft systems have consisted of an accident probability, a confidence level, and the test period for demonstrating the requirement. For each set of values for these parameters, there is a maximum number of accidents that can occur during the demonstration period. It is this maximum number of accidents that is of importance in the demonstration period. The task of determining the maximum number of accidents is not as simple and straightforward as some have tried to make it. The significance of the three parameters is explained and the procedure is given for using statistical sampling techniques to arrive at the equivalent accident rate. (Author)

A70-38941 # **The opportunities of fibre technology.** Brian Locke (National Research Development Corp., London, England). *(Production Engineering Research Establishment, Symposium on Fibre Technology, Melton Mowbray, England, Apr. 23, 1970.) Hovering Craft and Hydrofoil,* vol. 9, July 1970, p. 8-14. 10 refs.

Discussion of the advantages held forth for the design and manufacture of hydrofoil and hovering craft by the sophisticated engineering techniques known as 'fiber technology.' The general nature of composite materials, the mechanical properties of whiskers, polycrystalline fibers, and matrice materials, as well as composite material design or fiber arrangements are tabulated, illustrated and discussed along with costs, applications, and markets. Special attention is given to glass and carbon fiber materials. Costs and strength/weight ratios for mechanical and structural parts made of conventional and composite materials are compared, and the advantages of fiber technology and the opportunities it holds forth are pointed out. It is shown that strength, stiffness, lightness, mouldability, uniformity, and, for complex or awkward shapes, low cost warrant consideration of using composite materials in hydrofoil and hovering craft design and manufacture. M.V.E.

A70-38942 # **A means of providing neutral or positive stability for hovercraft for all wind directions.** J. W. Flower (Bristol, University, Bristol, England). *(Production Engineering Research Establishment, Symposium on Fibre Technology, Melton Mowbray, England, Apr. 23, 1970.) Hovering Craft and Hydrofoil,* vol. 9, July 1970, p. 15-19.

Description of a cam-operated fin-tab assembly providing hovercraft with directional stability and control for all wind directions. It is shown that fins (at least two in number), tab operated via cams can in principle be arranged to give: (1) neutral directional stability for all relative wind directions, (2) positive directional stability for all wind directions, together with means of trim, and (3) direct control. These capabilities can be implemented by a single cam for each fin under certain conditions appropriately detailed. M.V.E.

A70-38948 **An occurrence of highly localized clear-air turbulence over the Southern Mediterranean.** J. B. McGinnigle. *Meteorological Magazine,* vol. 99, July 1970, p. 208-210.

Discussion of the occurrence of a highly localized clear air turbulence associated with a simultaneous temperature rise of 8 C observed at 1550 GMT on Nov. 28, 1963 from an aircraft at flight level 19,500 ft over the Southern Mediterranean. A chart of the surface synoptic situation at 15 GMT, a tephigram obtained from a Malta radiosonde ascent at 12 GMT, and a hodograph constructed from the ascent winds are presented and examined. It is shown that the aircraft seems to have passed through a frontal zone within a dry and extremely turbulent layer. O.H.

A70-38951 **The widebodies: Superjets and airbuses - The American superjets.** John O'Keefe. *Esso Air World,* vol. 22, May-June 1970, p. 150-154.

Discussion of the new generation of American wide-bodied jets consisting of the Boeing 747 which has recently made its debut, and of the Lockheed L-1011 TriStar, and the McDonnell Douglas DC-10 which will be introduced into regular service in 1971. The need for these giant aircraft in this time of rapidly increasing air traffic is pointed out. Introduction costs of the jets and increased profits obtained are considered, and the accommodations provided for the passengers are discussed. Expansions in the ground facilities demanded by the operation of the superjets are examined. G.R.

A70-38952 **The widebodies: Superjets and airbuses - The European airbuses.** *Esso Air World,* vol. 22, May-June 1970, p. 155-159.

Discussion of the twin-engined European airbuses, which are designed for shorter routes and lighter traffic than are the three- and four-engined American superjets. At the present time, Europe has three airbus projects. Two have reached the prototype construction stage, and the third is in the mock-up and design stage. It is pointed out that Europe's problems in developing large-capacity transport aircraft spring from the lack of a domestic market large enough on its own to justify launching a major new air transport project. The programs for the development of the airbuses is discussed and the design data for the aircraft are presented. Layouts for the seating arrangements are shown. G.R.

A70-38953 **The widebodies: Superjets and airbuses - Fanjets for the widebodies.** Kenneth T. Fulton. *Esso Air World,* vol. 22, May-June 1970, p. 160-164.

Discussion of the new aircraft engines which make the economies in operating costs now being offered by the jumbo jets possible. The new engines offer the opportunity of significantly lower specific fuel consumptions combined with easier maintenance, enhanced reliability, reduced noise, and smokeless exhausts. Despite major differences in component design and arrangement, the new

Pratt and Whitney, General Electric and Rolls-Royce engines are essentially similar in concept. In its construction each engine has a large diameter single-stage fan in which the traditional inlet guide vanes have been eliminated. G.R.

A70-39140 # **On the characteristics of two-dimensional slide plate of ground effect machines with small attack angle.** Kyoshi Watanabe, Hiroo Hirano, and Shigeo Uchida (Nagoya University, Nagoya, Japan). *Nagoya University, Faculty of Engineering, Memoirs,* vol. 21, Nov. 1969, p. 331-342. 7 refs.

Investigation of the bearing force and moment produced by the motion of an inclined flat plate which is supported by the ejection of compressed gas from the center. The clearance between the plate and the ground is assumed to be very small compared with the length of the plate moving at a constant velocity along the ground, so that the theory of flow with a low Reynolds number is applied. The coefficients of the lift, drag, and pitching moment about the center of the plate are expressed by functions with two sets of parameters, one of which represents a relative angle of inclination, while the other consists of a jet pressure coefficient and a reduced Reynolds number. O.H.

A70-39198 **At the crossroads in air-traffic control. III.** Gordon D. Friedlander. *IEEE Spectrum,* vol. 7, Aug. 1970, p. 76-89.

Control of air traffic from the ground is only half the story - the airborne electronic equipment, displays, instrumentation, and human response are necessary to complete the loop in any practicable system. A few versions of collision-avoidance systems are entirely under airborne control. Based upon experience, pilots are wary of the hazards at certain major airports; in approaching other terminals, however, they have a sense of confidence that is inspired by the existence of the latest ATC equipment and facilities that afford a high degree of safety to pilots, passengers and aircraft. (Author)

A70-39202 # ***Composite technology and carbon/carbon materials.*** John E. McDonald (Sandia Laboratories, Albuquerque, N. Mex.). In: Carbon composite technology with special emphasis on carbon/carbon systems; American Society of Mechanical Engineers and University of New Mexico, Annual Symposium, 10th, University of New Mexico, Albuquerque, N. Mex., January 29, 30, 1970, Proceedings. Albuquerque, American Society of Mechanical Engineers, 1970, p. 13-33. 12 refs.

Discussion of the potential of composites and their impact on research development, with particular reference to the carbon-carbon composites. It is shown that due to composites, weight savings of 20 to 40% were realized in the aircraft over the past few years. The extrapolation of these data over the next decade indicates that a structural weight fraction in aircraft may be reduced from one-fourth to one-half with concomitant increases in operational efficiency, payload, and performance. It is indicated that the advent of composites is having and will continue to have substantial influence on engineering design and usage of this class of materials. New approaches to design and material and process development must be evolved and reduced to practice. The properties of carbon-carbon composites for high-temperature applications are discussed. Z.W.

A70-39265 **Kinetics and aerodynamics of fuel combustion processes (Kinetika i aerodinamika protsessov goreniia topliv).** Edited by B. V. Kantorovich. Moscow, Izdatel'stvo Nauka, 1969. 155 p. In Russian.

Contents:

Foreword (Predislovie), p. 5, 6.

Fuel combustion in a supersonic flow (Gorenie topliva v sverkhzvukovom potoke). V. A. Chernov and E. N. Kiseleva, p. 47-51.

Flame stabilization in the wake of a hot gas (Stabilizatsiia plameni na sputnoi strue goriachego gaza). E. L. Solokhin and V. A. Mironenko, p. 52-59.

Fluid atomization and two-phase flows (Raspylivanie zhidkosti v dvukhfaznye techeniia). M. S. Volynskii, p. 60-73.

Calculation of nonequilibrium recombination in a nozzle of the combustion products of hydrogen in air (K raschetu neravnovesnoi rekombinatsii v sople produktov sgoraniia vodoroda v vozdukhe). V. M. Khailov, p. 74-87. 12 refs.

A70-39359 # ***Three-dimensional boundary layer near the plane of symmetry of a spheroid at incidence.*** K. C. Wang (Martin Marietta Corp., Research Institute for Advanced Studies, Baltimore, Md.). *Journal of Fluid Mechanics,* vol. 43, Aug. 17, 1970, p. 187-209. 18 refs.

Development of incompressible laminar boundary-layer results on both the leeside and the windside of a prolate spheroid by use of an implicit finite difference method of the Crank-Nicolson type. Particular attention is given to the determination of separation and of embedded streamwise vortices. No restriction on the angle of attack or the thickness ratio is imposed, nor are any of the common assumptions such as similarity, conical flow, etc., invoked. The results suggest an embedded vortex region existing between the regular boundary-layer region and the separated region. At higher angles of attack, the vortex region becomes so thick that it, itself, might also be designated as separated. This possibility leads to questions of applicability of existing theories on three-dimensional separation. F.R.L.

A70-39407 # **Economic study of satellite systems for telecommunications, air traffic control and navigation.** Bertrand Manuali and Claude Ganier (Centre National d'Etudes Spatiales, Paris, France). *ITU Telecommunication Journal,* vol. 37, Jan. 1970, p. 17-29. Translation.

Summary of economic studies of satellite systems which have been conducted in France for nearly two years, and which are mainly based on the Dioscures project and on the Aerosat project proposed by the Communications Satellite Corporation. All the systems compared rely exclusively on space relays. A preponderant role is assigned to satellites using frequencies in the L band (1540-1660 MHz). However, a satellite system using the VHF band (118-136 MHz) is also studied. Each of the three space systems considered used two generations of satellites, the first until 1978 and the second until 1985. Estimated aeronautical income obtained from leasing telephone circuits and the decrease in standards of aircraft separation when systems of the Dioscures type are brought into operation are discussed. Maritime income (telecommunications, navigation, meteorology) is investigated, and costs and profit/loss comparisons are considered. G.R.

A70-39409 # **The role of small earth stations in civil communication satellite systems.** J. L. Blonstein (Plessey Radar, Ltd., Addlestone, Surrey, England). *ITU Telecommunication Journal,* vol. 37, May 1970, p. 221-227.

Discussion of some of the potential and untapped uses of communication satellites and of the families of small earth stations that will be brought into being as a result. The initiation of regional communications systems via satellite is considered, and the application of communication satellites to television distribution is discussed. Aspects of air traffic and maritime communications and navigation are investigated, and some problems of data exchange are considered. Other areas of use examined include meteorology, communication involving mobile users, education broadcasts, and surveys of natural resources. The design of small earth stations with antennas having diameters of various magnitudes is discussed. G.R.

A70-39412 **Design and materials.** New York, Society of Automotive Engineers, Inc. (SP-360), 1970. 38 p.

Contents:

Preface. 1 p.

The effect of casting variables and section size on the stress-rupture life of a high temperature nickel base alloy. R. D. Lloyd (Avco Corp., Stratford, Conn.), p. 1-9.

Design considerations in selecting alloys for aircraft structures. M. J. Rich (United Aircraft Corp., Stratford, Conn.), p. 10-22. 19 refs.

Directional solidification to produce columnar grain and single crystal structures. F. L. VerSnyder (United Aircraft Corp., Stratford, Conn.), p. 23-35. 20 refs.

A70-39414 **Design considerations in selecting alloys for aircraft structures.** M. J. Rich (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Design and materials. New York, Society of Automotive Engineers, Inc. (SP-360), 1970, p. 10-22. 19 refs.

Discussion of the many factors the aircraft designer has to consider in selecting an alloy. The important factors in selecting alloys for aircraft structure are shown to be the useful specific strength of the material, resistance to corrosion, producibility, and cost. Because of the high worth of a pound in aircraft, the major design consideration becomes the strength factor. The useful strength of the material depends not only on the specific static and fatigue strength, but on the reliability required, as well as the ability of the material to resist damage. For reliability, the scatter or statistical strength distribution becomes an important design factor for both static and fatigue-loaded structures. For structures subjected to fatigue loading, the dynamic stress-strain behavior of the material and the notch sensitivity are factors used in determining the useful strength. For compression-loaded structures, the important material properties are the yield condition and the stress-strain relationship beyond yield. The fail-safe design philosophy used in aircraft structures requires that the useful strength be limited by the fracture toughness and fatigue crack propagation rate of the material. For fail-safe structures, the damage tolerance is achieved by designing for residual strength and life. O.H.

A70-39501 # **Synthesis of helicopter stabilization systems using modal control theory.** T. R. Crossley and B. Porter (Salford, University, Salford, Lancs., England). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1036.* 10 p. 9 refs. Members, $1.25; nonmembers, $2.00.

This paper presents procedures for designing controllers for complex dynamical systems using single- and multi-input modal control theory. It is shown that the design of the appropriate modal controller for a given system is greatly facilitated by the inspection of mode-controllability indices which constitute the mode-controllability matrix of the system. The design procedures enable controllers for multi-input systems to be synthesized by sequential applications of a single-input theory or by an alternative method in which it is possible to impose gain constraints on the modal controller. The power of these procedures is demonstrated by the design of both longitudinal and lateral controllers for the Sikorsky SH-3D Sea King helicopter. (Author)

A70-39502 * # **An automatic guidance concept for VTOL aircraft.** W. C. Hoffman, J. Zvara (Aerospace Systems, Inc., Burlington, Mass.), A. E. Bryson, Jr. (Stanford University, Stanford, Calif.), and N. D. Ham (MIT, Cambridge; Aerospace Systems, Inc., Burlington, Mass.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1035.* 9 p. Members, $1.25; nonmembers, $2.00. Contract No. NAS 12-2097.

A simplified mathematical model of a VTOL aircraft is developed which treats ground range-to-go as the independent variable, altitude and cross range as state variables, and the three commanded velocity components as control variables. By considering perturbations about a nominal path and minimizing a performance index which is a quadratic function of the state and control variable deviations, a simple linear guidance law is obtained. To implement the guidance scheme, the feedback gains would be precalculated and stored, along with the nominal state and control variable histories, as functions of range-to-go in the on-board computer. During flight, the actual state variables would be measured and their deviations from nominal used to calculate optimal corrections to the stored nominal control variables. Simulation results with the tandem-rotor CH-46C helicopter demonstrate the guidance scheme's ability to accommodate a variety of off-nominal conditions. (Author)

A70-39503 * # **A system model for low level approach.** W. A. Johnson and D. T. McRuer (Systems Technology, Inc., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1034.* 10 p. Members, $1.25; nonmembers, $2.00. Contract No. NAS 2-4892.

Description of a system model for analyzing Category II approaches, and illustration by examples of analytical applications. The approach system model described is shown to establish a structure containing the system elements, command inputs, disturbances, and their interactions in an analytical framework such that the relative effects of changes in the various system elements on precision of control and available margins of safety can be estimated. The model is also shown to provide valuable indications for the design and integration of suitable autopilot, display, and navigation elements, and for the assessment of the interaction of those elements with the pilot/copilot. M.V.E.

A70-39504 # **Increasing airport capacity and terminal area safety by means of the scanning beam instrument landing system.** George W. Cherry, Barton DeWolf, and Duncan MacKinnon (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1033.* 19 p. 8 refs. Members, $1.25; nonmembers, $2.00.

The current terminal air traffic control system must be upgraded to take advantage of new technological developments if airport capacity is to be expanded to meet demand. A simple model of runway landing capacity shows that the rate of capacity increase resulting from a reduction in the dispersion of arrival times at the runway threshold increases as the dispersion decreases, and that significant capacity increases can be obtained through the use of more accurate guidance. For this purpose, a slot-coincidence motion scheme for use in the high-capacity airport is presented which takes advantage of the accuracy of the new scanning beam ILS and on-board control systems. Trajectory design concepts and feed-forward guidance laws are developed and some simulation results are presented using a detailed model of the CV-880. (Author)

A70-39505 # **A practical solution to automatic landings using digital flight control computers.** Harold N. Tobie (Boeing Co., Seattle, Wash.) and Kenneth W. Ramby (General Electric Co., Binghamton, N.Y.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1032.* 8 p. Members, $1.25; nonmembers, $2.00.

Description of the automatic landing flight test program conducted for the evaluation of the triplex, digital automatic flight control system designed around automatic landing requirements. The objective of the flight program is the development of a digital

fail-operative autoland system with increased control precision and increased pilot confidence adequate for Category III conditions. Specific landing system requirements and problems are reviewed. The flight test work described indicates that Category IIIA automatic landing performance can be accomplished by application of present and forthcoming aircraft systems technology. M.V.E.

A70-39506 # An ultrasonic altitude-velocity sensor for airplanes in the vicinity of the ground. H. Maeda and Y. Umeda (Kyoto University, Kyoto, Japan). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1031.* 7 p. Members, $1.25; nonmembers, $2.00.

This paper shows the possibility of an ultrasonic sensor which detects the altitude and the vertical velocity of an airplane in the vicinity of the ground. The principle of the present technique depends on the measurement of time in which the ultrasonic wave propagates the distance between the airplane and the ground, because the sonic velocity is approximately constant at the usual atmospheric temperature. Furthermore, by differentiating the altitude signal with respect to time, it is also possible to detect the vertical velocity of the airplane. The fundamental performances of this sensor, i.e., the detectable altitude limit, effects of the power plant noise, effects of the attitude, slipstream and forward velocity of the airplane, effects of ground conditions and so on, are investigated with some experiments carried out in the laboratory and also by the flight tests using a helicopter. From those results, it is expected that the altitude and the vertical velocity can be found easily and accurately with the ultrasonic sensor, e.g., at the hovering flight of helicopters or at the take-off and landing flight of conventional airplanes. (Author)

A70-39511 # Optimal and suboptimal velocity-aiding for VOR/DME systems. Norbert B. Hemesath (Collins Radio Co., Cedar Rapids, Iowa). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1024.* 11 p. 5 refs. Members, $1.25; nonmembers, $2.00.

The use of on-board velocity sensors to improve the positional accuracy of VOR/DME navigation systems is described. The analytical formulation of the problem combines velocity and VOR/DME data in an optimal filter. Suboptimal filters of reduced complexity are also described. Performance analyses are given for the specific cases where either an inertial system or an air data system is the available velocity sensor, and comparisons are made between the rms performance of optimal and suboptimal filters. The analyses show that velocity-aiding can substantially improve positional accuracy and that suboptimal filtering can be achieved without disastrous performance penalties. (Author)

A70-39527 # Generalized navigation error analysis. Fred G. Rea and Norman H. Fischer (Battelle Memorial Institute, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1004.* 12 p. 7 refs. Members, $1.25; nonmembers, $2.00. Research supported by the Battelle Memorial Institute.

Navigation error analysis techniques are developed for various aircraft and rocket guidance systems. By computing all errors in inertial coordinates, all cases result in similar systems of nine first-order linear differential equations. Three types of Gaussian normal statistical error sources are considered; statistical biases, white noise, and colored noise. Statistical biases are computed by numerical integration of the basic linear differential equation. To compute errors due to white and colored noise sources, the state vector is augmented and the associated matrix Riccati equation numerically integrated. Redundant and nonorthogonal sensors are analyzed. A digital computer program implementing these techniques is described and sample results are shown. (Author)

A70-39529 # The influence of bobweights on pilot-induced oscillations. T. Peter Neal (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1002.* 9 p. 9 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-3294.

Discussion of the influence of bobweights on flying qualities, and proposal of design procedures for minimizing unwanted effects. First, a method of analysis is developed. This is followed by application of the method to several pilot-induced-oscillations (PIO) situations. Finally the various options available to the airplane designer are discussed. It is shown that the use of a control-system bobweight without consideration of its effects on the airplane's dynamics can lead to serious PIO problems, and that the latter can be minimized by increasing the sensitivity of the bobweight to pitch acceleration, using a given criterion. When this criterion is satisfied, the contribution of the bobweight to stick force per g may still be limited by the fact that the closed-loop feel-system roots can be driven unstable. This problem can usually be tackled by the use of a viscous stick damper. It is recommended that the final control-system design be checked against the short-period damping ratio and stick force per g requirements of MIL-F-8785B. M.V.E.

A70-39530 * # A pilot-vehicle systems approach to longitudinal flight director design. D. T. McRuer, D. H. Weir, and R. H. Klein (Systems Technology, Inc., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1001.* 13 p. 10 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 2-3746.

Definition of principles, functional requirements, and analytical procedures for specifying and designing flight director/vehicle systems for longitudinal control of transport-type aircraft during landing approach. Recent developments in the theory of manual control displays now make feasible the statement of principles for analytical design of flight directors, given the dynamics of the (augmented) vehicle and its manual control system. The principal result from the theory is that there are effective director/vehicle controlled element dynamics which are preferred from the standpoint of pilot response and system performance. Other considerations include response compatibility, display consistency, and autopilot monitoring. It is shown how this leads to rules and analytical procedures which allow the director computer feedbacks to be selected, weighted, and equalized to provide an effective director/vehicle system which satisfies both pilot-centered and guidance and control requirements. M.V.E.

A70-39531 # On the prediction and optimality of aircraft maneuvers associated with approach and landing. Glenn D. Buell, Jr. (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-1000.* 9 p. 6 refs. Members, $1.25; nonmembers, $2.00.

Two critical aircraft maneuvers associated with approach and landing are analyzed. Optimal solutions, for both the manual go-around and automatic flare maneuvers, that include state and control variable constraints are obtained. Two matrix operators are derived that can be used for inflight recursive computation of the minimum and maximum attitude loss associated with a pilot controlled go-around maneuver. The flare optimization includes both touch-down dispersion and normal acceleration and is successfully approximated by a closed loop mechanization. A third matrix operator is derived for recursive prediction of the longitudinal touchdown point. These methods could provide valuable inputs to a flare decision process. (Author)

A70-39533 * # **Influence of turbulence on lateral-directional flying qualities.** James A. Franklin (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-998.* 17 p. 10 refs. Members, $1.25; nonmembers, $2.00. Contract No. NSR-31-001-104.

Flight evaluations using a variable stability airplane were made to determine the independent and interacting effects of turbulence induced aerodynamic disturbances and lateral-directional dynamics on flying qualities associated with a precision heading control task. Trends in pilot rating obtained in the test program for variations in turbulence disturbances and airplane dynamics are explained in terms of measures of precision of task performance, pilot control workload, and pilot compensatory behavior derived from time histories of the flight evaluations. Pilot-vehicle systems analyses substantiate the performance-workload data and provide a more fundamental understanding of the heading control task in turbulence. (Author)

A70-39546 * # **Parameter plane stability analysis of a flight vehicle.** S. M. Seltzer (NASA, Marshall Space Flight Center, Astrionics Laboratory, Huntsville, Ala.) and Jackson T. Huang (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-983.* 10 p. Members, $1.25; nonmembers, $2.00.

The parameter plane stability analysis method permits simultaneous variation of two stability parameters to indicate vehicle stability characteristics. It provides a simple and more powerful analytical design technique than classical analytical approaches such as root locus or Nyquist techniques. This approach was used in designing the current U. S. Army YO-3A aircraft and is being used in some preliminary design studies for the proposed reusable space shuttle; examples of both are presented. The parameter plane technique is amenable to computer utilization. (Author)

A70-39558 # **The ram-wing - A comparison of simple one-dimensional theory with wind tunnel and free flight results.** Roger W. Gallington (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, Colo.) and Mark K. Miller (USAF, Oklahoma City Air Material Area, Tinker AFB, Okla.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-971.* 10 p. 9 refs. Members, $1.25; nonmembers, $2.00.

The one-dimensional channel flow theory with leakage is described. Using this theory, lift and drag laws are derived and the pitching moments caused by small changes in altitude and shape of the lower surface are discussed. The results of wind tunnel tests are compared with prediction from the one-dimensional theory. A series of successful free flight model tests are illustrated, described and analyzed. (Author)

A70-39563 # **Application of optimal control theory to satellite-based oceanic air traffic control.** Stuart H. Starr and Barry M. Horowitz (Mitre Corp., McLean, Va.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-966.* 10 p. 19 refs. Members, $1.25; nonmembers, $2.00.

This paper describes the application of stochastic optimal control theory to the design and analysis of a satellite-based Air Traffic Control (ATC) system for the North Atlantic. The longitudinal and lateral motion of several oceanic aircraft is simulated by postulating the existence of an ATC system, part of which is derived from optimal control considerations. The simulated environment includes such factors as errors arising from navigation, wind and surveillance. The control algorithm includes a Kalman filter in tandem with an optimal regulator, with adjustable update and command rates, and command thresholds. The analytical tool that is developed herein can be used as a basis for deriving the expected separation standards to be used with a future satellite-based system. In addition, it can be used to determine the impact of design trade-offs on system performance. (Author)

A70-39566 # **Optimal longitudinal control for obstacle clearance on takeoff.** Alfred C. Robinson and James P. Loomis (Battelle Memorial Institute, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-963.* 12 p. 12 refs. Members, $1.25; nonmembers, $2.00.

Formulation of an obstacle-clearance criterion function intended to help finding takeoff trajectories optimal with respect to that criterion. A large number of solutions are shown in order to study the effect of aircraft design parameters on takeoff performance. Two different computing methods are used in finding the optimal trajectories, and the limitations and merits of these methods are discussed. Design objectives for obstacle clearance are clarified. M.V.E.

A70-39567 # **Sensitivity optimization - A lateral-directional flight control case study.** F. A. SanFilippo (General Electric Co., Binghamton, N.Y.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-962.* 6 p. Members, $1.25; nonmembers, $2.00.

The min-max problem in linear optimal control is used as a basis for automated design of linear time-invariant controllers. A performance functional is maximized with respect to artificial plant disturbances and minimized with respect to plant controls. Implementation of control laws obtained at increased disturbance levels are found to produce corresponding reductions in sensitivity. This is demonstrated in a flight control synthesis problem using four wide-ranging flight conditions of the B-58 aircraft. (Author)

A70-39579 # **Structural design loads for strength and fatigue, computed with a multi-variable load environment model.** James D. Yost and Guinn S. Johnson (General Dynamics Corp., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-948.* 9 p. 12 refs. Members, $1.25; nonmembers, $2.00.

Documented oscillograph recorded multichannel data (primarily F-205D) was used to develop an eight variable mathematical environment model of fighter aircraft response per Mil Spec 8866A mission segments. The F-106 fighter was selected for demonstration of the model. F-106 detailed flight test results, fatigue cyclic test data and 3770 flight hours of normal service recorded response data were available to facilitate evaluation of the model. These data made it possible to empirically compute structural component loads for comparison with F-106 design values. On the basis of these analyses, new design criteria for strength and fatigue are recommended. (Author)

A70-39580 * # **The gust-alleviation characteristics and handling qualities of a free-wing aircraft.** Richard F. Porter and Joe H. Brown, Jr. (Battelle Memorial Institute, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-947.* 15 p. 11 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 2-5116.

Discussion of the results of an analytical study of the dynamic characteristics of aircraft employing an unconventional wing, free to pivot about a spanwise axis forward of its aerodynamic center, and subject only to aerodynamic pitching moments imposed by lift and drag forces and a trailing-edge control tab. The left and right wing

panels operate independently, with symmetrical tab displacement being used to control the angle of attack and differential tab deflections causing asymmetric panel deflections for lateral control. The influence of the free-wing concept was determined by comparing the turbulence responses and handling qualities of the free- and fixed-wing versions of a 3000-lb gross-weight aircraft. It is demonstrated that the free-wing concept provides natural gust alleviation which greatly reduces the perturbations in atmospheric turbulence. The most dramatic reductions are in normal load-factor increments, vertical path displacements, and roll disturbances. M.V.E.

A70-39581 # **The influence of the static and dynamic aerodynamic characteristics on the spinning motion of aircraft.** William Bihrle, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-946.* 8 p. Members, $1.25; nonmembers, $2.00. Navy-supported research.

Identification of the aerodynamic characteristics that must be accurately determined in order to compute the full scale spinning motions of an aircraft. The roles that the static, damping, cross and acceleration aerodynamic derivatives play in the spin are analyzed and discussed. It is shown that the yawing moment characteristics associated with lateral control and effective dihedral are the two most important aerodynamic parameters involved in the spinning phenomenon. By contrast, the aerodynamic acceleration derivatives and the cross derivative play an insignificant role. The information of this study can be employed for identifying aerodynamic fixes that are most likely to act as 'anti-spin' devices and for conceiving automatic control techniques for spin prevention or spin recovery. M.V.E.

A70-39582 * # **Dynamic stall simulation problems.** Lars E. Ericsson and J. Peter Reding (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-945.* 9 p. 20 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 1-7999.

Study of the difficulties and problems encountered in simulating dynamic airfoil stall in wind tunnel tests. The proposed winged space shuttle vehicles will experience stall flutter in their 'pitchover' from high entry attitudes to substall cruise attitudes, which calls for a thorough understanding of the dynamic airfoil stall problem. It is shown that dynamic stall is a flow phenomenon that is very difficult to simulate in subscale tests in ground facilities. For, at high frequencies, the pitch-rate induced accelerated flow effects can be large enough to change the stall type from leading edge stall to turbulent trailing edge stall, and vice versa. And at low Reynolds numbers, the turbulence (or similar effect) generated by the oscillation can cause a change in stall type from thin airfoil or laminar trailing edge stall to leading edge stall. In addition to these specific dynamic stall simulation problems, there are to be considered the usual problems of tunnel wall and support interference. The now recognized non-two-dimensional nature of all separated flow is another factor to consider. Analytic flow concepts are developed for dynamic stall. It is felt that they may provide the basic understanding necessary before subscale test data can be used to predict full-scale dynamic stall characteristics. M.V.E.

A70-39583 # **Theoretical studies to refine the prediction of unsteady aerodynamics of supersonic elastic aircraft.** Jack Morito Ii (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Guidance, Control and Flight Mechanics Conference, Santa Barbara, Calif., Aug. 17-19, 1970, Paper 70-944.* 15 p. 12 refs. Members, $1.25; nonmembers, $2.00.

This paper interprets the inaccuracies arising from the 'Mach box' evaluation of unsteady aerodynamic forces based on the method of Aerodynamic Influence Coefficients (AIC), and proposes refinements to minimize these inaccuracies. The basic equations of inviscid flow are reviewed and the assumptions and restrictions inherent in present application of the AIC method are discussed. The inaccuracies, which result in large fluctuations of the pressure distribution, stem primarily from 'distortion' of the leading edge which results from a Mach box grid representation of the wing planform. The refinement consists of a subdivision of the grid of pulse-receiving box control points. Numerical examples are included to demonstrate its efficiency. The downwash singularity near a subsonic leading edge is also considered and a numerical procedure for evaluating its effect is shown. (Author)

A70-39614 **A comment on the refinement of the linearized transonic flow theory.** Iawo Hosokawa (Tennessee, University, Tullahoma, Tenn). *Physical Society of Japan, Journal,* vol. 29, July 1970, p. 252. 6 refs.

Comment on applications of the nonlinear correction theory - known as the author's (1960) refinement of the linearized transonic flow theory - to circular-arc bodies of revolution flying at transonic speed. It is shown that in the case of such applications, there is no need to match the solution to the linearized transonic flow theory anywhere on the body in the manner prescribed by the original nonlinear correction theory for a circular body of revolution. A new prescription, including the contribution of an originally neglected quadratic term, is given. This new prescription has been used with success to calculate the pressure coefficient distribution on circular-arc bodies of revolution. M.V.E.

A70-39622 **Contribution to the comparison of the information value of program and random tests (Beitrag zum Vergleich der Aussagefähigkeit von Programm- und Random-Versuchen).** Gerhard Jacoby (Carl Schenck Maschinenfabrik GmbH, Darmstadt, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, July 1970, p. 253-258. 17 refs. In German.

Discussion of the information value of program and random tests used to estimate some fatigue life and cumulation damage problems in aircraft design. An intrinsic problem of advanced aircraft and lightweight design is shown to be concerned with the information value of programmed load and random tests and the merits of cumulative damage hypotheses. New results dealing with these problems are presented, and due recognition is given to the pattern of the load spectrum as an essential, differentiating factor. Various types of random tests with analog or digital demand value input are discussed with respect to their advantages and disadvantages. On the basis of such tests, new concepts are derived for continued research in this area. O.H.

A70-39643 # **A comparative study of demand forecasting techniques for military helicopter spare parts.** Robert E. Markland (Missouri, University, St. Louis, Mo.). *Naval Research Logistics Quarterly,* vol. 17, Mar. 1970, p. 103-119. 43 refs.

This paper deals with techniques applicable to predicting spare parts demand for military helicopters. The military helicopter is a distinct weapons system, whose unique configuration may preclude the direct application of forecasting techniques which have proved successful for other weapon systems. Furthermore, although the military helicopter has become extremely important tactically in modern warfare, it has received scant attention in terms of research concerning its supply support. Specifically, this paper summarizes research done to measure and compare the forecasting accuracy of six mathematical models, as they were applied to three prominent military helicopters. In addition, the paper describes attempts that were made to define, where possible, the conditions under which a specific forecasting technique might be applicable. In general, it is shown that the most accurate set of helicopter spare parts demand forecasts are produced by a second order polynomial exponential

smoothing model. This model is observed to have most accurately described the highly volatile, and upward-trended demand time series which were the subject of the study. (Author)

A70-39644 What does development time cost (Wieviel kostet Entwicklungszeit). W. Herbst (McDonnell Douglas Corp., St. Louis, Mo.). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, July-Aug. 1970, p. 179-181. 6 refs. In German.

Discussion of the cost and time optimization possibilities afforded by the application of network planning techniques to development projects. The network planning of complex aircraft development projects is considered. The definition of a cost function for each network activity is shown to make it possible to determine and optimize the additional cost of stretching or compressing the development program and to level resources as a function of elapsed time. A simple example is used to demonstrate the fundamental relations between program characteristics. Finally, some practical implementation problems of the technique of network planning are pointed out. M.V.E.

A70-39647 Information technology advances in aircraft maintenance with the aid of aircraft integrated data systems (Fortschritte in der Informationstechnologie für die Flugzeugwartung mit Hilfe von integrierten Borddatensystemen). E. L. Takacs (Austrian Airlines, Vienna, Austria). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, July-Aug. 1970, p. 188-191. 7 refs. In German.

Discussion of the significance of aircraft integrated data systems (AIDS) for aircraft maintenance. It is pointed out that, in developing a new maintenance concept to reduce costs and increase safety, information is of great importance since it represents the raw material for maintenance management. It is shown how current computer technology opens the possibility of monitoring aircraft systems and recording parametric data in the operational environment during flight by means of AIDS. Maintenance-significant information can be retrieved either during flight or on the ground after landing, and selection of the retrieval mode should be based on an accurate cost analysis. M.V.E.

A70-39648 Some new considerations in the design of jet engine combustion chambers (Neuere Gesichtspunkte für die Auslegung von Brennkammern in Luftstrahltriebwerken). H. J. Höper (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, July-Aug. 1970, p. 191-194. 6 refs. In German.

Continued discussion of design criteria of jet engine combustors, and review of related current trends and problems. Leading combustion theories are examined, particularly the reaction-rate and reaction-efficiency theories. The theoretical and practical aspects of translating these theories into applications of optimal combustion efficiency are reviewed, along with the design and performance characteristics of the various combustion chamber types. Special attention is given to the heat-transfer, cooling, and engine-material problems associated with the current trends towards higher flight altitudes, inlet and outlet temperatures, and inlet pressures. M.V.E.

A70-39667 Propulsion. *Space/Aeronautics,* vol. 54, July 1970, p. 21-25.

Discussion of progress made in the further development of aerospace propulsion systems taking also into consideration important problems which still have to be solved. The unraveling of the turbofan's aerodynamic interactions is discussed and the promise of space storable propellants made possible by mild cryogenics is considered. Problems connected with excessive throat erosion are examined, and the development of systems with long-burning-time solids for 'gentle' spacecraft propulsion is reported. A biowaste resistojet for controlling space station attitude is discussed. G.R.

A70-39668 Electronics. *Space/Aeronautics,* vol. 54, July 1970, p. 29-31, 33, 35.

Discussion of present trends in electronics. The development of fly-by-wire systems is considered and power-by-wire approaches to replace the conventional hydraulic lines in an aircraft are examined. The connection of ATC's future with area navigation is investigated. High-precision pointing systems built around star trackers for attitude control on space missions are considered. Central processors for handling most onboard data management are discussed. G.R.

A70-39669 Accessory systems. *Space/Aeronautics,* vol. 54, July 1970, p. 37-40.

Discussion of changes in aircraft accessory systems and spacecraft power systems. The development of actuators developed for fly-by-wire control systems is discussed taking into account trends to redundancy and to integration of valving and servo. The increasing importance of pyrotechnic devices for aircraft applications is examined. The development of a large, compactly stowable solar array for providing power in space is considered. G.R.

A70-39673 # Design increments in planning a regional airport. Jack D. Downey. *Logistics Spectrum,* vol. 4, Summer 1970, p. 26-29.

Description of the Dallas-Fort Worth regional hub airport design, characterized by novel concepts in airport planning. It is shown that the design is on the verge of a triple breakthrough in the development of worldwide air transport hub facilities: the high-speed spine roadway with localized spin-off parking; the circular concept of the terminal facilities with its continuous flow capability for optimum passenger and aircraft access; and a mechanically controlled high-speed interterminal system for passengers and baggage. The results of this design will be evident in the provision of a restraint-free airport, capable of 178 instrument operations per peak hour, located in the center of the North, South and East, West international routes. The airport will have the largest passenger terminal complex in the world when it is completed, and will make the Dallas-Fort Worth region a major international transportation hub. O.H.

A70-39699 # A simplified method for determining stagnation-point heat transfer to an elliptical model. Donald D. McBride (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Spacecraft and Rockets,* vol. 7, Aug. 1970, p. 1010-1012. 9 refs. AEC-supported research.

Analytical investigation of the effect of blunting of an elliptically shaped body on the stagnation point heat-transfer coefficient. A method for obtaining a 'no-blowing' heat-transfer coefficient from the stagnation pressure, the model radius of curvature at the stagnation point, and the model diameter is outlined. A variation of the effective radius with nose radius and Mach number is derived which makes it possible to solve the equation for a no-blowing stagnation point heat-transfer coefficient. O.H.

A70-39700 * # Laminar heating in interior corners at Mach 19. J. Wayne Keyes and Ralph D. Watson (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *Journal of Spacecraft and Rockets,* vol. 7, Aug. 1970, p. 1012, 1013. 7 refs.

Study of heat transfer and surface oil flow on symmetrical and asymmetrical corner configurations, such as at wing-fuselage junctures and in two-dimensional inlets of hypersonic vehicles, at Mach 19 in the Langley 22 in. helium tunnel at a freestream Reynolds number of approximately 1,500,000. The heat transfer data obtained for three different corner configurations are summarized and analyzed. In general, the results show that the surface flowfield and heating in asymmetrical corners are similar to that observed in symmetrical corners. O.H.

A70-39701 * # **Incipient cross-stream liquid jet atomization at high altitude and velocity.** Paul B. Gooderum and Dennis M. Bushnell (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *Journal of Spacecraft and Rockets,* vol. 7, Aug. 1970, p. 1014-1017. 17 refs.

Investigation of the aerodynamic breakup of liquid jets exiting an orifice in a reentry vehicle into a gaseous crossflow, the dynamic pressure of which is greater than a critical value. The variation of the critical Weber number with Knudsen number was examined experimentally for various liquid sprays and crossflows in a tunnel with a conical nozzle producing various Mach numbers and static densities. The results indicate that the boundary of aerodynamic breakup is a straight line and that there is no effect of Knudsen number or high local static temperature on the critical Weber number for primary atomization of liquid jets injected into a gaseous crossflow. O.H.

A70-39702 # **Effect of a spike on the drag and on the aerodynamic stability of blunt bodies in supersonic flow.** Carlos Zorea (Ministry of Defence, Scientific Dept., Tel Aviv, Israel) and Josef Rom (Technion - Israel Institute of Technology, Haifa, Israel). *Journal of Spacecraft and Rockets,* vol. 7, Aug. 1970, p. 1017-1019. 16 refs.

Investigation of the effect of a spike on the nose drag and the static stability of blunt bodies at Mach numbers 1.5 and 2.25 at various Reynolds numbers and spike lengths. A method for estimating the critical spike length is presented, and the results are plotted graphically. They indicate that there exists an optimum spike length for drag reduction at zero angle of attack, defined as the critical length, that the drag reduction caused by the spike diminishes as the angle of attack is increased, and that the static stability of the blunt configuration is unaffected by the addition of the spike. O.H.

A70-39704 # **Subsonic-hypersonic aerodynamic characteristics of several bodies of revolution.** Amado A. Trujillo (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Spacecraft and Rockets,* vol. 7, Aug. 1970, p. 1022, 1023. 8 refs. AEC-supported research.

Summarization of aerodynamic characteristics for four low-drag, high-volume reentry vehicle shapes. Extensive work in this field done by several authors is reviewed. Static stability characteristics and equations defining model shapes for the four fineness ratio 3 models investigated are presented, and the experimentally determined zero degree angle-of-attack freebody drag data for the Mach number range 4.0 to 11.4 are plotted as a function of Reynolds number. O.H.

A70-39716 # **Iterative method of determining the flight characteristics and performance of single-rotor helicopters (Iteracyjna metoda wyznaczania charakterystyk lotnych i osiągów śmigłowców jednowirnikowych).** Lechosław Kalinowski. *Instytut Lotnictwa, Prace,* no. 41, 1970, p. 3-36. 6 refs. In Polish.

Description of methods for calculating the flight characteristics of classical, high-performance, and compound helicopters over the entire speed range in steady inclined flight. The methods were designed for use with digital computers. Allowance is made for all the basic phenomena occurring in helicopter flight, and the results take into account the wobble plate steering margin, compressibility, separation, ground effects, and autorotation. Performance evaluation is based on repetition of calculations for different velocities, heights, and ascent angles. Formulas and relationships are given for calculating the aerodynamic forces and moments of different helicopter sections, attitude, power required for lift and propulsion, and relative positions of different elements. T.M.

A70-39720 **Aircraft gas turbine engine exhaust smoke measurement.** *SAE Aerospace Recommended Practice,* ARP 1179, May 4, 1970. 8 p.

Description of the recommended practice for standardization of test equipment and procedures for measuring the smoke emission from aircraft gas turbine engines. The recommendations are divided into the following sections: (1) definitions and terminology, (2) equipment, (3) test procedures, (4) information and data to be recorded, (5) data reduction and analysis, and (6) presentation of results. Z.W.

A70-39724 **Electromagnetic interference on aircraft from jet engine charging.** *SAE Aerospace Information Report,* AIR 1147, June 1, 1970. 2 p. 9 refs.

Consideration of jet engine charging as a source of precipitation static radio interference which has become a significant problem requiring definite provisions for discharge. Charging as high as 800 microamps with water injection has been observed with maximum takeoff power on the large jet engines of transport aircraft. In general, the effects on the aircraft communication system are similar to those from charging by frictional contact of the aircraft with atmospheric particles and, as such, can be handled by use of static wick dischargers. Studies have been carried out as to possible methods of preventing engine charging by fuel additives. Another alternative is the use of conducting probes in the hot exhaust efflux for ion collection. A third possibility is to actively discharge the aircraft through a special corona point assembly connected to a high voltage power supply. F.R.L.

A70-39733 # **Theory of an aircraft vertical gyro with a hydraulic damping device (K teorii aviatsionnoi girovertikali s gidravlicheskim uspokoitelem).** R. G. Pinelis (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Moskovskii Universitet, Vestnik, Seriia I - Matematika, Mekhanika,* vol. 25, May-June 1970, p. 75-81. 6 refs. In Russian.

Solution of the problem of determining the conditions of limitation of ballistic deviations of an aircraft vertical gyro if vertical movements of the aircraft are taken into account and damping is introduced in the instrument design. In contrast to a previous analysis of this problem (Pinelis, 1969), where damping was introduced into the device with the aid of a radial correction system described by Ishlinskii (1963), in the present case it is assumed that the natural vibrations of the vertical gyro are damped with the aid of a hydraulic damping device. Also, in accordance with Roitenberg (1966), it is assumed that the angular velocity of rotation of the gyroscope rotor is not constant but varies according to a certain law. In taking into account the effect of the hydraulic damper, it is assumed that the gimbal suspension of the gyropendulum is mounted in a stabilized ring suspended in an independent gimbal suspension and that the perpendicular to the plane of this ring is kept continuously coinciding with the axis of the gyroscope rotor by means of servomotors. A.B.K.

A70-39767 # **A complete system of equations for Sedov's integral (Pro odnu povnu sistemu rivnian' integrala Sedova).** V. P. Fil'chakova (Akademiia Nauk Ukrains'koi RSR, Institut Matematiki, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 32, June 1970, p. 508-512. In Ukrainian.

Derivation of a complete system of n + 1 equations for determining the constants in Sedov's integral which realizes conformal mapping of a given polygonal airfoil lattice onto a Rieman surface in a domain within a system of concentric circles of unit radius. The system obtained includes an equation for the sides of a polygon, a periodicity condition (consisting of two real equations), and a condition for enclosing a polygon in a lattice (also consisting of two real equations). V.P.

A70-39771 # **Calculation of flows past bodies in the presence of strong blowing (Rozrakhunok obtikannia til pri naiavnosti sil'nogo vduvu).** A. P. Komashenko (Kiivs'kii Derzhavnii Universitet, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 32, June 1970, p. 535-537. In Ukrainian.

Analysis showing that the range of applicability of similar solutions of supersonic flow problems for slender bodies with blowing can be extended by introducing a new asymptotic expansion at the leading edge of a thin plate. A system of equations (and boundary conditions) describing the flow at the plate leading edge is derived, and the corresponding geometrical and gas dynamic parameters are determined. V.P.

A70-39801 **Aerothermodynamics (Aerotermodinamika).** Edited by L. G. Loitsianskii. Leningrad, Izdatel'stvo Mashinostroenie (Leningradskii Politekhnicheskii Institut, Trudy, No. 313), 1970. 152 p. In Russian.

Contents:

Preface (Predislovie), p. 3, 4.

Hydrogasdynamic processes in a boundary layer, jets, and ducts (Gidrogazodinamicheskie protsessy v pogranichnom sloe, struiakh i kanalakh).

Laminar boundary layer on a plate with arbitrary catalytic properties in the presence of vibrational-dissociative relaxation of the gas (Laminarnyi pogranichnyi sloi na plastine s proizvol'nymi kataliticheskimi svoistvami pri nalichii kolebatel'no-dissotsiatsionnoi relaksatsii gaza). S. B. Koleshko and Iu. P. Lun'kin, p. 5-12. 6 refs.

Finite difference scheme for calculating steady flows behind a receding shock wave (Konechno-raznostnaia skhema dlia rascheta ustanovivshikhsia techenii za otoshedshei udarnoi volnoi). I. M. Breev and F. D. Popov, p. 13-20. 5 refs.

Application of the method of characteristics to the solution of universal equations for a laminar boundary layer (Primenenie metoda kharakteristik k resheniiu universal'nykh uravnenii laminarnogo pogranichnogo sloia). V. E. Koriakin, p. 20-28.

Two-parameter solution of the equations for a laminar boundary layer in a gas (Dvukhparametricheskoe reshenie uravnenii laminarnogo pogranichnogo sloia v gaze). V. I. Liubenov, p. 28-35. 7 refs.

Laminar boundary layer in a high-velocity gas flow (Laminarnyi pogranichnyi sloi v gazovom potoke bol'shikh skorostei). V. I. Liubenov, p. 35-44. 10 refs.

Numerical solution of equations in the two-parameter theory of the boundary layer (Chislennoe reshenie uravnenii dvukhparametricheskoi teorii pogranichnogo sloia). E. F. Ozerova and L. M. Simuni, p. 44-53.

Influence of the multidimensionality of the radiation field on the jet flow of a radiating gas (Vliianie neodnomernosti polia izlucheniia na struinoe techenie izluchaiushchego gaza). Iu. P. Golovachev, p. 53-59. 6 refs.

Asymptotic turbulent boundary layer on a free stream boundary (Asimptoticheskii turbulentnyi pogranichnyi sloia na granitse svobodnoi strui). A. I. Kamenetskii, p. 59-62.

Empirical method of calculating the turbulent boundary layer in an incompressible fluid (Empiricheskii metod rascheta turbulentnogo pogranichnogo sloia v neszhimaemoi zhidkosti). A. I. Kamenetskii, p. 62-67. 10 refs.

Heat exchange at large Prandtl numbers in a steady turbulent flow (Teploobmen pri bol'shikh chislakh Prandtlia v ustanovivshemsia turbulentnom potoke). N. P. Snegova, p. 67-71. 7 refs.

Turbulent boundary layer in a multicomponent mixture on a chemically active surface (Turbulentnyi pogranichnyi sloi v mnogokomponentnoi smesi na khimicheski aktivnoi poverkhnosti). V. M. Cherniakov, p. 72-82. 10 refs.

Heat and mass transfer in a turbulent jet system during diffusion combustion (Teplo- i massoobmen v sisteme turbulentnykh strui pri diffuzionnom gorenii). N. G. Gontsov, p. 82-89.

Turbulent boundary layer on a cone in a supersonic flow in the presence of an inflowing foreign substance (Turbulentnyi pogranichnyi sloi na konuse v sverkhzvukovom potoke pri nalichii vvoda inorodnogo veshchestva). M. Kh. Strelets, p. 90, 91.

Turbulent flow of liquid in an anisotropically rough duct (Turbulentnoe techenie zhidkosti v anizotropno-sherekhovatom kanale). N. I. Akatnov and V. F. Tul'vert, p. 92-97.

Interaction between an acoustic perturbation and a shock wave (Vzaimodeistvie akusticheskogo vozmushcheniia s udarnoi volnoi). A. P. Skabin and V. A. Tarasiuk, p. 97-101. I

A radial gas bearing with an annular injection line (Radial'nyi gazovyi podshipnik s kol'tsevoi liniei nadduva). N. D. Zablotskii, p. 101-105.

A method of constructing an asymptotic solution to problems of gas lubrication with injection (Odin metod postroeniia asimptoticheskogo resheniia zadach gazovoi smazki s nadduvom). N. D. Zablotskii, p. 106-110. 7 refs.

Determination of the angular rigidity of a cylindrical gas suspension (Opredelenie uglovoi zhestkosti tsilindricheskogo gazovogo podvesa). L. S. Osep'ian and I. E. Sipenkov, p. 110-116.

Effect of unsteadiness on the bearing capacity of a sectoral gas bearing (Vliianie nestatsionarnosti na nesushchuiu sposobnost' sektornogo gazovogo podshipnika). B. S. Grigor'ev, p. 117-122.

Experimental and applied hydroaerodynamics (Eksperimental'naia i prikladnaia gidroaerodinamika).

Experimental investigation of the influence of polyacrylamide additions on friction drag for flow in a gap between coaxial cylinders (Eksperimental'noe issledovanie vliianiia dobavok poliakrilamida na soprotivlenie treniia pri techenii v zazore mezhdu koaksial'nymi tsilindrami). Iu. F. Ivaniuta and N. G. Khislavskaia, p. 123-127.

Propagation of shock waves in a pipeline with a fast-acting valve (Rasprostranenie udarnykh voln v truboprovode s bystrodeistvuiushchim klapanom). Iu. I. Isakov and R. L. Petrov, p. 127-130.

A shock tube with a diffuser near the diaphragm (Udarnaia truba s diffuzorom vblizi diafragmy). V. V. Grigor'ev, S. N. Isakov, and B. A. Kuklin, p. 131-136.

Fan-shaped jet near a cylinder in transverse flow (Veernaia struia vblizi tsilindra v poperechnom potoke). O. N. Bushmarin, A. A. Zhurin, L. G. Popov, and V. V. Iakovenko, p. 136-142.

Experimental investigation of a twisted jet issuing from a circular slot at the base of a semiinfinite cylinder (Eksperimental'noe issledovanie zakruchennoi strui, vytekaiushchei iz kol'tsevoi shcheli u osnovaniia polubeskonechnogo tsilindra). O. N. Bushmarin, A. M. Sukachev, and V. V. Ikovenko, p. 143-147.

A70-39814 # **Turbulent boundary layer on a cone in a supersonic flow in the presence of an inflowing foreign substance (Turbulentnyi pogranichnyi sloi na konuse v sverkhzvukovom potoke pri nalichii vvoda inorodnogo veshchestva).** M. Kh. Strelets. In: Aerothermodynamics (Aerotermodinamika). Edited by L. G. Loitsianskii. Leningrad, Izdatel'stvo Mashinostroenie (Leningradskii Politekhnicheskii Institut, Trudy, No. 313), 1970, p. 90, 91. In Russian.

Derivation of a rule for converting the local coefficient of surface friction for a plate in the presence of an inflowing foreign substance to the corresponding coefficient for a cone in a supersonic flow at zero angle of attack. It is shown that Van Driest's rule (1960) regarding a turbulent boundary layer on a cone in a supersonic flow can be generalized to the case where a material differing in physical properties from the material of the main flow is introduced into the boundary layer. A.B.K.

A70-39838 # **Invariant system for automatic stabilization of a vertical takeoff and landing (VTOL) aircraft in steady flight (Invariantnaia sistema avtomaticheskoi stabilizatsii samoleta vertikal'nogo vzleta i posadki (SVVP) na ustanovivshemsia rezhime poleta).** R. M. Maresh and V. T. Vigovskii. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 168-176. In Russian.

Investigation of the possibility of using rotor systems and jet engines, primarily intended for takeoff and landing operations, to ensure invariance of a VTOL aircraft's coordinates during automatic control of longitudinal motion in the presence of turbulence and internal disturbances. Equations of disturbed longitudinal motion are derived for a VTOL aircraft in horizontal cruise flight. The coordinates whose invariance must be ensured consist of the flight altitude and pitch angle. Conditions for invariance are formulated, and a structural diagram of the required control system is explained. Also described is an invariant control system for aircraft stabilization during load release in flight. The disturbances which act in this situation are grouped into those associated with the shift in center of gravity and those arising from a change in aircraft weight. T.M.

A70-39839 # **Application of methods of invariance theory to the development of high-frequency automatic aircraft flight control systems (Primenenie metodov teorii invariantnosti dlia sozdaniia vysokotochnykh sistem avtomaticheskogo upravleniia poletom samoleta).** A. M. Fal' and N. A. Iatskov. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 177-182. 8 refs. In Russian.

Discussion of several methods of accurate aircraft stabilization during lateral motion during the flight in a perturbed atmosphere. The possibility of compensating for the effect of atmospheric perturbations is considered. Invariant systems of deflection control and composite invariant systems are examined and analyzed. O.H.

A70-39842 # **Two methods for cross wind compensation in an automatic aircraft stabilization system (O dvukh metodakh kompensatsii bokovogo vetra v avtomaticheskoi sisteme stabilizatsii samoleta).** A. M. Rudin. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 197-204. In Russian.

Analysis of two automatic control systems for ensuring the monotonous approach of an aircraft to a chosen landing path with subsequent stabilization on this trajectory in the presence of disturbances arising from radio noise in the beacon equipment and the action of cross wind. One system is based on internal compensation for the cross-wind disturbance with noise suppression by filters in the control loop. Conditions for cross-wind compensation are obtained from the transfer function relating this disturbance with the controlled coordinate. This system requires a flexible feedback system with respect to the course signal. The second method ensures invariance with respect to cross-wind disturbances by a specified arrangement of internal feedbacks in the system. This method involves autonomous measurement of the cross-wind disturbance, and its destabilizing influence is countered by the formation of an appropriate control signal. Doppler measurements and an inertial gyro platform provide data for determining the drift angle as an indication of the disturbance. T.M.

A70-39843 # **Invariant automatic air conditioning system in a hermetically sealed aircraft cabin (Invariantnaia sistema avtomaticheskogo konditsionirovaniia vozdukha v germeticheskoi kabine samoleta).** G. D. Grishunin and N. M. Chumakov. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 204-212. In Russian.

Analysis of the problem of improving the precision of automatic air conditioning systems for sealed aircraft cabins in order to meet the stringent requirements imposed by modern flight speeds, ascent rates, altitudes, and durations. Equations are given for the dynamics of the cabin which is treated as a multivariable plant with interacting parameters. Control laws are derived for air pressure, temperature, and humidity, and attention is given to the problem of controlling each of these parameters individually without adverse effects on the others. The required feedback and compensation systems are considered to be technically feasible and present no serious problems. T.M.

A70-39844 # **Structural synthesis of invariant systems for automatic control of plant motion along a given trajectory (Strukturnyi sintez invariantnykh sistem avtomaticheskogo upravleniia dvizheniem ob'ekta vdol' zadannoi traektorii).** L. M. Boichuk. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 221-227. 8 refs. In Russian.

Structural synthesis of invariant systems for automatic control of plant motion, using an inverse method which does not require linearization of the equations of motion and which accounts in a more complete manner for the real properties of the plant. The method is based on an initial formulation of the desired differential equation of motion with subsequent determination of the controls required to satisfy this equation. If the initially formulated equation of motion does not contain disturbances, then the forced solution component will not be dependent on them and invariance of the synthesized system can be achieved. Differential equations of motion are derived for the center of mass of an object moving near a nonrotating earth with spherically symmetrical gravity and atmosphere. Control laws are derived for the required thrust and angle of attack, and programs are described for structural synthesis of the control system. The approach requires the measurement of all state variables for the plant and knowledge of all components in the equations for plant dynamics in order to formulate the initial differential equation of motion. T.M.

A70-39845 # **Stabilization of the coordinates of an elastic aircraft during flight in a perturbed atmosphere (Stabilizatsiia koordinat uprugogo samoleta pri polete v vozmushchennoi atmo-**

sfere). V. V. Udilov. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 227-231. In Russian.

Analysis of an invariant autopilot control system during flight in a turbulent atmosphere with allowance for the elastic properties of the aircraft. The problem involves automatic control of the height and pitch angle of a canard-type aircraft; the flight dynamics are described by a system of linear differential equations with constant coefficients. The effects of external disturbances are described both for the aircraft's positional coordinates and for coordinates characterizing flexural deformations. Conditions for the invariance of these coordinates with respect to the disturbance are formulated, and a control law is given which assumes the presence of information for both a rigid frame of the aircraft and the elastic deformations of the fuselage. Numerical calculations were performed to evaluate the effects of autopilot inertia on the accuracy of compensation for the external disturbance. T.M.

A70-39847 # **Relation between invariance conditions and the characteristics of a multidimensional control system for a turboramjet engine (O sviazi uslovii invariantnosti s kharakteristikami mnogomernoi sistemy upravleniia TRDF).** V. A. Bodner and Iu. A. Riazanov. In: Application of invariant automatic control systems; All-Union Conference on Invariance Theory and Its Use in Automatic Control Systems, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Proceedings. Volume 2 (Primenenie invariantnykh sistem avtomaticheskogo upravleniia; Vsesoiuznoe Soveshchanie po Teorii Invariantnosti i ee Primeneniiu v Sistemakh Avtomaticheskogo Upravleniia, 3rd, Kiev, Ukrainian SSR, May 31-June 5, 1966, Trudy. Volume 2). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 310-317. In Russian.

Determination of the relationship between invariance conditions and the characteristics of a multivariable control system for a turboramjet engine under the transient conditions of startup and ascent to nominal altitude. The study is based on the synthesis of system characteristics by approximating the optimal transfer functions. The analysis shows that stable operation of the control system (with a predetermined control quality) requires regulation of the parameters of units controlling the gas temperature and the engine speed during startup and ascent to altitude. The proposed method of analysis makes it possible to determine scaling factors for gas temperature and engine speed deviations during transient flight conditions; these factors characterize the invariance of the system with respect to disturbances and improper control inputs. T.M.

A70-39900 * # **Aerodynamics of slender bodies and wing-body combinations at a free-stream Mach number equal to one - Theory and experimental evaluation.** John R. Spreiter (Stanford University, Stanford, Calif.) and Stephen S. Stahara (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-798.* 12 p. 22 refs. Contract No. NAS 2-5410.

Description of some recent theoretical results obtained for steady inviscid transonic flows around a variety of three-dimensional bodies of aerodynamic interest. The local linearization method for axisymmetric flow is combined with the transonic equivalence rule to calculate pressure distributions for free-stream Mach number one on the surface and in the near flow field of a number of slender, pointed, axisymmetric and nonaxisymmetric bodies, including simple wing-body combinations, for both nonlifting and lifting conditions. Comparisons with experimental results exhibit good agreement, except near the rear of some of the bodies, particularly those with maximum thickness far forward or on lifting bodies at larger angles of attack. An examination of the causes for these discrepancies suggests that the former is probably due primarily to wind-tunnel wall interference, and the latter to boundary-layer separation and vortex generation. M.M.

A70-39913 # **Synthesis of load loops with a random force signal for endurance testing of aircraft structures (Sintez tsepei nagruzki so sluchainym silovym signalom dlia ispytaniia aviakonstruktsii na prochnost').** Ia. Dreksler and Ia. Gavel. In: Identification and equipment for statistical investigations; All-Union Symposium for Statistical Problems in Technical Automation, 1st, Moscow, USSR, February 14-18, 1967, Proceedings (Identifikatsiia i apparatura dlia statisticheskikh issledovanii; Vsesoiuznyi Simpozium po Statisticheskim Problemam v Tekhnicheskoi Kibernetike, 1st, Moscow, USSR, February 14-18, 1967, Trudy). Edited by V. S. Pugachev. Moscow, Izdatel'stvo Nauka, 1970, p. 271-280. In Russian.

Investigation of the problem of varying the probability of rectangular energy pulses at the input of a hydraulic amplifier in such a manner as to ensure an output signal distribution (stresses at the critical point of the test element) corresponding to a given test program. The hydraulic loading loop is synthesized by choosing any of 15 structural elements which were previously tested in actual operation. Optimization during selection of elements was ensured by using certain principles of strategic games theory with two participants. Test results for the loading loop show the dependence of the output signal's probability density on the probability of occurrence and repetition rate of energy pulses. T.M.

A70-39923 # **Assessment of the radiation hazards of supersonic transport.** L. Elias (National Aeronautical Establishment, Ottawa, Canada). *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin,* no. 1, 1970, p. 1-33. 15 refs.

Assessment of the radiation hazard involved in projected supersonic transport (SST) operation, on the basis of current knowledge of the environment and biological dose/effect relations. The analysis indicates that to the average passenger the risk of cancer induction is small, less than 1 in a million, as is the probability of damage to the reproductive cells affecting his immediate offspring. The overall detriment to the population as a result of genetic damage distributed by the passengers of the supersonic transport is estimated to be less than 0.003% of the natural incidence mutation. The radiation dose that could be received from a possible encounter with a violent solar outburst of cosmic rays, though a remote possibility (the frequency of giant 'relativistic' flares may be one or two per decade), could well exceed normally acceptable limits. The development of a flare-warning system and the formulation of flight avoidance procedures appear to be feasible and would overcome this problem. A comparison of SST operation with present subsonic operation at 35,000 to 40,000 feet shows that the SST would be exposed to a higher level of radiation, but for a shorter period of time. Over the same route the dose received per mile is approximately the same in the two cases. Hence passengers would be exposed to no greater radiation hazards than under current subsonic jet operation. Crews could be protected through restriction of duty time on polar routes to 200 to 300 hr/yr. M.V.E.

A70-39966 **Beta III titanium for fasteners.** John B. Guernsey (Colt Industries, Inc., Pittsburgh, Pa.). *Metals Engineering Quarterly,* vol. 10, Aug. 1970, p. 10-13.

Description of the properties and applications of a new Beta III Ti-11.5Mo-6Zr-4.5Ti alloy. This alloy exhibits a previously unobtainable combination of properties. It is cold formable, heat treatable to high strengths, tough, stable in elevated temperature service and very resistant to stress-corrosion cracking. These attributes, particularly the cold formability, make it a very attractive material for aircraft fasteners. Z.W.

A70-39970 Current and prospective applications for beryllium. Emory L. Terry (Brush Beryllium Co., Cleveland, Ohio). *(American Society for Metals, Golden Gate Metals Conference, San Francisco, Calif., Sept. 25-27, 1968, Paper GG8-10.2.) Metals Engineering Quarterly*, vol. 10, Aug. 1970, p. 53-56.

Tabulation of the known production, development and potential uses of beryllium. The most important material characteristics and the forms of beryllium are listed for each of the applications. The material design requirements are classified according to thermal, mechanical, and nuclear properties. Special attention is given to the development of aircraft brake disks of beryllium. Z.W.

A70-40001 * Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970. 221 p. $10.00.

Contents:

Combustion generators.

Some observations of the aerodynamics of a large MHD generator channel. W. Luchuk (ARO, Inc., Arnold Air Force Station, Tenn.), p. 3, 4.

Comparison of experimental and analytical results for a 20-MW combustion-driven Hall configuration MHD generator. O. K. Sonju, J. Teno (Avco Everett Research Laboratory, Everett, Mass.), and T. R. Brogan, p. 5-10. 15 refs.

The performance of a family of diagonal conducting wall MHD open cycle generators. J. B. Dicks, Y. C. L. Wu, L. W. Crawford, J. K. Koester, J. W. Muehlhauser, L. Edwards, P. Chang, and J. W. Stephens (Tennessee, University, Tullahoma, Tenn.), p. 16-28. 6 refs.

Electrode size effects in combustion-driven MHD generators. E. S. Rubin and R. H. Eustis (Stanford University, Stanford, Calif.), p. 35-40.

Plasmas and discharges.

A high pressure potassium vapor diode study. N. A. Evans (GE Space Sciences Laboratory, King of Prussia, Pa.), p. 49-53. 11 refs.

Analytical and experimental studies of thermionically emitting electrodes in contact with dense, seeded plasmas. J. K. Koester (Tennessee, University, Tullahoma, Tenn.), M. Sajben, and E. E. Zukoski (California Institute of Technology, Pasadena, Calif.), p. 54-60. 10 refs.

Influence of controlled turbulence on gaseous discharges. S. T. Demetriades, C. D. Maxwell, G. S. Argyropoulos, and G. Fonda-Bonardi (STD Research Corp., Pasadena, Calif.), p. 64-69. 7 refs.

Investigation of the behavior of the discharge and the flow in a homopolar device. H. O. Noeske (General Electric Co., Philadelphia, Pa.), p. 71-74.

Design and operational characteristics of the Langley 20-megawatt plasma accelerator facility. W. R. Weaver, D. R. McFarland, A. F. Carter, and G. P. Wood (NASA, Langley Research Center, Hampton, Va.), p. 77-81. 7 refs.

Closed cycle generators and generator design.

Results of initial subsonic tests in the NASA-Lewis closed loop MHD generator. R. J. Sovie and L. D. Nichols (NASA, Lewis Research Center, Cleveland, Ohio), p. 82-89. 6 refs.

Performance of a large scale, non-equilibrium MHD generator with rare gases. H. B. Zauderer and E. Tate (GE Space Sciences Laboratory, Philadelphia, Pa.), p. 95-100. 7 refs.

Current distribution in conducting wall MHD generators. R. H. Eustis, R. M. Cima, and K. E. Berry (Stanford University, Stanford, Calif.), p. 119-127. 10 refs.

Liquid-metal magnetohydrodynamics.

Liquid-gas separation using impinging two-phase jets. D. Bogdanoff (California Institute of Technology, Pasadena, Calif.), p. 149-153.

Preliminary experimental results from a one-wavelength MHD induction generator. E. S. Pierson (Illinois, University, Chicago, Ill.), p. 161-164.

A nuclear electric propelled spacecraft using a 300 KWe liquid metal magnetohydrodynamic power system. R. M. Bernero, A. S. Jacobsen (General Electric Co., King of Prussia, Pa.), and N. A. Evans (Pennsylvania, University, Philadelphia, Pa.), p. 165-169. 5 refs.

Channel flows and instabilities.

Compressible turbulent boundary layers with MHD effects, electron thermal nonequilibrium, and finite rate ionization. E. J. Felderman and M. D. High (ARO, Inc., Arnold Air Force Station, Tenn.), p. 180-183.

Ionization instabilities in a continuous-electrode generator. R. M. Evans, J. F. Louis, M. Mitchner, and C. H. Kruger (Stanford University, Stanford, Calif.), p. 190-192.

Electrothermal instability in plasmas with current flow parallel to the magnetic field. A. Solbes, T. Nakamura, and J. L. Kerrebrock (MIT, Cambridge, Mass.), p. 209-215. 6 refs.

A70-40002 # Some observations of the aerodynamics of a large MHD generator channel. Wallace Luchuk (ARO, Inc., Arnold Air Force Station, Tenn.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 3, 4.

Consideration of the aerodynamic behavior of two MHD generator and diffuser configurations. The data provide a physical picture of the gasdynamic characteristics of the generator channel through its normal operating range and into the stall. The aerodynamic aspects discussed are the channel pressure distributions up to and into the stall, the stagnation pressure loss measured at the channel exit, and the variation of supersonic nozzle static pressures with power. F.R.L.

A70-40028 # Applications of reinforced plastics in aircraft. Herbert S. Schwartz (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Mechanics of composite materials; Office of Naval Research, Symposium on Naval Structural Mechanics, 5th, Philadelphia, Pa., May 8-10, 1967, Proceedings. Symposium co-sponsored by the General Electric Co. Edited by F. W. Wendt, H. Liebowitz, and N. Perrone. Oxford, Pergamon Press, Ltd., 1970, p. 113-127.

Study of the use of low viscosity polyester resins of the styrene cross-linking type for the lamination of glass fabric so that this material can be used for fabrication of complex shaped parts for aircraft. The first major application of low-pressure glass polyester laminates was in radomes. They have also been used in development of fuselage and wing structures. Some highly stressed reinforced plastic structures which have been used on military aircraft are parts of the empennage, a fairly recent example being the vertical tail structure above the horizontal stabilizer on the Grumman E-2A aircraft. Reinforced plastics are also considered to be suitable for rotating parts, such as helicopter and propeller blades, jet engine compressor blades, and for pressure vessels. F.R.L.

A70-40040 # The application of finite element stiffness matrix for composite structures. M. E. Waddoups and J. R. Blacklock (General Dynamics Corp., Fort Worth, Tex.). In: Mechanics of composite materials; Office of Naval Research, Symposium on Naval Structural Mechanics, 5th, Philadelphia, Pa., May 8-10, 1967, Proceedings. Symposium co-sponsored by the General Electric Co. Edited by F. W. Wendt, H. Liebowitz, and N.

Perrone. Oxford, Pergamon Press, Ltd., 1970, p. 439-453. 7 refs. Contracts No. AF 33(615)-3323; No. AF 33(615)-5257.

Development of a finite stiffness matrix element for use in the solution of plane problems when analyzing a composite material. A major constraint on the development was that the elements were to be embedded into operational General Dynamics matrix methods programs, and therefore the mid-side force deflection coordinates were required for the plate elements. The work was done on an aircraft component design program; thus the final element work could be checked against experimental data. The task was essentially three-phased: material characterization, element formulation and checkout, and structural analysis and test. F.R.L.

A70-40057 # **Summary of composites research in Japan.** Tadashi Tao (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan). In: Mechanics of composite materials; Office of Naval Research, Symposium on Naval Structural Mechanics, 5th, Philadelphia, Pa., May 8-10, 1967, Proceedings. Symposium co-sponsored by the General Electric Co. Edited by F. W. Wendt, H. Liebowitz, and N. Perrone. Oxford, Pergamon Press, Ltd., 1970, p. 841-858.

Brief review of the applications of the FRP material in Japanese aircraft industries. Developmental and fundamental research accomplished on this material in Japan are outlined. FRP has been used in Japan for commercial purposes for many years. It was introduced into space and aeronautical applications with the production of aircraft. The most current findings of this research were reported on before the symposium on 'FRP in Space and Aeronautics' held at the University of Tokyo in 1967. M.M.

A70-40083 Transitioning to the Boeing 747. Ed Mack Miller (United Air Lines, Inc., Chicago, Ill.). *Shell Aviation News,* no. 385, 1970, p. 2-5.

Discussion, from the pilot's point of view, of the transition training necessary to operate the Boeing 747 after having had experience with other jet aircraft. In flight, most maneuvers are executed at about the same speed as the Boeing 707, including takeoffs and landings. Because of the pilot's eyelevel, some 27 ft above the ground, careful attention must be given during transition to flareout level and taxi speeds. The Inertial Navigation System (INS) is described, and some particulars of the the electrical, fuel, and hydraulic systems are given. Systems redundancy is a feature of the aircraft. F.R.L.

A70-40085 # **PCM command control system.** Oscar L. Cooper (National Center for Atmospheric Research, Boulder, Colo.). *Facilities for Atmospheric Research,* Mar. 1970, p. 19-21.

Description of the new improved command control system developed for high altitude ballooning operations. The digital system employs pulse-duration modulation (PDM/FM), but is commonly referred to as a pulse-code-modulation (PCM) system, since it is used together with PCM telemetry. Its range operation, determined by the radio horizon of the ground control equipment, is up to 450 n mi, depending on balloon altitude. The system consists of a ground control equipment located at one or more ground bases for command control of the balloon, an aircraft encoder designed for use aboard a balloon-tracking aircraft, and a balloon-borne unit consisting of a receiver and decoder modules. The design and operation of the system components, in particular that of the balloon package, is explained in detail. O.H.

A70-40109 Airborne measurement of turbulent fluxes. Mikio Miyake, Mark Donelan (British Columbia, University, Vancouver, Canada), and Yasushi Mitsuta (Kyoto University, Kyoto, Japan). *Journal of Geophysical Research,* vol. 75, Aug. 20, 1970, p. 4506-4518. 17 refs. ESSA Contracts No. E 295-68N; No. E 207-69N.

A description is given of an airborne turbulent flux measurement system consisting of fast response sensors to measure two components of the relative wind velocity, temperature, humidity, and aircraft motion. Its performance and attendant data reduction schemes are illustrated with some data obtained during the Barbados oceanographic and meteorological experiment (Bomex) in May 1969. The nature of typical Bomex data is discussed, using spectra and cospectra obtained through this airborne sensor system. (Author)

A70-40110 # **Large rate of normal injection near trailing edge.** L. Ting and A. Ismail (New York University, Bronx, N.Y.). *Quarterly of Applied Mathematics,* vol. 28, July 1970, p. 181-190. 16 refs. Contract No. DA-31-124-ARO(D)-464.

Analysis of a simple model of flow field in order to be able to obtain solutions to the problem of large surface blowing which take into account the upstream and downstream influences when there is a large rate of normal injection near the trailing edge. The model simulates the flow field of injection with a certain density from a reservoir of constant stagnation pressure, through slots normal to a surface moving at supersonic speed. For the analysis, the flow field of injectant is assumed to be inviscid and incompressible, and to be uncoupled from the outer field by imposing a unique relationship between pressure and local inclination along the dividing streamline. F.R.L.

A70-40119 A parameter identification self-adaptive control system. I. S. Parry (RAF, London, England) and Constantine H. Houpis (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). *IEEE Transactions on Automatic Control,* vol. AC-15, Aug. 1970, p. 462-468. 6 refs.

In a high-performance aircraft, changes in Mach number, angle of attack, and altitude can cause a large variation in the short-period transfer function. To provide the pilot with a constant pitch rate control characteristic, an airborne computer with inputs of elevator deflection angle and pitch rate is used to identify and track changes in the elevator effectiveness. Empirical equations are defined to approximate the aircraft time constant, damping factor, and natural frequency as functions of elevator effectiveness in three difference equations, which are iterated to model the aircraft. Parameters in the difference equations are systematically perturbed until the equation, which uses a value of elevator effectiveness intermediate between the values in the other two equations, also has the smallest mean-square error from the actual aircraft response. The value of elevator effectiveness in this intermediate equation is then presumed to be the same as that of the aircraft and is used to set the loop gain to a predetermined suitable value. Simulation with an aircraft whose elevator effectiveness varied over a range of 240:1 showed that the desired loop gain was maintained within a factor of two for both pilot command inputs and for random gust disturbances of a root-mean-square magnitude of 20 ft/s. (Author)

A70-40127 Air cargo terminal analysis. J. D. Stites (Lockheed-Georgia Co., Marietta, Ga.). In: American Society of Mechanical Engineers, American Institute of Aeronautics and Astronautics, and Society of Automotive Engineers, International Forum for Air Cargo, 5th, Frankfurt am Main, West Germany, September 15-17, 1970, Proceedings. Conference co-sponsored by the Verein Deutscher Ingenieure. New York, American Society of Mechanical Engineers, 1970, p. III-1 to III-9.

Quantitative results of an air cargo terminal analysis, which have established that the most significant factor in cargo ground operations costs is the proper use of manpower, and planning efforts must be aimed at minimizing this item. Mechanization is not a large expense item as compared to personnel costs, and therefore should be one of the prime tools for reducing manpower costs. Increased use of preunitized cargo will greatly reduce airline costs. Whether an airline wants to get out of the break bulk business will be a matter of policy and rate structure, but the operating cost differences are most significant. F.R.L.

A70-40128 The air cargo container system and its impact on aircraft requirements. Robert C. Hornburg (McDonnell Douglas Corp., Long Beach, Calif.). In: American Society of Mechanical Engineers, American Institute of Aeronautics and Astronautics, and Society of Automotive Engineers, International Forum for Air Cargo, 5th, Frankfurt am Main, West Germany, September 15-17, 1970, Proceedings. Conference co-sponsored by the Verein Deutscher Ingenieure. New York, American Society of Mechanical Engineers, 1970, p. IV-1 to IV-9.

Discussion of the impact of the development and usage of standard intermodal containers as the probable pattern for the development of a total transportation system. To achieve intermodal capability it is necessary to establish certain standard features and requirements for the module or containers that will be required to interface with all prime transportation movers and a variety of handling equipment. The benefits of containerization are presently being proved in each mode. F.R.L.

A70-40139 Further measurements in a simulated atmospheric boundary layer. J. Counihan (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). *Atmospheric Environment,* vol. 4, May 1970, p. 259-275. 12 refs.

Extensive power spectral and correlation measurements have been made in a simulated neutral atmospheric boundary layer in a wind tunnel. These measurements verify the existing data by showing that the flow in the simulated boundary layer is reasonably representative of real boundary layer flow. Comparison with the available full scale data shows good agreement provided that the height of the atmospheric boundary layer appropriate to rural terrain, which is the type represented here, is assumed to be of the order of 2000 ft. Normally a height of 1000 ft is adopted. It is also shown that measurement of the integral length scales of turbulence may provide a more accurate method of estimating the atmospheric boundary layer height. (Author)

A70-40141 Angular contact ball bearings - Track position at high speeds. K. C. Falcon (Rolls-Royce, Ltd., Bristol, England) and C. Andrew (Bristol, University, Bristol, England). *Institution of Mechanical Engineers, Proceedings,* vol. 184, pt. 1, no. 19, 1969-1970, p. 351-366; Communications, T. F. Blenkiron, R. A. Hobbs, and E. P. Kingsbury, p. 367, 368; Authors' Reply, p. 369. 18 refs. Research supported by the Ministry of Technology.

The track position of the balls on the outer race of an angular contact bearing of the series and size used on the main shaft of aero gas turbine engines was measured in a test rig. The test rig was capable of simulating the operating conditions of the bearing with respect to axial load, inner race speed and high lubricant flow rates. The contact angle, defined by the track position, was deduced from the measurement of sub-surface displacements in the race using a number of small transducers embedded therein. The resulting contact angles were compared with values predicted from a number of unconfirmed theories in current use. At conditions of high speed and low load the correlation is poor; an over-estimation of the cage speed, arising from the false assumption that gross ball slip does not occur, gives rise to an over-estimation of the changes of contact angles from their nominal values. (Author)

A70-40148 Propulsion systems of the future - The combinations of turbojet and ramjet of 'Nord-Aviation' (Propulseurs de l'avenir - Les combinés turbo-stato de Nord-Aviation). M. Gozlan (Société Nationale Industrielle Aérospatiale, Paris, France). *Schweizerische Technische Zeitschrift,* vol. 67, Aug. 20, 1970, p. 657-660. In French.

Discussion of aircraft engine designs of a French aerospace company which combine the advantages of the turbojet and the ramjet. Advantages and drawbacks inherent in turbojet and ramjet engines are examined. Work conducted by 'Nord-Aviation' to arrive at a design which would combine the features of both jet engine types in a way that would ensure optimum performance is discussed. A number of designs is considered including the Griffon 02 and a configuration capable of obtaining a velocity of Mach 3. Problems involved in reaching still higher velocities are investigated taking into account questions of propellant selection. G.R.

A70-40157 Aviation, airports and technology in the 1970s. Peter Masefield (British Airports Authority, London, England). *Science Journal,* vol. 6, Sept. 1970, p. 45-50.

Discussion of the development of aviation in the 1970s taking also into consideration a brief outlook into conditions at the end of the century. The vast continuous increase in air traffic is examined giving attention to traffic concentrations in the major traffic centers of the world. It is expected that the trend towards larger aircraft which began with the Boeing 747 will continue and lead to new aircraft capable of carrying up to 1000 passengers cruising at speeds in excess of Mach 1 but without trailing a sonic boom. It is pointed out that there are reasonable prospects that supersonic flight at great heights will be possible without disturbance on the ground. The development of STOL and VTOL is examined and reduction in aircraft noise is discussed. Safe and convenient transport from anywhere to anywhere on earth, in no more than about 45 min achieved by ballistic transport is predicted for the end of the century. G.R.

A70-40182 # Influence of wing sweep variation on the dynamics of control processes (O vliianii izmeneniia strelovidnosti kryl'ev na dinamiku protsessov upravleniia). B. N. Petrov, Zh. S. Ageev, B. V. Viktorov, and I. S. Ukolov. *Akademiia Nauk SSSR, Izvestiia, Tekhnicheskaia Kibernetika,* May-June 1970, p. 190-195. In Russian.

Description of a mathematical model for the dynamics of the angular motion of a variable geometry (variable wing sweep) aircraft treated as a variable mechanical system with specified relative motions of its elements. Differential equations of angular motion are derived, and an approximate analysis is made for the influence of inertial moments on the dynamic properties of the aircraft as a control plant. Using a hypothetical aircraft as an example, it is shown that the mechanical aspects of sweep variation have little influence on the transient processes in the course and pitch control channels. In the roll control channel, the inertial components have a very strong influence on the damping properties. It is concluded that roll control in these circumstances should be primarily carried out by an autopilot. T.M.

A70-40270 # Hypersonic flow diagnostic studies in a large arc-heated wind tunnel. James L. Folck and Richard T. Smith (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *AIAA Journal,* vol. 8, Aug. 1970, p. 1470-1476. 25 refs.

This study consisted of the experimental investigation of test flow in an arc-heated hypersonic wind tunnel. These tests utilized a high-voltage d.c. arc heater which operated at input powers in excess of 50 Mw and provided reservoir pressures ranging from 100 to 1500 psi and bulk enthalpies from 1500 to 4000 Btu/lb. Local freestream measurements of Pitot pressure, mass flux, stagnation point heat-transfer rate, and wall static pressures were obtained at the exit of a nominal 2-ft-diam conical nozzle. Stagnation enthalpy profiles at the nozzle exit became peaked at high stagnation pressures. From these data, centerline enthalpies as high as 6500 Btu/lb were indicated in the flow. Selective comparisons between theory and experiment are presented. At a reservoir enthalpy of approximately 2500 Btu/lb and for stagnation pressures in excess of 500 psi, the expanded flow data were in good agreement with equilibrium expansion theory. However, below 500 psi, the data compared more closely with non-equilibrium theory with the flow frozen downstream of the nozzle throat. (Author)

A70-40271 # **Effects of flow unsteadiness on hypersonic wind tunnel spectroscopic diagnostics.** Thomas M. Weeks (USAF, Flight Dynamics Laboratory Wright-Patterson AFB, Ohio). *(American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 4th, Cincinnati, Ohio, Apr. 28-30, 1969, Paper 69-331.) AIAA Journal,* vol. 8, Aug. 1970, p. 1478-1482. 10 refs.

Analysis of the nonlinear effects of time-varying flow properties on the interpretation of spectroscopic measurements. Both direct-emission as well as electron-beam techniques are considered. A method based on this analysis is evolved whereby both average and mean square fluctuating temperatures can be obtained using conventional instrumentation. The method is applied to several selected experimental cases cited in the literature, including recent arc-heated hypersonic wind tunnel electron beam measurements. The theory is extended to include species number density fluctuations when temperature fluctuations are also present. (Author)

A70-40276 # **Prediction of the turbulent near-wake of a symmetrical aerofoil.** P. Bradshaw (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *AIAA Journal,* vol. 8, Aug. 1970, p. 1507, 1508. 7 refs.

Calculation of the turbulent near-wake of a symmetrical airfoil, treating the presence of a trailing edge as an extreme case of a disturbance giving rise to a new inner boundary layer. A simple 'mixing length' fit to Chevray's and Kovasznay's (1969) wake measurements (including shear stress profiles) is made, resulting in a determination of a 'universal' constant in the wake mixing length formula for the inner wake. This 'mixing length' fit is valid far enough downstream for displacement surface calculations. T.M.

A70-40280 # **Transient behavior of charring ablators.** Jay R. Roland (USAF, Washington, D.C.) and Martin C. Jischke (Oklahoma, University, Norman, Okla.). *AIAA Journal,* vol. 8, Aug. 1970, p. 1516-1518.

Study of the transient behavior of charring ablators on the basis of a theoretical calculation involving a one-dimensional transient heat-transfer model. The decomposition and chemical interactions of the original ablator material are characterized in the model by a constant temperature decomposition, absorption of heat (heat of pyrolysis), yielding of a residue matrix (char), and evolving gaseous products (pyrolysis gases). The constant-temperature decomposition model appears to predict well the gross behavior of charring ablators. Homogeneous combustion and aerodynamic blocking are included through use of homogeneous combustion and blockage factors. G.R.

A70-40282 # **Drag of streamers at subsonic speeds.** R. K. Fancett and W. A. Clayden (Royal Armament Research and Development Establishment, Sevenoaks, Kent, England). *AIAA Journal,* vol. 8, Aug. 1970, p. 1519-1521.

Discussion of a number of tests which were undertaken to measure the drag of streamers in order to determine the drag dependence on parameters such as size, weight, shape, and velocity. The tests were undertaken in a small subsonic tunnel with a working section 0.46 m square. The speed range was from 14 to 37 m/sec giving Reynolds numbers from 950,000 to 2,320,000 per meter. The drag was measured by attaching the streamers to the center span of a streamlined strut connected to a 3-component semiconductor strain gauge balance. G.R.

A70-40288 # **Large-amplitude slow oscillation of wedges in inviscid hypersonic and supersonic flows.** W. H. Hui (Southampton, University, Southampton, England). *AIAA Journal,* vol. 8, Aug. 1970, p. 1530-1532.

Discussion of a method which combines techniques reported by Hui (1969) and Kuiken (1969) for an investigation of the general case of large-amplitude slow oscillation of any wedge angle in both hypersonic and supersonic flows. It is assumed that the bow shocks on both sides of the wedge are attached. A simple solution in closed form is obtained which, for the special case of a slender wedge in hypersonic flow, reduces to Kuiken's solution. G.R.

A70-40345 **Heat transfer from the gas and flow-passage elements of a rotating gas turbine.** V. I. Lokai and V. A. Trushin (Kazan'skii Aviatsionnyi Institut, Kazan, USSR). *(Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Jan.-Feb. 1970, p. 94-100.) *Heat Transfer - Soviet Research,* vol. 2, July 1970, p. 108-115. 12 refs. Translation.

A70-40351 **Aerodynamic effects on the measurement of mass properties using a Trebel Dynamic Balancing Machine.** R. D. Green (Air-Log, Ltd., Aldershot, Hants., England) and E. Dearden (Ministry of Technology, London, England). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 818.* 32 p. $36. per set of 36.

Measurement of mass properties of bodies using a Trebel FVD.500 Dynamic Balancing Machine, dealing specifically with bodies whose external shape is unsymmetrical about the axis of rotation. The rotation of such bodies results in an aerodynamic force which, because the balancing machine assumes that all forces are caused by rotating masses, represents an error in the measured mass properties. It would also constitute an error in dynamic balancing because weights would be added to the body to compensate for the aerodynamic force as well as the mass forces. It was found that, when aerodynamic effects are appreciable, they can be measured on the machine by carrying out a series of runs at different speeds of rotation in the low speed range. F.R.L.

A70-40359 **L-1011 on-board weight and balance system.** Leo P. Ferrante, Jr. and Francis Waung (Lockheed-California Co., Burbank, Calif.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 837.* 11 p. $36. per set of 36.

The new generation of jumbo jets brings with it the requirements for more precise and accurate methods for determining aircraft gross weight and center of gravity (C.G.). Wide bodied aircraft of the Lockheed L-1011 type, having a payload capability of over 300 passengers and nearly 50 tons must have assurance that the present manual system employed to determine loading is both accurate and economical. The Lockheed L-1011 on-board weight and balance system provides C.G. accuracy of plus or minus 1% MAC and gross weight accuracy of 1% of actual. Elimination of the costly passenger seating variation allowance is made possible by the much more accurate determination of passenger C.G. Forward and Aft C.G. Limit indicators are provided which alert the flight crew in the event that either C.G. limit is exceeded. Utilization of an on-board system in this manner must meet with FAA approval. Lockheed's first step in this direction is installing the system on the first three L-1011 flight test airplanes. The system value is further enhanced by hard landing indicators which sense vertical load on each gear as a function of time. Potential growth is the implementation of zero fuel C.G. and zero fuel gross weight parameters. Knowledge of these parameters safeguards against fuel burn-off moving the C.G. out of limits during the flight as fuel is consumed. Visual indicators would be employed as 'Go,' 'No Go' indicators. (Author)

A70-40360 **A merit factor suitable for evaluation of a variety of aircraft types and missions.** David F. Gebhard (Grumman Aircraft Corp., Bethpage, N.Y.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 842.* 20 p. $36. per set of 36.

Development of a merit factor based on the concept that the best aircraft is that which can do the biggest job (payload x n mi) at

the lowest weight and in the least time. The factor can be calculated using aircraft data frequently appearing in the literature. The manner in which cruise speed affects the factor is described for jet and shaft driven aircraft. The equation derivation can also be used to match aircraft characteristics to mission load, range, and speed requirements. An approximation is presented which permits use of the merit factor for helicopters and other aircraft exhibiting a drag increase with speed which is more severe than that predicted by the conventional drag polar. For subsonic shaft-driven fixed-wing aircraft additional equations are presented which permit calculation of the factor in various terms. F.R.L.

A70-40363 A theoretical contribution to the study of weight growth factor in aircraft design. Ettore Antona (Torino, Politecnico, Turin, Italy). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 839.* 20 p. 7 refs. $36. per set of 36.

Consideration of certain definitions of the aircraft growth factor, and review of some underlying aircraft design theories. The aircraft growth factor definitions of Driggs (1952) and Ballhaus (1954), as well as the latter's theories, are recalled. In particular, the growth factor, defined as derivative of the total weight with respect to the fixed weight portion, is considered. Some suggestions for the evaluation of the partial weight derivatives involved in the expression of the aircraft growth factor are briefly discussed, taking into account the special nature of the preliminary design phase. A general approach to the subject is proposed in an attempt to find a way toward an exhaustive exploration of this important area of aircraft design. Theoretical bases for the aircraft growth factor are established as a starting point for the research. It is shown that the weight growth factor can be expressed by a formula that includes derivatives of variable weight components, constituting growth functions involved in the design solution under study, as well as derivatives conditioning the desired kind of growth. In certain cases, such constraint derivatives satisfy compatibility requirements. The difficulties of obtaining reliable expressions for weight derivatives are also examined from a general point of view. M.V.E.

A70-40364 A computerized approach to aircraft loadability. James B. Partida (Lockheed-California Co., Burbank, Calif.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 836.* 31 p. $36. per set of 36.

Description of a computerized loading program which combines all the possible configuration variables and utilizes a high speed plotter to present the results graphically. This program provides a means of combining the many variables in the establishment of an aircraft design which must be utilized in order to give a meaningful picture of loadability. The program has the ability to analyze many sets of design parameters and present the results graphically with the use of the high speed Calcomp Plotter. In addition, the program can be used in presenting prospective customers with a graphic loadability of their desired aircraft configurations. The program's ability to vary input from case to case during a single run enables the user to review many aircraft configurations within a short period of time. M.V.E.

A70-40365 Loadability of 'Concorde.' J. Francis (British Aircraft Corp., Ltd., Filton Div., Bristol, England). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 835.* 37 p. $36 per set of 36.

This paper studies the loading of the 'Concorde.' The flight balance situation for a supersonic aircraft is compared with that for a subsonic aircraft. The fuel system, which has a big influence in achieving flight balance, is described, with special attention paid to the trim transfer portion of the system. Aircraft loading is covered and a description given of a fuel loading procedure that will satisfy all flight requirements. (Author)

A70-40366 An analytical approach to landing gear weight estimation. Paul R. Kraus (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 829.* 25 p. 6 refs. $36. per set of 36.

Demonstration that increased sensitivity can be acquired in landing gear weight estimation through an analytical approach. Such an approach is discussed in terms of three basic steps: estimation of ground loads according to the specifications of MIL-A-8862; resolution of forces and moments into each structural member of the landing gear; and the estimation of cross-sectional areas of the gear members to arrive at the structural weight of an analytical model. Various problems encountered in converting the landing gear structural model weight into realistic manufactured weight are discussed. Some actual results and parameter variation curves are presented. F.R.L.

A70-40367 Helicopter mechanical power transmission. Lester R. Burroughs (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 844.* 26 p. $36. per set of 36.

Summary of the history of Sikorsky Aircraft in the power transmission field from 1939, when the VS-300 was first flown, to the present turbine-powered helicopters. The design of the drive system of a large current production helicopter is reviewed, together with the test programs conducted to develop the system components and to qualify them for high service intervals. Areas of weight savings incorporated in this system, as well as those areas to be considered in future designs are discussed. F.R.L.

A70-40369 A definition of the aircraft stretch efficiency factor. H. R. Rugg (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 838.* 38 p. $36. per set of 36.

Description of a method of defining the aircraft stretch efficiency factor as a function of productivity and as a function of the payload growth factor of the aircraft. The stretch efficiency factor, an effective means of evaluating the ability of a candidate aircraft to meet an arbitrary target mission, can also be used to evaluate potential methods of stretch and to estimate the amount of stretch required by each method. A means of estimating the payload capability and required takeoff gross weight of candidate aircraft for target mission requirements is also provided. The study utilizes a computer trending model which displays outputs on a cathode ray tube (CRT). Typical stretch efficiencies are presented for a transport helicopter. F.R.L.

A70-40370 Minimum weight analysis of fuselage frames. A. R. DiPierro (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 826.* 53 p. 13 refs. $36. per set of 36.

Description of an automatic, iterative method for obtaining the minimum weight design of a structure which supports given loads and whose design requirements such as stresses, deflections, and geometric constraints are satisfied throughout the structure to prescribed limits. It is assumed that the design parameters are known, that a continuous weight function can be constructed, and that a program exists for calculating the output stresses or deflections at selected points on the structure. The design variables are varied automatically and simultaneously in a calculated direction for minimum weight until a fully stressed design is obtained. The rate of convergence is dependent on the initial guesses of the input variables, on the dimensionality of the problem, and on the complexity and behavior of the structure. Particular attention is devoted to an

illustrative example involving the design of a fuselage frame under assumed design criteria and under multiple loading conditions. It is found that the method can effect an appreciable weight saving and is especially applicable to trade-off and sensitivity studies. O.H.

A70-40371 * A fundamental approach to aircraft manufacturing cost estimating in the conceptual design phase. Darrell E. Wilcox and Thomas J. Gregory (NASA, Office of Advanced Research and Technology, Mission Analysis Div., Moffett Field, Calif.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 865.* 15 p. 6 refs. $36. per set of 36.

Description of an improved method for estimating manufacturing costs in the conceptual design phase. It is shown that detailed design definition, including such physical characteristics as the total number of parts and pieces and the size and weight of each part, can be achieved with an extension of a typical structural synthesis computer program that is based on analytical descriptions of standard design practice. It is also pointed out that a simulated cost buildup can be generated from the parts list by analytically describing standard manufacturing practices, material lists, and the labor time required in each manufacturing step for every part. The application of these concepts to the estimation of the manufacturing costs of a vertical stabilizer box structure serves to describe the proposed method, which is then compared with present cost estimating techniques used in the conceptual design phase. In conclusion, some suggestions are offered for extending the new approach to the estimation of design, tooling, and test costs. M.V.E.

A70-40376 Automated method for calculating mass characteristics of fuel in tanks at various angles of attack. Edward Jacobs and Donald P. Gholson (Avco Corp., Avco Aerostructures Div., Nashville, Tenn.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 850.* 29 p. $36. per set of 36.

Description of an automated process for calculating mass properties for fuel volumes. The tank shapes are such that they can be approximated by subdivision into tapered boxes with straight line edges. The data are calculated for levels incremented every .25 in and oriented at any angle of attack. The mass properties consist of total weight, three axis center of gravity and moment of inertia, and a product of inertia in the X-Z plane. The input consists of coordinates for the tapered box corner points, the Z intercepts for planes oriented at the angle of attack and passing through the lowest and highest corners in the box, the Z intercept for the initial cutting plane, the angle of attack with its tangent plus the tangent for twice the angle of attack, fuel density and an indicator to signal program termination. Special use is made of the prismoidal equation for solving fuel level mass properties. Other techniques involve variations of FORTRAN logic and the use of the 1130 disk files for data storage and transfer. The function of each section of the primary equations are explained. M.M.

A70-40379 Design and experimental studies of a thrust deflector for VTOL direct lift engines. David Migdal (Grumman Aerospace Corp., Bethpage, N.Y.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 841.* 28 p. 10 refs. $36. per set of 36.

Results of design and experimental studies conducted on a thrust deflector applicable to fuselage mounted lift engines installed in a VTOL aircraft. It was assumed that the equivalent of 60 deg (-15 deg to +45 deg) of total deflection will be required and that an aerodynamically smooth external surface is necessary for high-speed forward flight. With these requirements, a two-dimensional external flap deflector, integral with the fuselage, was investigated. The flap was designed as an isentropic plug nozzle, with a hinge point slightly downstream of the throat. Massflow, shadowgraph, pressure and force data were obtained. The shadowgraph and pressure data indicated that for all positive deflections (0 to 45 deg) the flow could be deflected in a very short length via a low-loss shock system. For negative deflections an efficient coanda effect was obtained. The experimental data indicate that a single three-dimensional external flap deflector is an efficient device for thrust vectoring of aft engines.

A70-40380 Balancing options in aircraft configuration design. Karl L. Sanders and D. O. Nevinger (Teledyne Ryan Aeronautical, San Diego, Calif.). *Society of Aeronautical Weight Engineers, Annual Conference, 29th, Washington, D.C., May 4-6, 1970, Paper 840.* 40 p. 11 refs. $36. per set of 36.

Discussion of several means of balancing an aircraft design. Equations are developed to determine required configuration changes and to analyze the associated weight penalties. A hypothetical fighter aircraft is chosen as an example to demonstrate the applicability of the suggested procedure and to compare the weight penalties resulting from several balance methods. M.M.

A70-40515 Criteria used in simulation of the force exerted by a supersonic jet striking an obstacle. M. V. Sushchikh, V. I. Pogorelov, and D. E. Tikhonov-Bugrov (Mekhanicheskii Institut, Leningrad, USSR). (*Zhurnal Tekhnicheskoi Fiziki,* vol. 40, Feb. 1970, p. 395-397.) *Soviet Physics - Technical Physics,* vol. 15, Aug. 1970, p. 295, 296. Translation.

Analysis of the parameters which define the force exerted by a jet on a target. These dimensionless parameters are determined with the aid of Sedov's (1954) dimensional analysis. It is shown that for a practical range of variation of the dimensionless parameters, the ratio of the axial force acting on the target to the nozzle thrust remains constant, and that it is independent of the number of nozzles. This result is verified experimentally, using air and argon jets. V.P.

A70-40531 Recording effects of rain erosion with high speed photographic techniques. Daniel J. Novak (Dynalectron Corp., Land-Air Div., Holloman AFB, N. Mex.). *SPIE Journal,* vol. 8, June-July 1970, p. 187-193. 5 refs.

Study of the effects of artificial rain on missile and space vehicle systems by means of high speed photographic techniques. Sleds traveling at speeds up to Mach 5 have carried various test items through artificial rain so that scientists can study the effects of the rain on test items at various stations along the sled path, as well as the total erosion effects after the vehicles are recovered. Detailed photographs of the test object while in the environment are best recorded by synchroballistic techniques. By sampling at intervals along the path, progressive deterioration can be recorded with space-time correlations as the test item passes through the rain field. Aerodynamic characteristics are recorded using photographic shadowgraph techniques. Engineering and general surveillance data is provided by high speed cameras and various lighting techniques. F.R.L.

A70-40532 Synthetic resin adhesives in the aircraft industry (Kunstharzkleber in der Flugzeugindustrie). A. Foulon. *Archiv für technisches Messen und industrielle Messtechnik,* Aug. 1970, p. R 93-R 95. In German.

Review of the advantages offered by the use of synthetic resin adhesives in the fabrication of aircraft components. Among the advantages cited are a simplification of the structure of certain components, a reduction in bonding time, the elimination of complex bonding equipment, easier formation for leaktight bonds, and (in the case of fiberglass-reinforced plastics) the production of highly fire-resistant materials. The use of synthetic resin adhesives in transducers employing wire strain gauges is also cited. A.B.K.

A70-40579 The influence of operational and technical factors on air transport regulation. Stephen Wheatcroft. *Aeronautical Journal,* vol. 74, Aug. 1970, p. 623-628; Discussion, p. 628, 629. 7 refs.

Discussion of the prominent characteristics and the possible future improvements of the present air transport regulatory system, defined as the total system by which all relevant aspects of public policy are brought to bear upon airline operations and the ways in which they influence the air services available to the traveling public. The nature of the overall system of regulation which has been devised to reconcile the conflicts between collective and personal demands upon air transport development are first examined. The significant place which the promotion of aeronautical technology occupies in this system is reviewed. The probable impacts of new technological development on the air transport system in the next decade are considered. Finally, the question whether the present system of regulation ought to be modified to create a more appropriate balance between collective and personal demands is discussed. O.H.

A70-40580 The Concorde flight test programme. E. H. Burgess (British Aircraft Corp., Ltd., Bristol, England). *Aeronautical Journal,* vol. 74, Aug. 1970, p. 636-642.

Description of the progress made to date in the Concorde flight test program. A brief survey of the Concorde design features and its flight test program is presented. The progress in testing the aircraft is shown to have been so far remarkably good; 80% of the flight envelope up to 1.5 Mach has been explored to date, including simulated engine failure, engine relights at 47,000 ft, and the use of reverse thrust as a means of accelerating the aircraft's descent without building up speed, a particularly important requirement in ATC maneuvers. Rates of descent up to 6000 ft have already been demonstrated satisfactorily. Several mechanical and technological details of the aircraft design and operation, verified during the test program, are then discussed. They include the development of wing vortices in the landing approach, the visor design, fuel transfer, longitudinal stability at subsonic and transonic speeds, and the rate of roll. O.H.

A70-40581 The high speed track facility and its comparison with other full scale testing techniques. D. Howe (Cranfield Institute of Technology, Cranfield, Beds., England). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, Aug. 1970, p. 643-649. 9 refs.

Discussion of the general design considerations and basic characteristics of a track facility for V/STOL aircraft tests which cannot be satisfactorily performed in either wind tunnel or flight testing. Following a review of the limitations of wind tunnels and flight testing of V/STOL aircraft, the characteristics and design features of a track facility, the basic concept of which is that of a test rotor or model mounted above a rail vehicle, is considered, and an optimum design, which is potentially capable of being used for actual experiments, is suggested. A very preliminary cost comparison indicates that the facility could be constructed for less than half the capital expenditure required to build a useful V/STOL wing tunnel. O.H.

A70-40582 Vibration testing in helicopters - A practical aspect. C. E. P. Jackson (Westland Helicopters, Ltd., Yeovil, Somerset, England). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, Aug. 1970, p. 650-658.

Discussion of the various techniques used for practical vibration measurements of helicopters. The three categories of vibrations existing in helicopters, i.e., the basic, acceptable, and unacceptable vibrations, are characterized, and the general approach to stress and load investigations is outlined. The principal features of the methods used for airframe vibration measurements and fatigue testing during the design and development stages of a new helicopter type are reviewed and explained. Finally, a detailed description of a new vibration monitoring technique for diagnosis of faults arising in helicopters in service is presented. O.H.

A70-40583 Vibration testing of helicopters. D. E. H. Balmford (Westland Helicopters, Ltd., Yeovil, Somerset, England). *(Royal Aeronautical Society, All-Day Symposium on Test Facilities for Helicopters, London, England, Nov. 26, 1969.) Aeronautical Journal,* vol. 74, Aug. 1970, p. 659-662.

Discussion of the need for dynamic testing of helicopters in terms of defining the design problems where testing is required to assist or substantiate decisions made in the light of mainly theoretical evidence in the initial stages of design before hardware becomes available for testing. Not only testing associated with assessing or minimizing the vibration of helicopters is considered, but also problem areas which result in dynamic testing requirements. Two dynamic problem areas facing the helicopter designer are discussed: one concerned with instabilities both aeroelastic and mechanical, the second concerned with forced vibration problems. The consequent dynamic testing is described. O.H.

A70-40585 Maximum lift on slender wings. D. W. Bridson and G. L. Hancock (Queen Mary College, London, England). *Aeronautical Journal,* vol. 74, Aug. 1970, p. 671, 672. 7 refs.

Examination of the problem of whether slender wings of low aspect ratio with sharp leading edges and leading edge separation, in which conventional stall no longer applies, can approach the theoretical inviscid maximum lift coefficients. It is demonstrated that slender wings of aspect ratio 0.5 do achieve their maximum circulatory lift coefficient. However, it is not possible to calculate this maximum value a priori because no method exists for establishing the distance apart of the trailing vortices for this type of wing. O.H.

A70-40586 Flutter of skew panels by the matrix displacement approach. V. Kariappa and B. R. Somashekar (National Aeronautical Laboratory, Bangalore, India). *Aeronautical Journal,* vol. 74, Aug. 1970, p. 672-675. 9 refs.

Application of the general matrix displacement method to the problem of supersonic flutter and vibration of skew panels. The basic elements considered are the parallelograms for which the natural stiffness, inertia and aerodynamic influence coefficient (AIC) matrices can be derived. The assembled matrices, which refer to the complete panel, may then be achieved elegantly from the elemental matrices with the help of Boolean matrix operations. After obtaining the required stiffness, inertia and AIC matrices, the equations of motion under the influence of elastic, inertial and aerodynamic forces can be formed in the form of matrix algebra and solved for the complex eigenvalues and vectors. O.H.

A70-40609 # Hypersonic flow past a triangular wing (Obtekanie treugol'nogo kryla giperzvukovym potokom). A. L. Gonor. *Prikladnaia Matematika i Mekhanika,* vol. 34, May-June 1970, p. 481-490. 6 refs. In Russian.

Analysis of the flow pattern at the windward side of a wing with supersonic leading edges, with particular reference to the difficulties associated with obtaining a correct solution to the problem. These difficulties arise due to the fact that in the flow field behind a strong shock wave, there exist simultaneously uniform potential regions and vortex regions which must be smoothly joined. An analytical theory of hypersonic flow past a wing with an attached shock wave is proposed which makes it possible to join the potential and vortex regions behind the shock wave. V.P.

A70-40619 # Aircraft fuel contents gauging in the seventies. I. B. Johnson and J. K. Leigh. *Aviation Review,* Sept. 1970, p. 6-8.

Discussion of fuel contents gauging, a subject which will be of acute importance when long-range supersonic flight, and possibly

VTOL flight, become commonplace. A delicate balance must be struck, since fuel quantities must not be below safe minimums, and an excessive amount of fuel jeopardizes takeoff safety, reduces payload, and causes excessive fuel consumption. Integration with the flowmeter system, a dc torquer display, and digital capacitance-measuring techniques should improve the capacitance fuel gauge and give it a useful life extending into the 1980s. Whether a new principle such as hydrostatics or nuclear radiation will supersede the capacitance technique will depend largely on the progress and acceptance of thickened fuels. It is considered doubtful whether any system will supplant the capacitance system for measuring liquid kerosene unless it can offer, cheaply and reliably, an accuracy better than 0.5% of tank capacity, and 0.5% of quantity present under normal variations of environment in the flight attitude. F.R.L.

A70-40738 Principal characteristics of flight mechanics and ballistics (Grundzüge der Flugmechanik und Ballistik). Herman Stümke. Braunschweig, Friedrich Vieweg und Sohn GmbH, 1969. 537 p. 851 refs. $26.45. In German.

Flight dynamics of mirror symmetric aircraft and axisymmetric bodies such as projectiles and missiles which are heavier than air and move within the range of the earth's gravitational forces is considered. A common basis for the motions of all these bodies is first established, taking into account the shape, gravity, and motion of the earth. The remaining chapters are concerned with a detailed treatment of the flight mechanics of mirror symmetric fixed-wing aircraft and the ballistics of axisymmetric bodies. Within these two major problem areas, the subject-matter is systematically subdivided according to whether force equations are sufficient for describing the motion, or whether an additional application of moment equations or even additional controls is necessary. (Author)

A70-40740 # Early experience with the 747. J. G. Borger, L. H. Allen, Jr., and Scott Flower (Pan American World Airways, Inc., New York, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 2nd, Los Angeles, Calif., July 20-22, 1970, Paper 70-886.* 14 p. Members, $1.25; nonmembers, $2.00.

Brief description of experience gained in the first six months of operations of the B747 aircraft. Experience deals with the airframe, engines and components, performance, pilot and engineer training, maintenance requirements, ground equipment and flight and ground handling of passengers, baggage and cargo. M.M.

A70-40750 # Direct aircraft maintenance costs - Military and commercial. Herman L. Gilster and Lloyd Woodman, Jr. (U.S. Air Force Academy, Colorado Springs, Colo.). *Air University Review,* vol. 21, July-Aug. 1970, p. 51-57. 8 refs.

Discussion of possibilities for decreasing direct maintenance costs of military aircraft on the basis of a comparative analysis of present aircraft maintenance costs in the military and the commercial sectors. This analysis shows that the direct cost of military aircraft maintenance is significantly higher than that of the airlines. The main reason for this is the extensive use of labor in the military. The adoption of a more capital-intensive approach is, therefore, recommended. This is to be done by making more extensive use of maintenance support equipment and by the use of spares and material to effect repairs. Other approaches toward the reduction of maintenance costs are connected with the extension of such systems as the Malfunction Detection, Analysis and Recording (MADAR) diagnosis system and with changes in the whole concept of planned replacement for many aircraft components. G.R.

A70-40760 A remote temperature and dewpoint indicating and recording device. S. V. Datar and P. M. Pakkir Mohammed (Meteorological Office, Poona, India). *Institution of Telecommunication Engineers, Journal,* vol. 16, May 1970, p. 317-324.

Description of an instrument designed primarily for use at airports to provide accurate and continuous indications and records of dry bulb and dewpoint temperatures of the air. Using suitable thermistors and a dewcel as the temperature and dewpoint sensors, respectively, the instrument is capable of indicating and recording the air and dewpoint temperatures, with an accuracy better than plus or minus 0.5 C for air temperature and plus or minus 1 C for dewpoint. The transmission of information is over cables, and the instrument can easily be adopted for a wide variety of other applications. (Author)

A70-40764 The role of small earth stations in civil communication satellite systems. J. L. Blonstein (Plessey Radar, Ltd., Addlestone, Surrey, England). *Institution of Telecommunication Engineers, Journal,* vol. 16, May 1970, p. 378-387.

Description of the potential and uses of communication satellites with particular reference to the small ground stations involved. The following applications of communications satellites are discussed: (1) regional telecommunication, (2) TV distribution, (3) air traffic and maritime communications and navigation, (4) rapid data exchange, and (5) weather satellite systems, satellite photography, and education. A view of typical size ranges of small earth stations is shown, also including a large commercial station for comparison purposes. The more important characteristics and equipment of these stations are discussed. Z.W.

A70-40766 Automation in electronic test equipment. Volume 7 - Factory and depot for incoming inspection, production testing, quality control, maintenance, and re-build operations. Edited by D. M. Goodman. New York, New York University, 1969. 575 p. $22.

Contents:

MINI-BACE. R. C. Kellett and K. W. Smith (North American Rockwell Corp., Anaheim, Calif.), p. 3-78.

Controller/Programmer/Evaluator. D. L. Sauder and R. L. Kitchen (Conductron Corp., St. Charles, Mo.), p. 81-169.

ATE for depot level maintenance. P. M. Knapp and W. A. Scanga (AAI Corp., Cockeysville, Md.), p. 173-237. 6 refs.

APAR/MAC/COTES. R. W. Roberts (Sandia Laboratories, Albuquerque, N. Mex.), p. 241-268.

Survey of automatic checkout systems for Saturn V stages. D. M. Schmidt (NASA, Marshall Space Flight Center, Huntsville, Ala.), p. 271-313.

GPATS, the AN/GSM-204(V). J. Lashley and W. Metcalf (Emerson Electric Co., St. Louis, Mo.), p. 317-480.

The AN/USM-247 Versatile Avionic Shop Test (VAST) system. R. G. Loughlin (PRD Electronics, Inc., Jericho, N.Y.), p. 485-537.

An infrared tester for printed circuit boards and microcircuits. R. W. Jones (North American Rockwell Corp., Anaheim, Calif.), p. 541-586.

A70-40771 GPATS, the AN/GSM-204(V). J. Lashley and W. Metcalf (Emerson Electric Co., St. Louis, Mo.). In: Automation in electronic test equipment. Volume 7 - Factory and depot for incoming inspection, production testing, quality control, maintenance, and re-build operations. Edited by D. M. Goodman. New York, New York University, 1969, p. 317-480.

Description of a General Purpose Automatic Test System (GPATS) using a building block concept, aimed at producing equipment for evaluating the performance of avionic systems at the depot level. However, the application of this equipment to field level, carrier shop, or other levels is possible if workload and maintenance criteria warrant an automatic testing approach. A prototype develop-

ment program successfully demonstrated the concept. GPATS with functionally oriented hardware and avionics systems-oriented software provided substantial test time reduction, increased flow rates, and added fault isolation capabilities. GPATS solves the problem of increasing inventory of specialized test equipment which becomes obsolete as new or improved avionics equipment is developed. Systems currently programmed for GPATS are typified by landing systems, counter measures, navigation, flight control, communication, radar, and fire control systems. F.R.L.

A70-40772 The AN/USM-247 Versatile Avionic Shop Test (VAST) system. R. G. Loughlin (PRD Electronics, Inc., Jericho, N.Y.). In: Automation in electronic test equipment. Volume 7 - Factory and depot for incoming inspection, production testing, quality control, maintenance, and re-build operations. Edited by D. M. Goodman. New York, New York University, 1969, p. 485-537.

Discussion of the VAST (Versatile Avionic Shop Test) system, a total maintenance concept intended to provide immediate and long range solutions to the problems of supporting avionic equipment in the avionic shops aboard aircraft carriers. It involves establishing a unified test philosophy, including maintainability specifications for the design of avionic equipment, definition of a standardized test system adaptable to changing test requirements, and the structuring of a maintenance management organization to implement the VAST concept. The standardized test system utilizes multiple independent test stations which are time shared by a central computer. Each VAST Test Station is capable of performing self checks to verify its performance. Building blocks may also be self tested and fault isolated to the module and piece-part level. Avionic test programs are prepared initially by performing a detailed analysis of the test requirements for each avionic system. From this data English language programs, test diagrams, and diagnostic flow charts are derived. Object test programs are then generated and verified via hardware demonstrations. F.R.L.

A70-40784 Wind gusts - 0-300 ft altitude - Homogeneous terrain. G. B. Skelton (Honeywell, Inc., Minneapolis, Minn.). In: Aerospace vehicle flight control systems. New York, Society of Automotive Engineers, Inc. (SP 358), 1970, p. 21-27. Contract No. AF 33(615)-67-C-1563.

Development of statistical models for the gust field in the lowest 300 ft of the atmosphere over a homogeneous terrain. Some of the underlying physical principles of gusts are reviewed in terms of the Navier-Stokes equations, gust energy, the gradient Richardson number, and the gust covariance tensor. A great deal of additional gust data is shown to be necessary, but in spite of substantial lack of information a gust model was developed and simulation tests were run to determine gust effects on the Ryan XV-5 V/STOL aircraft. It is shown that shear across wings is an important parameter and that wing-to-tail transport delay is essential in forming any gust model. T.M.

A70-40785 Liquid metal servoactuation packages for flight controls. R. C. Kumpitsch and D. C. Sturges, Jr. (General Electric Co., Avionic Controls Dept., Binghamton, N.Y.). In: Aerospace vehicle flight control systems. New York, Society of Automotive Engineers, Inc. (SP 358), 1970, p. 28-33. USAF-sponsored research.

A most promising approach in the field of flight control surface actuation is the use of independent integrated hydraulic actuator packages located at each flight surface actuation station. This concept eliminates hydraulic plumbing throughout the vehicle thus reducing the external connections to only electric power and command signals which are easily made redundant. The most compact and universal configuration of these packages will use a liquid metal hydraulic fluid thus making them capable of sustained operation in high-temperature environments without need of coolant systems. This paper summarizes the research, development, and experimental work that has been done so far. (Author)

A70-40786 The flow difference sensor. G. D. Jenney (Hydraulic Research and Manufacturing Co., Valencia, Calif.). In: Aerospace vehicle flight control systems. New York, Society of Automotive Engineers, Inc. (SP 358), 1970, p. 34-42.

Loss of aircraft from ground-fire strikes on hydraulic systems and primary flight controls was the incentive for developing the Flow Difference Sensor, a device that cuts out flow in damaged lines and bypasses it to effect minimum loss of fluid. This system decreases aircraft vulnerability greatly and reduces fire hazard. This paper describes the design, operation, and flight qualification tests of the instrument. (Author)

A70-40799 # Institute of Aviation - The central scientific and research base of the aircraft and engine industry (Instytut Lotnictwa - Centralne zaplecze naukowo-badawcze przemysłu lotniczego i silnikowego). Jerzy Grzegorzewski. *Instytut Lotnictwa, Biuletyn Informacyjny,* vol. 7, May-June 1970, p. 2-15. In Polish.

Description of the history of the Polish Institute of Aviation, and outline of the present facilities and test programs. Test stands are discussed for engines, turbine compressors, axial-flow ventilation systems, and aerodynamic studies. Combustion research and engine endurance studies are delineated, and the available electronic test equipment is surveyed. In-flight tests and rocket programs are considered together with the prospects for future research and further development. T.M.

A70-40809 Holographic subsonic flow visualization. C. J. Reinheimer, C. E. Wiswall, R. A. Schmiege, R. J. Harris, and J. E. Dueker (McDonnell Douglas Corp., St. Louis, Mo.). *Applied Optics,* vol. 9, Sept. 1970, p. 2059-2065. 9 refs. Research sponsored by the McDonnell Douglas Independent Research and Development Program.

A pulsed ruby laser holographic interferometer was used to detect density gradients in the airflow around an airfoil at subsonic speeds in a low speed wind tunnel. These experiments proved that vibration of the optical components or object between exposures of the interferometric hologram does not destroy the detection of density gradients but actually can aid in the flow visualization. The density gradients determined from the fringe pattern analysis are consistent with the anticipated flow pattern. (Author)

A70-40868 # The effect of disposable load drop on the range of aircraft. Milton J. Thompson (Texas, University, Austin, Tex.). *ASME, Transactions, Series B - Journal of Engineering for Industry,* vol. 92, Aug. 1970, p. 590-594.

A simple analytical procedure is presented for the determination of the range or radius of action of an aircraft, based on the well-known Breguet equation, under conditions where a portion of the total payload, other than fuel, is to be dropped during the flight. It is assumed that this portion of the disposable load or dropped load is released at the midpoint of the total distance flown. If the radius of action is compared with the value corresponding to no dropped weight being carried during the flight, the results may be normalized in terms of two weight parameters: (1) the ratio of the total disposable load of fuel and dropped load to the takeoff gross weight, and (2) the ratio of the dropped load to total disposable load. Numerical results are presented for a wide range in the values of these ratios disclosing some rather unique properties of the functional relationships involved. A comparison is made with the results of graphical determinations of bombing range, using methods originally presented by Diehl, it being shown that the present method agrees closely with Diehl's approximate empirical relation for a limited range of the values of the weight parameters. The procedure described is equally adaptable to either propeller or jet-driven aircraft. (Author)

A70-40887 Some characteristics of stabilized smoke flames. B. K. Biswas and R. H. Essenhigh (Pennsylvania State University, University Park, Pa.). *Combustion and Flame,* vol. 15, Aug. 1970, p. 93-96.

Results of some recent experiments which indicate that flames

ranging from smoky yellow to blue, with yellow inner cores, can be generated at the top of a smoke column. The experiments are part of a more general program on reduction of air pollutant emissions from incinerators. An aerodynamic flame holder is proposed to avoid problems of intermittent flaming, with consequent emission of puffs of thick smoke. F.R.L.

A70-40896 # **Aircraft noise exposure tradeoff studies at three major airports.** Dwight E. Bishop (Bolt Beranek and Newman, Inc., Los Angeles, Calif.). *Acoustical Society of America, Meeting, 79th, Atlantic City, N.J., Apr. 21-24, 1970, Paper.* 17 p.

Application of the methodology of Noise Exposure Forecast (NEF) contours for the case of three major airports (Los Angeles, O'Hare, JFK), utilizing actual flight path and runway configurations for the three airports, and FAA estimates of volumes of operations and type of aircraft projected for 1975. The NEF value at any point on the ground takes into account the noise levels produced by different aircraft classes and the number of takeoffs per aircraft class per daytime and nighttime periods. In the study two contours were computed for each airport situation representing NEF values of 30 and 40. Changes in noise exposure were summarized in terms of the land areas falling within the two NEF contours. The study is considered to show that a combination of changes in operational techniques and, more importantly, a reduction in the basic noise output of major commercial transport aircraft can drastically reduce the impact of aircraft noise in areas surrounding major airports. F.R.L.

A70-40911 ATCAS, the new Italian completely automatic air traffic control system (ATCAS, il nuovo sistema italiano 'air traffic control' tutto automatico). Paolo Regi. *Aviazione di Linea - Aeronautica e Spazio,* vol. 8, Sept. 1970, p. 512-515. In Italian.

Description of ATCAS, the completely automated Italian ATC system. The complete automation of the system is a solution to the currently overcrowded and chaotic air traffic situation. The ATCAS project has been launched with the participation of various companies. Eventually, the project will lead to the complete automation of ATC over the Italian skies. M.M.

A70-40918 The effects of yaw on conical wings at high supersonic speeds. R. Hillier (Cambridge University, Cambridge, England). *Aeronautical Quarterly,* vol. 21, Aug. 1970, p. 199-210. 7 refs. Research supported by the Science Research Council.

In recent papers Squire has presented results for the shock shape and pressure distribution on the lower surface of unyawed, lifing, conical bodies with sharp leading edges. The work, a development of Messiter's first-order correction to Newtonian theory, was successfully applied to wings of diamond and caret section. This paper shows how the method may be used to include the effects of yaw. Results are presented here for the flat wing and some biconvex sections. Comparisons are made with experiment for both the flat and biconvex wings and agreement is shown to be good. (Author)

A70-40919 On the minimum induced drag of ground-effect wings. P. R. Ashill (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Quarterly,* vol. 21, Aug. 1970, p. 211-232. 9 refs. Research supported by the Ministry of Technology.

An approximate theory, which yields the minimum induced drag of a planar wing with end-plates in ground effect, is presented. As a check on the accuracy of the method, it is compared with the exact linearised theory in the case of end-plates of vanishing depth (planar configuration). This shows that, within the limitations of the linearised lifting-surface theory, the present method is accurate in the range of wing heights of interest. In Section 5 the theory is compared with experiment. In this comparison two interpretations of the theory are employed. The first assumes that the vortex trace is the projection of the trailing edge of the configuration onto a plane normal to the direction of motion when the wing incidence is zero. The second is different from this only in that no constraint is placed on the wing incidence. Of the two interpretations the first is found to be in better agreement with experiment than the second for the planar configuration. However, the opposite is found to be true when end-plates of sufficient depth are fitted. A reason for this is proposed in Section 5. (Author)

A70-40920 On the flight path relative to the air of an aircraft circling in a uniform wind. M. N. Brearley (Royal Australian Air Force Academy, Melbourne, Australia). *Aeronautical Quarterly,* vol. 21, Aug. 1970, p. 233-242.

When an aircraft flying at a constant airspeed performs circular orbits relative to the ground, its path relative to the air has interesting features if a wind of uniform velocity is blowing. The locus, which is here called an aeroid, bears some resemblance to a prolate trochoid; its equation is obtained in parametric and intrinsic forms, and its curvature and other fundamental properties are derived. In the final section of the paper some practical implications are considered, including the effect of wind on the fuel consumption per orbit of a circling aircraft and the influence of winds of different headings on the path for a landing approach. (Author)

A70-40924 The prediction of aerofoil pressure distributions for sub-critical viscous flows. R. C. Lock, P. G. Wilby (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England), and B. J. Powell (Ministry of Technology, National Physical Laboratory, Teddington, Middx.; Kingston College of Technology, Kingston-upon-Thames, England). *Aeronautical Quarterly,* vol. 21, Aug. 1970, p. 291-302. 10 refs.

The paper first describes an approximate method for calculating inviscid flows round arbitrary aerofoils at sub-critical Mach numbers, based on second-order theory with empirical improvements to give better agreement with exact theory; several comparisons are shown. This method is then used as the basis of an iterative procedure for calculating the effect of the boundary layer on the surface pressures and overall forces; several comparisons are given with recent experimental results. (Author)

A70-41035 Local heat transfer around a circular cylinder at low Reynolds number and in transverse slip flow. K. M. Krall and E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). In: Space systems and thermal technology for the 70's; American Society of Mechanical Engineers, Space Technology and Heat Transfer Conference, Los Angeles, Calif., June 21-24, 1970, Proceedings. Part 2. New York, American Society of Mechanical Engineers, 1970. 8 p. 9 refs.

Local heat transfer has been measured as it occurs between the surface of a circular cylinder heated electrically to a uniform heat flux and air in cross flow at Reynolds numbers between 7 and 5000 and Mach numbers between 0.2 and 0.5. The tests were performed in a small, low density wind tunnel. The local heat-transfer distribution is fuller near the forward stagnation point than the one for uniform wall temperature. As a consequence, the average heat transfer of the uniformly heated cylinder is by 15 to 30 percent larger than for a constant temperature. The effect of slip causes a decrease in heat transfer near the stagnation point but leaves the rearward region essentially unaltered. The experimental results are compared with analytic solutions of the Navier-Stokes equation and the energy equation performed by numerical integration on a digital computer. (Author)

A70-41055 * Vapor volume entrained in the boundary layer due to boiling on a vertical plate in a low gravity field. J. Navickas and H. R. Melton (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: Space systems and thermal technology for the 70's; American Society of Mechanical Engineers, Space Technology and Heat Transfer Conference, Los Angeles, Calif., June 21-24, 1970, Proceedings. Part 2. New York, American Soci-

ety of Mechanical Engineers, 1970. 8 p. 6 refs. Contract No. NAS 7-101.

Development of a method for predicting the volume of vapor entrained in the bulk of the liquid as a result of a boundary layer boiling in a low gravity field. The method is applicable to a boundary layer with negligible velocity compared to the vapor velocity and the gravity vector acting parallel to the heated wall. Methods of velocity calculation of discrete bubbles were applied to the two-phase boundary layer to obtain an effective vapor velocity. A method developed by Moore (1965) was used to obtain the bubble drag coefficients at very low Mach numbers in the transition area between the Stokes' flow region and the spherical cap region. The drag coefficients for the various flow regimes were used in integrating the vapor mass conservation equations to obtain an effective boundary-layer vapor film thickness, which also was calculated with a simplified vapor velocity equation derived by Harmathy (1960). It was shown that the simplified method frequently can be used to estimate the volume of vapor entrained in the bulk of the liquid in a low gravity cryogenic storage system. The method was used to predict the quantity of vapor entrained in the hydrogen tank boundary layer during the orbital coast period of the Saturn S-IVB stage. The analytical results are compared to the flight data. Z.W.

A70-41126 Present problems of position finding and navigation in the space, in the air, and at sea; Proceedings of the International Congress, Hamburg, West Germany, October 28-30, 1969. Volume 1. Congress supported by the Ministerium für Bildung und Wissenschaft. Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1970. 476 p.

Contents:

Preface. 1 p.

An introduction to estimation - Development of optimum estimation as an extension of simple averaging with application to an integrated navigation system. J. C. Pinson (North American Rockwell Corp., Anaheim, Calif.). 46 p.

Application of Kalman filtering techniques to the Apollo program. R. H. Battin and G. M. Levine (MIT, Cambridge, Mass.). 57 p. 5 refs.

Attitude reference platform for rotating altitude research rockets. M. Pütz (Bodenseewerk GT, Überlingen, West Germany). 18 p.

Applications of inertial guidance technology for space navigation. K. Fertig (MIT, Cambridge, Mass.). 52 p. 25 refs.

Navigation results on the Mariner mission to Mars - 1969. N. A. Rensetti and J. P. Fearey (California Institute of Technology, Pasadena, Calif.). 19 p.

Surveying the use of satellites for sea and air navigation. E. A. Steinhoff (USAF, Missile Development Center, Holloman AFB, N. Mex.). 53 p.

Results of the CCIR Meeting in Sept./Oct. 1969 in respect of the use of satellites for sea and air navigation. P. R. Werle (Deutsche Bundespost, Darmstadt, West Germany). 9 p.

Operational, technical and economic aspects of an aeronautical satellite system for civil air traffic control. R. H. G. Martin and O. L. Geigner (EUROCONTROL, Brussels, Belgium). 42 p.

Integrated communication, navigation and identification. W. J. Sen (USAF, Electronic Systems Div., Bedford, Mass.). 17 p.

Operational requirements of shipping for a satellite system and its contribution to the maritime distress system. C. Dorian (U.S. Department of Transportation, Washington, D.C.). 34 p.

The Navy Shipboard Navigation Satellite System. H. Nordenberg (U.S. Navy, Hyattsville, Md.). 17 p.

Global navigation and traffic control using satellites. L. M. Keane, D. L. Brandel, P. D. Engels, and R. M. Waetjen (NASA, Electronics Research Center, Cambridge, Mass.). 37 p. 10 refs.

A70-41131 Operational, technical and economic aspects of an aeronautical satellite system for civil air traffic control. R. H. G. Martin and O. L. Geigner (EUROCONTROL, Brussels, Belgium). *(Deutsche Gesellschaft für Ortung und Navigation, Internationale Navigationstagung, Hamburg, West Germany, Oct. 28-30, 1969, Paper.)* In: Present problems of position finding and navigation in the space, in the air, and at sea; Proceedings of the International Congress, Hamburg, West Germany, October 28-30, 1969. Volume 1. Congress supported by the Ministerium für Bildung und Wissenschaft. Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1970. 42 p. Translation.

Examination of the most important operational, technical, and economic problems involved in the realization of an aeronautical satellite system. General problems pertaining to flight safety are discussed, with emphasis on the role played by artificial satellites. The technical problems involved in the operation of an aeronautical satellite system are examined, taking into consideration satellite trajectories, frequency selection, satellite tracking, and the communication system. Z.W.

A70-41132 Integrated communication, navigation and identification. William J. Sen (USAF, Electronic Systems Div., Bedford, Mass.). In: Present problems of position finding and navigation in the space, in the air, and at sea; Proceedings of the International Congress, Hamburg, West Germany, October 28-30, 1969. Volume 1. Congress supported by the Ministerium für Bildung und Wissenschaft. Düsseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1970. 17 p.

Discussion of the direction, the conduct, and the results of a concept study concerning the combining of the various telecommunications devices that provide Communication, Navigation Aids and Identification (CNI) of or to military aircraft. Radio systems with terminals aboard military aircraft are considered. An analysis is made, the objective of which is to test the hypothesis that new technology can provide an integrated system meeting the worldwide needs of military aircraft in the 1970's more effectively than separate systems. The analysis includes: a review of CNI systems, a derivation of operational needs for CNI, the synthesis of a feasible CNI system, a discussion of its capabilities, and a comparison of it with separate systems, as they might exist in the future. O.H.

A70-41137 Glass/plastic composite windshields. George L. Wiser (Sierracin Corp., Sylmar, Calif.). *SAMPE Journal,* vol. 6, Aug.-Sept. 1970, p. 29-35, 52.

Description of glass-plastic composite electrically-heated windshields which are currently in production at The Sierracin Corporation, and are in service. Windshields for both military aircraft and commercial jet airliners are included. Topics such as the advantages of composite construction, design details and considerations, materials and processes involved in their manufacture, qualification testing, specialized inspection techniques required, and service experience are discussed. G.R.

A70-41243 # Transmission of an acoustic pulse through a plane vortex sheet. M. S. Howe (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 43, Aug. 28, 1970, p. 353-367. 20 refs. Research supported by the Ministry of Technology and Rolls-Royce, Ltd.

This paper discusses the linear theory of the transmission of an acoustic pulse through a plane discontinuity of velocity. It is shown that elementary ideas of geometrical acoustics which have received much attention in the recent literature lead to the erroneous prediction of a zone of silence. It is in precisely this zone that unstable disturbances and broad-fronted pulses of enhanced intensity

propagate, having been triggered-off by the arrival of the pulse at the vortex sheet. The apparent qualitative agreement between geometrical acoustics and experimental data regarding sound radiation from the interior of supersonic jets is shown to be purely fortuitous, and it is argued that a complete analysis of such problems must depend on a deeper and possibly non-linear treatment. (Author)

A70-41250 The helicopter - An offer of new hope for the commuter, airline passenger. Alfred E. Andreoli (California State Polytechnic College, San Luis Obispo, Calif.). *VertiFlite,* vol. 16, Sept. 1970, p. 4-8.

Results of a preliminary design study for a metropolitan area commuter air transportation system that would compete economically with high-speed ground transportation. A number of aircraft configurations were considered during the design phase with the compound helicopter being selected as the most logical choice from the viewpoint of all the requirements and constraints. The aircraft would be operated in the first 2000 ft above ground level, flying under full automatic control along imaginary reserved 'tubes.' The system can be controlled by a central computer with multiple data links which allow real-time aircraft control. Aircraft guidance and navigation is accomplished by means of onboard equipment which is a parallel combination of an inertial system and a radio navigation system. The design and capacity of terminals are analyzed, and attention is given to the realizable cost benefits. T.M.

A70-41257 Twenty-third Franco-British Louis Blériot Day - Instruments and electronics in aviation (23e Journée Franco-Britannique Louis Blériot - Instruments et électronique dans l'aviation). M. Sebastian de Ferranti (Ferranti, Ltd., Hollinwood, Lancs., England). *L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 5-11. In French.

Review of the history of electronics and instrumentation in aviation, with discussion of the reasons for their development, i.e., accomplishment of all-weather flight, blind landings and takeoffs, avoidance of obstacles, etc. The earliest instruments were the anemometer and the barometric altimeter, proceeding by stages to development of radar sophisticated navigation and radio-communications systems, computers, data processing, and flying control. F.R.L.

A70-41258 The Dioscures project (Le projet Dioscures). B. Manuali (Centre National d'Etudes Spatiales, Paris, France). *L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 13-19. In French.

Discussion of the French Dioscures project, intended as a means of air traffic control, particularly over the Atlantic. The system is based on distance measurement by simultaneous use of two geostationary satellites, which makes it possible at one and the same time to pinpoint the aircraft and to carry out radio communication. Cost estimates and profit potentials are given. F.R.L.

A70-41260 Stress analysis of a fuselage section by finite elements (Calcul des tensions dans un fuselage par la méthode des éléments finis). Pierre Beckers and Guy Sander (Liège, Université, Liège, Belgium). *L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 30-39. 7 refs. In French.

Application of the finite element method to the stress analysis of a fuselage section of a swing tail cargo aircraft (the 4-engine Douglas DC-7). The method is briefly reviewed for the case of displacement models, followed by presentation of the finite element models specially adapted to the case studied. Emphasis is given to the rational choice, for each type of finite element, of the deformation modes from the point of view of adaptation to their structural function, while remaining economical in service. The results derived from a more conventional calculation method, and from model testing are compared. It is considered that certain deformation modes which were neglected in the dimensioning calculation are of more importance than expected. F.R.L.

A70-41261 Choice of materials for compressor disks from low cycle fatigue tests (Choix des matériaux pour disques de compresseur d'après les essais de fatigue lente). Jean Thiery, Jean Cardalliaguet, and Guy Viaud (SNECMA, Département Etudes Métallurgiques, Paris, France). *L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 40-46. In French.

Demonstration that, in a general way, the dimensioning of turbocompressor disks should be established commencing with the behavior of the material under low-cycle fatigue. The usual characteristics for dimensioning are the elastic limit and the creep behavior. The discussion concerns the fatigue produced by repetition of stops and starts of the machine, and the cracks produced in the stress concentration zones. This fatigue is characterized by a small number of repeated cycles at low frequency. F.R.L.

A70-41262 Buzz in supersonic air intakes (Pompage dans les entrées d'air supersoniques). Jacky Leynaert (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International Aéronautique, 9th, Paris, France, June 2-4, 1969.) L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 47-62. 19 refs. In French.

Discussion of the sustained unsteady phenomenon of buzz in a supersonic air intake, which takes place when the flow is reduced below a certain limit. A quite common form of it arises from detachments occurring in the vicinity of the entry, such as that of a shear layer under the cowl, or detachment of the boundary layer at the base of a shock wave. These phenomena are essentially three-dimensional and complex, but it is possible to represent them schematically in an elementary and overall form in order to clarify the various forms buzz may take, and to provide a means of assessing the influence of some characteristic parameters on air intake design. F.R.L.

A70-41264 The Grumman F-14 American Navy fighter (Le chasseur naval américain Grumman F-14). Georges Bruner (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique,* no. 22, 1970, p. 70-75. 18 refs. In French.

Discussion of the Grumman F-14 carrier-based fighter development program. After giving up the Navy version of the F-111 as a basic aircraft, a plan was launched for equipping the U.S. Navy with a multimission fighter. Because of the sometimes incompatible requirements resulting from the variety of missions to be achieved, the program was planned to be performed in two steps: VFX-1 in 1973, and VFX-2 in 1976. After competition with other companies, the Grumman variable geometry aircraft project was chosen. In spite of its inherent difficulties, the variable geometry configuration offers major advantages for an aircraft of this type. The Grumman F-14, which will be constructed in three versions, is expected to fly in 1971, 1973, and 1975. F.R.L.

A70-41320 # Inlet data for engine analysis. P. H. Kutschenreuter, Jr., M. T. Moore, and T. P. Collins (General Electric Co., Evendale, Ohio). *American Institute of Aeronautics and Astronautics, Propulsion Joint Specialists Conference, San Diego, Calif., June 15-19, 1970, Paper 70-1214.* 8 p. Members, $1.00; nonmembers, $1.50.

Discussion of the inlet data for engine stability analyses from a propulsion point of view. The discussion is based on the idea that it is the system contractor's responsibility to define the inlet distortion characteristics including scaling laws, and the engine contractor's responsibility to evaluate the engine stability with such characteristics. To facilitate accomplishment of the latter, selected items for consideration in the areas of pretest agreement, on-line test data results, and posttest data analysis are enumerated and in some cases illustrated with data trends. Substantially more than the raw test data and a 'road map' is shown to be necessary if the inlet/engine

stability assessment is to be efficiently conducted and limitations understood by the aircraft/engine team. Through certain pretest agreements, propulsion applicability of inlet test results can be greatly enhanced. Timely availability of certain system contractor posttest inlet analyses results can greatly expedite meaningful engine assessment by propulsion engineers, avoiding duplication and thus dilution of the total inlet/engine stability effort. O.H.

A70-41344 Design study of a transportable earth station for satellite communications systems. Kevin C. O'Brien and Henry J. Scagnelli (Bell Telephone Laboratories, Inc., Whippany, N.J.). In: Institute of Electrical and Electronics Engineers, International Conference on Communications, San Francisco, Calif., June 8-10, 1970, Proceedings. Volume 2. Edited by Donald Green. New York, Institute of Electrical and Electronics Engineers, Inc. (Conference Record. Volume 6), 1970, p. 30-17 to 30-23.

A transportable earth station design is proposed here which can serve as a tool for system testing and as a model for a series of earth stations where some degree of transportability is required. The earth station employs a 32-foot offset Cassegrain antenna designed in sections such that the entire structure can be transported and erected by a small crew with a minimum of special equipment. Using a slant axis pedestal and a novel drive and control system achieves transportability without sacrificing structural stiffness. The station can be stored in two commercial trailers and carried by a standard cargo aircraft, thus providing a high degree of flexibility in system use. (Author)

A70-41347 Airline communications requirements for the seventies. B. F. McLeod (Pan American World Airways, Inc., Miami, Fla.). In: Institute of Electrical and Electronics Engineers, International Conference on Communications, San Francisco, Calif., June 8-10, 1970, Proceedings. Volume 2. Edited by Donald Green. New York, Institute of Electrical and Electronics Engineers, Inc. (Conference Record. Volume 6), 1970, p. 33-2 to 33-6.

Discussion of the features required for a new and largely automated airline communications system which is to be planned for the near future. The development and application of a system improving the present operating efficiency, free of many present restraints, and cooperating with many other systems to form a Flight Information System is considered. Several examples of communications services provided by this system are presented. They include collecting, analyzing, storing, transmitting, receiving, and presenting information required by air traffic control and advisory services, the flight crews, and company ground offices. It is shown that the technology required by such a system already exists; modest portions of the system are already installed in the B-747 and newer aircraft. However, development of a detailed specification and production of associated hardware will still require a large effort. O.H.

A70-41348 Data Link communications for the seventies. L. C. Keene (ITT, New York, N.Y.). In: Institute of Electrical and Electronics Engineers, International Conference on Communications, San Francisco, Calif., June 8-10, 1970, Proceedings. Volume 2. Edited by Donald Green. New York, Institute of Electrical and Electronics Engineers, Inc. (Conference Record. Volume 6), 1970, p. 33-10 to 33-12.

Discussion of the design and performance of the Data Link communications system planned for improving the air traffic control. The principal objective of this system, consisting of an airborne and a ground subsystem, is shown to be to facilitate the speed of information flow between controller and pilot in congested airspace, including the terminal area, stack-ups, traffic patterns, storm avoidance, etc. The features of the system are reviewed. The system is expected to be welded into a viable chain for air traffic control in the 70s. O.H.

A70-41349 Airframe requirements for future communications. R. Dunn (Boeing Co., Commercial Airplane Group, Renton, Wash.). In: Institute of Electrical and Electronics Engineers, International Conference on Communications, San Francisco, Calif., June 8-10, 1970, Proceedings. Volume 2. Edited by Donald Green. New York, Institute of Electrical and Electronics Engineers, Inc. (Conference Record. Volume 6), 1970, p. 33-13 to 33-19.

Discussion of the optimization of airframe and system designs for future aeronautical communications systems. It is shown that to achieve optimization - i.e., maximum performance with minimum penalties to system and to aircraft - it is necessary that compatible characteristics of each be fully exploited. Therefore, the impact of airplane configuration, structural technology, and advancements in electronic technology are examined, and it is concluded that this impact must be carefully taken into account in the early stages of new airplane development cycles. O.H.

A70-41405 # Starting of low-drag supersonic blade cascades (Amorcage des grilles d'aubes supersoniques à trainée aérodynamique faible). Yves Ribaud. *La Recherche Aérospatiale,* July-Aug. 1970, p. 191-195. 9 refs. In French.

Study of the start and cruise conditions of quasi-isentropic flow cascades in low-drag supersonic compressors for aircraft engines. It is shown that the flow varieties involved impose definite limitations on the wave configuration to be maintained and lead to a retention of leading edge angles distinctly inferior to the value that analysis yields for an individual profile under two-dimensional flow with shock. The analysis demonstrates the difficulties encountered in the design of first-generation supersonic compressors. M.V.E.

A70-41407 # Measurement of the pressure field induced by the oscillation of a control surface and comparison with theoretical results (Mesure du champ de pression induit par l'oscillation d'une gouverne et comparaison avec les résultats théoriques). Roger Destuynder. *La Recherche Aérospatiale,* July-Aug. 1970, p. 205-211. In French.

Comparison of the pressure field measured on a rectangular wing with theoretical computation results. The unsteady pressure field induced by the oscillation of a control surface has been measured in incompressible flow on a rectangular wing of low aspect ratio. The experimental method used for these measurements is described, and these experimental results are compared with those obtained from computations based on lifting surface theory, taking into account the logarithmic singularities of the hinge and of the lateral edges of the control surface. Even though some as yet unexplained differences do subsist between theoretical and experimental results, the comparison indicates that the theoretical computation method used represents a perceptible progress in the evaluation of pressures induced by the oscillation of control surfaces. M.V.E.

A70-41408 # Measurement of the inertial constants of a structure of arbitrary shape, rigid or flexible, by means of a vibration test (Mesure des constantes d'inertie d'une structure quelconque, indéformable ou non, à l'aide d'un essai de vibrations). Daniel Engrand and Jean Cortial. *La Recherche Aérospatiale,* July-Aug. 1970, p. 213-219. In French.

Description of a new version of a method, originally developed by Kappus (1966), for measuring the inertial constants of an aircraft or rocket, or any other rigid or even flexible structure, without materializing any rotation axis. The necessary equipment is very similar to that normally used for ground vibration tests. The only additional device to be provided is an elastic suspension for obtaining all the natural modes corresponding to the rigid-body movements of the structure. From the measurements of the generalized masses of these modes, it is possible to compute the inertial constants, namely: the center of inertia, the inertia tensor, and the mass. When the structure is not strictly rigid, a purification process based on the mean square method permits to 'rigidify' the structure at the price of

a few additional measurements and some slight approximation errors. The method makes it also possible to account for the incidental presence of masses extraneous to the structure proper. M.V.E.

A70-41422 Sound generation by a fluctuating jet (Schallerzeugung eines pulsierenden Ausströmvorganges). H. Ising (Berlin, Technische Universität, Berlin, West Germany). *Acustica,* vol. 23, no. 3, 1970, p. 142-148. 5 refs. In German.

Theoretical and experimental study of sound generation by a fluctuating jet, taking into account a wide range of subsonic jet velocities. It was found that with increasing Mach number the contribution of the momentum source increases with respect to the volume source. This result is confirmed by the following findings: (1) the directional characteristics change their spherical shape and become more and more kidney shaped, and (2) the sound pressure at the open tube inlet increases at first linearly and then with the square of the jet velocity when a siren stimulation is used. Z.W.

A70-41440 Study of the transition on a plate to sinusoidal wall in incompressible flow (Etude de la transition sur une plaque à paroi sinusoïdale en écoulement incompressible). Than-Son Duong, Pierre Gougat, and Guy Lengellé (CNRS, Laboratoire d'Aérothermique, Meudon, Hauts-de-Seine, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 271, no. 3, July 20, 1970, p. 179-182. In French.

Precise determination of the region of transition in the boundary layer of a flat plate in incompressible flow. The effect of a harmonic wall perturbation is demonstrated, and is compared to the effect of a very small incidence variation. The tests were carried out in a subsonic Eiffel-type wind tunnel. F.R.L.

A70-41444 Theoretical study of the variation of aerodynamic parameters of a supersonic flow of ionized argon subjected to Laplace accelerating forces (Etude théorique de la variation des paramètres aérodynamiques d'un écoulement supersonique d'argon ionisé soumis à des forces de Laplace accélératrices). Bernard Forestier, Bernard Fontaine, Philippe Bournot, and Paul Parraud (Aix-Marseille, Université, Marseille, France). *Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques,* vol. 271, no. 3, July 20, 1970, p. 198-201. In French.

Results of a study undertaken to analyze the experimental results previously reported by Fontaine et al. (1970). The flow is assumed to be steady, one-dimensional, nonviscous, and in thermodynamic equilibrium. The heat transfers and the radiation losses are neglected, as well as the Hall effect. The study is applicable to the case where the applied magnetic and electric fields are constant. Considering the value of the magnetic Reynolds number as about 1.5, account is taken of the induced magnetic field; however, in order to utilize Pain's formulation (1967), it is assumed to be a linear function of x alone. F.R.L.

A70-41489 Aircraft accidents at night. Anchard F. Zeller (USAF, Norton AFB, Calif.). *Aerospace Medicine,* vol. 41, Sept. 1970, p. 1066-1069.

Although approximately one-fourth of Air Force flying is accomplished during the night hours, there apparently has not been a systematic published evaluation of the accidents which occur at night. The current study examines 103 night accidents which occurred during a two-year period. Some, although relatively few, were the direct result of darkness. The kinds of accidents experienced, the phase of flight under which they occurred, and the causes of night accidents were evaluated and compared to day accidents in the same kinds of aircraft. Accident rates on the basis of 100,000 hours were computed. The overall nighttime rate of 2.9 was considerably lower than the comparable daytime rate of 4.6. When all night experience is considered collectively, there is little difference between the night and daytime experience for most kinds of aircraft. Cargo aircraft were the exception, with an extremely favorable night rate of 0.8 as contrasted to a day rate over twice as high, 1.7. The specific reasons for this favorable night experience in cargo aircraft are not immediately discernible. (Author)

A70-41714 On the steady flow past an oblique flat plate at a high Reynolds number. Ken-ichi Kusukawa (Tokyo Metropolitan University, Tokyo, Japan). *Physical Society of Japan, Journal,* vol. 29, Aug. 1970, p. 479-495. 13 refs.

Study of the stationary flow of a viscous fluid past a flat plate at a small incidence, using Oseen's (1927) linearized theory. Special attention is given to the behavior of flow at high Reynolds numbers, using the Fourier transformation. A parameter is defined which governs the character of the flow. It is shown that Oseen's asymptotic flow corresponds to a large value of this parameter, while another type of the asymptotic flow occurs at a small value of this parameter. Z.W.

A70-41743 * # Drag coefficients for free molecule flow in the velocity range 7-37 km/sec. J. W. Boring and R. R. Humphris (Virginia, University, Charlottesville, Va.). *AIAA Journal,* vol. 8, Sept. 1970, p. 1658-1662. 10 refs. Contract No. NAS 1-2538.

Measurement of the momentum transfer by a beam of nitrogen molecules to solid surfaces for molecular energies of 8 to 200 eV (velocity range 7 to 37 km/sec). The results of these measurements make it possible to calculate drag coefficients for the situation where nearly monoenergetic molecules all moving in the same direction impinge upon a solid convex body. Drag coefficients for nitrogen molecules striking spheres of Echo 1 and Echo 2 satellite material are found to be in the range from 1.9 to 2.2. (Author)

A70-41744 * # Influence of measured freestream disturbances on hypersonic boundary-layer transition. R. D. Wagner, Jr. (NASA, Research Section, Washington, D.C.), D. V. Maddalon, and L. M. Weinstein (NASA, Langley Research Center, Aero-Physics Section, Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-704.) AIAA Journal,* vol. 8, Sept. 1970, p. 1664-1670. 16 refs.

Results of a study of transition in hypersonic flow over a wide range of test conditions in the Langley M = 20 helium tunnel. Direct measurements of the facility free-stream disturbances have been made with a constant current anemometer which has a frequency response capability of 500 kHz. In unheated flow, fluctuation mode diagrams identify the disturbances as sound waves produced by moving sources of sound (the turbulent nozzle wall boundary layer). The test section disturbance levels can be quite high with a maximum of about 3.5% rms mass flow fluctuation (which corresponds to about 6% rms static pressure fluctuation) when transition of the nozzle wall boundary layer occurs in the portion of the nozzle which can influence the test section disturbance level via direct acoustic radiation. For the same range of test conditions, transition measurements have been made on a 10° half-angle wedge. A strong correlation between the movement of transition on the model and the free-stream disturbance level is observed; transition appears to be dominated by the intense sound radiation of the nozzle wall boundary layer. The results show that the free-stream disturbances are a major contributor to the unit Reynolds number effect on transition Reynolds number. Heat-transfer transition data using heated flow (as opposed to unheated) indicated a significant effect of heating the flow, the transition Reynolds number decreasing with heated flow. (Author)

A70-41745 * # Analysis of an active thermal protection system for high-altitude flight. Paul A. Libby (California, University, La Jolla, Calif.) and Peter Hendricks (California, University, La Jolla; TRW Systems Group, Redondo Beach, Calif.). *AIAA Journal,* vol. 8, Sept. 1970, p. 1671-1678. 12 refs. Grant No. NGR-05-009-025.

A thermal protection system which may be of interest for sustained, high-altitude hypersonic flight is analyzed. It involves no net mass and energy transfer, air being injected into the boundary layer in the nose region where convective heating cannot be handled by radiation and withdrawn from the boundary layer in downstream region where possible radiative cooling normally exceeds convective heating. A zero net mass transfer can be achieved. Radiation cooling plays a dominant role in the system. Quite aside from the practical applicability of the system there would appear to be interest in the analysis of the laminar boundary layer with a mass transfer distribution, which is initially unknown but which is determined by a local energy balance involving radiative transfer. (Author)

A70-41752 # **Supersonic combustion tests with a double-oblique-shock SCRAMjet in a shock tunnel.** I. T. Osgerby, H. K. Smithson, and D. A. Wagner (ARO, Inc., Arnold Air Force Station, Tenn.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-827.) AIAA Journal,* vol. 8, Sept. 1970, p. 1703-1705. Contract No. AF 40(600)-70-C-0001.

Preliminary results of a continuing research program to develop a capability for testing integrated scramjets in a gasdynamic hotshot tunnel. During this research program, an integrated double-oblique-shock scramjet model was developed to provide a test bed for supersonic combustion tests and for instrumentation development essential in the analysis of combustion test results. Results are presented for tests in which hydrogen fuel was injected into the combustor. Injection of the fuel, from sonic orifices in the wall normal to the flow, did not lead to satisfactory combustion data supposedly because of the cold boundary layer. Injection through sonic orifices in a series of diamond airfoil injectors led to combustion data which were confirmed by a number of measurements. The measured increases were proportionate to increases in computed average equivalence ratio. The results are compared with numerical solutions. In general, the measured temperatures and pressures were higher than the calculated values. P. v. T.

A70-41768 # **Rational method of designing single-stage turbines of gas turbine engines and determining their parameters (Ratsional'nyi metod vybora parametrov i rascheta odnostupenchatykh turbin GTD).** V. A. Strunkin. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 110, 1969, p. 35-46. In Russian.

Development of an improved method of designing single-stage gas turbines, which by introducing two new parameters eliminates some drawbacks of other existing methods. The idea of the method is to design for minimum diametric dimensions, rather than proceed from a large number of stage parameters selected within a recommended but, nevertheless, wide range of values, as in the conventional approach. The extensive computational labor involved in adjusting some parameters (e.g., a too large negative reactance or inadequate ratio between the lengths of nozzle guide vanes and rotor blades) to their prescribed values is greatly reduced. V.P.

A70-41773 # **Turbulence in the zone of interaction between a jet and a flow (Turbulentnost' v zone vzaimodeistviia strui s potokom).** V. A. Kosterin, L. A. Dudin, B. A. Rogozhin, Iu. S. Alekseev, and G. M. Shalaev. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 110, 1969, p. 84-92. 10 refs. In Russian.

Description and application of a thermoanemometer used for measuring turbulence characteristics in the zone of interaction between a gas flow and injected air jets. The proposed device is distinguished by the presence of a pneumometric tube which can be oriented in the direction of the flow velocity at the point where a measurement is being performed. The results of a study of the turbulence intensity in an airflow past a cone and in the zone of interaction between pairs of flat jets and an entraining flow, using this device, are presented. It is found that the absolute values of the turbulence intensity are considerably higher in the zone of interaction between an entraining flow and jets than in the zone of interaction between an entraining flow and poorly streamlined bodies. It is concluded that by varying the jet parameters it is possible to vary the turbulence intensity in the zone of interaction between a jet and a flow in any direction desired. A.B.K.

A70-41777 # **Analysis of the conditions of operation of gas-turbine rotor bearings from the results of a computer calculation of their thermal regime (Analiz uslovii raboty podshipnikov opor rotorov GTD po rezul'tatam rascheta ikh teplovogo rezhima na ETsVM).** V. M. Demidovich and V. A. Chernoglazov. *Kazanskii Aviatsionnyi Institut, Trudy, Seriia Aviatsionnye Dvigateli,* no. 110, 1969, p. 122-127. In Russian.

Results of a large series of thermal calculations of a type of roller bearing very frequently used as gas-turbine engine compressor rotor bearings. The calculations were performed with reference to two types of lubricant (transformer oil and MK-8 oil) widely used in gas-turbine engines. The program was set up in such a way that the total losses incurred in driving each of the bearings were first estimated for a single value of the operating temperature and the radial load at various rpm regimes. Then a conversion was made to the given operating temperature by introducing an arbitrary parameter representing the unknown lubricant flow multiplied by the temperature drop between the bearing and the lubricant at the input. The results of the calculations are presented in the form of a nomogram. A.B.K.

A70-41804 * # **Some analysis of parawing canopy behavior during free flight deployment.** Dewey L. Clemmons, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1189.* 12 p. Members, $1.25; nonmembers, $2.00.

An analysis is made of certain parawing data obtained during the deployment of 400 sq ft and 4000 sq ft parawing canopies in free flight at dynamic pressures to 100 psf and altitudes to 20,000 feet. Special attention is given to the first reefed stage of deployment because it constrains the minimum load that can be achieved at high dynamic pressure and because structural damage to the fabric was most prevalent in this stage. An improved reefing concept is described and its flexibility, in terms of meeting various requirements, is discussed. (Author)

A70-41805 # **Mid-air retrieval - Optimizing performance and weight of the aircraft-borne and descent systems.** John W. Stone and Frank M. Highley, Jr. (All American Engineering Co., Wilmington, Del.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1201.* 11 p. Members, $1.25; nonmembers, $2.00.

Systems have been developed for a wide variety of payloads and missions. Analytical and descriptive approaches to improving the overall system performance are presented, with emphasis on reducing the weight and volume of the descent system. Significant reduction in descent system weight can be achieved with state-of-the-art systems. Reducing pick-up 'g' levels and /or use of gliding descent systems would result in further weight reduction. Retrieval of a package of fixed weight and also over a wide weight range are considered. Analysis of each mid-air retrieval requirement from a total system standpoint is emphasized. (Author)

A70-41806 # **AERCAB - The flying ejection seat.** W. Mawhinney (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) and R. Gross (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of*

Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1213. 10 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Systems being evaluated will improve the recovery rate of downed crewmen by providing them with the capability of flying away from their damaged aircraft. The aircraft ejection seat is to be equipped with deployable lifting surfaces and a propulsion source to create a 'flying ejection seat.' As part of a joint-services effort, the Navy is evaluating concepts in the rotary-wing and fixed-wing categories, and the Air Force is investigating a parawing concept. This paper discusses the program status, performance characteristics of the various concepts, evaluation and testing, and future plans. (Author)

A70-41807 # **The F-111 crew module development.** J. L. Charleville (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1210.* 7 p. Members, $1.25; nonmembers, $2.00.

The F-111 crew escape module is the first ejectable crew module to be utilized in an aircraft. It is normal to expect considerable development in such a venture, and some of this development involved state-of-the-art improvement. This paper describes the state-of-the-art considerations, including the main parachute and the pyrotechnics severance system, and examines the development areas. Development areas involved cross wind parachute deployment, low speed parachute inflation, module stabilization, impact attenuation and flotation self righting. (Author)

A70-41808 # **Design philosophy of the SIIIS-3 ejection seat escape system.** Walter R. Peck and Robert J. Manzuk (Stencel Aero Engineering Corp., Asheville, N.C.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1211.* 8 p. Members, $1.25; nonmembers, $2.00.

A need exists for an improved ejection seat escape system which will provide the user with state-of-art performance in a lightweight, minimum envelope, low cost system. The SIIIS-3 ejection seat escape system has been designed to four criteria: minimum weight, minimum envelope, minimum cost, and maximum performance. The design philosophy followed encompassed four basic concepts: simplicity, modularization, multiple function device utilization, and redundant structure elimination. It is believed the design goals have been achieved in the SIIIS-3 seat which is being feasibility tested by the U.S. Navy. (Author)

A70-41809 # **Development of a 600 knot extraction capability.** J. C. Rivedal (Stanley Aviation Corp., Denver, Colo.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1209.* 4 p. Members, $1.25; nonmembers, $2.00.

A tractor rocket powered escape system has been designed for use at speeds up to 600 knots. The system uses a two speed mode operation to allow use of the g-field deployed parachute at lower speeds. A drogue parachute is used to stabilize the man at higher speeds and altitudes and a standard barometric time delay is used to open the recovery parachute pack under these conditions. Certain portions of the system, normally on the seat, have been located in the parachute pack. The system has been optimized for maximum effectiveness at the speeds where most emergency escapes have been made. (Author)

A70-41810 # **The effect of variations in drogue gun firing angle on stabilization times for the MEW ejection seat system.** G. R. Drew and T. J. Bozack (U.S. Navy, Naval Aerospace Recovery Facility, El Centro, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1208.* 8 p. Members, $1.25; nonmembers, $2.00.

Operational ejection seat escape systems have employed small parachutes to stabilize and decelerate the seat-man mass after ejection and prior to deployment of the main parachute. These stabilizers are normally deployed by means of a drogue gun which projects a steel slug which tows the stabilizer into the windstream. On all operational ejection seats used by the U.S. Navy, the drogue slug is projected upwards and slightly downstream (in relation to the seat occupant). It is shown for the critical zero speed ejection case, that the time required for seat stabilization is less when the stabilizer is deployed downwards and slightly to the rear (in relation to the seat occupant). For the intermediate to high speed ejection cases, the time required for stabilization is relatively short (compared with the low speed case), and the direction of stabilizer deployment in these cases in non-critical. For future pre-stabilized ejection seat designs, selection of the drogue gun firing angle (and the resultant direction of stabilizer deployment) should therefore be based on the optimum deployment angle selected for the zero speed case, that is, downward and to the rear. (Author)

A70-41812 # **Midair rescue using the pilot airborne recovery device (PARD).** Dale E. Williams and Louis A. Girard (Goodyear Aerospace Corp., Akron, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1206.* 20 p. 5 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(657)-70-C-0235.

The requirement exists to provide a discretionary capability for personnel in a disabled aircraft to eject and either descend to the surface or remain airborne for an extended period of time. Various optional modes of midair rescue of the aircrewman also is required. The PARD element of the rescue system has proceeded from the feasibility phase into the development phase with successful test demonstrations of buoyance, midair pickup, and seat ejection. Analysis has been conducted to establish a concept definition for a complete rescue system including the pickup aircraft, energy absorber, and the location and homing avionics. Various human factor aspects also were investigated. (Author)

A70-41814 # **One-hundred ton airdrop from a C-5A aircraft.** Gene A. Petry and Robert L. Hester, Jr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1203.* 9 p. Members, $1.25; nonmembers, $2.00.

The C-5A aircraft has a unique capability of being able to deliver by airdrop multiple loads up to 200,000 pounds total weight. Current airdrop procedures are being used. A different rigging and deployment method is presented which will reduce the high shock forces being experienced and insure controlled load lock releases. A proposed rapid extraction technique permits the capability of the aircraft to be better utilized by increasing the airdrop density within a given area for a single air pass and also increases the number of drop zones available by a reduction in length requirement for single air pass delivery. (Author)

A70-41816 # **Development status of BALLUTE system for stabilization and retardation of aircraft stores.** Albert C. Aebischer (Goodyear Aerospace Corp., Akron, Ohio) and Earl S. Suters, Jr. (USAF, Armament Development and Test Center, Eglin AFB, Fla.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1200.* 10 p. 8 refs. Members, $1.25; nonmembers, $2.00.

During the past several years, certain research programs have demonstrated the feasibility of the attached BALLUTE (BALLoon-parachUTE) for stabilization and retardation of aircraft-deliverable

stores, high-altitude descent devices, and planetary entry vehicles. This decelerator consists of a fabric structure attached to the aft end of a payload and can be inflated from a packaged condition to a predetermined shape for a predictable increase in aerodynamic drag. Various programs that contributed to the present state of development are summarized. Wind-tunnel and flight testing of attached BALLUTE configurations on the USAF M-117 and M-118 munitions is described. The velocities during these tests were in the subsonic through transonic regimes. (Author)

A70-41817 # **The use of an attached inflatable decelerator for store delivery from high speed aircraft from low altitude.** Abraham Flatau, Donald N. Olson, and Miles C. Miller (U.S. Army, Edgewood Arsenal, Md.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1199.* 9 p. Members, $1.25; nonmembers, $2.00.

Feasibility study of an aerodynamic decelerator and stabilization device for achieving rapid trailover, with minimum altitude loss, of a 40-lb store dispensed from a high-speed aircraft operating at low altitude. The ballistic properties necessary to meet the trajectory requirements were calculated, and such factors as packageability, deployment characteristics, and flight stability were considered in the selection of the attached inflatable decelerator. Wind tunnel tests, using pressure and scale models, resulted in aerodynamic data used in a stress-analysis and trajectory computer programs. Ballistically matched scale models were free-flight tested and provided an indication of the effects upon stability of varying certain design parameters. Full-scale units were wind tunnel tested prior to flight testing form helicopters and high-speed F-4 aircraft. The results of these flight tests showed that excellent deceleration was achieved due to the large drag coefficient and was accompanied by excellent stability. The range from launch to impact was very repeatable, and the resultant flight-test data correlated with the trajectory predictions based on the wind tunnel data. The study demonstrated that the attached ram air inflatable decelerator offers a means of delivering stores from low through high speed and at extremely low altitudes while providing high drag, stability, a favorable ratio of decelerator weight to payload weight, and excellent packageability. M.V.E.

A70-41818 # **Ring buckling of inflated drag bodies.** A. D. Topping (Goodyear Aerospace Corp., Akron, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1198.* 8 p. 12 refs. Members, $1.25; nonmembers, $2.00.

Buckling instability may occur in at least three types of aerodynamic decelerators: toroidal drag bodies, drag cones, and the tucked-back balloon-parachute (Ballute). Buckling criteria for inflated compression members are reviewed, and tests of inflated columns of Mylar, Dacron-neoprene, and stainless steel-silicone fabrics are reported in support of the theoretical development. The theory is then extended to the buckling of a ring in and out of the plane of its centerline. A drag body consisting of a simple torus connected by a skirt to a forebody is used as an illustrative example. (Author)

A70-41819 # **The shape and stresses in an arbitrarily shaped gore parachute under an arbitrary pressure distribution.** B. W. Roberts (Sydney, University, Sydney, Australia). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1197.* 13 p. Members, $1.25; nonmembers, $2.00.

In a previous paper a theoretical model was presented for the inflation of a parachute. Therein it was stated that the inflation process is not simply a question of canopy filling, but instead a complex connection between the so-called stress-displacement equations and the unsteady pressure distribution acting on the canopy. The present paper takes the previously derived stress-displacement equations (along with some minor corrections to the previously given boundary conditions) and solves these equations, with certain assumptions, for any arbitrarily prescribed pressure distribution acting upon the canopy. The solution to these equations gives the shape and stress distribution corresponding to any gored parachute under any instantaneous pressure distribution that might be acting during the inflation process. The numerical results refer to a flat, circular parachute, 16-1/2 ft in diameter, with a solid gored section. Further results are derived for parachutes with a ribbon section or a ring-slotted section under any arbitrary presssure distribution. The change of shape and stress distribution in any of the above parachute types is calculated for reefing lines of various lengths, or for parachutes with a pilot parachute attached to the apex. In addition, the effects of various rigging line lengths or an arbitrary number of gores can be included. This work represents the elastic section of a rigorous, two part aeroelastic analysis of the parachute during inflation and during the steady descent. (Author)

A70-41820 * # **Structural analysis of a parawing during deployment.** Paul M. Kenner (LTV Aerospace Corp., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1196.* 16 p. 15 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 1-6957.

A finite element method is used to determine the critical stress distribution in the canopy of an intermediate scale (5000 lb payload), twin keel, parawing. The analysis accounts for finite strains and non-linear material properties, and includes both tape and anisotropic triangular membrane elements. The loading conditions and canopy geometry were taken from the results of a data analysis of a NASA drop test. The coefficients describing the stress-strain relations of the parawing fabric were obtained from a recent test program conducted by the NASA Langley Research Center. The convergence of the finite element method is demonstrated by the results obtained for a tape-stiffened, cylindrical membrane using the parawing material properties and a uniform internal pressure distribution of the same mean intensity as that experienced by the parawing. The first step solutions for the test problem converged with sufficient accuracy in three iterations to allow a large displacement solution by the piecewise linear (linear incremental) approach. Such convergence was not attained for the parawing solutions due to the asymmetric geometry and loading conditions. However, an iterative solution using the total load does predict failure stress levels in the region where a tear failure was experienced in the drop test, indicating that the failure was the result of the loading conditions rather than an initial weakness in the fabric. The results also imply that the use of additional suspension lines along the side lobe leading edges would reduce the fabric stress in the critical region. (Author)

A70-41821 * # **Stress analysis of spacecraft parachutes using finite elements and large deformation theory.** W. M. Mullins and D. T. Reynolds (Northrop Corp., Ventura Div., Newbury Park, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1195.* 16 p. 12 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 9-8131.

An analytical method has been developed for determining the unique shape and internal load distribution that satisfies equilibrium and boundary conditions for a parachute under the influence of known riser and aerodynamic forces. The parachute is treated as a deformable membrane, using finite elements with nonlinear elastic properties to represent the structure. An iterative procedure, performed by a digital computer is used to find the equilibrium shape. The method is applicable to polysymmetric parachutes which have meridional members (cords or radial tapes) that can be assumed to carry all meridional forces in the canopy. Reefed and nonreefed configurations can be analyzed, and the canopy may be fully or partially inflated. Predicted canopy shapes and failure loads are shown to agree with aerial drop test results. (Author)

A70-41822 * # **Hi-glide personnel canopies - Efforts toward identification of requirements.** Ralph J. Speelman, III (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), Charles Bradshaw (NASA, Langley Research Center, Low Speed Vehicles Branch, Hampton, Va.), John Sobczak (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.), and George L. C. Menard (U.S. Navy, Naval Aerospace Recovery Facility, El Centro, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1194.* 12 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Presented are the results to date of a Joint Service Task Team's efforts to identify the desires/requirements of potential users of current hi-glide canopy (Para-Foil, Parawing, Sailwing and Volplane) technology. Trade-off plots are provided for such items as release altitude, offset capability, release point error, wind offset, and various system performance parameters. Present performance envelope guidelines are outlined. A series of questions are provided which can be used to generate a reasonably complete listing of capabilities and characteristics required for operational commitments. Estimates of probable user requirements for both premeditated and emergency escape type applications are also included. (Author)

A70-41823 # **Estimation of wind effect on gliding parachute cargo systems using computer simulation.** Thomas F. Goodrick (U.S. Army, Natick Laboratories, Natick, Mass.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1193.* 10 p. Members, $1.25; nonmembers, $2.00.

The results of computer simulations show the effect of wind on the accuracy of gliding parachute cargo systems utilizing both non-proportional and proportional automatic manual control. Parameters used in the study are indicative of the characteristics of gliding systems currently being developed. Proportional control and two-step proportional control are only slightly better than non-proportional automatic control. Even with accurate position and heading data, manual control impact accuracy is limited although high winds can actually be used to improve accuracy. (Author)

A70-41824 # **Several reefing techniques for various gliding devices.** Edwin D. Vickery (Pioneer Parachute Co., Inc., Manchester, Conn.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1192.* 9 p. Members, $1.25; nonmembers, $2.00.

A variety of reefing systems is discussed for such gliding devices as the Parawing, Sailwing, Para-Flyer, Paraplane, and Volplane. A 17.25-ft Parawing with a lacing-reefing-line system was successfully tested at 110 KIAS with a 523-lb suspended weight. Personnel-size Sailwings were live tested with a lacing system which proved to be reliable and reduced the opening shock. Para-Flyers having a wingspan as large as 51 ft have been successfully tested, using a unique annular reefing system. A velocity-sensitive reefing system that utilizes pilot-chute drag force has been tested on the Paraplane. A 312-sq ft Volplane with two encircling bands and reefing cutters was tested at 105 KIAS with a 222-lb suspended weight; the first-, second-, and third-stage opening forces were 615, 575, and 525 lb, respectively. Personnel-size (226-sq ft) Volplanes with a single encircling band and a hydraulically operated release mechanism have been dummy and live tested. With but a few exceptions, meaningful and complete reefed-opening data for these gliding devices are lacking. To date, no one reefing-system concept has been fully explored for universal application. (Author)

A70-41825 # **Static and dynamic longitudinal stability of a semi-rigid para-foil.** R. Harley Walker, Jr. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1191.* 15 p. 16 refs. Members, $1.25; nonmembers, $2.00.

Wind-tunnel investigation of the pitching motion of a semirigid model of the Para-Foil gliding descent system. The dynamic stability of this one-degree-of-freedom system is concerned with the nature of the pitching oscillations that result from static stability tendencies after a disturbance from the steady-state trim. In the experiments, the model was allowed to perform free oscillations about one axis. Motion parameters were obtained from the data. The pitching and the damping moment stability coefficients were determined as functions of time. The aerodynamic stability coefficients (pitching and damping moment stability coefficients) are found to be accurately determined from analysis of the measured motions as obtained from various reference pivot positions. Some nonlinearity with angle of attack is found to exist in both stability coefficients, and for some pivot positions two values of steady-state trim are determined. The data obtained confirm that the trim angle and the stability coefficients change with reference pivot position. It is shown that the Para-Foil stability characteristics can be predicted for various rigging configurations (pivot positions), using the results of the experiments. V.P.

A70-41826 # **Parafoil flight performance.** John D. Nicolaides (Notre Dame, University, Notre Dame, Ind.) and Michael A. Tragarz. *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1190.* 10 p. 12 refs. Members, $1.25; nonmembers, $2.00.

The steady state flight performance of the Parafoil is computed by using aerodynamic coefficient data obtained from wind tunnel tests of both small scale models and full scale units. The actual free flight performance of the Parafoil is obtained from both manned ascending flights and aircraft jumps. Attention is also given to the flight stability and control of the Parafoil and to its unique landing flare. The agreement between the performance predictions based on the wind tunnel data and the results obtained from actual flight tests is good and allows the favorable consideration of the performance of more advanced Parafoil designs. (Author)

A70-41827 # **Theoretical investigation of the aerodynamic characteristics of all-flexible parawings.** S. B. Spangler and J. N. Nielsen (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1188.* 10 p. 9 refs. Members, $1.25; nonmembers, $2.00.

A theoretical method for predicting the aerodynamic performance of all-flexible parawings is described. The method is based on slender-wing theory and employs circular-arc approximations to the actual wing sections in the crossflow plane to account for the principal nonplanar effects of canopy shape. Calculations for conical parawings indicate that spanwise camber has the effects of increasing the lift-curve slope and the normal-force-to-induced-drag ratio over those values for a flat triangular wing of the same aspect ratio. Comparisons with aerodynamic data for two parawings for which good shape data are available indicate good agreement of lift and drag. Line load comparisons using the predicted detailed load distribution indicate that the chordwise load distribution is sensitive to the manner in which the canopy shapes are fit, particularly in those regions where the canopy leading edge is re-entrant due to rigging line constraints. (Author)

A70-41828 * # **Parawing technology for spacecraft land landing - A progress report.** J. H. Moeller and E. M. Linhart (Northrop Corp., Ventura Div., Newbury Park, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1187.* 9 p. 5 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 1-7467.

This paper describes some of the significant findings of a 2½ year program conducted to investigate the suitability of the all-flexible parawing as a primary descent system for large spacecraft. The program included wind tunnel tests of small parawings and 75 aerial drop tests of 400 sq ft and 4000 sq ft parawings. The parawing configuration, structural arrangement and method of multistage reefing are described. Deployment data are presented to show that deployment loads could be maintained at a level of 3.0 to 3.5 G's. L/D performance of the wings in free gliding flight was in the range of 2.5 to 2.75. However, significant modulation of L/D for control of glide path angle was not achieved using either tip-line or rear-keel-line control. Also, the large parawings showed a susceptibility to localized canopy fabric damage during initial deployment and reefed inflation. Overall, the program demonstrated that large parawings could be built, deployed at high speed and brought to a configuration for controlled, gliding flight. (Author)

A70-41829 * # **Glide performance of advanced parawings.** William C. Sleeman, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1186.* 5 p. Members, $1.25; nonmembers, $2.00.

Review of the highlights of extensive parawing research and technology work accomplished in the past two years. Results of recent wind-tunnel tests of advanced twin-keel parawings are presented to indicate the improvements in performance obtained with these advanced configurations. Results of radio-controlled flight tests and simulator studies are also given to indicate the capabilities of piloting a gliding parawing vehicle to landing at a desired location. O.H.

A70-41833 # **Fabrics for gliding decelerators.** Stanley Schulman (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), Norman J. Abbott, and Theodore E. Lannefeld (Fabric Research Laboratories, Inc., Dedham, Mass.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1180.* 13 p. Members, $1.25; nonmembers, $2.00.

This work has been concerned with the development of fabric having suitable characteristics for use in gliding decelerators. Conventional woven fabric proved to be unsuitable because the desired low level of air permeability could not be achieved, particularly when the fabric was subjected to biaxial stress. Very low permeabilities were obtained by applying a coating having a weight of at least 0.5 oz/sq yd. Most conventional coating materials could not be used because of excessive adhesion between the coated surfaces under pressure packing conditions. The best coating procedure, giving the combination of high tearing strength and no pressure-induced adhesion, consisted of two base coats of a soft polyurethane covered with a coat of nylon. When applied to appropriately designed basket weaves, fabrics were produced which represent a considerable improvement over present commercially available fabrics, particularly with respect to tearing strength and ability to be pressure packed without adhesion. (Author)

A70-41836 # **Initial results on theoretical prediction of drag for a trailing decelerator at supersonic speeds.** Thomas W. Brunner (Goodyear Aerospace Corp., Akron, Ohio) and Robert M. Nerem (Ohio State University, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1177.* 13 p. 12 refs. Members, $1.25; nonmembers, $2.00.

The development of a method for predicting decelerator performance has been under investigation for several years. The present state of this program allows for the prediction of drag for a trailing decelerator in a supersonic flow and at zero angle of attack. These drag calculations are made using recently developed methods for computing flow fields into and around trailing decelerators in conjunction with empirical correlations to define base-pressure drag. The details of the flow field computations are briefly summarized, and initial results leading to drag prediction for balloon-parachutes (Ballutes) and parachutes are examined and compared with experimental data. (Author)

A70-41837 * # **Supersonic flow of nonuniform free-streams past aerodynamic decelerators.** Frankie G. Moore, Fred R. DeJarnette (North Carolina State University, Raleigh, N.C.), and Eugene N. Brooks, Jr. (U.S. Navy, Naval Ship Research and Development Center, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1176.* 12 p. 21 refs. Members, $1.25; nonmembers, $2.00. Grant No. NGL-47-004-006.

Flow fields past aerodynamic decelerators immersed in the wake of a primary vehicle are investigated analytically. Inviscid flow fields were computed by the methods of characteristics and integral relations, and laminar boundary layer properties were calculated numerically. Results for pointed wedges and cones showed an adverse pressure gradient on the surface which led to boundary layer separation in some cases and an inviscid surface Mach number going to unity for some wake profiles. Surface pressure distributions were found to correlate very well with the tangent cone approximation and reasonably well with a Newtonian theory applied to nonuniform free streams. (Author)

A70-41838 * # **Transient aerodynamic pressures during unsteady parachute processes.** Charles H. Eldred and Martin M. Mikulas, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1175.* 9 p. 11 refs. Members, $1.25; nonmembers, $2.00.

The gas dynamic equations of one-dimensional wave motion are used to characterize the behavior of transient pressures generated across parachute canopy surfaces. Theoretical predictions that subsonic transient pressure coefficients have a strong velocity dependence and can far exceed steady-state values are verified by experimental data. The theoretical equations are derived for the parachute problem, including terms to account for the effects of fabric and geometric porosity. Theoretical predictions are compared with data from a range of different unsteady problems. Implications of this theory for other analytical areas including stress analysis and apparent mass determination are discussed. (Author)

A70-41839 # **Comparison of hypersonic aerodynamic deceleration systems based on gun tunnel investigations.** Wolfgang Wyborny and Hans-Peter Kabelitz (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Gasdynamik, Porz-Wahn, West Germany). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1174.* 8 p. 32 refs. Members, $1.25; nonmembers, $2.00.

Results of force measurements of different deceleration devices for axisymmetric bodies with central spikes of different lengths and deflection angles, fixed spoilers (attached to the basic model at different axial stations) and conical slotted or unslotted flares at the base of the model are presented and compared. The tests were carried out in a gun tunnel at a free stream Mach number of 8.75 and a free stream Reynolds number based on the diameter of the cylindrical model part of 230,000. (Author)

A70-41840 # **A continuous surface of revolution parachute for supersonic/hypersonic speeds.** Charles A. Babish, III (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic*

Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1173. 10 p. 19 refs. Members, $1.25; nonmembers, $2.00.

High speed wind tunnel experiments were performed using parachutes specifically designed for compatibility with analytical flow field prediction techniques that employ simple mathematical models for the shape of inflated parachutes. The test parachutes (designated Supersonic-X), when operating at design conditions, are similar in shape and performance to divergent-convergent inlets in subcritical operation. Drag force measurements and still and motion picture coverage of the parachutes and their flow fields were obtained for all tests. Satisfactory parachute performance characteristics were exhibited for Mach numbers up to 8, parachute diameters up to 3.5 feet, and deployments behind a variety of forebodies. These tests demonstrate the feasibility of operating a continuous surface of revolution parachute at high speeds. (Author)

A70-41841 * # **Supersonic and subsonic wind-tunnel tests of reefed and unreefed disk-gap-band parachutes.** P. J. Bobbitt, R. J. Mayhue (NASA, Langley Research Center, Hampton, Va.), G. L. Faurote (Goodyear Aerospace Corp., Akron, Ohio), and L. L. Galigher (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1172.* 13 p. 8 refs. Members, $1.25; nonmembers, $2.00. USAF-supported research.

Low subsonic and supersonic wind-tunnel tests of 5.5-foot-nominal-diameter parachutes with geometric porosities of 10, 12.5, and 15 percent have been conducted to determine their stability and performance. Typical time histories from the supersonic tests of parachute drag, angle of attack, and cross-sectional area are shown and qualitatively compared with flight results. In addition, a discussion is given of data obtained at Mach numbers from 2 to 3 to determine the effects on performance of suspension-line length, amount of reefing, and forebody diameter. Average drag values are presented for all configurations with that of the 12.5-percent porosity parachute compared with flight data for 40-foot parachutes. (Author)

A70-41842 * # **A new technique for predicting the snatch force generated during lines-first deployment of an aerodynamic decelerator.** Earle K. Huckins, III (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1171.* 6 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Snatch force, for a lines-first type of deployment, is shown to be a result of the large increase in the linear mass density of the unfurling decelerator as the canopy skirt emerges from the deployment bag. An expression which approximates the snatch force is derived by means of a steady-state analysis which considers the wave propagation characteristics of the suspension lines. Results obtained by using the new technique showed significantly better correlation with flight data than results obtained by using the 'handbook method' which is based on the deployment process characteristic of a canopy-first type of deployment. (Author)

A70-41843 # **Theory on the dynamics of a parachute system undergoing its inflation process.** Royce A. Toni (Pioneer Parachute Co., Inc., Manchester, Conn.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16,1970, Paper 70-1170.* 8 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Study of phenomena associated with parachute inflation. The parachute-system inflation process is treated as a three-body dynamics problem. The three bodies are the inflating parachute, the attached payload, and the forebody from which the attached payload is extracted. The theory is presented in the form of four second-order nonlinear differential equations, the first three of which define the colinear motion of each of the three bodies. The fourth equation defines the radially emanating motion of the inflating parachute. These four differential equations suffice to define the three-body dynamics of the prescribed problem. The parameters considered are: the mass of the entrapped air in the inflating portion of the canopy; the drag effect of both the streamed and inflated portions of the canopy; the elasticity and damping characteristics of the parachute's suspension system; the wake of the forebody as it affects the motion of the extracted payload; and the friction between the payload and forebody during payload extraction. Solutions are obtained for some high-altitude applications. M.M.

A70-41844 # **A theory of vibrations in parachutes.** G. W. H. Stevens (Royal Aircraft Establishment, Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1169.* 8 p. 14 refs. Members, $1.25; nonmembers, $2.00.

The basic modes of vibration of a tethered parachute are outlined and a simple theory for determining their fundamental frequencies is developed. All frequencies appear to be inversely proportional to linear dimensions and their various ratios can be defined in terms of the canopy mass/lines mass ratio and a function of the elastic properties of the material. Some discussion is given to the mechanism by which parachute lines pick up energy from high speed airflows. The importance of high tenacity fibres for lines of small heavy parachutes designed for high speed use is demonstrated. (Author)

A70-41845 # **Flexibility as parameter of model parachute performance characteristics.** H. G. Heinrich and Thomas R. Hektner (Minnesota, University, Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1166.* 13 p. 13 refs. Members, $1.25; nonmembers, $2.00. Contract No. AF 33(615)-68-C-1227.

In parachute model experiments, performed for the study of static and dynamic parachute characteristics, one must consider, besides Reynolds and Mach number influences, the effects of canopy porosity, flexibility, and weight. Porosity or air permeability can conveniently be expressed in terms of effective porosity which is for a material with given physical properties a function of Reynolds and Mach numbers. For the definition of the structural characteristics a stiffness-weight index is proposed. This index has been established for model and full size parachutes. Fabrication techniques for building lightweight and highly flexible models were developed. Wind tunnel and catapult tests with models of different stiffness indexes showed significant differences in parachute drag, inflation and squidding characteristics. (Author)

A70-41846 * # **Low- and high-altitude tests of parachutes designed for use in low-density atmospheres.** Harold N. Murrow and Clinton V. Eckstrom (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1164.* 6 p. 10 refs. Members, $1.25; nonmembers, $2.00.

The purpose of this paper is to briefly summarize results from a series of aircraft drop tests from 10,000 ft of the same parachute configurations that were tested in an earlier program at altitudes above 130,000 ft. The mortar-type deployment method was identical to that employed in the high-altitude tests, and the test conditions were adjusted in an attempt to achieve maximum loading magnitudes similar to those experienced at high altitudes. Data comparisons show that for the low-altitude tests of disk-gap-band (DGB), modified ringsail, and cross parachutes, the inflation times are longer,

opening loads lower, and the air mass in the canopy wake (herein called 'apparent mass') significantly affects the opening sequence. Film and time histories will be shown to emphasize these points.
(Author)

A70-41850 **Challenge for the designer - Selecting a rotor-drive system.** Meade H. Mitchell and J. Nelson Daniel (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *Vertiflite,* vol. 16, Aug. 1970, p. 2-6.

Review of some of the proposed experimental and applied rotor-drive system concepts for rotary-wing aircraft that have evolved over the years. Two fundamental concepts of drive systems are considered, namely, the hub drive, characterized by driving the rotor at the hub, and the blade drive, in which power is applied to appropriate segments along the rotor blade. The more specific types within these two concepts, which can be broadly divided into mechanical drive and reaction drive methods, are described on several examples, and their features are compared and discussed. It is concluded that although there are numerous methods which could be used to drive helicopter rotors, the mechanical hub drive appears to be most advantageous on the basis of efficiency and noise. The large amount of experience that has been accumulated has resulted in a high degree of refinement of gear drive systems. Technology advances in the field of materials, lubrication, and new concepts will make this type of drive even more effective in the future. O.H.

A70-41863 * # **Loads induced by terminal-shock boundary-layer interaction on cone-cylinder bodies.** Lars E. Ericsson (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *Journal of Spacecraft and Rockets,* vol. 7, Sept. 1970, p. 1106-1112. 8 refs. Contract No. NAS 8-20354.

An analysis is described that can define the loads induced by shock-induced separation at high subsonic speeds. The supersonic flow region aft of the cone-cylinder shoulder is terminated by a normal shock that causes the boundary layer to separate. At increasing angle-of-attack the leeward side boundary layer is thickened due to crossflow effects and is more easily separated, resulting in a forward movement of the shock. On the windward side, opposite effects occur, and a negative forebody load is generated. When the angle-of-attack exceeds a critical value, the leeward side boundary layer can nowhere support the shock due to the steepening adverse pressure gradient near the shoulder. As a consequence, complete flow separation occurs on the leeward side with an associated large discontinuous change of the forebody load.
(Author)

A70-41866 # **Newtonian aerodynamic coefficients for an arbitrary body, including all 'shadowed' areas.** Melvin L. Roberts (General Electric Co., Aircraft Engine Technical Div., Cincinnati, Ohio). *Journal of Spacecraft and Rockets,* vol. 7, Sept. 1970, p. 1119-1121.

Discussion of a major computational difficulty which arises in applications of Newtonian hypersonic aerodynamic theory when one part of the body with a local body angle of attack less than 90 deg is shielded from the freestream (shadowed) by a portion of the body upstream of it. An approach to this problem is proposed in which the body is described by a series of planar cross sections, each defined by a finite number of points. A technique is developed for rapidly ascertaining whether each body point is shadowed, and for determining unambiguously the elemental surface areas and associated local body normals. V.P.

A70-41877 # **Effect of specific heat ratio on surface pressure coefficient for lifting cones.** D. J. Jones (National Aeronautical Establishment, Ottawa, Canada). *Journal of Spacecraft and Rockets,* vol. 7, Sept. 1970, p. 1144-1146. 7 refs.

Theoretical investigation of the dependence of the surface pressure coefficient on the specific heat ratio for yawed conical bodies in supersonic streams. The study is based on Rasmussen's (1967) approximate pressure formula for hypersonic flow past an unyawed cone. Although the formula is applicable only to zero incidence, it is considered sufficient since incidence variations can be accounted for by tangent cone approximations. It is shown that over a large range of Mach numbers, cone half-angles, and relative incidences, the surface pressure coefficient for a specific heat ratio of 5/3 differs only about 2% on the average from the values obtained with a specific heat ratio of 7/5. T.M.

A70-41891 # **A new high strength glass for aircraft transparencies.** D. L. A. Hands and S. E. Kay (Triplex Safety Glass Co., Ltd., London, England). *Aircraft Engineering,* vol. 42, Sept. 1970, p. 54-56.

Description of a newly developed glass with properties of particular interest for aerospace applications. The product, Triplex Ten Twenty, is already being used on the Concorde SST, and is commercially available. The glass starts with universally available soda lime glass as raw material, and does not involve the costs of a special composition glass. The strength is achieved by putting the outer surfaces of the glass into compression, and the center into tension. It is superior to air toughened glass against bird impact. In addition to cockpit glazing, it is considered that Ten Twenty glass has possibilities for use in passenger cabin windows, where scratch and solvent resistance, higher temperature operation, and flammability characteristics are superior to the conventional acrylic windows. F.R.L.

A70-41920 **Airborne computers - Is the special-purpose machine economically effective.** J. T. Shepherd (Elliott Flight Automation, Ltd., Rochester, Kent, England). *Electronic Engineering,* vol. 42, Sept. 1970, p. 44-47.

Discussion of airborne digital computers in modern aircraft systems taking into consideration an optimization of the computer for the system requirements. It is shown that this approach is leading to a wide variety of airborne computers, each optimized for a specific group of tasks, which in turn generates further airborne applications. System requirements are investigated and design parameters are discussed. Aspects of implementation of the factors considered are taken into account. G.R.

A70-41922 **Airborne data acquisition - Solving system-design problems.** R. S. Hopkins (Sperry Airborne Data Acquisition Systems). *Electronic Engineering,* vol. 42, Sept. 1970, p. 52-55.

Discussion of the requirements for airborne data acquisition and of the equipment designed to meet these requirements. The requirements are connected with legal regulations making provisions for a recording of the flight path in case of accident and needs to observe engine performance and crew efficiency. Design requirements for airborne data-acquisition units are examined and the components used in such units are discussed. Scanner-encoder arrangements are considered and a circuit description is given. Some current developments designed to reduce the size and weight of the equipment and improve their reliability are examined. G.R.

A70-42108 # **On a class of quasi-conical supersonic wings with curved subsonic leading edges.** R. Coene (Delft, Technische Hogeschool, Delft, Netherlands). *Journal of Engineering Mathematics,* vol. 4, Apr. 1970, p. 155-167. 8 refs.

It is shown that for a certain class of wings with subsonic, curved leading edges, in linearized supersonic flow, the perturbation potential can be expanded in terms of functions which are solutions of homogeneous flow problems. If the boundary conditions on the wing are of polynomial form, the homogeneous flow problems are elementary. Some calculations are carried out for flat wings with gothic and ogee planforms under incidence. (Author)

A70-42174 **Yak-40, bizjet from the USSR.** James Holahan. *Business and Commercial Aviation,* vol. 27, Sept. 1970, p. 62-66.

Description of the flight characteristics and physical features of the Soviet Yak-40 business jet offered for export. It is noted that the design appears to be rugged and unsophisticated. Its main features are a voluminous fuselage, supported by an unswept, trapezoidal, thick wing with large, conventional flaps and no high-lift devices, fences, or frills. The aircraft is powered by three relatively small, 3300-lb thrust engines. Quite likely, the third engine was added as the simpler way to get good airfield performance rather than resorting to the complexities of a wing with high-lift devices. It is concluded that, on the whole, this unique and interesting airplane is more in a class with the large turboprops than with the business jets. In both cost and performance, it ranges below Gulfstream I. Little sales promise for the USA is predicted. Z.W.

A70-42175 **The SN-600 Corvette.** Richard N. Aarons. *Business and Commercial Aviation,* vol. 27, Sept. 1970, p. 85-87.

Description of the design and performance of the SN-600 Corvette business jet developed in France. The Corvette will be powered by two Pratt and Whitney JT 15D-1 turbofan engines rated at 2200 lb thrust each. The aircraft is provided with a long wing - a full 42 ft in span - with a relatively high aspect ratio. The wing is fitted with ailerons, spoilers, speedbrakes, and long travel, wide-span double-slotted flaps. To keep the design simple, hydraulics was avoided as much as possible. The ailerons, rudder, and elevator, for example, are all manually powered through a system of cables and pushrods; flaps and speedbrakes are electrically operated. The electrical system drives the landing gear retraction mechanism as well as items mentioned above. The specifications and performance of the aircraft are presented. Z.W.

A70-42209 # **Accelerated supersonic motion of a plate at a finite angle of attack (Uskorennoe sverkhzvukovoe dvizhenie plastiny pri konechnom ugle ataki).** O. G. Goman. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* July-Aug. 1970, p. 70-75. In Russian.

Discussion of the unsteady supersonic motion of a plate with an attached shock wave in an ideal gas at finite (but not infinitely small) angles of attack. It is assumed that the laws governing the velocity variations and the changes in the inclination angle of the plate are arbitrary and that the Strouhal numbers are small. Under these assumptions and for Mach numbers smaller than unity, the prehistory of motion is satisfactorily characterized by the instantaneous values of the nonstationarity parameters and their derivatives. It shows that by using this result, it is possible to appreciably simplify the system of equations describing perturbed nonstationary motion, and to obtain an analytical solution to this system. V.P.

A70-42224 # **Influence of the dust content of the flow on the results of hypersonic wind tunnel experiments (Vliianie zapylennosti potoka na rezul'taty ispytanii v giperzvukovykh aerodinamicheskikh trubakh).** B. I. Bakum, T. N. Dombrovskaia, and V. I. Lagutin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* July-Aug. 1970, p. 187-189. 6 refs. In Russian.

Discussion of the mechanism and nature of the influence of a dust content of roughly 0.05% in hypersonic wind tunnel flows on the test results, on the basis of an elastic collision model. It is shown that the dust content of the flow increases the drag force for slender models but decreases the drag force and the longitudinal damping moment coefficient for blunt-nosed models. V.P.

A70-42272 # **Performances of cascade of blades with small aspect ratio. I.** Shintaro Otsuka and Showgo Hayashi. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, May 1970, p. 178-184. In Japanese, with abstract in English.

Experimental study, at the center of blade span, of the performance of low aspect ratio (AR) compressor blades in cascade. All blades had the same span (50 mm), and their AR's were 2.08, 1.39, 1.04, and 0.83. Stagger angle (alpha) was varied from 0 to 60 deg, and the angle of attack (alpha sub i) from 0 to 15 deg. Results show that the total pressure loss coefficient has a minimum value at an AR about equal to 1, irrespective of alpha and alpha sub i. At alpha sub i over about 5 deg the turning angle increases, and at alpha sub i = 0 it decreases gradually with increasing AR. In the case where alpha = 30 deg, it keeps an almost constant value, irrespective of AR, at alpha sub i = a constant. In cases of alpha = 50 and 60 deg, it increases when alpha sub i equals or exceeds 5 to 10 deg with increasing AR. F.R.L.

A70-42273 # **Study on the spoiler for aircraft.** Shigetoshi Takata. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Apr. 1970, p. 131-153. 24 refs. In Japanese, with abstract in English.

Experimental investigation of phenomena related to the effectiveness of a spoiler and a law underlying the phenomena. A quantitative study was made of the phenomenon whereby the spoiler wake is affected by the portion of airfoil behind it, and of the tendency of the spoiler wake region to shrink. The former phenomenon was designated as wake plate effect, while the latter was called reattach tendency. A wake model reasonably representing the law related to the phenomena, and an airfoil model with a normal spoiler which was obtained from a circle through a conformal transformation were combined into one mathematical model. Using this mathematical model, a theory on spoilers was developed on the basis of the two-dimensional potential theory and was simplified to an approximate theory for practical purposes, which proved to agree fairly closely with experiments. M.M.

A70-42274 # **Some effects of systematically varied location of one concentrated mass on transonic flutter characteristics of sweptback thin cantilever wing. I.** Eiichi Nakai and Toshiyuki Morita. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Mar. 1970, p. 93-103. 9 refs. In Japanese, with abstract in English.

Experimental investigation of effects of the spanwise location of an engine pod-like concentrated mass on the transonic flutter characteristics of thin cantilever wings having a sweptback angle of quarter chord line of 20 deg and panel aspect ratio and taper ratio of 4.0 and 0.4 respectively. The investigation has been made in a 60 x 60 cm transonic blowdown wind tunnel for flutter testing at Mach numbers between 0.759 and 0.963. The experimental results are given in a comparison of the boundary of flutter density and experimental flutter-velocity coefficient of the wing-pod configuration tested as a function of Mach number. The results are also compared with the results calculated by the matrix iteration method employing the two-dimensional incompressible unsteady flow theory as required oscillatory aerodynamic forces. M.M.

A70-42276 # **A method to calculate the supersonic flutter speed of plate wings.** Michihiro Natori and Shigeo Kobayashi. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Mar. 1970, p. 111-121. 15 refs. In Japanese, with abstract in English.

Description of a method for calculating the supersonic bending-torsion flutter speed of cantilever plate wings of low aspect ratio. The deflection mode is assumed in a double power series expansion of spanwise and chordwise variables, and the flutter determinant is derived by means of the principle of minimum potential energy of the dynamic problem. The chordwise variable is measured from the

midchord line along the stream direction for swept-back wings. For the aerodynamic force, the piston theory including the effect of wing thickness is used. Numerical computation is made for a cantilever trapezoid. It has been observed that the ten terms approximation yields good results as compared with the twenty terms approximation. It has been found that the effect of aerodynamic damping on flutter speed is very slight. Reasonable results are obtained in comparison with experimental results. M.M.

A70-42278 # **A consideration on recirculating jet curtain flow.** Rinichi Murao, Tadashi Sato, and Miyako Kutsumi. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Feb. 1970, p. 56-61. In Japanese, with abstract in English.

Study of the recirculating jet curtain flow by using a flow model of a recirculating jet. Recirculating flow, in addition to the hover height and the geometry of the recirculating air intake, is shown to be an important parameter for determining the minimum power required for a recirculating air cushion vehicle. To examine this parameter, a simple flow model of a recirculating jet based on the results of flow visualization by means of an air-bubble technique is proposed. Based on this flow model, an analysis is made presenting an explanation of the above mentioned characteristics of a recirculating jet. O.H.

A70-42279 # **Spring constants of a peripheral-jet air cushion vehicle in heaving motion.** Satoru Ozawa. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Feb. 1970, p. 69-73. 5 refs. In Japanese, with abstract in English.

Description of a theoretical method to calculate the static and dynamic spring constants of a peripheral jet air cushion vehicle in heaving motion, and to obtain the response characteristics of the vehicle to sinusoidal input. The results obtained by using this method are discussed and analyzed. The analysis indicates that the static spring constant is affected by the characteristics of the fan, while the dynamic spring constant is affected by the air supplying system which includes the fan, duct, and air chamber. O.H.

A70-42280 # **Non-linear heaving motion of plenum-chamber-type air cushion vehicles.** Akiya Yamamoto. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Feb. 1970, p. 73-78. In Japanese, with abstract in English.

Investigation of the nonlinear heaving motion of plenum-chamber air cushion vehicles, induced by the sinusoidal irregularity of the ground. An analysis of this motion is presented, and its nonlinear effects are particularly demonstrated by a numerical experiment using a digital computer. O.H.

A70-42281 # **An experimental study on heaving motion of peripheral jet ground effect machines.** Tsuneyo Ando and Sohei Masuda. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Feb. 1970, p. 78-84. 6 refs. In Japanese, with abstract in English.

Experimental investigation of the heaving motion of a circular ground effect machine model, induced by a simple harmonic motion of the machine ground board. A brief description of the model and its operation is presented. It is shown that the model hovers by the action of the air supplied from external blowers, and is guided vertically by means of its cylindrical part which is inserted into a fixed air duct and is free for vertical translation. The peripheral jet type nozzle attached to the model is interchangeable. Two types of these nozzles were tested experimentally, and the static hover and both free and forced vibration characteristics were studied in detail. The natural frequencies of each model calculated from the static characteristics are compared to the frequencies of the ground movement to which the models resonate, and the basic data for the heaving motion are presented. O.H.

A70-42282 # **Take-off and landing performances of a GETOL airplane.** Hiroshi Maeda, Hironori Fujii, and Yoshinori Inagaki. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Feb. 1970, p. 84-90. 5 refs. In Japanese, with abstract in English.

Study of several problems of the takeoff and landing performances of a Ground Effect Takeoff and Landing (GETOL) aircraft equipped with an air cushion landing gear instead of a conventional one. Takeoff and landing distances of a hypothetical GETOL aircraft are estimated and compared with those of a conventional aircraft, and it is shown that in some cases the GETOL aircraft has STOL characteristics. The energy absoprtion capability of the air cushion landing gear in the touch-down condition during the landing flight is evaluated. The evaluation indicates that the hypothetical GETOL aircraft has a sufficient landing capacity. O.H.

A70-42284 # **Investigation of unsteady aerodynamic forces acting on a thin aerofoil at stall flutter.** Hiroshi Sakata. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Jan. 1970, p. 10-23. 11 refs. In Japanese, with abstract in English.

Investigation of the problem of high angle-of-attack derivatives, using the following approach: qualitative equations of aerodynamic derivatives are derived, assuming that the vortex sheet theory is approximately applicable to the flow field with the separation around a vibrating thin airfoil at high angle-of-attack. The equation of the pitching moment derivative is examined and compared with experimental data. Theoretically indeterminate parameters in the equation are estimated. Using the variables and constants thus determined, lift derivatives are predicted and compared with experimental values. M.M.

A70-42295 * **New materials for manned spacecraft, aircraft and other applications.** Matthew I. Radnofsky (NASA, Manned Spacecraft Center, Supporting Development Branch, Houston, Tex.). *Air Line Pilot,* vol. 39, Sept. 1970, p. 25-32. 6 refs.

Discussion of the flame-resistant nonmetallic materials developed for manned-space applications taking into consideration the use of these materials in aircraft interiors and in other applications. Fibrous materials such as asbestos fiber, glass fiber, polyimide fiber, teflon fiber, metallic fibers, Durette fiber, Fypro, and Kynol are discussed, and fluoropolymers, nonflammable paper, and composite layups are considered. G.R.

A70-42296 **Improving landing/takeoff and terminal area safety.** Glen A. Gilbert (Glen A. Gilbert and Associates, Miami, Fla.). *Air Line Pilot,* vol. 39, Sept. 1970, p. 70-76.

Discussion of new tools for reducing mid-air collision exposure in terminal areas and for raising landing safety when no precision ground-based electronic landing aid is available. The circumstances surrounding landing accidents and mid-air collisions are examined. It is found that airborne three-dimensional area navigation (3-D RNAV) can make an important contribution in reducing accidents of both types. A description of 3-D RNAV equipment is given and 3-D RNAV approaches are considered. The employment of 3-D RNAV in the terminal area is discussed. It is pointed out that with 3-D RNAV equipment as a base, it becomes possible to give the pilot time control as an additional cockpit capability. G.R.

A70-42303 # **Lift fluctuations associated with unsteady chordwise flow past an airfoil.** C. L. Morfey (Southampton, University, Southampton, England). *ASME, Transactions, Series D - Journal of Basic Engineering,* vol. 92, Sept. 1970, p. 663-665.

A simple theory is given for unsteady lift on a flat-plate airfoil due to chordwise velocity perturbations. Horlock's theory for a frozen gust pattern convected at the free-stream velocity is included as a special case, and a distinction is drawn between streamwise and chordwise velocity perturbations. (Author)

A70-42311 # **Sonic booms in an inhomogeneous atmosphere (Wybuchy dźwiękowe w niejednorodnej atmosferze).** Andrzej Biestek. *Postępy Astronautyki,* vol. 4, no. 2, 1970, p. 59-72. In Polish.

Analysis of the influence exerted on sonic booms by refraction arising from a temperature gradient in the given material medium. Effects of atmospheric inhomogeneity are examined, and sonic booms caused by certain flight maneuvers are described. The criterion for localization of the first sonic boom in the atmosphere is outlined, and the refraction of shock wave radii is calculated. The zone of displacement and growth in intensity of interfering sonic booms are described along with the rate of growth in intensity. T.M.

A70-42336 # **Basic study of the after-burner.** Toshiyuki Ohya. *Ishikawajima-Harima Engineering Review,* vol. 10, May 1970, p. 229-242. 7 refs. In Japanese, with abstract in English.

Investigation of the problem of flame stabilization in afterburners of turbofan engines at low inlet temperatures. Various configurations of flame stabilization devices were tested at atmospheric inlet conditions. It is found that a V-gutter flame holder, with injection of small amounts of fuel into the flame holder wake, brings about a broadening of the combustion region of the air/fuel ratio. In addition, a brief description of a prototype afterburner test conducted is presented. O.H.

A70-42337 **Porous wall interference in transonic wind tunnel.** T. Kurata, A. Kubozono, and T. Shibata. *Mitsubishi Heavy Industries Technical Review,* vol. 7, no. 3, 1970, p. 283-291. 20 refs. In Japanese, with abstract in English.

Investigation of the interference effects and aerodynamic characteristics of porous walls of transonic wind tunnels. Results of measurements carried out in various porous wall wind tunnels are outlined. In an attempt to make the wall interference effects as low as possible, correction methods are applied to the measured values in a high subsonic, nearsonic, and low supersonic speed range respectively. The results are shown graphically, tabulated, and summarized. O.H.

A70-42344 **Measurements of air flows by means of the Mach-Zehnder interferometer (Messungen von Luftströmungen mit dem Mach-Zehnder-Interferometer).** Joachim Buxmann. *Forschung im Ingenieurwesen,* vol. 36, no. 4, 1970, p. 111-119. 11 refs. In German.

Discussion of air flow measurements conducted with a Mach-Zehnder interferometer on a two-dimensional turbine cascade. Data regarding the boundary layer regime, boundary layer thickness, velocity, and pressure coefficient at any desired point are obtained. The effect of the Mach number on exit angle and cascade losses is investigated. G.R.

A70-42346 **Method for the determination of exit flow parameters of transonic turbine lattices (Verfahren zur Ermittlung der Abströmgrössen transsonischer Turbinengitter).** Ortwin Lawaczeck (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *VDI-Forschungsheft,* no. 540, 1970, p. 4-15. 23 refs. In German.

Derivation of two methods for the determination of the characteristics of the flow downstream of a transonic turbine cascade. The first method is applicable only to cascades with blades which have the form of a flat plate while the second method can be used for arbitrary blade profiles. The theoretical results were verified by conducting flow measurements at transonic cascades in a cascade wind tunnel for two different cascade and profile arrangements. G.R.

A70-42385 **General aviation's immediate ground hardware needs.** H. W. Beningfield (Narco Scientific Industries, Inc., Fort Washington, Pa.). *Journal of Air Traffic Control,* vol. 12, Sept. 1970, p. 13-15.

Discussion of the major hardware problems of general aviation and some approaches to their effective solution. Two sets of problems are considered - namely, delays due to congestion at airports, and weather conditions the aircraft cannot tolerate and the pilot cannot detect in advance. The limitations of the present ATC system, resting on a radar system with limited resolution, are emphasized, and possible ways of how to obtain better position information and to improve area navigation approach procedures are discussed. It is suggested that an expansion of the present ATC system is not likely to work, and that a solution to the existing problems requires an imaginative new look at air traffic management in terms of changing airport 'controllers' to 'managers' relieved of the navigation, which is primarily the pilot's task. O.H.

A70-42480 **Fibres of high thermal stability.** J. Aveston (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *Composites,* vol. 1, Sept. 1970, p. 296-299.

A number of alternatives to glass fiber have been developed over the last decade with the object of improving the stiffness-to-weight ratio of resin- and aluminum-based composites. They are all at least one hundred times more expensive than glass, so their use is currently confined to areas where cost is of secondary importance such as the boron-epoxy wings for the F111 aeroplane and top quality sports equipment, or where the cost can be recovered in operating economies, as in the RB211 engine. (Author)

A70-42515 # **Eigen motion of airplane. I - Lateral motion.** Takashi Murayama and Hide Asano (Defense Academy, Yokosuka, Japan). *Japan Society for Aeronautical and Space Sciences, Transactions,* vol. 12, no. 21, 1969, p. 43-49. 6 refs.

Description of a new method for analyzing the rolling motion of an aircraft in flight at a small angle of attack following an initial disturbance. The motion of the aircraft is usually examined as oscillatory or nonoscillatory; while the aircraft response to a control action is treated as an oscillatory or exponential response. However, the actual response is more complex and involves transition from converging oscillatory motion to an exponential one. It is shown that the harmonic oscillatory motion frequently used in quantum mechanics may be applicable to this situation, entailing the use of a system of linear differential equations of motion with variable coefficients. It is shown that there exists a special flight situation described by an eigenfunction and termed eigenmotion. This eigenmotion is isolated in the rolling behavior, and the corresponding control conditions are examined. T.M.

A70-42528 **Acoustical duct treatments for aircraft; Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., April 8, 1969, Proceedings.** *Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3. 65 p.

Contents:

Foreword. H. H. Hubbard, p. iv.

The NASA acoustically treated nacelle program. J. G. Lowry (NASA, Langley Research Center, Hampton, Va.), p. 780-782.

Acoustic-lining concepts and materials for engine ducts. R. A. Mangiarotty (Boeing Co., Renton, Wash.), p. 783-794. 9 refs.

Structural and environmental studies of acoustical duct-lining materials. H. A. Watson, Jr. (Douglas Aircraft Co., Long Beach, Calif.), p. 795-814. 9 refs.

Parametric studies of the acoustic behavior of duct-lining

materials J. Atvars and R. A. Mangiarotty (Boeing Co., Renton, Wash.), p. 815-825.

Application of duct-lining technology to jet aircraft. A. H. Marsh (Douglas Aircraft Co., Long Beach, Calif.), p. 826-842. 14 refs

A70-42529 * # The NASA acoustically treated nacelle program. John G. Lowry (NASA, Langley Research Center, Aircraft Noise Alleviation Project Office, Hampton, Va.). *(Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., Apr. 8, 1969.) Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3, p. 780-782.

Because of the rapidly increasing noise pollution in the vicinity of large commercial airports, the government established an interagency panel in October 1965 to develop recommendations concerning the implementation of a coordinated noise-abatement program. A part of NASA's contribution to this program resulted in the awarding of contracts to The Boeing Company and The McDonnell-Douglas Corporation in May 1967, directed toward reducing the noise under the flight path of the current large four-engine fan-jet commercial transports. This paper is a brief review of the goals and scope of these contracts to study and develop nacelle modifications to minimize fan compressor noise radiation. (Author)

A70-42530 * # Acoustic-lining concepts and materials for engine ducts. R. A. Mangiarotty (Boeing Co., Commercial Airplane Div., Renton, Wash.). *(Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., Apr. 8, 1969.) Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3, p. 783-794. 9 refs. NASA-sponsored research.

A summary is given of a research program to develop acoustic-lining technology for engine ducts. The environment to which linings are exposed in the inlet and duct of a typical turbofan engine installation and the noise spectrum to be attenuated are described. Concepts of acoustic linings and their mechanisms for attenuating the propagation of sound in ducts are discussed, with particular application to turbomachinery. The procedure used for screening and selecting acoustical facing materials for linings is reviewed. A summary is given of the experimental methods employed in this procedure - measurement of the specific flow resistance, the specific acoustic impedance, and of the acoustic absorption coefficient - and a synopsis of the results is made. Suitable materials were evaluated as part of duct linings in a laboratory flow-duct apparatus, simulating an engine duct environment in which linings were subjected to sound levels up to 155 dB over-all sound-pressure level (SPL) and airflows up to Mach number 0.4. The most important acoustic and geometric characteristics that influence the acoustic attenuation and the results obtained are summarized. The attenuation of linings in a laboratory flow duct and in a full-scale engine are compared. Finally, a description and some results of a theoretical study developed for predicting the attenuation of linings is given and compared with the experimental measurements. (Author)

A70-42531 * # Structural and environmental studies of acoustical duct-lining materials. Herschel A. Watson, Jr. (Douglas Aircraft Co., Long Beach, Calif.). *(Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., Apr. 8, 1969.) Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3, p. 795-814. 9 refs. Research supported by the Douglas Independent Research and Development Funds and NASA.

This paper is a review of the structural aspects of current turbofan noise-suppression designs presented in conjunction with a summary of the environmental conditions, which determine the design criteria of duct-lining acoustical materials. The subject is confined to structural and environmental studies of acoustical materials and to the analyses, tests, and design criteria necessary to provide a certifiable noise-suppression system for commercial aircraft. Studies related to the structure and environment of duct-lining acoustical materials proposed for use in the noise-suppression systems of turbofan aircraft may be more clearly understood when preceded by: (1) an indication of where the systems are used within a power plant nacelle, (2) a complete definition of the environmental conditions under which the systems are expected to function, (3) an explanation of the basic acoustical function of the materials, and (4) a detailed description of typical duct-lining configurations. (Author)

A70-42532 * # Parametric studies of the acoustic behavior of duct-lining materials. J. Atvars and R. A. Mangiarotty (Boeing Co., Commercial Airplane Div., Renton, Wash.). *(Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., Apr. 8, 1969.) Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3, p. 815-825. Contract No. NAS 1-7129.

Fan noise radiated from the engine inlet and fan discharge of current fan jet airplanes during landing makes the largest contribution to perceived noise. This noise can be reduced by lining the engine inlet and duct walls with sound-absorbing materials. Because of the scarcity of analytical lining design methods which include duct airflow effects, an experimental program was conducted to investigate the influence of acoustic and geometric duct lining parameters on fan-noise attenuation. The significant parameters were found to be the acoustic impedance, treatment length, depth, core-cell dimensions, channel width, number of walls lined, number of layers in the linings, air velocity, and direction of flow with reference to sound propagation. The influence of these parameters is discussed. For simple single-layer linings a design technology has been developed by means of empirical equations. Experimental results show that this technology is valid, for duct sizes from 4 to 12 in., lining depths of ¼ to 1 in., and duct airflow Mach numbers from -0.4 to 0.4. (Author)

A70-42533 * # Application of duct-lining technology to jet aircraft. Alan H. Marsh (Douglas Aircraft Co., Long Beach, Calif.). *(Acoustical Society of America, Symposium on Aircraft Noise, Philadelphia, Pa., Apr. 8, 1969.) Acoustical Society of America, Journal,* vol. 48, Sept. 1970, pt. 3, p. 826-842. 14 refs. Research supported by the Douglas Independent Research and Development Funds and NASA.

Design studies of various acoustically treated inlet and fan-exhaust ducts were conducted for the JT3D turbofan engine installation on DC-8 airplanes. These design studies resulted in the selection of two configurations of treated engine inlets and one configuration of treated fan-exhaust ducts for full-scale fabrication and testing. On the basis of ground runup test results, one configuration was chosen for subsequent flyover noise and cruise-performance flight testing. This paper discusses some of the design concepts that were studied, presents some of the results of the full-scale ground runup tests, and also presents predictions of the change in flyover perceived noise level owing to installation of treated nacelles on DC-8-50/61 airplanes. (Author)

A70-42601 National Applied Mechanics Conference, Bucharest, Rumania, June 23-27, 1969, Proceedings (Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969, Proceedings). *Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 2, 1970. 250 p. In Rumanian.

Contents:

Factors affecting fuel consumption and economy from the standpoint of different aircraft (Asupra factorilor care influenţează consumul de combustibil şi economicitatea din acest punct de vedere a diferitelor avioane). N. Tipei and L. Stănoiu (Academia Română, Bucharest, Rumania), p. 269-281.

Aeroelastic stability of thin heterogeneous circular cylindrical panels (Stabilitatea aeroelastică a panourilor cilindrice circulare subţiri eterogene). L. Librescu, E. Mălaiu, and L. Beiner (Academia Română, Bucharest, Rumania), p. 283-308. 42 refs.

Theory of turbomolecular pumps (O teorie pentru pompele turbomoleculare). N. N. Patraulea and N. Postelnicu (Academia Română, Bucharest, Rumania), p. 453-459.

A70-42602 # **Factors affecting fuel consumption and economy from the standpoint of different aircraft (Asupra factorilor care influenţează consumul de combustibil şi economicitatea din acest punct de vedere a diferitelor avioane).** N. Tipei and L. Stănoiu (Academia Română, Institutul de Mecanică Fluidelor, Bucharest, Rumania). *(Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969.) Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 2, 1970, p. 269-281. In Rumanian.

Nondimensional treatment of known relations for calculating the range of a jet or propeller-driven aircraft. A very general relation which makes possible the comparative study of fuel consumption is derived. The possible existence of an equivalence point for aircraft of different type is demonstrated, together with the possibility of determining an optimum aircraft for a given distance. M.M.

A70-42603 # **Aeroelastic stability of thin heterogeneous circular cylindrical panels (Stabilitatea aeroelastică a panourilor cilindrice circulare subţiri eterogene).** L. Librescu, E. Mălaiu, and L. Beiner (Academia Română, Institutul de Mecanică Fluidelor, Bucharest, Rumania). *(Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969.) Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 2, 1970, p. 283-308. 42 refs. In Rumanian.

Analytical study of the flutter of complete circular cylindrical finite thin heterogeneous structures placed in a supersonic gas current parallel to the generatrices of the cylinder. The influence of the heterogeneousness on the critical flutter magnitudes is investigated. The importance of taking aerodynamic damping into account is stressed. Geometric and aerodynamic nonlinearities are taken into account in an analysis of the nature of the critical flutter boundary. M.M.

A70-42609 # **Unsteady supersonic flow around a cross-shaped wing-fuselage system in oscillating motion (Curgerea supersonică nepermanentă în jurul sistemelor aripă cruciformă-fuzelaj avind mişcări oscilatorii).** Dan Mateescu (Academia Română, Institutul de Mecanică Fluidelor, Bucharest, Rumania). *(Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969.) Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 3, 1970, p. 699-711. 6 refs. In Rumanian.

Determination of the perturbation velocities and pressure distributions for the case of a cross-shaped wing-fuselage system in a uniform supersonic current in oscillating tangential, pitching, and vertically translational motion. The method used is based on the reduction of unsteady supersonic flow to a series of steady flows around the same system, whose solutions are given. M.M.

A70-42610 **National Applied Mechanics Conference, Bucharest, Rumania, June 23-27, 1969, Proceedings (Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969, Proceedings).** *Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 4, 1970. 249 p. In Rumanian.

Contents:

Compatibility equations in the superelastic domain (Despre ecuaţiile de compatibilitate în domeniul superelastic). N. S. Pârvulescu (Bucureşti, Institutul de Petrol, Gaze şi Geologie, Bucharest, Rumania), p. 777-786. 7 refs.

Study of the frequency spectrum of transversal autovibrations of a bar caused by dry friction (Studiul spectrului de frecvenţe al autovibraţiilor transversale ale unei bare produse de frecarea uscată). Gh. Silaş and H. J. Klepp (Timişoara, Institutul Politehnic, Timişoara, Rumania), p. 787-795. 9 refs.

Dynamic stability of circular plates subjected to a variable periodic load (Stabilitatea dinamică a plăcilor circulare solicitate de sarcini variabile periodic). N. D. Popescu (Petroşani, Institutul de Mine, Petroşani, Rumania), p. 817-846. 6 refs.

New investigations of short wings with lateral jets (Noi cercetări asupra aripilor de alungire mică cu jeturi laterale). E. Carafoli and N. Cămărăşescu (IMFCA, Rumania), p. 947-962.

Aerodynamic characteristics in supersonic regime of rectangular and trapezoidal wings with spanwise variable profile (Caracteristicile aerodinamice în regim supersonic ale aripilor dreptunghiulare şi trapezoidale cu profil variabil în anvergură). D. Mateescu (Academia Română, Bucharest, Rumania), p. 963-980. 6 refs.

Unsteady compressible boundary layer of a rotating disk (Asupra stratului-limită compresibil nestaţionar pe un disc în rotaţie). I. Pop (Cluj, Universitatea, Cluj, Rumania), p. 981-986. 7 refs.

A70-42614 # **New investigations of short wings with lateral jets (Noi cercetări asupra aripilor de alungire mică cu jeturi laterale).** E. Carafoli and N. Cămărăşescu (IMFCA, Rumania). *(Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969.) Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 4, 1970, p. 947-962. In Rumanian.

Investigation of the lift of short wings by means of lateral fluid jets fired in the wing plane in spanwise direction. Following theoretical considerations, the experimental results obtained in a wind tunnel for a set of wings of different length are presented in chart form. M.M.

A70-42615 # **Aerodynamic characteristics in supersonic regime of rectangular and trapezoidal wings with spanwise variable profile (Caracteristicile aerodinamice în regim supersonic ale aripilor dreptunghiulare şi trapezoidale cu profil variabil în anvergură).** Dan Mateescu (Academia Română, Institutul de Mecanică Fluidelor, Bucharest, Rumania). *(Conferinţa Naţională de Mecanică Aplicată, Bucharest, Rumania, June 23-27, 1969.) Studii şi Cercetări de Mecanică Aplicată,* vol. 29, no. 4, 1970, p. 963-980. 6 refs. In Rumanian.

Determination of the aerodynamic lift, drag and momentum coefficients for rectangular and trapezoidal wings with an infinite span having a spanwise variable profile. The axial perturbation velocities determined by the author by a method developed in an early work are used. M.M.

A70-42629 # **The theory of trailing Taylor columns.** M. J. Lighthill (Cambridge University, Cambridge, England). *Cambridge Philosophical Society, Proceedings,* vol. 68, Sept. 1970, p. 485-491.

Study of the behavior of Taylor columns in a two-dimensional flow about a supersonic airfoil. It is suggested that Taylor columns be regarded as essentially like sonic booms. It is shown that, when the Rossby number is small but the Ekman number is very much smaller, in the flowfield far from a body moving at right angles to the axis of rotation of a large body of fluid the region of influence should not be a Taylor column parallel to the axis, but a trailing Taylor column, bent backward on both sides of the body at a small angle to the axis, this angle being proportional to the Rossby number. The physical significance of an experimental evidence for this conclusion are reviewed. A.B.K.

A70-42651 # **Flight evaluation of radar-inertial systems.** Robert W. Wedan (Institute of Navigation, Washington, D.C.). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 11 p. 10 refs.

Description of a V/STOL program which has developed navigation techniques for terminal approach and landing with emphasis on the use of ground-based radar for updating an on-board inertial navigator. Results obtained demonstrate the feasibility of computing position and velocity with high accuracy. The position indication appears to be at least as accurate as the reported radar accuracy. These static accuracies are accompanied by the availability of the time derivatives of position which is believed to be of value for control purposes during the approach. The accuracy of short term extrapolation of position and velocity indication have been measured. Results have shown that the accuracy of this mode is greatly improved by estimating platform drift angle in addition to position and velocity errors. It has also been shown that platform attitude update tends to provide a desirable independency of system performance on gyro drift rate. M.M.

A70-42652 # **Radiobeacons in space for aerial navigation.** Gianni Spatuzza (Fiat S.p.A., Turin, Italy). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 8 p.

Discussion of traffic safety problems in the field of aerial navigation. The possibility of setting up some form of assistance by means of artificial satellites is examined. Certain possible solutions of air traffic problems are considered, and the role of the satellite as a component of the safety system is stressed. M.M.

A70-42654 # **The application of the inertial system in the field of air navigation.** M. de Regibus (Compagnia Nazionale Alitalia, Rome, Italy). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 13 p.

Evaluation of the use of the inertial navigation system (INS) in meeting the specific requirements of air transportation. The basic aspects of INS are discussed, together with its general principles and system mechanization, performance and capabilities of INS in the field of commercial air transport, results obtained by airlines in evaluations of INS, and future application of INS as the only means of navigation and its compatibility with the requirements of ATC. It is pointed out that the capability of INS to continuously determine the position of an aircraft and to supply navigation guidance with a high degree of accuracy indicates that its widespread use could solve the serious problem connected with airspace capacity in relation to the air traffic density in some critical areas, particularly in the North Atlantic where the introduction of the INS could permit drastic reductions in lateral separations, thus considerably increasing the capacity of the airspace and that of the ATC system. M.M.

A70-42657 # **The 'Dioscures Project.'** Bertrand Manuali (Centre National d'Etudes Spatiales, Paris, France). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 24 p.

General discussion of the Dioscures satellite navigation system for aircraft and ships. The range of application of the Dioscures project envisages a system of substantially worldwide coverage, since it will operate over the Atlantic and the Pacific, and also provides a solution for Africa and the Middle East. Five satellites are to be put in orbit. The first two, serving the Atlantic, could be launched by the end of 1972, and the remaining three one year later. Toward 1977, the first generation of satellites would be followed by a second generation designed to provide a world coverage and a transmission capacity three times greater than the previous one. F.R.L.

A70-42658 # **Area navigation and the associated display methods.** Karl E. Karwath (Deutsche Lufthansa AG, Frankfurt am Main, West Germany). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 22 p. 19 refs.

Consideration of area navigation (ANAV), defined as a navigation system which enables an aircraft to fly any desired route with track guidance and the required accuracy within the area of coverage of station-referenced radio aids or within the limits of self-contained system capability. It provides the pilot with continuously updated position information in a directly interpretable form without plotting or further processing. Advantages to be expected involve improved airspace utilization both en route and in terminal areas. ANAV airborne equipment may consist of course line computers or self-contained systems such as Doppler or inertial navigation systems. Dynamic Map Displays (DMD) are discussed, and attention is given to three-dimensional navigation. F.R.L.

A70-42659 **Time/frequency techniques - Possible application to air traffic movements.** I. M. Hunter (Royal Aircraft Establishment, Farnborough, Hants., England). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 14 p.

Discussion of time/frequency systems, defined as systems primarily for range and velocity determination using stable clocks with ambiguity resolution and, where necessary, updated by periodic mutual reference. Such systems have the merits of generation of range information from one-way transmissions, a large capacity resulting from the use of time-ordered communications, and high quality information on radial velocity. The principles and tolerances are discussed, and it is concluded that airborne frequency standards of one part in 10 to the 11th power will be adequate for possible systems providing comprehensive navigation and surveillance facilities with a large degree of redundancy. Such systems could contribute to separation insurance and collision avoidance, and could be used in conjunction with satellites to give extended cover. It is thought that independent information on aircraft height could best be provided using simple passive ground equipment to measure elevation angle. F.R.L.

A70-42660 # **Horizontal navigation of the Concorde aircraft.** J. Hardouin (Institut Français de Navigation, Paris, France). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 14 p.

Discussion of the horizontal navigation of the Concorde SST, which will be accomplished by three Litton 51 systems which meet the ARINC 561 specifications. Three good attitude references which are unaffected by prolonged accelerations, and three independent sources of navigational data and guidance information will be provided. A link-up with the guidance data will make entirely automatic navigation possible. F.R.L.

A70-42667 **The application of correlation techniques to ILS and Terminal Area traffic control.** J. Benjamin (Royal Aircraft Establishment, Farnborough, Hants., England). *European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970, Paper.* 17 p. 7 refs.

There is a need in Civil Aviation for an improved ILS giving high integrity for automatic landing and it is evident that a new generation ILS will also play an important role in solving Terminal Area Congestion. An evolutionary approach based on correlation detection and hyperbolic phase fields is described. The varying applications are discussed in the context of a system designed to provide the aircraft with the 'information' which is necessary if aircrew are to cooperate more effectively with Air Traffic Control in IMC. (Author)

A70-42669 # **Magnetohydrodynamical supersonic flow of a slightly conducting fluid past a slender body of revolution placed in a circular wind tunnel.** Shigeaki Suwa (Defense Academy, Yokosuka,

Japan). *Japanese Journal of Applied Physics,* vol. 9, Aug. 1970, p. 857-865. 5 refs.

The wind tunnel interference problem in magnetohydrodynamics, in which an inviscid compressible fluid with small electrical conductivity flows steadily past a slender axisymmetric pointed body of revolution in a cylindrical perfectly insulated wind tunnel, in the presence of an applied slightly inclined magnetic field, is considered. The interference is found to induce electric field even if the magnetic Reynolds number is approximately zero. The lift of the body changes its sign according to the direction of the angle between the applied magnetic field and the direction of the uniform flow at infinity. (Author)

A70-42671 Gas turbine sand and dust effects and protection methods. H. D. Connors and J. P. Murphy (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *Society of Automotive Engineers, Combined National Farm, Construction and Industrial Machinery and Powerplant Meetings, Milwaukee, Wis., Sept. 14-17, 1970, Paper 700705.* 11 p.

Discussion of the development and application of sand and dust protection devices for helicopter-powering gas turbine engines. A brief history of the erosion problem is given. Solutions to this problem such as separators, screens, casing inserts, and coatings are evaluated with regard to their contribution to the extension of engine operating life. Engine wear and erosion characteristics are described and field experience with protective devices is presented. The incorporation of an inlet particle separator and engine internal changes are shown to have improved engine life in a sand and dust environment by a factor of 6. The mean time between depot return for erosion of military helicopter engines in Vietnam has risen from 1870 hr prior to separator installation to over 9500 hr after separator and steel insert installation. M.V.E.

A70-42672 Techniques for reducing sand and dust erosion in small gas turbine engines. H. E. Shoemaker and C. P. Shumate (International Harvester Co., San Diego, Calif.). *Society of Automotive Engineers, Combined National Farm, Construction and Industrial Machinery and Powerplant Meetings, Milwaukee, Wis., Sept. 14-17, 1970, Paper 700706.* 12 p. 5 refs.

Discussion of the results of an experimental investigation of the nature and characteristics of the effect of dust on the erosion of a small gas turbine engine. From laboratory tests, superior erosion-resistant materials were selected for evaluation in engine tests. These tests show that utilization of selected coatings can extend engine service life by a factor of two in a severe dust environment. Aerodynamic design changes tested to date have had little effect on life. The modifications appearing to be feasible involve the use of coatings, sleeves, and inserts. They alter unit weight only slightly. M.V.E.

A70-42684 # Contrails and aircraft downwash. R. S. Scorer and L. J. Davenport (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 43, Sept. 16, 1970, p. 451-464. 12 refs. Research sponsored by the Meteorological Office.

Discussion of the physics involved in an interpretation of the shapes of contrails in terms of the aircraft downwash. Aircraft downwash consists initially of a vortex pair descending with its accompanying fluid through the atmosphere. Condensation trails are formed in exhaust emitted into the accompanying fluid and the shapes of them and their evolution depend on the positions of the engines in relation to the wing tip vortices. The atmosphere is stably stratified and so the descending accompanying fluid acquires upward buoyancy. Consequently vorticity is generated at the outside of the accompanying fluid and the flow pattern in the vortex pair is altered so as to produce detrainment of its exterior part. So long as any air which is a mixture of accompanying fluid and exterior air is detrained, the vortices remain stable, but the width of the pair decreases and its downward velocity increases with time as a result of the buoyancy. Eventually the upper stagnation point in the motion relative to the vortices begins to move upwards relative to the vortices so that some mixed fluid is entrained into the circulation and the vortices immediately become unstable, mixing occurs, the pressure of the core rises, and any vortex core trails that may exist appear to burst. The motion produces downward-thrust blobs in trails from centrally placed engines, which correspond to the holes sometimes seen in cloud when distrails are formed. M.M.

A70-42701 * # Aerodynamic design integration of supersonic aircraft. Donald D. Baals, A. Warner Robins, and Roy V. Harris, Jr. (NASA, Langley Research Center, Full-Scale Research Div., Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-1018.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 385-394. 27 refs.

Review and assessment of the new supersonic aerodynamic design tools with an illustration of their applications and limitation. The supersonic technology of a decade ago - largely through theory extension and ingenious use of the high-speed computer - has been forged into a powerful design tool which can provide hard aerodynamic inputs early in the design cycle. This advanced technology has direct application to the supersonic transport, advanced military aircraft, and missiles. It should be kept in mind, however, that the complex of computer programs considered is merely a tool available to the designer. Like any complex tool, there must be complete understanding of its capability and limitations backed by critical operational use. An equally important point to be made is the stage at which the computer programs are introduced into the design process. The complex of computer programs should be utilized at every possible stage to guide the evolving design toward the performance goal. P.v.T.

A70-42702 # An experimental evaluation of exhaust nozzle airframe interference. W. C. Schnell and D. Migdal (Grumman Aerospace Corp., Bethpage, N.Y.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-430.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 396-400. 14 refs. Contract No. N 00019-68-C-0233.

Results from two test programs made to evaluate a range of nozzle types and installations for a twin-engine supersonic fighter. In one test series, simulated forebodies were mated with five aft-fuselage shapes and four interchangeable variable area nozzle types. A dual force balance system, recording static thrust, aircraft drag, and combined thrust-minus-drag, was used to assess the effects on interference drag of engine spacing, peripheral blockage, nozzle type (iris, variable flap ejector, plug and blow-in-door ejector), jet area, nozzle pressure ratio, and tunnel Mach number (0 to 1.3 and 2.2). The results reveal that marked reductions in high subsonic interference drag are possible with widely spaced designs and iris-type nozzles. A second series of central pipe-mounted tests at Mach 0.8 was used to obtain the effects of maximum pod to engine area ratio and inter-engine-fairing length and base area. (Author)

A70-42703 * # A simplified method of estimating the response of light aircraft to continuous atmospheric turbulence. E. L. Peele and Roy Steiner (NASA, Langley Research Center, Dynamic Loads Div., Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-766.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 402-407. 12 refs.

Power spectral density techniques employed in the design of large flexible civil aircraft for atmospheric turbulence are rather complex. For the small rigid aircraft, this degree of complexity may be unwarranted. Consequently, a procedure for determining the gust response based on two rigid-body degrees of freedom was investigated. Using certain simplifying assumptions, formulas are derived

and presented for calculating the vertical and lateral gust response to independently applied vertical and lateral gusts. The formulas utilize parametric charts of "response integrals" which are functions of the aircraft reduced frequency, the damping ratio, and a gust scale parameter. The response quantities for a given set of aircraft parameters can be obtained by substituting into appropriate formulas values of two response integrals read from the charts. Sample numerical calculations are included which illustrate the use of the simplified procedure. (Author)

A70-42704 # **Optimization of airfoils for maximum lift.** Robert H. Liebeck (Douglas Aircraft Co., Long Beach, Calif.) and Allen I. Ormsbee (Illinois, University, Urbana, Ill.). *(American Institute of Aeronautics and Astronautics and Canadian Aeronautics and Space Institute, Subsonic Aero- and Hydro-Dynamics Meeting, Ottawa, Canada, July 2, 3, 1969, AIAA Paper 69-739.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 409-415. 6 refs.

The pressure distribution which provides the maximum lift without separation for a single-element airfoil in an incompressible flow is determined using existing boundary-layer theory and the calculus of variations. The airfoil profiles corresponding to these pressure distributions are determined using second-order airfoil theory. The results indicate maximum lift coefficients as high as 2.8 for Reynolds numbers between five and ten million, and the corresponding drag coefficients are on the order of 0.01. Compressibility has not been considered directly, however the form of the optimum pressure distributions suggests that the critical Mach numbers should be on the order of 0.35. (Author)

A70-42705 # **Jet circulation control airfoil for VTOL rotors.** S. W. Yuan (George Washington University, Washington, D.C.). *(American Institute of Aeronautics and Astronautics and Canadian Aeronautics and Space Institute, Subsonic Aero- and Hydro-Dynamics Meeting, Ottawa, Canada, July 2, 3, 1969, AIAA Paper 69-741.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 417-423. 6 refs. Contract No. DA-44-177-AMC-200(T).

Study of the basic aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors. Elliptical airfoils of 18- and 12-% thickness ratios were designed and constructed. Experimental investigations for both models with trailing edge jets include force and pitching moment measurements. In addition, static pressure measurements were made in both spanwise and chordwise directions. These results were used to compare with available theories as well as other experimental data. Circulation control with dual jets for the elliptical airfoil of 18-% thickness ratio was tested with very satisfactory results. The aerodynamic response of the airfoil model to cyclic changes in jet mass flow was also determined. The cyclic results were very satisfactory and are presented in the form of pulsating lift coefficient, drag coefficient, and pressure coefficient as a function of pulsating jet coefficient. (Author)

A70-42706 # **A review of para-foil applications.** John D. Nicolaides (Notre Dame, University, Notre Dame, Ind.), Ralph J. Speelman, III (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), and George L. C. Menard (U.S. Navy, Naval Aerospace Recovery Facility, El Centro, Calif.). *(American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Conference, 2nd, El Centro, Calif., Sept. 23-25, 1968.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 423-431. 17 refs.

Discussion of the various para-foil application programs and the results obtained from various para-foil tests. Numerous tests of various para-foil designs carried out to date are described. These tests include wind tunnel studies of models ranging in size from 0.2 to 300 sq ft and free-flight tests of units ranging in size from 8 to 864 sq ft. It is pointed out that the tests have shown that the para-foil is able to achieve, depending on the specific design (aspect ratio, etc.) and on the specific angle of trim, lift-to-drag ratios exceeding 4. Full-scale unmanned drops and live jumps have demonstrated fast and reliable deployment, excellent flight stability in free glide and under manned or automatic control. Fully flared landings with near zero landing velocity have been demonstrated through use of the para-foil's wide range of control trim angles. The performance of para-foils in various applications is reviewed, and the performance parameters are shown to be sufficient to satisfy current military and NASA requirements. O.H.

A70-42707 * # **A two-dimensional mixed-compression inlet system designed to self-restart at a Mach number of 3.5.** Warren E. Anderson and Norman D. Wong (NASA, Ames Research Center, Moffett Field, Calif.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-447.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 431-436. 6 refs.

Methodology leading to the design of a Mach 3.5 high-performance, two-dimensional, mixed-compression inlet system with self-restart capability. The principal feature of the design is a variable ramp system employing a flexible isentropic surface to provide efficient external compression on-design and engine airflow matching with low spillage drag off-design. An engine-face variable bypass system was also provided. Pertinent experimental results are presented for a range of Mach numbers from 1.55 to 3.5. Results show high overall performance with moderate penalties associated with self-restart at Mach numbers of about 3.0 and above. Further bleed system optimization promises a means to eliminate these penalties and extend the self-restart capability to inlet systems of higher contraction ratios and thus potentially higher performance. (Author)

A70-42708 # **High bypass ratio fan noise research test vehicle.** Charles A. Warden (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-492.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 437-441.

To provide noise research capability, a fan test rig vehicle was designed and fabricated for the conduct of noise studies on single stage high bypass ratio fans. The fan test rig is free turbine-driven with a remote mounted JT3 engine providing the hot gas supply to the modified JT3D drive turbine. Flexibility has been incorporated into the design of the rig to allow fans of different designs to be tested over a range of speed and operating conditions and a wide variety of design and installation features to be evaluated which are pertinent to the noise output from advanced engine and nacelle designs. (Author)

A70-42709 # . **Optimized design of subsonic lifting surfaces.** James W. McDonald and James R. Stevens (Northrop Corp., Aircraft Div., Hawthorne, Calif.). *Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 442-447. 7 refs. Contracts No. NOw-63-0726-c; No. NOw-65-0380-c.

A procedure, based on the kernel function method of linearized lifting-surface theory, for designing and analyzing wings in steady, low-speed flight is described. Optimized smooth surfaces were designed using this method for high lift and cruise operations. The optimization is obtained by constraining the spanwise lift distribution to be elliptic. The theoretically predicted performance of the lifting surfaces was compared to wind-tunnel data. It can be inferred from the results that if high lift is the prime requirement, then it is preferable to design an optimized, smooth, high lift wing and deflect the flaps to produce a kinky cruise configuration. The application of the procedure indicates that it reduces significantly the time and expense required to generate a wing having desired characteristics. (Author)

A70-42710 # **HSD map transformation mechanization.** E. A. O'Hern and T. C. Lu (North American Rockwell Corp., Autonetics Div., Anaheim, Calif.). *(American Institute of Aeronautics and Astronautics, Aerospace Computer Systems Conference, Los Angeles, Calif., Sept. 8-10, 1969, Paper 69-987.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 448-455.

Summary of the development of a computer software mechanization to accurately and efficiently drive and annotate a projected map in response to input latitude and longitude information. General system requirements are outlined, emphasizing the need for transforming earth location (latitude, longitude) to map coordinates (X, Y) for all required scales and latitude regions for a Lambert conformal chart projection, in such a manner as to provide the required accuracy while minimizing computational impact. The development of new transformation equations is outlined. Final configuration is shown to be selectable as a function of system accuracy requirements. The system error analysis procedure is described. Analysis results, showing the effects of mechanization equation configuration, map scales, and map regions, are presented. The resulting computer software mechanization is described, indicating the relative reduction in memory and duty-cycle requirements. Program advantages of the application of computer systems engineering to mechanization problems are noted. (Author)

A70-42711 # **Higher-order control system dynamics and longitudinal handling qualities.** Dante A. DiFranco (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *(American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-768.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 457-464. 7 refs. Contract No. AF 33(615)-3294.

Evaluation of an experimental investigation of the effects of higher-order control system dynamics on the longitudinal handling qualities of a fighter aircraft. This research was undertaken using the USAF/Cornell Aeronautical Laboratory variable-stability T-33 aircraft as an in-flight simulator. Different higher-order responses were simulated by altering the elevator feel system, elevator actuator, and aircraft short-period characteristics. Essentially the same configurations were evaluated by two pilots using a revised pilot rating scale. One pilot also rated the configurations for their PIO (pilot-induced oscillations) tendencies. Comments and ratings were related to a response delay parameter. Many of the higher-order control systems investigaged produced pronounced PIO tendencies in flight, and some were considered unflyable with certain higher-order characteristics. A comparison of fixed-base and in-flight evaluations indicated that configurations with significant PIO tendencies were rated poorer in flight, and configurations with little or no PIO tendencies were rated better in flight. (Author)

A70-42712 # **Altitude stability in supersonic cruising flight.** Robert F. Stengel (MIT, Cambridge, Mass.). *(American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, Los Angeles, Calif., July 14-16, 1969, Paper 69-813.) Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 464-473. 14 refs.

Definition, starting with the linearized, longitudinal equations of motion, of the causes of altitude deviation, the magnitude of their effects, and the stability of the motion for a wide range of altitudes and Mach numbers and for aircraft of varying lift-drag ratio, wing loading, thrust law, and pitch dynamics. In addition to suggesting necessary and favorable control laws, the effects of horizontal and vertical wind, atmospheric state variation, and engine "unstarts" are treated. A method of choosing the control to minimize altitude response to disturbances is outlined. It is concluded that long-term altitude deviations in supersonic flight are largely independent of aircraft configuration, although the thrust law has a strong effect on the stability of the motion, and the lift-drag ratio affects the magnitude of stability or instability. Altitude and velocity feedback can be used to reduce the pilot's altitude holding task. (Author)

A70-42713 # **Experimental-theoretical correlation of supersonic jet-on base pressure for cylindrical afterbodies.** A. L. Addy (Illinois, University, Urbana, Ill.). *Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 474-477. 24 refs. Contract No. DA-01-021-AMC-13902(Z).

Description of a modification of the component flow model by Korst used for evaluation of the base drag of cylindrical vehicles under powered supersonic flight conditions. An alternative and somewhat simpler empirical flow model modification is proposed. The recompression criterion is modified by assuming that the discriminating streamlines or the jet-boundary streamlines, as the case may be, are capable of recompressing by stagnating only to a fraction of the pressure rise from the base region to the downstream shock region as determined for the corresponding inviscid flowfields. The unknown fractional pressure rise is then determined by a detailed correlation of experimental and theoretical data. As a consequence of this modified flow model, the qualitative evaluation of the base drag utilizing the recompression coefficient is shown to be possible with a degree of confidence. In addition, the recompression coefficient correlation also provides a basis for a united comparison between the diversity of experimental base-flow data. O.H.

A70-42714 # **Wave drag of optimum and other boat tails.** George Maise (Grumman Aerospace Corp., Bethpage, N.Y.). *Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 477, 478.

Investigation of the problem of minimizing the boat tail drag of an aircraft or missile by optimizing the boat tail shape. Two particular aspects of this problem are considered. First, the shapes of minimum-drag boat tails are determined for supersonic flow. Secondly, the wave drag coefficients of these optimum bodies are compared to the drag coefficients of other commonly used coat tail contours such as conical, circular arc, and parabolic arc. The results are given graphically and discussed. O.H.

A70-42715 * # **Reduction of the low-frequency unsteady lifting-surface problem.** Gunter W. Brune (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Journal of Aircraft,* vol. 7, Sept.-Oct. 1970, p. 479, 480. 7 refs. Contract No. NAS 2-5006.

Description of a reduction of the low frequency problem in unsteady aerodynamics to a sequence of steady lifting-surface problems of the familiar type which are solved by existing methods. A reduction formula for the velocity potential of slowly oscillating wings at subsonic and supersonic speeds is derived. The formula can be used to apply existing steady aerodynamic programs for planar or nonplanar configurations to the problem of calculating dynamic stability derivatives. For this first order in frequency approximate theory, the stability derivatives do not depend on the reduced frequency; hence, they may be used to compute stability characteristics by the usual solution of an eigenvalue problem. O.H.

A70-42725 * # **An application of theory to compressor noise.** J. B. Ollerhead, C. L. Munch, and M. V. Lowson (Wyle Laboratories, Rockville, Md.). *Acoustical Society of America, Spring Meeting, 79th, Atlantic City, N.J., Apr. 21-24, 1970, Paper.* 19 p. 10 refs. Contract No. NAS 1-8278.

Application of earlier (Lowson, 1969) theoretical results to some experimental cases of compression noise. Reasonable agreement is found. This provides some justification for the simplifying assumptions made in the original theory and suggests that the theory

can be applied for prediction at the design stage. Results of an engine parameter study are given, showing the principal noise effects of the major engine design variables. M.M.

A70-42759 Experimental equilibrium conditions of dissociated and ionized hydrogen hypersonic flows. D. E. Bloxsom, Jr. (Rhodes and Bloxsom, Canoga Park, Calif.). In: The performance of high temperature systems; Proceedings of the Third Conference, Pasadena, Calif., December 7-9, 1964. Volume 2.
Edited by G. S. Bahn. New York, Gordon and Breach, Science Publishers, Inc., 1969, p. 443-447. 5 refs.

Study of hydrogen heated to 13,000 K at 1000-atm pressure by electric arc heating techniques. This hydrogen is in equilibrium and is partially dissociated and ionized. Flow of this hydrogen in wind tunnel nozzles has been investigated as to gas velocities by means of acceleration of small particles to the stream velocity. This terminal velocity permits the equilibrium state of the nozzle flows to be determined. Some such flows are in equilibrium; others are not; still others are mixed. Experimental data are presented with correlation to the equation of state of hydrogen at high temperatures. This work has applicability to the testing of spaceship hulls for microparticle impingement, since particle velocities of 36.5 km/sec have been obtained. Other areas of applicability include nuclear rockets and high-specific-impulse space engines driven by electrical means.
(Author)

A70-42775 A thunderstorm cloud. I. M. Imianitov, B. F. Evteev, and I. I. Kamaldina (Glavnoe Upravlenie Gidrometeorologicheskoi Sluzhby SSSR, Moscow, SSSR). In: Planetary electrodynamics; Proceedings of the Fourth International Conference on the Universal Aspects of Atmospheric Electricity, Tokyo, Japan, May 12-18, 1968. Volume 1. Conference sponsored by the International Association of Meteorology and Atmospheric Physics, the International Association of Geomagnetism and Aeronomy, and the Science Council of Japan. Edited by S. C. Coroniti and James Hughes. New York, Gordon and Breach, Science Publishers, Inc., 1969, p. 401-425. 29 refs.

Study of thunderstorm development processes on the basis of aircraft measurements of the electrical structure in about 300 cumulonimbus clouds in various stages of growth. Measurements included: (1) three electric field strength components in a coordinate system tied to the aircraft, (2) the intrinsic charge of the aircraft, (3) the relative distribution of precipitation droplets, (4) atmospheric aerological parameters, and (5) the aircraft flight characteristics. The most significant result of observations is the fact that the direction of the potential gradient over the cloud changes in the course of the development process. The mechanisms responsible for this effect are analyzed, and attention is given to relations between electrical and aerological cloud characteristics. It is shown that the probability of lightning occurrence is greatly dependent on turbulence within the cloud. T.M.

A70-42797 Measurement plan of atmospheric electric field for altitudes between 0 and 60 kilometers. Toshio Ogawa, Yoshikazu Tanaka, and Yuichi Tamura (Kyoto University, Kyoto, Japan). In: Planetary electrodynamics; Proceedings of the Fourth International Conference on the Universal Aspects of Atmospheric Electricity, Tokyo, Japan, May 12-18, 1968. Volume 2.
Conference sponsored by the International Association of Meteorology and Atmospheric Physics, the International Association of Geomagnetism and Aeronomy, and the Science Council of Japan. Edited by S. C. Coroniti and James Hughes. New York, Gordon and Breach, Science Publishers, Inc., 1969, p. 461-468. 8 refs.

Description of the measurement of the atmospheric electric field which was planned by means of a balloon for altitudes between 0 and 25 km and by means of a parachute borne by a small rocket for altitudes between 20 and 60 km. The balloon experiment was made on Sept. 20, 1966, and the rocket experiment was scheduled for early 1968. The measuring principle is described, together with the electric field antennas used in both experiments. M.M.

A70-42801 # Influence of the speed of translational motion on the dynamic characteristics of air-cushion vehicles of noncircular planform (Vliianie skorosti postupatel'nogo peremeshcheniia na aerodinamicheskie kharakteristiki apparatov na vozdushnoi podushke nekrugloi formy v plane). L. F. Kalitievskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 19, 1970, p. 3-5. In Russian.

Development of an analytical method of determining the influence of the horizontal flying speed on the aerodynamic characteristics of a ground effect machine with an elliptically shaped air cushion. The method is applicable in the case where the velocity vector of the flow is directed either along the major or minor axis of the ellipse. Formulas are derived which are suitable for determining the magnitude of the distortion of the air cushion by the flow and to obtain a law for the velocity distribution at any cross section of the cushion. These data are then used to calculate the aerodynamic characteristics of the vehicle in horizontal flight. V.P.

A70-42802 # Approximate method of calculating the downwash behind a straight wing for unsteady aperiodic motion at subsonic flight speeds (Priblizhennyi metod rascheta skosa potoka za priamym krylom pri neustanovivshemsia aperiodicheskom dvizhenii na dozvukovykh skorostiakh poleta). O. M. Papchenko. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 19, 1970, p. 6-17. 6 refs. In Russian.

Development of a numerical method of calculating the downwash angle at the control surfaces of an aircraft under unsteady aperiodic flight conditions which can be caused by a vertical gust, a change in angle of attack, and similar factors. In the method proposed, in order to describe unsteady periodic motions, the continuous variation of the aerodynamic characteristics is replaced by a discrete process. This makes it possible to construct a relatively simple vortex model and to interrelate the principal parameters. The compressibility of the air at large subsonic speeds is taken into account. The method is developed for straight wings but can be readily extended for wings of any planform. V.P.

A70-42803 # Approximate method of calculating a turbulent boundary layer on a permeable curvilinear surface (Priblizhennyi metod rascheta turbulentnogo pogranichnogo sloia na pronitsaemoi krivolineinoi poverkhnosti). M. Ia. Arie. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 19, 1970, p. 18-21. In Russian.

Discussion of a steady turbulent boundary layer of an incompressible fluid on a curvilinear surface with uniformly distributed suction. It is assumed that the longitudinal pressure gradient is small. An analysis of the momentum equation leads to complexes which are suitable for use as the form parameters of the boundary layer. The assumption of a small longitudinal pressure gradient makes it possible to use an empirical relation (corrected for suction) for the local friction drag coefficient, derived for a porous plate, as the resistance law. A differential equation for determining the form parameter of the boundary layer is derived, which in the absence of suction reduces to the well-known equation for a turbulent boundary layer on an impermeable surface. V.P.

A70-42804 # Flight safety of modern automated aircraft (K voprosu o bezopasnosti poleta sovremennykh avtomatizirovannykh samoletov). Ia. E. Tkachenko, I. A. Dikun, and B. S. Baev.

Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 19, 1970, p. 22-27. In Russian.

Discussion of the control system of highly automated aircraft, with particular reference to system failures. The probability of failure of the various control system elements is determined, and means of eliminating failures during flight are examined. Particular attention is given to servomotor failures in the hydraulic system due to contamination of the fuel. A number of failures associated with servomotor blocking cannot be localized by the pilot. Factors leading to servomotor slide valve blocking, and the results of such failures are examined in detail. Recommendations for coping with slide valve blocking situations are proposed. V.P.

A70-42809 # **Experimental investigation of pulsed exhaust systems of a two-cycle engine with turbosupercharger (Opytnoe issledovanie impul'snykh vypusknykh sistem dvukhtaktnogo dvigatelia s turbonadduvom).** D. A. Munshtukov. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 19, 1970, p. 49-58. 9 refs. In Russian.

Discussion of model tests performed to study the quality of mass and energy transport along the exhaust manifold of a two-cycle engine with turbosupercharger as a function of the diameter and length of the manifold and of the injector hole area. The existence of optimum manifold dimensions and of an optimum injector hole area is demonstrated. The test results (given in the form of tables and oscillograms) indicate that the injector hole area has a pronounced influence on the amplitude of the direct and reflected pressure waves. V.P.

A70-42812 # **Joining three-layer fiberglass-reinforced plastic panels by means of bilateral cover plates (Soedineniia trekhsloinykh panelei iz stekloplastika dvukhstoronnimi nakladkami).** L. A. Kolesnikov, V. E. Gaidachuk, and A. L. Brushkovskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 19, 1970, p. 80-86. In Russian.

Discussion of the strength of a joint of two fiberglass-reinforced plastic elements, obtained with the aid of bilateral adhesive patches, subjected to the action of linear axial forces. A variational technique is used to derive a linear inhomogeneous fourth-order differential equation for the axial strain in an adhesive patch. A particular solution of this equation is obtained, together with solutions for the homogeneous portion of the equation. The relations obtained are suitable for determining the magnitude and nature of the normal stress distribution in the elements of the joint as well as the tangential stresses in the adhesive layer. Using these relations it is also possible to determine the influence of various physical and geometrical parameters on the carrying capacity of joints. The analytical results are verified experimentally. V.P.

A70-42836 # **Application of the method of harmonic linearization to nonlinear automatic systems with finite automata (Primenenie metoda garmonicheskoi linearizatsii k nelineinym avtomaticheskim sistemam s konechnymi avtomatami).** M. V. Starikova. In: Method of harmonic linearization in the design of nonlinear automatic control systems (Metod garmonicheskoi linearizatsii v proektirovanii nelineinykh sistem avtomaticheskogo upravleniia). Edited by Iu. I. Topcheev. Moscow, Izdatel'stvo Mashinostroenie, 1970, p. 306-343. In Russian.

Description of a harmonic linearization method for the analysis of nonlinear automatic control systems containing finite automata which shape the control input in conjunction with a chosen logic algorithm characterized by a finite set of internal states for the automaton. The structure of the system changes due to the changes in the controlling unit's structure. Simple self-oscillating modes of operation are possible for such systems under the action of constant or slowly varying disturbances. The proposed method makes it possible to (1) determine conditions for the existence of periodic motions, (2) estimate the dependence of the amplitude and frequency of periodic motions on the system parameters and disturbances, and (3) delineate the regions of system stability. Examples of application include the analysis of self-oscillations in an automatic system of aircraft speed control by regulation of engine thrust. T.M.

A70-42880 # **A method of analyzing aircraft accident data by FORTRAN programs.** Suguki Ohhara, Miyako Okaue, Isao Kuroda, and Yukiko Kakimoto (Japan Air Self-Defense Force, Aeromedical Laboratory, Tachikawa, Japan). *Japan Air Self Defence Force, Aeromedical Laboratory, Reports,* vol. 10, Dec. 1969, p. 150-156. In Japanese, with abstract in English.

Description of an aircraft accident filing system using FORTRAN which provides copies of narrative descriptions of accidents when needed. The descriptions are filed on magnetic tape with 320 letters which provide a summary from the official aircraft accident reports. Japanese Kana letters, English letters, numbers, and special signs are used. G.R.

A70-42914 * **Response tests of cup, vane, and propeller wind sensors.** Dennis W. Camp, Robert E. Turner (NASA, Marshall Space Flight Center, Aero-Astrodynamics Laboratory, Huntsville, Ala.), and Luke P. Gilchrist (Lockheed Missiles and Space Co., Huntsville, Ala.). *Journal of Geophysical Research,* vol. 75, Sept. 20, 1970, p. 5265-5270. 8 refs.

Results of a wind tunnel test program performed to investigate the response parameters of two types of cup anemometers (Climet models 014-5 and 014-102), two types of wind vanes (Climet models 014-86 and 014-6), and a propeller anemometer (Young's Gill model 27100, four blade, 9 inches in diameter). The distance constant for the cups (wind speed sensor) was approximately 0.8 and 1.3 meters for 014-5 and 014-102, respectively. Values for the damping ratio of approximately 0.48 and 0.40 were found for the 014-86 and 014-6 vanes, respectively. Of main interest in the investigation of the propeller-type anemometer, other than its response, was the variation of the indicated speed as a function of angle of attack (the angle formed by the longitudinal axis of the anemometer and the wind flow direction). For an angle of attack within plus or minus 30 deg into or away from the flow direction, a cosine curve gives a good approximation to the data. (Author)

A70-42961 **Investigation regarding the optimum light construction of the wings of gliders. II (Untersuchung über den optimalen leichtbau von segelflugzeugtragflächen. II).** K. Beckel. *Aero-Revue,* Sept. 1970, p. 538-540. 16 refs. In German.

Discussion of suitable spar designs for the wings of gliders taking into consideration also conclusions regarding the design of the complete wing. The strains occurring in spar flanges are examined, and a calculation of the spar weight for various designs is considered. It is found that an aluminum honeycomb structure provides the most favorable values as a base material. The use of suitable surface layer materials is discussed taking into account the weight involved and economic considerations. Questions of maintenance and repair are also considered. A number of tables are presented showing weights for various designs and materials taking into consideration wing components and the complete wing. G.R.

A70-42962 **Water ballast loadings on sailplanes.** Wieslaw Stafiej (Szybowcowy Zakład Doświadczalny, Bielsko-Biała, Poland). *Aero-Revue,* Sept. 1970, p. 541-543.

Study of the influence of water ballast loadings on the behavior and the performance of gliders taking into consideration effects on the various components of the aircraft. The basic principles involved in the improvement of glider performance by the use of water ballast are examined. The effect of the water ballast tanks on the forces acting on the wing is analyzed, and the influence of water ballast on aileron loading is investigated. Effects regarding the tail unit, the fuselage, and the landing gear are discussed. Some design directions are given taking into account experience obtained with the new Polish high performance sailplane Cobra 17. G.R.

A70-42975 # **Harrier development from the flight test point of view.** J. F. Farley (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *(Canadian Aeronautics and Space Institute, Flight Test Symposium, Ottawa, Canada, Feb. 5, 1970.) Canadian Aeronautics and Space Journal,* vol. 16, Sept. 1970, p. 259-267.

Harrier flight testing is traced from the first flight of the P.1127 prototype in October 1960, through the Kestrel Tripartite squadron aircraft of 1965, up to the Harrier release to RAF service in April 1969. Mention is also made of future developments of the aircraft as well as the two seat version. It is shown that whilst the V/STOL development problems were novel for a close support jet strike aircraft, they were, in fact, quite easily overcome, if measured in terms of hours of flying or amounts of redesign. In contrast the problems that were met in the conventional flight envelope were considerable and involved many flying hours and significant redesign. It is shown, however, that these difficulties, although they occurred in conventional flight, were, in fact, the result of providing the V/STOL capability and, as such, are relevant to a discussion of V/STOL aircraft. (Author)

A70-43035 **Spark photography of models in free flight in a hypersonic shock tunnel.** R. J. North (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *Society of Motion Picture and Television Engineers, International Congress on High Speed Photography, 9th, Denver, Colo., Aug. 2-7, 1970, Preprint 99.* 6 p. 7 refs.

A spark photography technique has been developed to study the flow around, and forces acting upon, models in a hypersonic shock tunnel which have been released to free, unconstrained flight. The initial supports for the expanded-polystyrene models are fine nylon strings, which are broken during the establishment of the flow in the tunnel nozzle. Although the accelerations are large (on the order of several hundred g), the displacements during the very short period of steady flow (approximately 8 ms) average only about 100 mm. By analyzing the trajectories of the models, it is possible to determine the lift, drag and pitching moments with an accuracy comparable to that obtained using more conventional methods (e.g., strain-gage balances), with the advantage that the apparatus is simpler and there are no problems of support interference or of the frequency response of the measuring system. The light source used is a short-duration (0.2 microns) argon-jet spark, triggered at known intervals (on the order of 1 ms) by a hydrogen thyratron, and the camera consists simply of a single fixed plate on which the shadow images (typically five to eight in number) of the body are recorded. Details of the apparatus are given, together with results and photographs of various configurations in flight. (Author)

A70-43041 **Spark tracing method progress in the analysis of gaseous flows.** Frank Früngel. *Society of Motion Picture and Television Engineers, International Congress on High Speed Photography, 9th, Denver, Colo., Aug. 2-7, 1970, Preprint 41.* 5 p. 8 refs.

Developments are reported in the application of the spark-tracing method to the analysis of flows inside and in the vicinity of flames; in high-speed wind tunnels at any speed and at pressures as low as 10 torr; and also through nozzles and pneumatic valves of extremely small dimensions by means of a pulse transformator. The sparks are generated by short-rise-time high-voltage pulses of preset burst length including those below the one millimeter value, at quartz-controlled frequencies of 10, 20, 40 and 100 kHz. The upper application limit amounts to 60 atm. (Author)

A70-43056 **High speed holographic recording of transilluminated events.** J. W. C. Gates, R. G. N. Hall, and I. N. Ross (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *Society of Motion Picture and Television Engineers, International Congress on High Speed Photography, 9th, Denver, Colo., Aug. 2-7, 1970, Preprint 3.* 7 p.

Single-shot ruby and neodymium second-harmonic pulsed lasers have been developed and applied during the last two years to the holographic recording of rapid-transient events. Phase objects of particular interest to aerodynamics, mechanical engineering and combustion studied have been successfully recorded and their reconstructions visualized in three dimensions. The fields include multiple spherical shock waves from four spark sources, shock waves of complex shape, the propagation of isolated vortices and two-component fluid distributions in an internal combustion engine. To extend the range of high-speed events that may be recorded, particle distributions of various kinds have been evaluated for their ability to be accommodated within the given dimensions (length 600 mm, diameter 150 mm) of the essentially cylindrical working volume. Some comparisons are drawn between the results obtained with the developmental apparatus and that attainable using commercial ruby and Nd-doped lasers. Applications to shock tube and wind tunnel experiments are reported. (Author)

A70-43081 # **Trends in the construction of low- and medium-power turboprop engines. II (Tendencje w budowie turbinowych silników śmigłowych o małej i średniej mocy. II).** Walerian Kordziński. *Technika Lotnicza i Astronautyczna,* vol. 25, July 1970, p. 7-9, 26. In Polish.

Discussion of modern methods for operational control of turboprop engines in flight, and evaluation of development trends for those engines in view of their expected use for V/STOL aircraft. Propeller pitch control is described, along with the regulation of engine power and angular speed. Compression ratios, operating temperatures, speed ranges, fuel consumption, and weight to power ratios of modern engines are reviewed, and maintenance requirements are outlined. The development of turboprop engines for V/STOL aircraft is considered in terms of expected conditions of operation. T.M.

A70-43082 # **Influence of the wind gradient on aircraft piloting (Wpływ gradientu wiatru na pilotaż samolotu).** Marek Żebrowski. *Technika Lotnicza i Astronautyczna,* vol. 25, July 1970, p. 13-17, 37. 5 refs. In Polish.

Description of the conditions giving rise to horizontal and vertical wind gradients, and analysis of the influence of wind gradients on aircraft control in various flight situations. Examples of landing approach maneuvers are described in the presence of a normal wind gradient and gradients caused by tail winds, head winds, and gusts. Special attention is given to wind gradient effects on takeoff, ascent, and overflight conditions. T.M.

A70-43083 # **Certain possibilities of using radioactive isotopes in testing aircraft equipment (Niektóre możliwości zastosowania izotopów promieniotwórczych w badaniach sprzętu lotniczego).** Jerzy Lewitowicz. *Technika Lotnicza i Astronautyczna,* vol. 25, July 1970, p. 18-20. 11 refs. In Polish.

Discussion of the use of radioactive isotopes in aircraft engine diagnostics and defectoscopy. It is shown that isotopes can be used effectively to study thermodynamic and mechanical processes affecting the temperature distribution in turbine blades, the gas

densities at jet nozzle outlets, and the clearances and gaps in engine components. Special applications of isotopes provide information about component wear and failure for maintenance operations. T.M.

A70-43084 # **SAP - A new aircraft structural material (SAP - Nowy lotniczy materiał konstrukcyjny).** Janusz Czaplicki. *Technika Lotnicza i Astronautyczna,* vol. 25, July 1970, p. 21-26. 6 refs. In Polish.

Description of fabrication techniques for SAP (scorched aluminum powder) materials, and outline of their physical properties, durability characteristics, and aspects of industrial processing and working. The mechanical properties of these materials are illustrated by graphs showing the effects of composition, component dispersion, and prestressing. Prospects for the use of SAP materials in aircraft structural components are evaluated in terms of the ease of rolling, the high heat resistance, and the inherent corrosion resistance. T.M.

A70-43093 **Handling jet fuel at the airfield.** I. N. M. Hardy (Shell International Petroleum Co., Ltd., London, England). *Shell Aviation News,* no. 386, 1970, p. 16-21.

Review of the approach to handling jet fuels at airfields adopted by the Shell Company for this decade. The major changes and improvements based on experience and tests in this field are summarized as follows: (1) fuel entering the airfield depot will pass through a filter/water separator, and then through a similar monitor for a check; (2) the same procedure will be applied to fuel transferred from airfield storage into fueling vehicles or a hydrant system; (3) all fuelers and hydrant dispensers will be fitted with a filter monitor through which all fuels will be passed just before delivery into aircraft; (4) the complete airfield fuel handling system will be self cleaning and noncontaminating. All pipes and tanks will be noncorrodible or epoxy paint lined, and there will be no pockets for contaminant, dirt or water to accumulate; (5) tanks will have no floating suctions, and the product delivered from storage will be drawn from the lowest point of the tank; and (6) automation will be introduced at every stage where the improved techniques are justified. The economic aspects of these changes are discussed. V.Z.

A70-43105 **An associative memory for executive control functions in an advanced avionics computer system.** Robert O. Berg and Melvin D. Johnson (Honeywell, Inc., Systems and Research Center, Roseville, Minn.). In: Challenge of the seventies: Memories, terminals, peripherals; Institute of Electrical and Electronics Engineers, International Computer Group Conference, Washington, D.C., June 16-18, 1970, Proceedings. New York, Institute for Electrical and Electronics Engineers, Inc., 1970, p. 336-342. 6 refs.

The paper describes methods of using an associative memory for the implementation of executive control functions in an advanced avionics digital computer system. The various fields required in the associative memory word and functions of those fields in the task assignment routine are presented. It is shown that an associative memory can be used to mechanize an effective task assignment algorithm based on dynamic priority. (Author)

A70-43116 # **A control system design for an aircraft turbine engine (Řešení regulačního systému leteckého turbínového motoru).** Josef Salaba. *Zpravodaj VZLÚ,* no. 1, 1970, p. 5-27. 15 refs. In Czech.

Description of the development of two major specialized subsystems of an aircraft gas-turbine engine - namely, the constant fuel delivery and engine speed control circuits. A detailed description of the operation including several block diagrams is given, and the control circuit transfers are determined. Numerical solutions of certain constants and values of controller gains, when using a method of synthesis of control circuits based on an approximation of functions, are then made. A detailed analysis of both circuits is performed using an analog computer, and the results are discussed. Finally, suitable constants and controller gain values are recommended. O.H.

A70-43117 # **Experience from the operation of the digitally controlled milling machine FA 4 VN (Poznatky z provozu číslicově řízené frézky FA 4 VN).** Jiří Beránek. *Zpravodaj VZLÚ,* no. 1, 1970, p. 29-38. In Czech.

Discussion of the development, design, and operation of the digitally controlled milling machine FA 4 VN used for milling complex profiles. Following a description of the machine, the arrangement of its operational tests is discussed in detail. Finally, some practical examples illustrating the operation of the machine, which include profile milling of aerodynamical models and prismatic blades, are presented. The resulting data are tabulated and discussed. O.H.

A70-43118 # **A calculation of generalized aerodynamic forces acting on a wing in a subsonic flow (Výpočet zobecněných aerodynamických sil křídla v subsonické oblasti proudění).** Zdeněk Škoda. *Zpravodaj VZLÚ,* no. 2, 1970, p. 7-13. 7 refs. In Czech.

Description of a method of solving the linearized motion of a harmonically oscillating wing in a subsonic flow. The thin lifting surface is replaced by a system of lifting lines which in the stationary case change over into a system of lifting vortices. The integral equation of the lifting surface is by this approximation transformed into a system of one-dimensional singular integral equations which are solved by means of Multhopp's polynoms. The calculations are carried out by means of a computer for an arbitrary number of mutually independent modes of the wing without any restrictions as to the plan shape and the reduced frequency. The results of the calculations are intended, in the first place, for calculating the flutter speed of the wing. O.H.

A70-43119 # **Some problems involved in testing the fatigue life of helicopter parts and assemblies (Některé problémy průkazu únavové životnosti částí a skupin vrtulníku).** Vojtěch Nejedlý. *Zpravodaj VZLÚ,* no. 2, 1970, p. 15-32. 10 refs. In Czech.

Discussion of the role of the fatigue of material used for fabrication of helicopter parts and assemblies, as well as the methods for estimating the safe fatigue life of helicopters. Following a review of the various factors which affect the fatigue life of materials in general, the mechanical parts of assemblies of single-rotor helicopters with a turbine engine are briefly described; only this type of helicopter, corresponding to the British Sikorsky Westland Wessex helicopter, is considered. Principal emphasis is placed on the preparation and execution of a fatigue life test program, based mainly on the experience of British helicopter designers. Some examples of typical flight and fatigue tests used for ascertaining the typical loading spectra and service conditions are presented. Finally, principles underlying the estimation of the safe fatigue life of helicopters which can be extended to other branches of mechanical engineering are derived. O.H.

A70-43146 **The aircraft as scientific observation platform (L'avion, plateforme d'observations scientifiques).** Pierre Léna (Meudon, Observatoire, Meudon, Hauts-de-Seine; Paris, Université, Paris, France). *Space Science Reviews,* vol. 11, Sept. 1970, p. 131-151. 46 refs. In French.

Transition between high altitude manned observatories and unmanned balloon-borne or rocket-borne experiments is achieved with high flying aircraft, at altitudes above tropopause (greater than 12 km), which became readily available, at reasonable cost and reliability, in the past five or ten years. This paper reviews the development of scientific uses of aircraft, especially for astronomy and geophysics, with some emphasis placed on infrared problems, closely related to the scale height of the chief infrared absorber, i.e., telluric water vapor. Absorbers distribution vs altitude and spectral characteristics are summarized. Capabilities of various available aircraft are compared and the various ways to consider modifications are discussed: structural modifications or design problems to fit telescopes or light collectors on board. Tables II and III list the advantages of airborne observations, compared to other spatial carriers, and also the specific problems connected with aircraft. Adopted solutions to these problems are exposed and costs are briefly discussed. Finally, a few examples of scientific results, gathered in the few past years from aircraft, are given, both in astronomy and in geophysics. (Author)

A70-43188 # **Reactor for nuclear extended range aircraft.** F. D. Orazio, Sr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and J. E. Werle (Westinghouse Astronuclear Laboratory, Pittsburgh, Pa.). In: American Nuclear Society, National Topical Meeting on Aerospace Nuclear Applications, Huntsville, Ala., April 28-30, 1970, Proceedings. Meeting co-sponsored by NASA, the Southern Interstate Nuclear Board, and the Alabama Development Office. Huntsville, Ala., American Nuclear Society, 1970, p. 242-273.

There is a need for large military aircraft having the capability of extremely long flight endurance and range. Such aircraft could be used for surveillance type missions, or for an airborne command center to provide the country with a flexible, alert, mobile system capable of surviving a surprise nuclear attack. Because the payload, and therefore, the cost effectiveness, of a nuclear-powered aircraft increases with the overall size and weight of the airframe, the recent development of very large jet aircraft has made nuclear power economically attractive. The technological advancements of nuclear reactors for airborne purposes are discussed, along with the highlights of preliminary aircraft designs incorporating a high temperature, liquid metal cooled reactor. Concluding remarks include a discussion of some of the most critical problem areas that must be solved for the successful development of a nuclear-powered, long endurance, long range aircraft. (Author)

A70-43199 **Steam film cooling in combustion chambers of aircraft propulsion units (Dampffilmkühlung in Flugtriebwerk-Brennkammern).** H. Beer, B. Schlott (Stuttgart, Universität, Stuttgart, West Germany), and A. F. Schlader (Université Laval, Quebec, Canada). *Zeitschrift für Flugwissenschaften,* vol. 18, Aug. 1970, p. 286-290. 9 refs. In German.

Convective and radiant heat transmission in a gas turbine combustion chamber is calculated and compared with experimental results. The cooling of the flame tube by steam injection may be calculated applying conventional film-cooling correlations. (Author)

A70-43200 **Application of an experimental-computational procedure for the determination of the natural vibration parameters of an elastomechanical system at one exciter configuration (Anwendung eines versuchsmässig-rechnerischen Verfahrens zur Ermittlung der Eigenschwingungsgrössen eines elastomechanischen Systems bei einer Erregerkonfiguration).** Hans Günther Natke (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Aug. 1970, p. 290-303. 10 refs. In German.

A test and evaluation method given by the author for determining the natural vibration magnitudes of a linear elastomechanic system has been tested with a wing model. Experimentally, the method comprises the harmonic excitation of the system in one exciter configuration and the measurement of the forced vibrations for different excitation frequencies. Computationally, a quadratic equation system is to be solved. The expenditure in testing is reduced in comparison with that for the classical test method (phase resonance: experimental adaptation of the excitation for each normal mode). Previously, the normal vibration behavior of the specimen was investigated in two 'classical' ground vibration tests. In the present application, the tested new method not only proves useful but superior to the classical method. (Author)

A70-43213 **Concorde - The downstream reverse nozzle (TRA) which makes it possible to gain one ton per aircraft (Concorde - La tuyère à reverse aval (TRA) permettra de gagner une tonne par avion).** Jacques Morisset. *Air et Cosmos,* vol. 8, Sept. 26, 1970, p. 32, 33. In French.

Description of the new downstream reverse nozzle of the Concorde, which has been developed from a different concept from that of the secondary nozzle of the Olympus 593. The concept rests on a better arrangement of the pod, transposition of the jet inverter from upstream to downstream of the converger-diverger, and extensive use of welded stainless steel honeycombs. F.R.L.

A70-43246 **The reappearance of fog layers (Zur Wiederholung von Nebellagen).** Reiner Lamp. *Meteorologische Rundschau,* vol. 23, Sept.-Oct. 1970, p. 141-144. In German.

Study of the frequency with which fog will appear again at airports after the end of a period of bad visibility. It is investigated whether the assumption of a continuing danger regarding the reoccurrence of bad visibility after a disappearance of a fog layer in weather predictions for aircraft is justified. It is found that in general such a repetition of bad visibility is far below 50%. The repetition frequency for the time from May to August is less than 15%. G.R.

A70-43267 **International Forum for Air Cargo, 5th, Frankfurt am Main, West Germany, September 15-17, 1970, Proceedings (Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, September 15-17, 1970, Proceedings).** *Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970. 48 p. In German.

Contents:

Air cargo faces many new problems (Luftfrachtverkehr vor neuen Problemen). R. W. Schulz (Verein Deutscher Ingenieure, Düsseldorf, West Germany), p. 216-218.

Air cargo interfaces (Nahtstellen im Luftfrachtverkehr). H. M. Marx and J. Gaus (Dortech, Inc., Wiesbaden, West Germany), p. 218-223.

A terminal for centralized air cargo handling (Zentrale Luftfrachtumschlaganlage). H.-D. Herrmann and W. O. Kleiner, p. 224-229.

Computers in air cargo (Einsatz von elektronischen Datenverarbeitungsanlagen bei der Luftfrachtabfertigung). J. Gaus (Dortech, Inc., Wiesbaden, West Germany), p. 229-232.

Clearing air cargoes by computer (Rechnergestützte Luftfracht-Zollabfertigung). J. Stewart, p. 233, 234.

The air freight container in the non-interrupted transport chain (Der Luftfrachtcontainer im kombinierten Verkehr). H. Fahlbusch (Messerschmitt-Bölkow-Blohm GmbH, Donauwörth, West Germany), p. 235-239.

A70-43268 Air cargo faces many new problems (Luftfrachtverkehr vor neuen Problemen). R. W. Schulz (Verein Deutscher Ingenieure, Düsseldorf, West Germany). *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 216-218. In German.

For many years, air cargo traffic as measured in 'Tonne Kilometers' has increased more rapidly than air passenger traffic. In order to meet this high rate of growth, it is necessary to develop larger terminals having mechanized and automated handling equipment, and to improve the direct delivery container shipment. At present, a breakthrough toward mass air cargo traffic is hampered by rather high freight charges. They could be reduced by the introduction of large freighter aircraft having lower direct operating costs, however, these aircraft are not to be expected for the next future. (Author)

A70-43269 Air cargo interfaces (Nahtstellen im Luftfrachtverkehr). H. M. Marx and J. Gaus (Dortech, Inc., Wiesbaden, West Germany). *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 218-223. In German.

The economics of air freight in comparison with other forms of freight are, first of all, dependent on how rational and how quickly air freight can be handled on the ground. Possible improvements in handling capability in the total system present themselves especially in the following five areas: through the aircraft itself and its ground handling - here, especially the Jumbos present the greatest possibility for change; through the handling of freight, as it is related to the overall system of the airport; through cargo handling inside the terminal - by mechanization and automation of the facilities; through document handling and information flow changes - by employing of electronic data handling systems; by affecting the methods of freight receiving and forwarding - by establishing off-airport cargo consolidation centers where freight forwarders can build up and break down consolidations and containerized freight. The problems arising in these five interface areas are discussed and various ways toward solutions are described. (Author)

A70-43270 A terminal for centralized air cargo handling (Zentrale Luftfrachtumschlaganlage). H.-D. Herrmann and W. O. Kleiner. *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 224-229. In German.

In order to cover the future growth of air freight volume, air cargo terminals must have an adequate handling capacity, especially, for transit freight of Jumbo aircraft (B 747, L-500) and smaller feeder aircraft. In this article, a cargo terminal is proposed the airside ramp system of which is designed in such a way that all pallets and/or containers are handled on only one level. The computer-controlled system provides for automatic transportation of 40 containers. Within 75 minutes, nine aircraft (three B 747 and six B 707) can simultaneously be loaded and unloaded. The handling capacity of the terminal is in the range of 300,000 tons of freight per year. (Author)

A70-43271 Computers in air cargo (Einsatz von elektronischen Datenverarbeitungsanlagen bei der Luftfrachtabfertigung). J. Gaus (Dortech, Inc., Wiesbaden, West Germany). *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 229-232. In German.

An automated cargo and data flow system using on-line computers can solve many of the problems of cargo handling. Data processing techniques offer potential for this in two areas: the first is related to the data and document handling systems. Among these are the coordinated handling of freight documents, load planning, transmission of information to downline stations and customers as well as the control of inventory during storage and the movement of shipments at both origin and destination points and intermediate transfer points. The second potential for data processing relates to the control and steering of mechanized freight handling systems in the terminal. The article discusses the techniques of such an integrated computerized system and elaborates on some of the advantages that such a system can provide. (Author)

A70-43272 Clearing air cargoes by computer (Rechnergestützte Luftfracht-Zollabfertigung). James Stewart. *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 233, 234. In German.

The world's first computerized system to control the clearance of imported air cargo is scheduled to come into operation at London's Heathrow Airport in 1971. By means of the automated system it will be possible to drastically reduce paperwork, virtually eliminate complex manual calculations, and make goods available to customers more quickly than the present arrangements allow. Known as LACES (London Airport Cargo Electronic-data-processing Scheme), the system is capable of extension and it is expected to handle not only imports, but also exports at a later date. (Author)

A70-43273 The air freight container in the non-interrupted transport chain (Der Luftfrachtcontainer im kombinierten Verkehr). H. Fahlbusch (Messerschmitt-Bölkow-Blohm GmbH, Donauwörth, West Germany). *(Internationales Forum für Luftfracht, 5th, Frankfurt am Main, West Germany, Sept. 15-17, 1970.) Luftfahrttechnik Raumfahrttechnik,* vol. 16, Sept. 1970, p. 235-239. In German.

Development of air freight traffic after introduction of giant aeroplanes in the mid-1970s is marked by an increase in transportation efficiency above average. This efficiency in air traffic is diminished by relatively long times required for clearance, transfer and distribution of goods by surface conveyance. The air freight container, especially when included in a continuous air/land transportation chain, is a suitable means for rationalizing air freight traffic. After analyzation of the main aspects with regard to the requirements for air freight containers, i.e., weight, performance and purchase price, different technical conceptions for air freight containers are described. Examination of the problem whether or not air freight containers can be transferred to road and rail conveyance with all of its economy maintained, finally leads to the description of the existing prototypes of a nonintermodal and an intermodal container respectively. (Author)

A70-43274 * # Flight and wind tunnel investigation of installation effects on underwing supersonic cruise exhaust nozzles at transonic speeds. Daniel C. Mikkelson and Bernard J. Blaha (NASA, Lewis Research Center, Cleveland, Ohio). *NATO, AGARD, Aerodynamic Interference Specialists Meeting, Silver Spring, Md., Sept. 28-30, 1970, Paper.* 14 p. 10 refs.

Investigation of airframe installation effects on exhaust nozzle systems mounted on underwing engine nacelles by means of a combined flight and wind tunnel test program utilizing a modified F-106 aircraft. Flight tests were conducted in the transonic speed regime to determine nozzle performance and boattail drag for variable flap ejector, conical plug, and auxiliary inlet ejector nozzle concepts. Wind tunnel tests were conducted on isolated models of these nozzles and also on a 1/20-scale model of the F-106 aircraft with simulated underwing engine nacelles. Wing and nacelle pressures from these wind tunnel tests are used to qualitatively explain the

observed installation effects. The 1/20-scale model was also used to evaluate the effects of changes in nacelle geometry and angle of attack. M.V.E.

A70-43275 * # **Turbine cooling - Its limitations and its future.** Jack B. Esgar (NASA, Lewis Research Center, Airbreathing Engines Div., Cleveland, Ohio). *NATO, AGARD, Meeting, 36th, Florence, Italy, Sept. 21-25, 1970, Paper.* 26 p. 18 refs.

Analytical investigation of the relative merits of convection, transpiration, and full coverage film cooling methods for local turbine inlet temperatures from 2000 to 3500 F (1367 to 2200 K), gas pressures from 5 to 40 atmospheres (50.7 to 405.3 N/sq cm) and cooling air temperatures from 600 to 1200 F (589 to 922 K). Effects of wall thickness and material temperature were also investigated. Transpiration or full-coverage film cooling will probably be necessary to permit operation at local turbine inlet temperatures on the order of 3000 F (1922 K) and compressor pressure ratios of 20 or higher. Full-coverage film cooling is often superior to transpiration cooling because oxidation problems with transpiration-cooled materials reduce allowable metal operating temperatures. Increasing allowable metal temperature 100 F (56 K) or reducing cooling air temperature 200 F (111 K) can do more to improve convection cooling than is possible by improvements in current advanced state-of-the-art convection-cooled blade or vane design. (Author)

A70-43322 # **Gas flow past nonaxisymmetric bodies at sma angles of attack.** V. N. Mikhailov. (*Prikladnaia Matematika Mekhanika,* vol. 34, Jan.-Feb. 1970, p. 137-140.) *PMM - Journal of Applied Mathematics and Mechanics,* vol. 34, no. 1, 1970, p. 126-129. 5 refs. Translation.

Investigation of the supersonic flow of a perfect gas with constant velocity, pressure, and density around a finite nonaxisymmetric body at small angles of attack. The theory of small perturbations is usually used for the case of slender bodies where the solution is sought as the sum of two series of which one gives the solution for a zero angle of attack while the other is proportional to the angle of attack. In the case of thick bodies, the solution involves linearization with respect to a known flow disturbance (for example known axisymmetric flow), with the coefficients of linear equations for the secondary terms being dependent on the first terms of the series expansion in terms of the angle of attack. If the body is not axisymmetric, then the secondary terms depend on the body's orientation with respect to the flow velocity vector. The present study demonstrates that in this case, the solution can be obtained for any body orientation by knowing the solution for any two other orientations. T.M.

A70-43323 # **On equations of three-dimensional laminar boundary layer of bodies of revolution.** B. M. Bulakh and M. S. Simkin. (*Prikladnaia Matematika i Mekhanika,* vol. 34, Jan.-Feb. 1970, p. 145-149.) *PMM - Journal of Applied Mathematics and Mechanics,* vol. 34, no. 1, 1970, p. 134-139. Translation.

Derivation of uniformly accurate equations for the three-dimensional laminar boundary layer on a body of revolution placed at an angle of attack in a supersonic gas flow. The most significant result is that the parameters of gas flow in the boundary layer (near the region of a sharp bend in the generatrix) can be determined independently in each meridional plane passing through the body's axis of symmetry if the radius of curvature of the generatrix is of the same order of magnitude as the boundary layer thickness. T.M.

A70-43352 # **Optimization of stochastic processes (K zadache optimizatsii stokhasticheskikh protsessov).** A. A. Baloev and T. K. Sirazetdinov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 11-19. 6 refs. In Russian.

Discussion of a control process with distributed parameters which is described by a system of partial differential equations and which takes place in three-dimensional region during a prescribed time. The differential equations and boundary conditions given at the boundary of the region are determinate, while the initial conditions are random functions. The control process involves the minimization of a functional of the phase coordinates that describe the flow of the process and of the control inputs. One part of the equations is chosen such that the equations become optimal for any initial realization. The other part is optimal 'on the average' for the entire set of initial realizations. The problem of selecting the optimal stabilizer planform for an elastic aircraft is solved as an example. V.P.

A70-43356 # **Influence of the nozzle characteristics, temperature, and physicochemical properties of the fuel on the starting characteristics of gas turbine engine combustion chambers (Vliianie kharakteristik forsunki, temperatury i fiziko-khimicheskikh svoistv topliva na puskovye kachestva kamer sgoraniia GTD).** N. F. Dubovkin and A. P. Gorshenin. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 42-47. In Russian.

Analysis showing that the starting characteristics of gas turbine engine combustion chambers operating with standard hydrocarbon fuels depend primarily on the saturated vapor pressure and viscosity of the fuel. These fuel characteristics define the fuel evaporation rate, the size of dispersed particles, and the root angle of the flame. High airflow rates at the chamber inlet can be achieved by using fuels with a high combustion heat, a low evaporation heat, a high flame propagation rate, and a small ignition energy. Nozzle characteristics (except for some special cases) have only a slight effect on the maximum starting airflow rate, but always lead to a substantial shift in the starting characteristic as a function of the excess air ratio. V.P.

A70-43361 # **Optimization of the tuning of gas turbine engines (Optimizatsiia otladki gazoturbinnykh dvigatelei).** Iu. V. Kozhevnikov and R. I. Adgamov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 73-80. In Russian.

Consideration of the problem of adjusting the rpm, the thrust, the fuel flow rate per second, and the gas temperature in the characteristic cross section of a two-stage gas turbine engine. A general method of achieving this adjustment is proposed, as well as a simplified method which can be used in many particular cases of practical importance. The preparation of the initial data for optimal tuning of gas turbine engines during automated bench tests using computers is described. A.B.K.

A70-43362 # **A nonlinear aeroelasticity problem for a two body combination (Nelineinaia zadacha aerouprugosti dlia kombinatsii dvukh tel).** I. K. Arkhipov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 81-84. In Russian.

Study of the potential flow around a structure consisting of an oscillating cylindrical shell with an attached thin cantilever plate and subjected to a supersonic gas flow at zero angle of attack. A set of equations describing this problem is derived. The results indicate that the transverse component of the flow, produced by the oscillations of the plate, enhances these oscillations due to interference, and that the aerodynamic interference effect is responsible for the occurrence of limiting periodic cycles. O.H.

A70-43371 # **Preliminary estimate of the flow rate and thrust characteristics of noise-suppressing nozzles of turbojet engines (Predvaritel'naia otsenka raskhodnykh i tiagovykh kharakteristik shumoglushashchikh sopel TRD).** E. D. Nesterov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 130-132. In Russian.

Outline of a method of determining both the thrust and flow rate characteristics of noise-suppressing nozzles. The proposed method is employed in obtaining an estimate of the flow rate and thrust characteristics for a real case where the discharge coefficient of a conical nozzle is different from 1.0. A.B.K.

A70-43372 # Investigation of the cycle of a continuous combustion gas turbine engine with a stepwise heat removal (Issledovanie tsikla gazoturbinnogo dvigatelia nepreryvnogo goreniia so stupenchatym otvodom tepla). B. Kh. Perel'shtein and A. P. Tunakov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 133-139. 5 refs. In Russian.

Investigation of the feasibility of increasing the efficiency of the gas turbine engine cycle by means of a stepwise heat removal. Three successive steps of heat removal are considered: removal of heat from gas in the cooler, stepwise compression in the compressor, and ejection of gas in the atmosphere. Equations describing this cycle are derived, and the data obtained are plotted graphically and discussed. The results demonstrate a 40% increase in cycle efficiency compared with a cycle without this stepwise heat removal. O.H.

A70-43432 # Lift induced by suction flaps on augmentor wings. Y. Y. Chan (National Aeronautical Establishment, Ottawa, Canada). *CASI Transactions,* vol. 3, Sept. 1970, p. 107-110. 6 refs.

The suction effect at the hinge line of a flap of an augmentor-wing section is studied with a simplified model consisting of a thin airfoil with a trailing jet sheet and sinks locating at the upper and lower surfaces at the hinge line of the flap. The analysis is based on a small disturbance theory and the resulting equation is solved by a numerical method. The result shows that lift induced by hinge suction is quite appreciable in comparison with that generated by the basic configuration of an airfoil with a jet-augmented flap. (Author)

A70-43439 # Gas turbine cycle calculations - The effects of fuel composition and heat of combustion. T. A. P. S. AppaRao and E. P. Cockshutt (National Research Council, Ottawa, Canada). *CASI Transactions,* vol. 3, Sept. 1970, p. 162-169. 10 refs.

A procedure has been developed for the calculation of gas turbine cycles using a general hydrocarbon as the fuel. Computer programs have been developed to facilitate the calculations, by suitably modifying existing ones previously developed at the National Research Council, Ottawa. Using these programs, the effects of changes in the fuel composition and heat of combustion on the performance of typical turbojet, turbofan, turboprop and turboshaft cycles were studied. The performance of different fuels was compared with Standard Fuel performance. It is shown that thermal efficiency is a better performance criterion than specific fuel consumption, if fuel composition is a significant variable in cycle studies. Thermal efficiency and specific power may in many cases be computed with Standard Fuel without significant loss of accuracy; this applies for fuels with H/C ratios lying between 1.8 and 2.05 (or heating values between 10,200 CHU/lb. and 10,450 CHU/lb.) and thus embraces all common aircraft fuels plus many vehicular and industrial fuels. (Author)

A70-43453 Development of tension-torsion machine from an aircraft-carrier catapult problem. Thomas W. Butler (U.S. Naval Academy, Annapolis, Md.). *Experimental Mechanics,* vol. 10, Oct. 1970, p. 438, 439.

Development of a simple tension-torsion machine which produces radial loading paths and offers a simple, inexpensive way to perform certain tension-torsion tests. The principle underlying the design of the machine is utilizing the untwisting of a stretched cable which has been observed in hold back assemblages used for aircraft carrier catapults and consisting of tension bars and untwisting cables, and which has been found to be the major cause of premature failures of these tension bars. O.H.

A70-43455 # Holographic interferometry for study of transparent mediums (Interférometrie holographique pour l'étude des milieux transparents). Jean Surget (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Symposium International sur les Applications de l'Holographie, Besançon, France, July 6-11, 1970.) ONERA, TP* no. 851, 1970. 5 p. 14 refs. In French.

Review of developments carried out at ONERA in the field of holographic interferometry, followed by a quantitative study of an aerodynamic phenomenon by this method. The results agree perfectly with those obtained by a conventional interferometer, within the measurement dispersion limits, which are of the same order of magnitude for both methods. F.R.L.

A70-43486 Air traffic demanding more accurate controls. Justin Scott. *MicroWaves,* vol. 9, Sept. 1970, p. 48-50.

Discussion of new requirements and associated development problems for airport and air route surveillance radars, radar beacon systems, radar microwave links, and microwave instrument landing systems. Range improvement, frequency diversity, clutter elimination, and storm indication are discussed, and attention is given to transponder problems arising from multiple replies, lost targets, and beam lobing. The use of microwave links in place of coax or waveguide paths is examined, together with the improvement of microwave instrument landing systems by limiting reflections from other aircraft and buildings. T.M.

A70-43489 Queueing requirements in an automatic radar target detection system operating with a narrow bandwidth data link. David L. Bussard and Richard D. Wilmot (Hughes Aircraft Co., Fullerton, Calif.). *IEEE Transactions on Systems Science and Cybernetics,* vol. SSC-6, Apr. 1970, p. 81-91. 9 refs.

Automation of the radar target detection process for remotely located scanning radars in an air traffic control system results in a queueing requirement for target reports when the communication link transfer rate is less than that of the radar. To determine the nature of this queueing requirement, a systems model was developed which incorporates the effects of aircraft target spacing at random intervals, in flight corridors, and in close formation clusters. The entire system was simulated to determine the queueing statistics as a function of the target spacing parameters, the load, the total number of targets, and the mixture of different message lengths. Verification of the simulation for one case which used a simplified target location model with all targets randomly located was obtained by mathematical analysis. A comparison of the two types of target location models showed that the complex target location model created a queue whose mean and variance were significantly larger than that created by the simplified model with all targets randomly located. (Author)

A70-43499 The status of the hovercraft (Le statut de l'aéroglisseur). E. Du Pontavice (Nantes, Université, Nantes, France). *Revue Générale de l'Air et de l'Espace,* vol. 33, no. 2, 1970, p. 125-157. 103 refs. In French.

Consideration of the status of the hovercraft, which combines the characteristics of both ships and aircraft. A brief outline of experiments with hydrofoil craft is given, but it is considered that this device is being superseded by the hovercraft, or air cushion

vehicle. The latter has the advantage of being able to operate over both land and water. Various legal aspects of hovercraft operation are discussed in some detail. In general, hovercraft are treated in France, Great Britain, the U.S., and other countries as ships, and rules of the road which apply to ships are also applied to hovercraft. F.R.L.

A70-43501 # **The possibilities for European avionics in the Post Apollo programme.** J. Chaumeron and J. P. Guinard (Thomson - CSF, Paris, France). *EUROSPACE, U.S.-European Conference, 4th, Venice, Italy, Sept. 22-25, 1970, Paper.* 8 p.

Examination of the type of contribution that can be made to the Post Apollo program by the European industry in the field of avionics. Cooperation possibilities in the field of space shuttles, space tugs, and space stations and modules are considered, and their characteristics are analyzed. It is concluded that European avionics is in a position to offer significant contributions to the Post Apollo program. O.H.

A70-43502 # **Prospectus for a European company with regard to the operation of regional application satellite systems.** P. L. Burckhardt (Oerlikon-Bührle Holding, S.A., Zurich, Switzerland). *EUROSPACE, U.S.-European Conference, 4th, Venice, Italy, Sept. 22-25, 1970, Paper.* 10 p.

Consideration of the creation of operational application satellite systems to ensure that the investment in terms of technical and financial resources is to serve its purpose not only technologically, but also as an economic proposition. The most important projects are that of a telecommunications satellite for a European interurban network, and the project of an air traffic control satellite as proposed and prepared in cooperation between ESRO and NASA. F.R.L.

A70-43503 # **Inventory of the principal European wind tunnels capable of being used for aerodynamic tests in the Post Apollo Programme.** J. Brocard (Association Internationale des Constructeurs de Matériel Aérospatial, Paris, France). *EUROSPACE, U.S.-European Conference, 4th, Venice, Italy, Sept. 22-25, 1970, Paper.* 9 p.

Listing of the principal European wind tunnels suitable for use in the Post Apollo Program. A tabulation gives the main characteristics of tunnels operating in subsonic, transonic, supersonic, and hypersonic regimes and at low density. The wind tunnel information is updated each year. M.M.

A70-43507 # **A survey of some European hypersonic research.** D. Küchemann (Royal Aircraft Establishment, Farnborough, Hants., England). *EUROSPACE, U.S.-European Conference, 4th, Venice, Italy, Sept. 22-25, 1970, Paper.* 13 p. 11 refs.

Brief survey of European research activities (Eurohyp Programme) in the field of high-speed aerodynamics. This research is coordinated, to some extent, on an informal basis at working level, and the concerted efforts so far have proved to be very effective. Generally, the work is of a fundamental nature, with outlets into many possible applications. M.M.

A70-43529 # **Possibilities of estimating the durability of aircraft turbine engines (Możliwości oceny trwałości lotniczych silników turbinowych).** Stefan Szczeciński. *Technika Lotnicza i Astronautyczna,* vol. 25, Aug. 1970, p. 5-9. 9 refs. In Polish.

Investigation of a turbine engine maintenance problem involving the estimation of the time of reliable operation of rotor assemblies on the basis of continuous measurement of the rotor blade minimum tip clearance. Progressive reduction of this clearance during operation is caused by permanent deformations of rotor blades, disks, and casings and by wear of bearings. The proposed method of clearance monitoring is based on continuous measurement of the protrusion of a peg ground down by the blade tip, with simultaneous recording as a function of time. T.M.

A70-43530 # **Some problems in piloting helicopters (Pewne problemy pilotowania śmigłowców).** Ryszard Witkowski (Instytut Lotnictwa, Warsaw, Poland). *Technika Lotnicza i Astronautyczna,* vol. 25, Aug. 1970, p. 9-15, 28. 6 refs. In Polish.

Discussion of the piloting characteristics of helicopters, with emphasis on some special control problems arising in particular flight maneuvers. Hazards involved in performing turns are outlined for single-rotor and coaxial dual-rotor helicopters, indicating the advantages of the latter. A method is described for increasing the range of a two-engine category-B helicopter with one inoperative engine. The effects of suspended loads on the piloting characteristics are examined, together with difficulties arising during operations in snow. T.M.

A70-43532 # **Certain problems in the analysis and optimization of air transport operations (Niektóre zagadnienia badania i optymalizacji eksploatacji statków powietrznych).** Gustaw Potocki. *Technika Lotnicza i Astronautyczna,* vol. 25, Aug. 1970, p. 18-21, 40. In Polish.

Discussion of individual stages in the analysis of technical and operational functions in an air transport system from the viewpoint of improving efficiency and adapting to existing conditions. Successive steps which must be taken in the diagnostic, forecasting, and realization stages of analysis are explained, and the final evaluation of results obtained is illustrated. Some detailed studies actually performed according to the proposed program are outlined. T.M.

A70-43533 # **Future development of long-range air transport (Przyszły rozwój lotniczych przewozów dalekiego zasięgu).** Dorota Kujawska. *Technika Lotnicza i Astronautyczna,* vol. 25, Aug. 1970, p. 22-24. In Polish.

Discussion of trends in the growth of long-range air transport routes, with an attempt at predicting the resulting modifications to equipment and expenditures. About 70 per cent of the available passenger kilometers in 1975 will be in long-range routes, while about 73 per cent is expected for 1990. Supersonic and jumbo-jet transports will account for 55 per cent of aircraft in 1975 and 83 per cent in 1990. Hypersonic jets can be expected in service in the 1980s. It is stressed that these growth trends should be a convincing factor for immediate Polish long range route development, since further delay will require the acquisition of much more expensive equipment. T.M.

A70-43573 **The role of materials in flight propulsion systems.** E. F. Bradley and M. J. Donachie, Jr. (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Journal of Metals,* vol. 22, Oct. 1970, p. 25-30.

Discussion of material problems in aircraft engines with turbine inlet gas temperatures of 2300 F and higher. In order to assess the role of materials in flight propulsion systems, the parameters which affect engine performance are considered, together with factors involved in material selection. In addition, component applications and available materials are tabulated. A detailed consideration is given to each of the major constituent areas of the turbine including fan-compressor, augmenter/combustor, and turbine sections. The

requirements concerning new materials and improved properties, connected with continued advances in the gas-turbine technology during this new decade, are assessed. Z.W.

A70-43574 Current research on the surface protection of superalloys for gas turbine engines. G. W. Goward (United Aircraft Advanced Materials Research and Development Laboratory, Middletown, Conn.). *Journal of Metals,* vol. 22, Oct. 1970, p. 31-39. 15 refs.

Description of the current understanding of the mechanisms of surface degradation, and discussion of recent research leading to more resistant materials for gas turbine engines. Three major factors contributing to the surface degradation of turbine materials, including hot oxidation, thermal fluctuations, and hot corrosion, are discussed, and their interaction is examined. The chemical compositions of superalloys used for gas turbines are tabulated. The enhanced oxidation resistance gained by Al2O3 formation on the surface of alloys under both isothermal and so-called rig oxidation-erosion conditions is demonstrated. It is found that minor additions of chromium allow external Al2O3 scales to form at much lower concentrations of aluminum than required for the binary Ni-Al systems. The cyclic oxidation performance of an Al2O3-forming nickel alloy can be enhanced by improving the adherence of the oxide. This is achieved by minor modifications of alloy chemistry. The mechanism of hot corrosion by interaction of molten sulfates is described. The effect of different elements on the hot corrosion is discussed. Protective coatings composed mainly of aluminum for providing a reservoir of this element on the alloy surface are described. Z.W.

A70-43584 Calculation of radar reflecting properties of jet engine intakes using a waveguide model. John W. Moll (Department of Supply, Control Studies Establishment, Canberra, Australia) and Rolf G. Seecamp (Bureau of Meteorology, Melbourne, Australia). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-6, Sept. 1970, p. 675-683. 5 refs.

In the RCS analysis of jet aircraft, the engine intake and exhaust ducts present special problems which have not been widely discussed in the literature. In this paper an idealized example of a subsonic type of intake duct is chosen as an example for analysis. The idealization of the intake consists of a terminated circular waveguide, the termination being designed to represent the first stages of the jet engine. Examples of theoretical RCS and glint patterns predicted with this model are given, showing the phenomenon of compressor modulation and the effects obtained with changes in wavelength and receiver-transmitter geometry. (Author)

A70-43650 # Balloon platforms. Thomas W. Kelly (USAF, Cambridge Research Laboratories, Bedford, Mass.). In: International Academy of Astronautics, Orbital International Laboratory and Space Sciences Conference, Cloudcroft, N. Mex., September 28-October 2, 1969, Proceedings. Edited by J. P. Stapp, H. J. von Beckh, J. N. Howard, and E. A. Steinhoff. Holloman AFB, N. Mex., AFMDC, Publishing Management Branch, 1970, p. 354-371. 7 refs.

Discussion of the extent of the current use of plastic balloons and of the actual capabilities of today's balloon platforms. It is pointed out that current scientific uses of the constant-altitude type balloon cover a wide range of disciplines and applications including studies of atmospheric particulate matter, global wind fields, earth albedo, stratospheric tidal effects, composition of planetary atmospheres, solar activity and structure and high energy particles. Engineering applications related to the functional test of equipment account for nearly 50% of all balloon flights. Design and use of the two types of zero pressure balloons, unreinforced polyethylene and reinforced Mylar balloons are discussed. An outlook on new developments in balloon design to meet the exacting requirements of special investigations and applications is given. G.R.

A70-43656 Advances in dynamic gravimetry; Proceedings of the Symposium on Dynamic Gravimetry, Fort Worth, Tex., March 16, 17, 1970. Edited by W. T. Kattner (General Dynamics Corp., Fort Worth, Tex.). Pittsburgh, Instrument Society of America, 1970. 178 p. $10.00.

Contents:

Foreword. G. C. Henderson and W. T. Kattner (General Dynamics Corp., Fort Worth, Tex.). 2 p.

Dynamic gravity meters.

A gradiometer system for gravity anomaly surveying. M. B. Trageser (MIT, Cambridge, Mass.), p. 1-35. 7 refs.

Error sources in a dynamic gravimeter. P. L. Klingemeir (Bell Aerospace Co., Buffalo, N.Y.), M. A. Meldrum, and E. H. Metzger, p. 36-47.

New developments in gravity gradiometry. P. H. Savet (Grumman Aerospace Corp., Bethpage, N.Y.), p. 48-58. 10 refs.

Navigation instrumentation and operations.

Navigation requirements for dynamic gravimetry by means of gradient measurements. D. Anthony (USAF, Terrestrial Sciences Laboratory, Bedford, Mass.), p. 59-64.

Integrated marine navigation systems. D. R. Reinhartsen (ITT Aerospace, New York, N.Y.), p. 65, 66.

Radiolocation systems for dynamic gravimetry. J. T. Bradbury (Teledyne, Inc., Hastings-Raydist Div., Hampton, Va.), p. 67-74.

Altimetry/bathymetry.

Gravimetric error associated with rapid movement parallel to an undulating geoid. D. Greenewalt (U.S. Navy, Naval Research Laboratory, Washin ton, D.C.), p. 75-78.

Helicopter gravity measuring system. W. R. Gumert and G. E. Cobb (U.S. Army, Topographic Command, Washington, D.C.), p. 79-85.

Reduction techniques.

Some remarks on downward continuation of gravity. E. Groten (München, Technische Hochschule, Munich, West Germany), p. 86-94. 17 refs.

Identification of vertical deflections utilizing an inertial navigator and optimum data processing. C. L. Bradley (Analytic Sciences Corp., Reading, Mass.), p. 95-104. 13 refs.

Methodology of a probabilistic error analysis in airborne gravimetry. P. Meissl, p. 105-110. 13 refs.

Reformulation of the geodetic boundary value problem in view of the results of geometric satellite geodesy. K.-R. Koch (U.S. Coast and Geodetic Survey, Rockville, Md.), p. 111-114. 7 refs.

Applications.

Simulated terrain mapping with the rotating gravity gradiometer. C. C. Bell, R. L. Forward (Hughes Research Laboratories, Malibu, Calif.), and H. P. Williams (NASA, Huntsville, Ala.), p. 115-129. 45 refs.

Application of space and astronomic techniques to solid earth and ocean physics. W. M. Kaula (California, University, Los Angeles, Calif.), p. 130-135. 17 refs.

Development accomplished in the sixties destined for improving the seagravimeter Gss 2. A. Graf (München, Technische Hochschule, Lochham, West Germany), p. 136-141.

The new Askania seagravimeter Gss 3. H. D. Jacoby (Askania GmbH, Berlin, West Germany), p. 142-145.

Author index, p. 172.

A70-43661 **Radiolocation systems for dynamic gravimetry.** Joseph T. Bradbury (Teledyne, Inc., Hastings-Raydist Div., Hampton, Va.). In: Advances in dynamic gravimetry; Proceedings of the Symposium on Dynamic Gravimetry, Fort Worth, Tex., March 16, 17, 1970. Edited by W. T. Kattner. Pittsburgh, Instrument Society of America, 1970, p. 67-73; Discussion, p. 74.

Description of some of the present day radiolocation systems, including the DR-S Raydist, the newest and the most versatile form of radiolocation systems utilized in fixed-wing aircraft. The occasions where the system was used are cited, and the operating ranges achieved are defined. The simplicity of transferring the base stations from place to place, and other factors of interest are discussed. The variety of automatic accessories available with this system are described, including an automatic printer capable of recording position simultaneously with other data, an automatic track plotter whereby preplotted tracks may be navigated, and a number of other interesting accessories which are presently being evaluated for field use. Z.W.

A70-43662 **Gravimetric error associated with rapid movement parallel to an undulating geoid.** David Greenewalt (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Advances in dynamic gravimetry; Proceedings of the Symposium on Dynamic Gravimetry, Fort Worth, Tex., March 16, 17, 1970. Edited by W. T. Kattner. Pittsburgh, Instrument Society of America, 1970, p. 75-77; Discussion, p. 77, 78. Navy-supported research.

Gravity measurement made from a high speed aircraft flying parallel to an undulating geoid will be influenced by vertical accelerations associated with those undulations. Such accelerations will be a significant fraction of the associated gravity anomalies when the latter are elongate and less than 100 km in the shorter dimension, and when aircraft velocity is parallel to that short dimension and greater than about 200 kts. It also appears that when part of the geoid undulation can be represented by a sine function, there will be a certain aircraft velocity-altitude combination for which the vertical acceleration will exactly cancel that part of the associated gravity anomaly. Thus at a given velocity and altitude, a component of gravity variation will be undetectable. (Author)

A70-43663 **Helicopter gravity measuring system.** William R. Gumert and Glen E. Cobb (U.S. Army, Topographic Command, Washington, D.C.). In: Advances in dynamic gravimetry; Proceedings of the Symposium on Dynamic Gravimetry, Fort Worth, Tex., March 16, 17, 1970. Edited by W. T. Kattner. Pittsburgh, Instrument Society of America, 1970, p. 79-84; Discussion, p. 84, 85.

Description of the development of an efficient integrated helicopter gravity measuring system and its testing under a variety of operating conditions. This system consists of a stable-platform gravity meter, a laser altimeter, a pressure port calibrator, a 35-mm strip camera or IR scanner, a HIRAN navigational system, a digital logger, and the necessary interface and analog recording monitors. This system was installed in November 1968 in a helicopter. Approximately 100 flight hours were performed over a 2-1/2 month period. Three blocks of data were given special attention: rolling terrain, a continental slope area, and a rugged region in the Appalachians around Luray Caverns. Z.W.

A70-43666 **Methodology of a probabilistic error analysis in airborne gravimetry.** P. Meissl. In: Advances in dynamic gravimetry; Proceedings of the Symposium on Dynamic Gravimetry, Fort Worth, Tex., March 16, 17, 1970. Edited by W. T. Kattner. Pittsburgh, Instrument Society of America, 1970, p. 105-110; Discussion, p. 110. 13 refs. Contract No. AF 19(628)-69-C-0127.

This paper deals with airborne gravimetry using gravity sensing instruments at flight speeds of about 400 knots. The most important error sources not inherent in the gravimeter are the vertical acceleration errors and the errors in the Eotvos correction, caused by imprecise velocity and azimuth information. These errors make it impossible to obtain meaningful point gravity values and necessitate heavy filtering and smoothing. In order to get a better insight into the whole problem, and to allow a better judgment of what filtering methods are appropriate and what mean values are representative, it was felt desirable to set up a probabilistic model which utilizes some of the basic concepts of stationary stochastic processes. The model is outlined and illustrated by a numerical example. (Author)

A70-43731 **A simulation for a short takeoff and landing system traffic analysis.** Alan B. Newman (Grumman Aerospace Corp., Bethpage, N.Y.). *IEEE Transactions on Systems Science and Cybernetics,* vol. SSC-6, July 1970, p. 162-172. 10 refs.

Description of a model which has been developed to simulate an urban short takeoff and landing (STOL) system. The model was designed as a tool for the evaluation of flight hardware and also to provide insight into the specialized nature of an urban transportation system such as the one envisioned for the Northeast Corridor. The actions of aircraft are treated in the high level of detail characteristic of an urban shuttle system with its constraints and limitations. The aspects considered are: (1) variable passenger demands, (2) dispatching decisions, (3) takeoff and airspace regulations, (4) variations in interfering aircraft traffic, and (5) off-corridor services. The implementation allows for simulation and analysis of aircraft and passenger movements and the consequent interactions. Output is generated in terms of the realistic and useful figures of cost, revenue, and system performance needed to evaluate each phase of the STOL operation. The model was written in the general purpose simulation system language. M.M.

A70-43737 # **A linear theory of a jet-flapped airfoil in a jet stream with fully developed wake.** Teruhiko Kida (Osaka Prefecture, University, Sakai, Japan) and Takanori Take (Shiga Prefectural Junior College, Japan). *JSME, Bulletin,* vol. 13, Aug. 1970, p. 987-995. 11 refs.

Investigation of the effect of a free jet stream on a thin, jet-flapped airfoil with fully developed wake by using a linear theory based on the Tulin's linear theory and the Spence's thin jet theory. The basic relation is expressed as a linear integro-differential equation for the slope of the jet. The solution of this equation is expressed as a sum of a Fourier series together with the function including the logarithmic singular term. The results indicate that if the airfoil exists in the jet stream, the lift coefficient decreases as the width of the jet stream becomes narrow; if, however, the airfoil exists beneath the free surface, the lift coefficient increases as the distance from the free surface becomes small. O.H.

A70-43741 # **The break-up of a liquid droplet due to aerodynamic forces (Die Zerstörung eines Flüssigkeitstropfens aufgrund von aerodynamischen Kräften).** Wolfgang Körner. Karlsruhe, Universität, Fakultät für Naturwissenschaften, Doktor der Naturwissenschaften Dissertation, 1969. 102 p. 46 refs. In German.

A droplet with low viscosity of a liquid is suddenly exposed to a gaseous jet with high relative velocity. The droplet is destroyed due to both the shear stress and the normal stress exerted by the jet flowing past the droplet. By use of suitable model concepts and simplifying assumptions, solutions are derived for the fluid flow in the vicinity of the symmetry axis of the droplet and in the coupled liquid and gaseous boundary layers at the droplet's front face. Deformation and mass loss of the droplet are determined from the

liquid flow fields. Finally, a comparison is presented of pertinent experimental data taken from the literature and of numerical evaluations of the theory outlined in this paper. (Author)

A70-43869 **The development and presentation of technical evidence in products liability litigation.** Gordon R. Close (Lord, Bissell and Brook, Chicago, Ill.). *(American Society for Testing and Materials, Chicago District Council Meeting, Marquette University, Milwaukee, Wis., May 2, 1970.) Materials Research and Standards,* vol. 10, Oct. 1970, p. 8-12.

Discussion of legal criteria for the guidance of expert witnesses in the presentation of technical evidence before a jury in tort liability cases involving products. Changes in product liability legislation and the concept of strict liability in tort are discussed, together with criteria for presenting technical evidence to a jury of laymen. M.M.

A70-43887 **Passenger seaplanes and their bases.** R. A. Bell (Ministry of Transport, London, England). *Aeronautical Journal,* vol. 74, Sept. 1970, p. 703-717. 17 refs.

Attempt to analyze the virtues and drawbacks of passenger seaplanes. The past of the seaplane is reviewed from its inception to shortly after World War II, when its popularity and utility began to decline with the development of long-range landplanes. Some typical seaplane bases which were either in the planning stage or had actually been constructed are described and evaluated. A main difficulty was that the conveyance of passengers and luggage to and from seaplanes was clumsy and awkward. Servicing, refueling, and water handling were major problems. It is considered that the future of the seaplane lies mainly with the private user. F.R.L.

A70-43888 **Instruments and electronics in aviation (Twenty-Third Louis Blériot Memorial Lecture).** Sebastian de Ferranti (Ferranti, Ltd., Hollinwood, Lancs., England). *Aeronautical Journal,* vol. 74, Sept. 1970, p. 718-723.

Review of the history of electronics and instrumentation in aviation, with discussion of the reasons for their development, i.e., accomplishment of all-weather flight, blind landings and takeoffs, avoidance of obstacles, etc. The earliest instruments were the anemometer and the barometric altimeter, proceeding by stages to development of radar sophisticated navigation and radio-communications systems, computers, data processing, and flying control. F.R.L.

A70-43890 **On the rolling up of a trailing vortex sheet.** G. J. Hancock (Queen Mary College, London, England). *Aeronautical Journal,* vol. 74, Sept. 1970, p. 749-752. 7 refs.

Discussion of a continuous trailing vortex sheet, assuming that the sheet rolls up into two discrete vortices. These two discrete vortices are assumed to have cores of finite radius; inside the cores the flow is taken to be solid body rotation, while the flow outside the cores is the standard irrotational vortex field. An attempt is made to provide insight into the understanding of the conditions which limit wing lift, especially with reference to blown high-lift devices. F.R.L.

A70-43893 **The terminal forces acting on a light trailing wire.** P. R. Payne (Wyle Laboratories, Inc., Rockville, Md.). *Aeronautical Journal,* vol. 74, Sept. 1970, p. 759-761.

Use of Glauert's equations (1930, 1934) to obtain numerical results for a trailing wire shape which is of interest for trailing antennas, and the steady-state aerodynamic forces which act upon the aircraft. Computer solutions taking cable weight into account have indicated that the results for a weightless cable are realistic for many cases. For long wires it appears that most of the terminal weight is carried by aerodynamic forces on the wire, rather than by the aircraft, and that the total wire drag is much less than would be calculated for an equivalent vertical wire having the same vertical separation between aircraft and the terminal weight. F.R.L.

A70-43895 **Russian helicopters.** F. W. Free (British European Airways Corp., Ruislip, Middx., England). *(Royal Aeronautical Society, Half-Day Symposium, London, England, Mar. 11, 1970.) Aeronautical Journal,* vol. 74, Sept. 1970, p. 767-784; Discussion, C. Stammers (Westland Aircraft, Ltd., Yeovil, Somerset, England), M. C. Ginn (Westland Helicopters, Ltd., Yeovil, Somerset, England), R. C. Webb, and H. E. Le Sueur, p. 785.

Review of the historical development of the helicopter in Russia and the technical characteristics of the current types in service. The various types of Russian helicopters developed since World War II are briefly described and characterized. Particular attention is given to Mi-8 and Mi-2 helicopters, which are described in detail in terms of their configuration, performance and handling, all weather operation, airframe, rotor and transmission system, engines, systems and equipment, and servicing and maintenance. In addition, the Ka-26 and Mi-10K helicopters are also discussed in some detail. O.H.

A70-43940 # **Statistical estimation of heat-resistance characteristics of materials for gas-turbine engines (Statisticheskaia otsenka kharakteristik zharoprochnosti materialov dlia gazoturbinnykh dvigatelei).** I. P. Bulygin, V. M. Doronin, I. I. Zakharov, V. A. Zubrilova, N. I. Parfenova, R. N. Sizova, L. N. Timofeeva, and I. I. Trunin (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Materialovedeniia, Moscow, USSR). *Problemy Prochnosti,* vol. 2, July 1970, p. 75-81. In Russian.

Determination of the average value and scatter in the durability data of two heat-resistant alloys, on the basis of a large number of long-term strength tests. The alloys were selected from a series of melts. It is shown that it is possible to accurately determine durability data and its scatter for an alloy on the basis of results obtained from three or four melts whose characteristics are selected with allowance for a typical combination of durabilities of melts in mass production. Z.W.

A70-43941 # **Experimental investigation of the carrying capacity of disk models of natural gas blowers (Eksperimental'noe issledovanie nesushchei sposobnosti modelei koles nagnetatelei prirodnogo gaza).** Ia. M. Gusak and O. M. Chebotarev. *Problemy Prochnosti,* vol. 2, July 1970, p. 86-93. In Russian.

Description of the techniques and results obtained from start-up testing of wheel models of gas blowers of different designs. The strain behavior of the closing and carrying disks, blades, and rivets was investigated, together with their interaction during plastic strain. A comparison is made of the specific carrying capacity of disks of different designs. Z.W.

A70-43968 # **Scattering of aerodynamic noise by a semi-infinite compliant plate.** D. G. Crighton and F. G. Leppington (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 43, Oct. 2, 1970, p. 721-736. 13 refs. Research supported by the Ministry of Technology.

Investigation of the acoustic scattering properties of a semi-infinite compliant plate immersed in turbulent flow in the context of Lighthill's theory of aerodynamic noise. The turbulent eddies are replaced by a volume distribution of quadrupoles, and the reciprocal theorem is used to transform the quadrupole scattering problem into

one of the diffraction of a plane acoustic wave. This problem is solved by the Wiener-Hopf technique for the case when elastic forces in the plate are negligible, so that a local impedance condition relates the plate velocity to the pressure difference across the plate. Strong scattering of the near-field into propagating sound occurs when certain types of quadrupole lie sufficiently close to the plate edge, and explicit expressions for the scattered fields are derived in various cases. When fluid loading effects are small, and the plate relatively rigid, the results of Ffowes Williams & Hall (1970) are recovered, in particular the U5 law for radiated intensity. A quite different behavior is found in the case of high fluid loading, when the plate appears to be relatively limp. The radiated intensity then increases with flow velocity U according to a U6 law. In aeronautical situations, surface compliance is negligible in its effect on the scattering process, and the U5 law must then apply provided the surface is sufficiently large. M.M.

A70-43970 # **Similarity rules for thin aerofoils in non-stationary subsonic flows.** J. M. R. Graham (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics,* vol. 43, Oct. 2, 1970, p. 753-766. 12 refs.

Similarity rules are constructed for the load distributions induced on a thin two-dimensional wing at subsonic speeds by sinusoidal gusts whose wave fronts are at an angle to the leading edge of the wing. It is shown that these rules divide into two groups according to the value of a parameter dependent on the Mach number and the angle between the gust front and the wing. The similarity rules for each group relate all the members of the group to a simpler problem whose solution can be found by existing methods. The similarity between the two groups is also discussed in terms of the two methods of solution available and it is shown that each method of solution is applicable in all cases. (Author)

A70-43992 # **The opening force of solid cloth, personnel type parachutes.** Rudi J. Berndt and James H. DeWeese (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1167.* 12 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Analysis of the opening forces developed by solid cloth, personnel parachutes of the standard types C-9 and T-10. Test data acquired during experimental tests with 28-ft outer-diameter flat circular and 35-ft outer-diameter 10% extended skirt type canopies deployed at velocities up to 500 ft/sec true airspeed and at altitudes up to 21,900 ft form the basis for the analysis. Type C-9 canopies, incorporating two different material combinations, were deployed over a wide range of flight path angles and under three different canopy loading conditions. The type T-10 canopy was deployed along a near-horizontal flight path and under a single canopy loading. The results show that two distinct force peaks are generated during the filling process. An initial force peak is developed midway through the inflation cycle. In the case of the canopy type T-10, the initial force is also the maximum force generated during opening. For both canopy types, the magnitude of the initial force is a power function of the true velocity at time of snatch. The canopy type C-9 develops a final force peak which, for the majority of the experimental test conditions, represents the maximum opening force. Its timewise occurrence is just prior to the end of the parachute filling period. The value of the opening shock parameter is shown to be most sensitive to variations in mass ratio but also affected by the Froude Number of operation and by the elasticity of the parachute system. A quasi-empirical approach for the approximation of the maximum opening force of the type C-9 canopy is developed which considers all influencing parameters. (Author)

A70-43993 * # **An investigation of parachute opening loads, and a new engineering method for their determination.** A. J. McEwan (Northrop Corp., Northrop Ventura Div., Newbury Park, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1168.* 11 p. 19 refs. Members, $1.25; nonmembers, $2.00. Contract No. NAS 9-8131.

Progress has been made in the development of a trajectory and opening load prediction method based on the distance-dependency of the parachute inflation process and the inclusion of added mass. The primary assumptions and governing equations, and their evolutions, are presented. Parachute drag area during inflation is determined as a function of the distance the canopy has traveled since the beginning of inflation. Ewing's approach of determining added mass as a function of drag area is used. The method is applied to the clustered Apollo main parachutes, with reefing, for which the estimation of the empirical parameters is discussed. Added mass is neglected in the two reefed stages. Comparisons of calculations with test data show that the method is quite accurate for single and clustered parachute tests, although further work is required in parameter determination for the full open stage in cluster tests. It is concluded that the method is useful as an engineering tool. (Author)

A70-44016 **Life with the boom. I.** *Flight International,* vol. 98, Oct. 1, 1970, p. 519, 520, 526, 526a.

Description of the characteristics of sonic boom expected from SST overflights, and assessment of possible disturbances to man. Overpressure characteristics, rise times, and durations of Concorde sonic booms are examined, and research on effects on the ground is reviewed. Interference to normal sleep is analyzed, and possible disturbances to work habits are studied. T.M.

A70-44017 **Canadian-accented V/Stol.** *Flight International,* vol. 98, Oct. 1, 1970, p. 534-538.

Description of the flight characteristics and structural design of Canadair's CL-84 V/STOL aircraft. The aircraft uses a tilt-wing design with two propellers and a third tail rotor employed in the V/STOL phase. The aircraft's wing is hinged at its 45% chord station and is rotated by a hydraulic ball screw actuator. In the event of engine failure, the dead engine is automatically declutched and the propellers share the remaining engine. T.M.

A70-44033 * # **Airborne observations of contrail effects on the thermal radiation budget.** Peter M. Kuhn (ESSA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Journal of the Atmospheric Sciences,* vol. 27, Sept. 1970, p. 937-942. 8 refs. ESSA-NASA-sponsored research.

Direct infrared and solar radiometric observations were made to analyze the effects on the environment of any alterations in the radiation budget in regions of heavy jet traffic. The observations, made from the NASA Convair 990 jet laboratory, were coupled with Mie scattering and absorption theory calculations to analyze any inadvertent alterations in the natural atmospheric thermal radiation budget. It was found that a 500 m thick contrail sheet increases the infrared emission below the sheet by 21% but decreases the solar power below the sheet by 15%. The infrared increase cannot make up for the solar depletion, resulting in a net available incoming power depletion at the base of the sheet of 12%. Such a change at altitude results in a 7% reduction in the net total available thermal power at the earth' surface, which, in turn, results in a 5.3 C decrease in the surface temperature, if we assume contrail persistence. The actual temperature decrease is approximately 0.15 C with 5% contrail persistence. (Author)

A70-44095 **Armor used as airframe for helicopter.** Cecil Brownlow. *Aviation Week and Space Technology,* vol. 93, Oct. 12, 1970, p. 65-68.

Brief description of a Sikorsky-proposed two-man helicopter to be employed as an aerial armored reconnaissance vehicle (AARV) with an armor plate integrated into its basic airframe structure. The helicopter is proposed as an advanced follow-on to the present generation of Army light observation helicopters. The AARV has a fuselage length of 25.4 ft, a fuselage width of 4.5 ft, a fuselage height of 5.4 ft, and a rotor diameter of 35.4 ft. The half-inch-thick dual-hardness steel armor plating would represent roughly 1,800 lb of the helicopter's maximum gross weight of 6,800 lb. Army-developed transparent armor plating will be used for the window sections of the craft. The merits of the AARV design and fabrication are discussed. V.Z.

A70-44097 **Modern problems of propeller theory (Moderne Probleme der Propellertheorie).** W.-H. Isay (Hamburg Universität, Hamburg, West Germany). Berlin, Springer-Verlag, 1970. 222 p. 126 refs. In German. $16.

This book discusses the advances made in the field of propeller theory during the last six years. It is assumed that the reader is familiar with an earlier book by Isay with the title 'Propeller Theory, Hydrodynamical Problems' (1964). Aspects of the wing theory for propellers are discussed and a number of problems regarding the theory of propellers are investigated. Helicopter rotors are considered giving attention to aerodynamic and mechanical problems and to simplified methods for treating general flow conditions at a helicopter rotor. Questions of oblique flow involving a ship's propellers are examined. Propellers with vertical axis such as the Voith-Schneider propeller are considered. G.R.

A70-44098 **Theoretical magnetofluiddynamics.** Henri Cabannes (Paris, Université, Faculté des Sciences, Paris, France). (Translation of Magnetodynamique des Fluides /2nd Edition/, Paris, Centre de Documentation Universitaire, 1969.) New York, Academic Press, Inc. (Applied Mathematics and Mechanics. Volume 13), 1970. 244 p. 74 refs. $12.50.

A review of the magnetodynamics of fluids, defined as that discipline which attempts to study the interaction between magnetic fields and electrically conducting fluids, is offered to electrodynamicists and aerodynamicists. The course deals with the fundamental results relating to new laws and to new qualitative effects which appear during the interaction of a conducting medium with a magnetic field. Particular attention has been given to a study of the exact solutions of the equations of the magnetodynamics of fluids. The equations are established in a detailed way, for the case of continuous motions, as well as for the case of motions with shock waves. Attention is given to a study of various types of discontinuities. Rectilinear flows, flows in pipes and nozzles, and the structure of shock waves are studied. The work concludes with an examination of flows past plates, spheres, and thin foils. F.R.L.

A70-44099 # **Pilot, attention - Birds (Letchik, vnimanie - Ptitsy).** V. S. Lavrik, I. F. Rubtsov, and E. A. Shersher. Moscow, Voennoe Izdatel'stvo Ministerstva Oborony SSSR, 1970. 103 p. 39 refs. In Russian.

This pamphlet discusses the hazard of collisions between aircraft and birds. Accidents caused by such collisions in the Soviet Union and abroad are cited. The damage and the physical effects produced by collisions with birds are discussed. The measures for preventing such collisions are indicated. A listing of 704 bird species common in the Soviet Union is given, with descriptions of birds and their habits. Procedures for proving the fact of a collision with birds and for determining the damage are outlined. The measures taken in the USA against bird collision hazards are also noted. V.Z.

A70-44101 # **Load sequences for fatigue testing of components and full-scale aircraft structures.** J. Schijve (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-32.* 11 p. 45 refs.

Survey of fatigue testing methods and testing purposes for aircraft structures and components. Relevant test data regarding the effects of load sequences in frequently occurring high loads and large numbers of low-amplitude cycles are briefly described. The question whether the various testing methods can meet specific testing purposes is examined. A suggestion is made for exploring the usefulness of random flight-simulation tests for making life estimates in the design stage of an aircraft. M.M.

A70-44102 # **The monitoring of fatigue loads.** J. B. de Jonge (National Luchtvaartlaboratorium, Amsterdam, Netherlands). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-31.* 10 p.

To assess the consumed fatigue life of an aircraft structure, knowledge of the actual load experience of that structure is essential. Methods and techniques for monitoring structural loads are analyzed and discussed. An accurate measure of structural loads can be obtained by means of strain gages installed in critical areas of the aircraft structure. At the NLR, a strain-gage monitoring system is being developed of such simplicity that it can be installed in all aircraft of a fleet. A description of this system is given, and special reference is made to the 'counting technique' applied to evaluate the recorded loads. (Author)

A70-44103 # **An experimental investigation on wing box beams in bending.** E. Antona and G. Gabrielli (Torino, Politecnico, Turin, Italy). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-33.* 15 p. 12 refs. Research sponsored by the Consiglio Nazionale delle Ricerche.

The behavior of typical wing box beams in bending at increasing load levels up to failure is investigated by testing a set of specimens formed by two spars, two longitudinally stiffened flat panels and a few intermediate bulkheads varying in number from one to three. The panels are of two types, one with riveted extruded stiffeners, and another with integral stiffeners. The effects of crushing pressure, bulkhead flexural deformations and structure initial imperfections are particularly emphasized. The experimental results indicate that such effects are remarkable for the structures under investigation. They cover deformation components which, with increasing load levels, induce local failure stresses in addition to instability phenomena. (Author)

A70-44104 # **Pressure field induced on a lifting surface by an isotropic atmospheric turbulence (Pression induite sur une surface portante par une turbulence atmosphérique isotrope).** G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-30.* 12 p. 5 refs. In French.

Discussion of the aerodynamic theory of a lifting surface and of the integral equation which relates the pressure field to the angle of attack of a wing. The solution of this integral equation is shown to give an approximate Green function of the problem. This provides a method for computing the cross power spectrum of the pressure field induced by an isotropic atmospheric turbulence, once the cross power spectrum of the vertical component of the turbulence is given. The method is not more complicated than the one which relies on the assumption of uniformity of turbulence in span. As an example, the transfer function of the CONCORDE to turbulence has been computed by both techniques. M.M.

A70-44105 # **Application of computer techniques to aircraft design problems.** Jiro Kondo (Tokyo, University, Tokyo, Japan). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-28.* 14 p. 17 refs. Research sponsored by the Ministry of International Trade and Industries.

Discussion of the application of computer methods to the fundamental research of a short haul jet transport aircraft. Three different computer programs are considered; CAD (Computer Aid Design), ALSS (Airline System Simulator), and TDP (Traffic Demand Predictor). The CAD program is shown to be primarily applicable to designing aircraft; airframe configuration, aerodynamic performances, propulsion systems, weight, cost of construction, operating cost and other characteristics can be readily obtained, and future technical advances can be taken into account. The influence of introducing new aircraft into an airline system can be studied by ALSS, which simulates the overall operation of the airline network. A mathematical model representing the passenger's behavior, and a new objective function reflecting the airline's policy, are presented. The TDP program can be used for considering the competition between the various means of surface transportation, so that the air traffic can be studied as a part of the total transportation system, and its volume in the future can be fairly well predicted. O.H.

A70-44106 # **Computer Aided Design in the aircraft industry.** H. P. Y. Hitch (British Aircraft Corp. /Weybridge/, Ltd., Weybridge, Surrey, England). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-27.* 10 p.

Computer Aided Design as an aid to the designer/draughtsman is discussed in this paper. Progress at BAC (Weybridge) on the preparation of a Data Bank holding the geometric description of piece parts is outlined. The means for capturing the data is described along with ideas as to how the data should be used downstream in the manufacturing areas. A graphics Visual Display Unit is an essential tool in the idea and some experiences with a General Purpose Visual Display Unit, in the general scientific computing environment, are described. (Author)

A70-44107 # **Some problems of aircraft control surfaces aerodynamics.** V. G. Mikeladze (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-26.* 8 p.

Aerodynamic characteristics of low-aspect-ratio wing elevons with variable-sweep leading edge as longitudinal and lateral controls are considered. An estimation method of elevon aerodynamic characteristics with the use of the reversibility theorem at subsonics and the linear theorem at supersonics is presented; a physical pattern of flow past a low-aspect-ratio wing with elevons extended to high angles by means of pressure distribution at subsonic, transonic and supersonic speeds is shown. The results of systematic analytical and experimental investigations of particular elevon parameters effect on their aerodynamic characteristics are given. (Author)

A70-44108 # **Downwash at unsteady motion of a small aeroplane at low airspeeds - Flight investigation and analysis.** V. Kočka (Výzkumný a Zkušební Letecký Ústav, Prague, Czechoslovakia). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-25.* 17 p. 22 refs.

Measurements of the downwash were carried out on a small A 145 transport aeroplane not only at rectilinear steady flights but also at unsteady flights. The method of measuring the local downwash angle by means of vanes in front of the horizontal tailplane was supplemented by the determination of the effective downwash angle from the directly measured forces on the horizontal tailplane. There were applied identification methods and statistical tests of significance to judge the suitability of the mathematical models used. The value of the downwash angle derivative measured at unsteady flights was significantly lower than that measured at steady flights. These phenomena have been analysed and a simple method of estimation of a weighted effective value of the downwash angle derivative has been proposed. (Author)

A70-44109 # **Stability augmentation in aircraft design.** F. O'Hara (Royal Aircraft Establishment, Bedford, England). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-24.* 15 p. 14 refs.

A review is made of the use of stability augmentation in aircraft design, particularly from the point of view of potential benefits for aircraft handling and operation. The use of simple systems and of advanced control techniques are discussed, for both pilot and autopilot modes of flight, and for both conventional and VTOL aircraft. Possible performance gains with artificial stabilisation are considered, and the application of autocontrol techniques to load limitation is touched on. (Author)

A70-44110 * # **Practical aspects of sonic boom problems.** Antonio Ferri (New York University, Bronx, N.Y.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-23.* 10 p. 15 refs. Grant No. NGL-33-016-119.

Investigation of SST configurations selected from the standpoint of minimizing sonic booms. It is indicated that for a total length of 300 ft and total initial weight of the same order as the present U.S. SST designs, sonic booms having shock pressure rise of the order of 0.6 lb/sq ft can be obtained. Values as low as 0.3 are possible for aircraft designed for cross-country flights. (Author)

A70-44111 # **Experimental methods of the analysis of noise sources in compressors and jets (Méthodes expérimentales d'analyse des sources de bruit des compresseurs et des jets).** J. Taillet (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-22.* 12 p. 25 refs. In French.

Discussion of methods for the study of noise sources in aircraft taking into account tests at compressors involving dynamic pressure measuring devices and turbulence investigations for jets. The smallest devices for the determination of pressure described are microphones with electrets of 5 mm diam and a thickness of 1.5 mm. The devices considered make it possible to determine fluctuating pressure distributions and thermal convection. The analysis of the turbulence for the jets is based on the study of spatial-temporal relations of the IR radiation of the jet. G.R.

A70-44112 # **Investigations regarding the reduction of the noise from jets (Recherches sur l'atténuation du bruit de jets).** G. Richter (SNECMA, Moissy, Seine-et-Marne, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-21.* 11 p. In French.

Study of measures for reducing the noise from jet aircraft giving attention to a device which is only effective during flight near the ground and does not interfere with the jet when cruising altitudes are reached. The noise sources in jet aircraft are investigated and the effects of devices for reducing the noise are studied. The effects of these devices on the jet structure are explored. The determination of the intensity of IR radiation is discussed. It is found that turbulence fluctuations in the jet represent predominant noise sources. Devices for reducing noise are, therefore, generally directed toward a reduction of the noise from this turbulence. G.R.

A70-44113 # **The influence of near-field flow on the sonic boom.** K. Oswatitsch and Y. C. Sun (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für theoretische Gasdynamik, Aachen, West Germany). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-20.* 15 p. 10 refs.

The influence of near-field flow on sonic boom has been studied for an incident triangular wing with constant lift distribution. Confined in its scope to the front shock of the wing, the present analysis reveals nevertheless features of flow important for sonic boom prediction which cannot be adequately described by the theory of Whitham in its prevalent form. Moreover, the present analysis points to limitations of the usual approximation procedure in sonic boom study and indicates some practical possibilities to influence the sonic boom in addition. (Author)

A70-44114 # **The evolution of handling qualities requirements.** F. C. Haus. *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-19.* 14 p. 12 refs.

Discussion of various stages leading to the establishment of specifications and definitions of the handling qualities of aircraft. It is noted that handling qualities should be expressed in engineering terms. Early assessments of handling qualities were based on measurements made during elementary evolutions. Inspection of the block diagram covering the loop pilot-control system-aircraft shows that the evolution of handling qualities requires consideration of many factors, one of the most important being the pilot's work load. The modern study of handling qualities is made in two different ways. One of them is experimental, using assessment by the test pilot and trying to correlate the pilot rating with engineering data. The other method is theoretical. It is based on the inspection of the transfer functions of all the elements of the block diagram and tries to use these transfer functions to evaluate the ease or difficulty of piloting an aircraft. The two methods are complementary. M.M.

A70-44115 # **Comparison of heat transfer measurements in free flight and in a wind tunnel at M = 7 at similar Reynolds numbers and temperature ratios.** Bo Lemcke (Ministry of Defence, Aeronautical Research Institute, Bromma, Sweden), Alan Naysmith, John Picken (Royal Aircraft Establishment, Farnborough, Hants., England), and Hans Thomann (Eidgenössische Technische Hochschule, Zurich, Switzerland). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-06.* 10 p. 9 refs.

Comparison between tunnel tests and free flight heat transfer data. A free flight model consisting of a paraboloid of revolution was designed and built in England. Prior to the flight from the Woomera range in Australia it was tested in the hypersonic tunnel Hyp 500 in Sweden. At M = 7.17 it was possible to simulate Reynolds number and cooling ratio. As the same model and the same instrumentation were used in both cases, nearly perfect aerodynamic simulation was possible. The heat transfer results from the two experiments are in close agreement with theoretical predictions for laminar and turbulent boundary layers. The transition Reynolds number in flight was lower than in the wind tunnel. There are indications that vibrations from the rocket motor affected transition in flight. The transition Reynolds number varied during flight in a way that suggests that the boundary layer was affected considerably by changes in angel of incidence. No comparable effect was detected during the wind tunnel tests. M.M.

A70-44117 # **Experimental and theoretical investigations of different configurations of lifting re-entry vehicles in hypersonic low density flow.** G. Koppenwallner and W. Wuest (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-03.* 11 p. 13 refs.

Pressure distribution, force and heat transfer measurements on different lifting reentry vehicles (blunted half-elliptical cones, delta wing, cylindrical cone) are reported. The measurements which included also the hinge moments of control surfaces, have been done in the hypersonic low density wind tunnel of the Aerodynamische Versuchsanstalt Göttingen in the Mach number range from 8 to 22 and Reynolds number range 10,000 to 40,000. The experimental results are compared with calculations obtained by different methods. (Author)

A70-44119 # **On the use of slotted walls in two-dimensional testing of low-speed airfoils.** G. V. Parkinson (British Columbia, University, Vancouver, Canada) and A. K. Lim. *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-08.* 10 p. 5 refs. Defence Research Board of Canada Grant No. 9551-13.

Experiments are described in which two-dimensional tests were made on 2 sets of 4 airfoils of the same profile but different chord at the same Reynolds number in a low speed wind tunnel with two interchangeable walls. Airfoils of one set had a fixed slot plus a slotted flap at 45 deg. Lift, drag and pitching moment were measured through a full incidence range for several longitudinally slotted wall configurations, and for solid walls. Some of these configurations were used for testing the second airfoil set, of the same profile without slot or slotted flap. Comparisons are made with existing theories, and it is concluded that the theories applicable to slotted walls are inadequate. (Author)

A70-44120 # **High lift applications of spanwise blowing.** J. J. Cornish, III (Lockheed-Georgia Co., Marietta, Ga.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-09.* 12 p. 6 refs.

A method for increasing the lift of a wing or other aerodynamic lifting surface is described. The method employs a jet of air blown spanwise along the upper surface of the wing at approximately the quarter-chord line. The jet of air, due to its entrainment, acts like a line sink and carries away the flow which has separated from the leading edge of the wing and causes the flow to reattach to the after portion of the wing downstream of the jet. A strong vortex forms around the jet which effectively increases the aerodynamic camber of the wing/jet combination. The increased camber and the reattached flow allow increased lift coefficients to be developed on the wing. (Author)

A70-44123 # **Calculations of transonic flow.** Julian D. Cole (California, University, Los Angeles, Calif.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-12.* 10 p. 5 refs.

A brief survey is given of methods for calculation of plane transonic flow around airfoils. Two hodograph based methods for shock-free flows and two physical space methods for flow with shock waves are discussed. The last method which is a relaxation procedure for equations of mixed type is discussed in more detail. Comparison of the results of the different methods for shock-free cases is made. Some calculations are also presented for flows with shock waves. (Author)

A70-44125 # **Some problems and features of transonic aerodynamics.** H. H. Pearcey and J. Osborne, Sr. (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *International Council of the Aeronautical Sciences, Con-*

gress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-14. 16 p. 39 refs.

Consideration of the problems posed by the local coexistence of subsonic and supersonic flows (referred to collectively by the term 'transonic' flows) about various surface spots, edges, or parts of aircraft during flight. Transonic flows on swept wings, nacelle lips, and helicopter rotor blades are examined. Special attention is given to very small, leading edge regions of embedded supersonic flows. The so-called 'peaky flow' concept is developed with respect to accelerations and decelerations in local supersonic flows. Attention is drawn to some flows that are still little understood in spite of their practical importance. M.V.E.

A70-44126 # **Lifting aerofoils with supercritical shock-free flow.** J. W. Boerstoel and R. Uijlenhoet (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-15.* 10 p. 10 refs.

Nieuwlands hodograph theory for lifting quasi-elliptical aerofoils has been applied to compute a number of profiles with supercritical shock-free flow at the design condition. These profiles appear to have nose camber only. The pressure distribution at the design condition is of the peaky type. The minimum radius of curvature at the nose is of the order of 0.2% to 1¼% of the chord length. It is possible to compute the coordinates with sufficient precision for engineering applications. The shapes of the profiles computed depend upon seven parameters. It appears that four of these parameters have to be chosen carefully in order to avoid limit lines or branch points in that part of the physical plane, which is of interest. One of the profiles has been tested in the NLR Pilot tunnel to investigate: (1) the effect of viscosity on the theoretical results; (2) the off-design behavior. The pressure distribution in the experimental design condition (this is the condition with the weakest shocks) indicates practically shock-free flow. A 20% loss in lift is found at this condition. By deflecting a trailing-edge flap the lift loss could be reduced to 10% without worsening the drag characteristics. The margin between rapid drag rise boundary and buffet boundary at high Mach numbers appeared to be small. (Author)

A70-44127 * # **New approaches to hypersonic aircraft.** John V. Becker (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-16.* 28 p. 31 refs.

The strong interactions between the aerodynamic, structural, and propulsive systems of hypersonic air breathers offer important opportunities for achieving improved vehicles. One of the most promising is the use of the hydrogen fuel heat sink to provide cooling of major areas of the airframe. This possibility is explored in some detail, with considerations of the theoretical possibilities, engine designs for minimum cooling, comparative analysis of candidate high-level cooling systems, recent fluid-mechanical studies of slot cooling, structural designs compatible with practical cooling systems, and aerodynamic features made possible in actively cooled vehicles. The results suggest that hypersonic cruise vehicles constructed of largely unshielded aluminum or titanium alloys are feasible and offer a number of advantages. Further studies of the problems and possibilities of this category of hypersonic vehicles are suggested. (Author)

A70-44128 # **Stability and control problems of hypersonic aircraft (Problèmes de stabilité et de contrôle d'avions hypersoniques).** René Cérésuela (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-17.* 15 p. 20 refs. In French.

Discussion of some of the aerodynamic problems of hypersonic flight in the light of experimental results. The problem of aerodynamic fineness is considered in relation to longitudinal and transversal stability requirements and the presence of bulky engines. The compatibility of external and internal flows and the associated geometry problems of air intakes and exhausts are reviewed. The aerodynamic difficulties arising from the deformations undergone by the light and hot aircraft structures are discussed. M.V.E.

A70-44129 # **Aerodynamics and heat transfer of waveriders.** V. W. Keldysh and G. I. Maikapar (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-18.* 10 p. 13 refs.

Elements of flows behind a systems of plane and conical shocks, creating bodies which are named 'wave-riders,' are used for investigation and estimation of aerodynamic forces and heat fluxes to super- and hypersonic vehicles. Lift-to-drag ratio of such vehicles may be higher than for the wedge or simple wave-rider with one plane shock and the same lift. Experiments with models of wave-riders confirmed the existence of the flow in vicinity of (1) the sharp leading edge, corresponding to the wedge flow with strong shock in the normal section; (2) the line of shocks intersection, corresponding to the strong shock, reflected from the wall, in the normal plane. (Author)

A70-44131 # **Comparing the classification of the fatigue strength behaviour of small specimens and large scale components.** Kurt Pfleiderer and Franz Joseph Arendts (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-34.* 9 p. 6 refs.

Discussion of effective fatigue strength testing of helicopter rotors by conducting small specimen tests which are integrated into the overall development program of full-scale components. A justification for conducting extensive fatigue strength tests with small specimens is presented, and the prerequisites are given which enable the results of these tests to be related to full-scale components. Both base materials used today in aircraft construction, i.e., metal and composites, are systematically compared, and special problems involved in the development of dynamically stressed structures made of composites are illustrated. The results obtained by using the small specimen method during the development of the Bölkow rigid rotor system are discussed. O.H.

A70-44132 # **A theoretical and experimental research on the fatigue behavior of reinforced sheets.** L. Lazzarino and A. Salvetti (Pisa, Università, Pisa, Italy). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-35.* 14 p. 14 refs.

Study of the fatigue behavior of stiffened panels for aircraft structures, carried out to determine the effect of repeated buckling by compression loads on the panel fatigue strength, and to establish criteria for a 'fail safe' panel design. In the first case, extensive static and fatigue tests as well as strain measurements were conducted on a large number of panels of different sizes. Based on the test results, the causes of fatigue cracks and the effects of these cracks on the behavior of panel structures under loads are investigated. In the second case, stresses in cracked stiffened panels under tension loads were theoretically evaluated. In particular, the effect of the stiffener size and that of the type of the stiffener-sheet junction on the stresses near the crack were examined. The data obtained can be utilized to determine the critical crack length and the fatigue crack propagation rate. O.H.

A70-44134 # **Pilot influence on the dynamic design of aircraft.** G. V. Aleksandrov, A. N. Predtechenskii, and Iu. I. Sidorov (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-37.* 24 p.

Discussion of the influence of the pilot on the dynamic design of aircraft taking into consideration the physiological state of the pilot at the time when he performs different operational taks. The use of the limits of pilot adaptability as a criterion for selecting aircraft characteristics is discussed. Time reserved for control and limits of adaptability are considered, and effects of the dynamic design on the crew comfort are investigated. G.R.

A70-44139 # **Flight simulation as a design tool especially with respect to the German activities in this field.** H.-G. Schumann (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-41.* 22 p. 15 refs.

The first part of the paper describes the present state of the simulation technique both for ground and inflight simulations and deals with the advantages and difficulties of both simulation methods. In the second part the German activities with inflight-simulators are described. (Author)

A70-44140 # **The use of flight simulation in the development of the SAAB AJ37 Viggen system.** Alan R. McLean (Saab-Scania, Linköping, Sweden). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-42.* 12 p. 5 refs.

The potential of flight simulation as a means of reducing development time and costs was appreciated at an early stage in the Viggen program, and expansion of the existing simulation facilities commenced in 1962. A brief description of the current equipment configuration is given, covering both analog and digital computers, simulator cockpits and special-purpose equipment. The way in which these facilities have been and are being used in various phases of the Viggen program is described, including control-system and autopilot development, tactical mission simulation, head-up display optimization and dynamic program check-out for the airborne digital computer. Areas in which simulation has proved especially valuable are discussed and comparison is made with flight test results. (Author)

A70-44141 # **Simulator and in-flight study of the work load of aircraft crews (Etude au simulateur et en vol de la charge de travail des equipages d'avion).** Jean-Claude L. Wanner (Direction Technique des Constructions Aéronautique, Service Technique Aéronautique, Paris, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-43.* 13 p. In French.

Discussion of the techniques and methods of evaluating and analyzing the tasks of aircraft crews. Aircraft flight quality criteria are reviewed, crew tasks are defined, and typical pilot behavior is analyzed. The work load concept is defined, and various methods of work load measurement are critically examined. Finally, the characteristics are spelled out that must be imparted to simulators for turning them into reliable aids in accurate work load assessment. M.V.E.

A70-44142 # **Helicopter rotor tests in the large wind tunnel of Modane (Essais de rotor d'hélicoptère dans la grande soufflerie de Modane).** Michel Lecarme (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France) and Claude Armand (ONERA, Centre d'Essais, Modane, Savoie, France). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-44.* 13 p. 6 refs. In French.

Discussion of some of the results of the first phase of a long-term research program aimed at increasing the flight speed of helicopters. In the 8-m diameter test section, the 4-m diameter rotor can be tilted by 120 deg from propeller position to helicopter position. An internal balance measures the six components of the forces acting on the rotor, and a 110-channel ring transmits the electric signals originating in the stress and pressure pickups in the blades. Presented examples of results include instantaneous forces on the blades, differential and absolute pressures on the rotating blades, flow visualization by smoke emission, and rotor noise measurements. M.V.E.

A70-44143 # **Propulsion test facilities requirements for the future.** Harvey M. Cook (ARO, Inc., Arnold Air Force Station, Tenn.) and Roy R. Croy (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-45.* 9 p. 6 refs.

The advent of the C-5A and SST-type aircraft, with their attendant large subsonic and supersonic propulsion systems has brought the need for improved altitude simulation testing capabilities into sharp focus. A rationale to support the trend toward even larger aircraft and engines and identification of the time period wherein they will probably evolve is discussed. The evolution of advanced propulsion test units for component development in supersonic combustion ramjets, the development or evolution toward large bypass ratio engines and hybrid power plants, coupled with the methods which one might use to perform their normal development evolution, will be described. (Author)

A70-44144 * # **Current NASA research in turbojet propulsion.** Eugene J. Manganiello (NASA, Lewis Research Center, Cleveland, Ohio). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-46.* 22 p. 45 refs.

During the past 5 years, the NASA Lewis Research Center has been increasing its effort in turbojet propulsion. Intensive work is now underway in inlet, compressor, combustor, turbine, and nozzle component technology, along with investigations of integrated engine systems, including inlet flow distortion effects on engine stall, and airframe-propulsion system interactions. Recent progress and experimental results are presented in each of these major areas of investigation. (Author)

A70-44145 # **Some experiments on two-stream propelling nozzles for supersonic aircraft.** W. G. E. Lewis and F. W. Armstrong (National Gas Turbine Establishment, Farnborough, Hants., England). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-48.* 10 p.

The experimental technique developed at NGTE for evaluating the internal performance of supersonic propelling nozzles is outlined. An investigation of a family of axisymmetric, two-stream ejector-type nozzles designed for sustained cruising flight at around Mach 2, is then described. With the primary nozzle throat diameter and final shroud exit diameter maintained constant, the effects were explored of varying the shroud throat/primary throat area ratio, and the axial spacing between the primary and shroud throats. Each configuration was tested at conditions appropriate to supersonic cruise, over a range of secondary/primary airflow ratio. The results are presented in terms of gross gauge thrust efficiency and secondary airflow acceptance characteristics. (Author)

A70-44146 # **The external drag at subsonic and supersonic speeds of fuselage-side air intakes for strike-fighter aircraft.** M. D. Dobson and E. L. Goldsmith (Royal Aircraft Establishment, Bedford, England). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-49.* 15 p. 17 refs.

Experiments designed to measure the external drag of fuselage-side intakes are described. The drag associated with varying internal flows has been measured and the effects on drag of changes of intake design (e.g., cowl lip radius, compression surface angle or position etc.) have been measured and compared with estimates. (Author)

A70-44147 # **Hybrid-combustion in acceleration-ram rocket drives (Hybrid-Verbrennung in Beschleunigungs-Staustrahl-triebwerken).** O. Lutz (Braunschweig, Technische Universität, Braunschweig, West Germany), E. Riester, and K. Schadow (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig and Trauen, West Germany). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-50.* 12 p. 12 refs. In German.

For definite mission of a missile advantages of a ram rocket drive over that of a solid propellant rocket may be found. The investigation of this problem is the task of this report. The initial acceleration by a rocket booster are also taken into account. The gas generator of the ram rocket is a rocket combustion chamber including a boron loaded solid propellant, in which a liquid oxydizer is injected (hybrid reaktion). The very rich exhaust gases leaving the generator are used as fuel for the ramjet combustor. After optimizing the system there is a gain in payload of 24 p.c. for a constant speed ram rocket compared with a solid propellant rocket. If in addition the ram rocket is used to accelerate the missile, the gain in payload will increase to 43 p.c. (Author)

A70-44148 # **Engineering solutions to some conflicts between transonic flight and jet V/STOL.** J. W. Fozard (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-51.* 15 p.

Discussion of the history of the development of the jet V/STOL Hawker Siddeley Harrier aircraft powered by the Rolls-Royce (Bristol) Pegasus engine. The constraints imposed by the V/STOL aspects on the designer's freedom to choose those features giving the best transonic flight properties are first discussed. Two further major areas of conflict are then reviewed: the first concerns the solutions developed to provide satisfactory flying qualities in the pitching plane in conventional (fully wingborne) flight, while the second concerns the behavior and handling of the aircraft during takeoff and landing. O.H.

A70-44149 # **A commentary on descent capability, landing performance, and landing impact criteria for V/STOL aircraft.** E. D. Foy (Vought Aeronautics Corp., Dallas, Tex.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-53.* 12 p.

There is continued pressure upon the designer to improve aerodynamic performance in the approach by reducing landing approach speeds and increasing rates of descent. At times, performance objectives are set which fail to consider the tradeoff aspects of high vertical impact velocities with their resultant weight penalties. In this paper the interplay between descent capability, landing performance and structural criteria is examined, with particular regard to STOL landings. An expression of the relationship between mean impact sink rate and design sink rate for the landing gear is presented which made use of statistical data from a wide variety of conventional aircraft. The point is made that the high order of direct lift control inherent in STOL airplanes should produce smaller differences between mean and design sink rates than those exhibited historically by such conventional aircraft, and an alternative method of deriving this relationship is discussed. (Author)

A70-44150 # **Wind-tunnel wall effects for V/STOL airplanes with lift jets.** R. Jenny and B. Häni (Swiss Federal Aircraft Factory, Emmen, Switzerland). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-54.* 12 p. 7 refs.

Lifting an aeroplane by vertically directed jets can lead to severe aerodynamic problems, such as lift loss, loss of stability, hot gas ingestion, etc. Extended wind-tunnel testing of such configurations is therefore necessary. Although well established wind-tunnel technics are commonly used, there still remain important questions unclear. Until now, not much quantitative information is available on the importance of wall effects. Wall interference effects have been computed by using known theoretical models for a jet penetrating vertically into a uniform parallel flow. After minor modifications of one of the jet models, it was possible to study more complex jet arrangements. In some cases, calculated boundary corrections have been compared with measurements in the wind-tunnel. (Author)

A70-44151 # **The effects of lateral control non-linearities on the handling qualities of light STOL aircraft - A flight simulator study.** D. R. Madill, O. M. S. Colavincenzo (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada), and W. E. B. Roderick (National Aeronautical Establishment, Ottawa, Canada). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-55.* 23 p. 18 refs. Defence Research Board of Canada Grant No. DRB-0301-20.

The effects of wheel force and roll moment nonlinearities on the handling qualities of light STOL aircraft on approach are examined, using the NAE variable stability helicopter. Emphasis is on manual control but a few powered control results are also presented. Pilot opinion ratings and questionnaire replies form the data basis for this study. Statistical techniques are used to remove pilot bias in the rating data and to improve the sensitivity of the experiment. The projection of the results to larger STOL aircraft is considered briefly. (Author)

A70-44152 # **Some experimental research on a new aircraft configuration incorporating ejector-type thrust augmentors for VTOL.** D. C. Whittley (De Havilland Aircraft of Canada, Ltd., Toronto, Canada). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-56.* 9 p.

There are certain well documented advantages associated with ejector-powered VTOL aircraft which arise because the high intensity primary jet is mixed with secondary air so as to markedly reduce temperature, velocity and noise. However, previous experience with experimental VTOL aircraft has shown that the ejector system occupies most of the useful volume in the fuselage thus tending to

preclude meaningful application of the concept. The present paper describes research work on some new aircraft configurations in which the ejector system is contained within the root section of a wing having double-delta planform so that the fuselage centre section remains mostly free for storage of fuel and payload. The configurations which are described suggest the use of lightweight lift jets or lift fans to power the ejector system with separate engines for cruise propulsion. The primary jets are directed inward toward the centre line and adhere to the fuselage contour to form a single keel-like lifting jet. Experimental results are presented showing ground proximity effects in hover and aerodynamic/jet interference effects during the transition flight regime. The configuration is shown to exhibit certain favorable interference effects. (Author)

A70-44153 # **Design problems and solutions for five types of low-disk-loading, high-speed VTOL aircraft.** Robert L. Lichten (Bell Helicopter Co., Fort Worth, Tex.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-57.* 18 p. 23 refs.

The solitary success of the helicopter among transport/utility VTOL aircraft types is based on its ability to lift an economical payload vertically and suggests that most future higher-speed VTOL machines will utilize low-disk-loading rotors in the vertical flight mode. For high-speed flight some form of variable geometry will be used to avoid helicopter limitations. Rotors can either be maintained in a horizontal plane or tilted forward to propeller position; in either case they are unloaded, and speed of rotation may be reduced and/or blades contracted, or they may be stopped and blades folded. Five specific configurations treated cover the addition of wings, compounding, variable-diameter, tilting, and tilting plus folding. Problems and solutions in dynamics, design, weight considerations and aerodynamics are discussed. It is concluded that all offer advantages of various VTOL applications, with economical cruise performance available from about 200 to 500 knots. Providing VTOL capability causes some penalty in weight and cost compared to equivalent airplanes in transport functions. (Author)

A70-44154 # **Study of automatic conflict detection and resolution in air traffic control planning.** A. Benoit, Y. Charvet, P. Kuypers, and R. H. G. Martin (EUROCONTROL, Brussels, Belgium). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-58.* 11 p.

The paper presents an analysis of one possible method of planning the traffic flow based on the minimization of the state of potential conflict in a given traffic sample. The basic principles of the method include prediction of flight paths, definition of an instantaneous zone of protection assessed in terms of length and definition of a function characterizing the probable state of conflict of the traffic sample. It implies the definition of a detection logic which amounts to determining the intersection of pairs of zones of protection, and suggests a conflict resolution procedure based on possible flight plan amendments in order to minimize the state of conflict function. (Author)

A70-44155 # **The operation and economics of the supersonic transport.** John M. Swihart (Boeing Co., Supersonic Transport Div., Seattle, Wash.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-59.* 15 p. 7 refs.

The United States SST will have the most advanced flight deck instrumentation and cockpit displays of any manned flight article when it is introduced into airline service in 1978. This paper will briefly describe these displays and their use during a commercial flight. The economics of the supersonic transport have been widely questioned. An economic analysis of the operation of this advanced aircraft will be presented. Comparisons to the economics of the introduction of the turbojet transport into the piston engine transport will be made. The results will show that the SST will be very attractive in the passenger market of the 1980s. (Author)

A70-44156 # **Aerodynamic energy exchangers for hybrid airbreathing-rocket propulsion systems.** F. Berner and M. Hermann. *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-61.* 13 p.

New methods of direct exchange of mechanical energy between flows have been investigated theoretically and experimentally. These methods are of interest for propulsion systems of the ramjet type incorporating a rocket motor as a source of high energy gas. The investigated concepts differ from the ejector in that the energy exchange is based not only on shear stresses but also on moving pressure fields. Results of the analytical and experimental investigation are presented and are compared with the corresponding data of ejectors operating with the same driving and driven media. (Author)

A70-44157 # **Stability of the elastic fuselage of a flight vehicle when stabilized by a nonideal static automatic pilot during a supersonic flight (Ustoichivost' uprugogo korpusa letatel'nogo apparata, stabiliziruemogo neideal'nym staticheskim avtopilotom, pri sverkhzvukovom polete).** N. G. Krasnoshapka. *Gidroaeromekhanika i Teoriia Uprugosti,* no. 11, 1970, p. 3-8. 6 refs. In Russian.

Analysis of the dynamic stability of a flight vehicle with an elastic fuselage at supersonic speed when a nonideal static automatic pilot is used for simultaneous angular-displacement and side-shift stabilization. Equations of elastic oscillations of a one-dimensional body proposed by Goroshko (1965) are used to describe the dynamic stability of this craft during a supersonic flight. Concepts of the piston theory are applied to determine the aerodynamic forces acting on the elastic system during stabilization. A region of stability of this flight vehicle is constructed as a function of the control-system and thrust parameters. V.Z.

A70-44158 # **A method of determining the lift of a profile (Ob odnom metode opredeleniia pod'emnoi sily profilia).** V. N. Kravets. *Gidroaeromekhanika i Teoriia Uprugosti,* no. 11, 1970, p. 9-16. 12 refs. In Russian.

Description of a method for determining the aerodynamic parameters of an array of slender weakly curved periodically recurring congruent airfoils in a plane potential flow of inviscid incompressible fluid. The lift of such an array is determined by substituting for it a continuous system of flow inlets and outlets, and vortices. The results are extended to a plane-parallel flow in a rectangular plane duct with parallel walls. Airfoils positioned in the middle of a duct at zero angle of attack and ones positioned off the middle are considered. V.Z.

A70-44174 **What is STOL.** J. W. Meek. *Air Line Pilot,* vol. 39, Oct. 1970, p. 8-10.

Discussion of various aspects involved in creating a STOL system which will be operating out of city centers. A suitable definition of a STOL is considered, and measures are discussed for providing the high level of safety deemed necessary for air traffic within urban areas. Problems of navigation are examined, and guidance systems for approach and departure are considered. Airport criteria are investigated, and aircraft emergency containment systems are outlined. G.R.

A70-44175 **CAS/PWI shopping list.** Lou Davis. *Air Line Pilot,* vol. 39, Oct. 1970, p. 16-18, 38.

Discussion of systems and approaches for preventing mid-air collisions of aircraft. Collision Avoidance (CAS) and Proximity Warning Indicator (PWI) systems and approaches combining features from various systems are considered. The merits of various approaches to ensure collision avoidance are discussed. One of the systems described harnesses the IR signals of strobe light to detect an intruding aircraft. The high degree of flexibility that appears to be present in the time-frequency system considered is pointed out. On the other hand, it is thought that the lower level PWIs do not offer much promise of protection outside of the high-performance aircraft having CAS time-frequency, as a source of warning information. G.R.

A70-44200 **Smoke emission control.** *Esso Air World,* vol. 23, no. 1, 1970, p. 9-14.

Discussion of the significance of the jet engine as an air pollution source and the action being taken to reduce the smoke emitted. Relative contributions of the principal sources of atmospheric pollutants to the air pollution in the U.S. are examined. It is found that jet aircraft contribute about 1% of the total pollutants. The composition of the jet exhaust smoke is investigated. A smoke reduction program is discussed, and the effect of fuel types and additives is examined. Aspects of burner redesign are discussed. It is pointed out that with the availability of the reduced smoke JT8D burners for production engines, and utilization of these burners by the airlines in their overhaul programs, the visible smoke from the existing fleet of transports will be significantly reduced. G.R.

A70-44207 **Three-dimensional separation of the boundary layer on a circular cone at incidence (Séparation tridimensionnelle de la couche limite sur un cône circulaire en incidence).** Bernard Roux and Jacques Marcillat (Aix-Marseille, Université, Marseille, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 271, no. 8, Aug. 24, 1970, p. 418-421. 13 refs. In French.

Study of the separation of the boundary layer at a circular cone taking into consideration experimental investigations at Mach number 6.85 and a theoretical analysis. The model investigated is a cone with a semiapex angle of 9 deg. The equations considered in the theoretical analysis are those of the laminar boundary layer with the customary assumptions as discussed by Hayes (1951) and Moore (1952). The presence of a perfect gas in thermodynamic equilibrium is assumed in the numerical method used for computing the theoretical results. Theoretical and experimental results obtained for an angle of attack of 9 deg show satisfactory agreement. G.R.

A70-44322 **The 'Fenestron' shrouded tail rotor of the SA.341 Gazelle.** René Mouille (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France). *American Helicopter Society, Journal,* vol. 15, Oct. 1970, p. 31-37.

The shrouded tail rotor developed by the Société Nationale Industrielle Aérospatiale for the SA.341 'Gazelle' eliminates most of the drawbacks of the conventional tail rotor of mechanically-driven helicopters. Protected by the tail fin, in which it is enclosed there is no risk of the tail rotor touching the ground during approach and landing, and impact with any object becomes practically impossible. Total aircraft power required in hovering is 3-4 per cent higher than in the case of a conventional tail rotor, but slightly less power is needed in forward flight. Also, since the tail fin is designed with a cambered airfoil to furnish antitorque thrust in forward flight, all the tail rotor transmission system is alleviated of this load and if, for any reason, the antitorque rotor should become inoperative, the aircraft can return to base instead of having to make an immediate autorotational landing. Considering the low values of alternating stresses in the blades and control components, this system is particularly attractive for high-speed rotary wing aircraft. (Author)

A70-44323 * **A note on a phenomenon affecting helicopter directional control in rearward flight.** Robert J. Huston and Charles E. Morris, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Helicopter Society, Journal,* vol. 15, Oct. 1970, p. 38-45. 5 refs.

This paper presents the results of a wind-tunnel investigation of tail-rotor performance that was initiated because of directional-control problems that have occurred with helicopters in a low-velocity tail wind. The investigation has identified significant adverse effects of the main-rotor wake that include an increase in the adverse fin force, a decrease in the tail-rotor thrust obtained, and an increase in the tail-rotor torque required. The adverse effects are the result of the immersion of the tail rotor and fin in a large-scale vortex generated by the interactions of the main-rotor wake and the wind in the presence of the ground. When rearward airspeed is increased to a critical value, the free-stream flow carries the large-scale vortex away from the tail rotor and fin. This causes a discontinuity in tail-rotor power and collective pitch required. Model test data are shown that simulate flight results. (Author)

A70-44324 **Increasing tail rotor thrust and comments on other yaw control devices.** Frank Robinson (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Journal,* vol. 15, Oct. 1970, p. 46-52. 7 refs.

The first part of this paper deals with the tail rotor thrust deficiency experienced by most of today's helicopters, and the various means by which the thrust can be increased, including the use of more blade area, higher tip speeds, and blades having cambered airfoils. The compromises necessary are discussed, including the high pedal loads resulting from any increase in blade chord. Then, in more detail, a comparison is made of several airfoils suitable for tail rotors, including one with forward camber and one with full camber. The results obtained with two tail rotors using full camber in current development programs are discussed. The second part of the paper considers several alternates to the tail rotor. A hypothetical helicopter is used as a base to compare the performance of a conventional tail rotor with that of a fan-in-the-fin or a tailcone-fan. The theoretical approach used points out some of the inherent limitations of each configuration. (Author)

A70-44326 **Environmental engineering; Society of Environmental Engineers and Koninklijk Instituut van Ingenieurs, Anglo Dutch Symposium, Technische Hogeschool te Delft, Delft, Netherlands, April 1-3, 1970, Preprints.** London, Society of Environmental Engineers, 1970. 306 p. $14.40.

Contents:

Design for surviving the space environment. R. Somoza (ESRO, Noordwijk, Netherlands), p. 2.0-2.38.

Materials problems in space. J. Dauphin (ESRO, Noordwijk, Netherlands), p. 3.1-3.20. 5 refs.

Reliability implications in design, manufacture and testing. R. Brewer (Associated Semiconductors Manufacturers, Ltd., Southampton, England), p. 4.1-4.9.

Environmental specifications. E. S. Ward (Standard Telephones and Cables, Ltd., Cockfosters, Herts., England), p. 5.1-5.9.

The effect of electromagnetic environmental conditions on the transmission of electrical signals with special reference to data transmission. W. Vogl and E. Popp (Siemens AG, Munich, West Germany), p. 6.1-6.13.

Acoustic testing, aircraft structures. J. A. Hay (British Aircraft Corp. /Weybridge/, Ltd., Weybridge, Surrey, England), p. 7.1-7.26. 6 refs.

Some special problems in vibration and shock isolation. A. J. Francken (Noordelijk Technisch Instituut TNO, Haren, Netherlands), p. 8.1-8.22. 8 refs.

Shock and bump testing. K. Spång (Institutet för Miljöteknik, Stockholm, Sweden), p. 9.1-9.12.

Atmospheric corrosion of metals. J. W. Boon (Nederlandse Centrale Organisatie TNO, Delft, Netherlands), p. 10.1-10.19.

Deterministic versus stochastic signals. R. G. Boiten (Delft, Technische Hogeschool, Delft, Netherlands), p. 11.1-11.58.

Some aspects of vibration testing. J. T. Broch (Bruel og Kjaer A/S, Copenhagen, Denmark), p. 12.1-12.27. 38 refs.

Analysis of response of structures to vibration environment. H. H. 't Hart (Institute TNO for Mechanical Constructions, Delft, Netherlands), p. 13.1-13.21.

Application of lasers for deformation and vibration analysis. H. J. Raterink (Nederlandse Centrale Organisatie TNO; Delft, Technische Hogeschool, Delft, Netherlands), p. 14.1-14.15. 6 refs.

Accelerated vibration testing. J. A. L. Yarnold (Atomic Weapons Research Establishment, Aldermaston, Berks., England), p. 15.1-15.16. 24 refs.

A70-44329 # **Acoustic testing, aircraft structures.** John A. Hay (British Aircraft Corp. /Weybridge/, Ltd., Weybridge, Surrey, England). In: Environmental engineering; Society of Environmental Engineers and Koninklijk Instituut van Ingenieurs, Anglo Dutch Symposium, Technische Hogeschool te Delft, Delft, Netherlands, April 1-3, 1970, Preprints. London, Society of Environmental Engineers, 1970, p. 7.1-7.26. 6 refs.

Outline of acoustic fatigue testing of aircraft structures. An indication is given of the mechanism by which sound waves produce fatigue of aircraft structures, and of the environments in which acoustic fatigue exists. Some common forms of test facilities, and some of the available methods of simulating the environment for test purposes are reviewed. The inadequacy of current methods for predicting the fatigue life of real structures from accelerated tests is discussed. It is pointed out that, at the current state of the art, a considerable degree of uncertainty is associated with the interpretation of the test results, so that considerable improvements in the whole process of testing are required. O.H.

A70-44394 # **Model study of high bypass jet noise.** J. E. Ancell and N. Shapiro (Lockheed-California Co., Burbank, Calif.). *Acoustical Society of America, Spring Meeting, 79th, Atlantic City, N.J., Apr. 21-24, 1970, Paper.* 14 p.

Description of preliminary results of a high bypass model jet noise study. The jet model facility is shown, and the results cover 16 far-field test runs, with ratios of secondary to primary velocity from 0 to 2 and specific velocity combinations. The validity of the jet model used in the study has been established quite well from the results of the simple primary jet test runs, considering noise power as a function of velocity, spectrum shape, and directivity pattern. Tests with combined primary and secondary flow for some velocity ratios have demonstrated a reduction or attenuation effect on both sound pressure level and power level compared with the noise from the primary central jet alone. The effect was observed for ratios of secondary to primary velocity ranging from about 0.33 to 0.67, and was greatest at the higher frequencies. The amount of sound pressure level reduction varied with microphone position, being greater, for example, at the angle of maximum radiation, than for the integrated sound power. These reductions occurred in spite of increased mass flow due to addition of secondary air. M.M.

A70-44395 * # **Research approaches to the alleviation of aircraft noise.** W. H. Mayes, P. M. Edge, Jr., and A. B. Connor (NASA, Langley Research Center, Hampton, Va.). *Institute of Environmental Sciences, Annual Technical Meeting and Equipment Exposition, 16th, Boston, Mass., Apr. 12-16, 1970, Paper.* 24 p.

The phenomena of aircraft noise generation and community response which are generally pertinent to the problem of airport-community noise are discussed. Included are results on such engine noise alleviation approaches as acoustic duct lining technology, aerodynamic flow choking, minimization of internal flow interactions, and reduction of jet exhaust velocity. The significance of such other factors as the subjective response of people and the dynamic responses of buildings are also included. (Author)

A70-44396 **Control behavior of jet engines (Das Regelverhalten von Strahltriebwerken).** Franz Fett (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Nordrhein-Westfalen, Forschungsberichte,* no. 2065, 1970. 116 p. 18 refs. In German. Research supported by the Landesamt für Forschung des Landes Nordrhein-Westfalen.

Development of a calculation procedure (based on linear theory) which makes it possible to investigate the dynamic behavior of jet engines of any type. In particular, the procedure makes it possible to calculate beforehand the control behavior for normal external actions and, in addition, to determine the reactions of jet engines when, for special reasons, additional external actions are foreseen. As a result, the effects of perturbations which occur can be followed. The proposed calculation procedure is illustrated in the case of several types of jet engines, taking into account the number of external actions. A.B.K.

A70-44400 # **Entrainment theory for axisymmetric, turbulent, incompressible boundary layers.** J. Richard Shanebrook (Union College, Schenectady, N.Y.) and William J. Sumner. *Journal of Hydronautics,* vol. 4, Oct. 1970, p. 159, 160. 13 refs. NSF Grant No. GK-12697.

Extension of Head's entrainment theory to predicting the development of incompressible, turbulent boundary layers on bodies of revolution. Such shapes are shown to be employed in the design of many engineering devices such as aircraft fuselages, marine submersibles and cowlings for propulsion units. A system of differential equations is developed which is numerically integrated and the results, giving momentum thickness and shape factor prediction, are graphically compared with the data of Freeman. The results demonstrate that the entrainment theory represents a firm basis which enables convenient extension to more complicated situations, such as predicting the drag on the body and the boundary-layer velocity profile entering an aft-mounted propulsion unit. O.H.

A70-44413 **An avionics system for a new fighter aircraft (Avionik-System für ein neues Kampfflugzeug).** Roland Ziegler. *Flugrevue/Flugwelt International,* Oct. 1970, p. 43-46, 51. In German.

Description of an avionics system for a proposed two-seater fighter aircraft. Certain criteria regarding the design of a modern weapons system are outlined, and the mission-determined functions of an avionics system are summarized. A detailed description is given of an integrated navigation and attack system using both ground-dependent and ground-independent navigation data. The system may employ one or more computers and also includes a Decca type 72 Doppler radar and a Sperry SGP 500 transfer gyro. A.B.K.

A70-44456 **Evaluation of the lap belt and pre-inflated air bag during impact with human sled subjects.** C. D. Gragg, C. D. Bendixen. T. D. Clarke, H. S. Klopfenstein, and J. F. Sprouffske

(USAF, Aeromedical Research Laboratory, Holloman AFB, N. Mex.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 1. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 27-43. 9 refs. Research supported by the U.S. Department of Transportation.

Investigation of the protection provided in aircraft crashes by an air bag which is installed as an addition to a typical seat/lap belt configuration which is now standard on most aircraft. Tests were conducted for studying the load pattern to the human anatomy in a typical aircraft situation when restrained either with a lap belt only or with a lap belt plus an air bag. The subjective reactions of the sled subject when he is interfaced with the air bag were studied. G.R.

A70-44460 **Reliability of in-flight escape systems and survival equipments in U.S. Navy ejections - Successful and unsuccessful.** Erna V. Rice (U.S. Naval Safety Center, Norfolk, Va.) and Frank H. Austin, Jr. (U.S. Navy, Washington, D.C.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 1. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 157-162.

Discussion of the reliability of in-flight escape systems and survival equipments in U.S. Navy ejections taking into consideration a study of Navy ejections occurring in 1968 and 1969, and of recommendations for survival in aircraft accidents. The survival rate for actual ejections for the two-year period was 86.5%. However, when total systems reliability was critically evaluated, only 64.3% of the cases were found to be without malfunction. This indicates that many ejectees survived in spite of systems malfunctions. G.R.

A70-44464 **Helicopter automatic approach and hover coupler systems.** Louis Cotton and Richard Mills (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 1. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 255-278.

Since 1958, helicopters have been equipped with various forms of automatic approach and hover systems. Progress in the development of these systems has been steady, but the need exists for further expansion and refinement. Areas of particular interest include integrated cockpit display equipment, improved handling qualities, reduced pilot workload and fatigue, and external load stabilization. Fortunately much promising equipment has already been flight tested successfully. (Author)

A70-44465 **Survival in foam.** O. S. Willey, Jr. (Gulf and Western Industrial Product Co., Swarthmore, Pa.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 1. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 279-287.

Discussion of a concept for protecting aircraft passengers and crew from fire in otherwise survivable crashes. The concept is to insulate the passenger from any fire and to provide a breathable air supply until arrival of the crash and fire fighting crews. This is accomplished by producing a life sustaining environment inside the fuselage with high expansion foam. Upon signal, which can be either manual or automatic, the passenger compartment will be completely filled with foam within 30 sec. This foam will provide insulation from heat, smoke, and flames while supplying breathable air trapped in the millions of tiny bubbles. G.R.

A70-44466 **Commercial and military aircraft emergency egress systems.** Joseph D. Caldara and Frank B. Pollard (Aircraft and Missile Consultants, Manhattan Beach, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 1. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 295-333. 14 refs.

Discussion of the possibility to save lives in survivable aircraft accidents by providing emergency exits taking into consideration the design and operation of high energy egress systems. An analysis of passenger survival opportunity is made. It is found that jammed exits are responsible for fatal accidents. Possibilities for providing emergency egress by severing doors and strategically located panels from the fuselage using explosive cutting action is considered. The use of liquid and solid propellants is discussed. G.R.

A70-44482 **The use of stretch fabric materials in personnel escape parachutes.** Kenneth R. Wilson. In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 357-368. USAF-sponsored research.

Discussion of the concept, design considerations, evaluation of the preliminary testing, and the present state-of-art of the development of a stretch-fabric personnel parachute system. High speed escape (canopy loading) and low speed escape (reliable deployment) systems are considered. Problems of high speed escape are examined. It is pointed out that the use of 'stretch' fabric could greatly relieve the canopy opening forces involved by permitting a greater flow of air mass through the increased mechanical porosity of the canopy fabric itself prolonging canopy opening time and thereby resulting in reduced stress on both the parachute and wearer. The configurations of several test parachutes are described and the development of special-purpose stretch fabrics is discussed. G.R.

A70-44483 **An engineering treatment of continuous-flow requirements in aircraft passenger oxygen systems using the phased dilution principle.** James Whitla (Lockheed-California Co., Burbank, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 369-397.

Analysis of the economic advantages of supplying pure oxygen, followed by air or a mixture of air and oxygen to the lung from an engineering standpoint. Such sequencing or phased dilution of inspired gas constituents is considered with regard to hypothetical 'ideal' and 'working' respiratory cycles applied to continuous-flow oxygen systems of the type found in commercial jet and other aircraft, for the use of passengers. The generally accepted calculated minimum added oxygen theoretically required is shown to be in excess of quantities actually necessary for most of the cabin altitude range from 10,000 to 40,000 ft. Performance requirements predicted by calculation, and values from simulator and human subject tests, are compared. Breathing mask efficiencies are discussed in relation to currently approved designs and as a basis for new design and development. G.R.

A70-44485 **Catalytic combustion fuel tank inerting techniques.** Robert G. Clodfelter and Steven Shook (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 411-430.

Discussion of the catalytic combustion technique for inerting aircraft fuel systems. It is pointed out that the catalytic combustion approach offers potential advantages over other combustion concepts by providing efficient oxygen conversion over a wide range of operating conditions with the generation of only a small amount of corrosive reaction products. Three exploratory development phases

of the catalytic inerting program are discussed. As a result of the investigations it is felt that the catalytic inerting technique has great possible potential for use in fuel system fire protection for military and civilian aircraft. G.R.

A70-44486 Passenger emergency evacuation briefing cards - Recommendations for presentation style (A summary report). H. B. Altman (Douglas Aircraft Co., Long Beach, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 455-474. 12 refs. Research supported by the Douglas Aircraft Independent Research and Development Funds.

Discussion of two studies which were conducted to obtain information on passengers' acceptability regarding presentation styles used in developing aircraft emergency information cards. In the first study, 33 undergraduate students in psychology were given briefing card samples and instructed to rank them according to content from the 'most-to-least' preferred style of presentation. The judges in the second study were Douglas Aircraft Co. employees. In general, the presentation style preferred by most judges was that of simple sequential action, graphic displays of information with a minimum of keyword descriptors. G.R.

A70-44487 Emergency life-saving instant exits for transport aircraft. B. Chesterfield (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and F. B. Burkdoll (Engineering - Explosive Technology, Inc., Fairfield, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 475-488.

In conjunction with the Air Force Systems Command, Aeronautical Systems Division, Wright-Patterson AFB, Explosive Technology (ET) is further developing an Emergency Life-Saving Instant Exit (ELSIE) System. Flight testing following qualification will be conducted early in 1971. This paper describes the design details and the rationale behind that design which results in a system with the following characteristics: (1) Opens emergency exits in less than 1/1000 second. (2) Automatically deploys an escape slide/raft. (3) Is jam-proof even after severe deformation of the fuselage. (4) Door jettisons outward. Successful function cannot be prevented by inboard obstructions or congestion. (5) Is instantly operable following a crash, by any passenger or crew, yet cannot be operated inadvertently. (6) Allows quick and easy refurbishment after operation. ELSIE consists of an electromechanical safe/arm actuator, confined transfer lines (SMDC), and a linear shaped explosive cutting charge (Jetcord). The system can be included in the original design, or can be retrofitted into existing aircraft without impairment of the structural or aerodynamic integrity. The system's capabilities and applicability to alternate usage are described. (Author)

A70-44488 The advances of testing and promulgation of information of safety, survival and life support equipment. Claude F. Robb and A. Marshall Irving (Dayton T. Brown, Inc., New York, N.Y.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 489-491.

Discussion of the work and the responsibilities of a testing laboratory which was initially established to conduct testing for the Navy. The laboratory was established because it was thought desirable that equipment in addition to being tested by the manufacturer should also be subjected to tests by a laboratory with no connection whatsoever to the manufacturer. The testing of parachutes and components is considered and improvements in quality obtained as a result of the testing are discussed. Other activities of the laboratory are concerned with the testing of aircrew protective helmets and the preparation of maintenance manuals. G.R.

A70-44491 The F-111 crew escape module. J. L. Charleville (McDonnell Aircraft Co., St. Louis, Mo.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 529-537.

Description of the history, operation, and various systems of the F-111 crew escape module, the first production cockpit type escape module to be used in operational aircraft. The F-111 crew module provides answers to many of the problems associated with ejection seat escape systems, including protection against windblast, limb flailing, landing hazards, excessive and oscillating accelerations, drowning, and adverse climate survival, and also improves crewman comfort and efficiency. Its pilot acceptance has been generally good and it has proven successful in seven emergency ejections. It has set the pace for future aircraft that have requirements which dictate a crew escape module system. M.M.

A70-44492 Prediction of escape survivability. J. L. Charleville (McDonnell Aircraft Co., St. Louis, Mo.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 539-542.

Description of a method for predicting the escape and survivability rates in various portions of an aircraft flight envelope. In this method the aircraft flight envelope is first divided into zones that are significant in terms of escape system capability. Using the escape statistics from an existing aircraft, the escape rate within each of the zones is then determined. Corrections are applied to the existing escape rates in each zone to compensate for differences in the mission profile between the existing aircraft and the aircraft under consideration. M.M.

A70-44496 Hijack detection programs. John E. Shields (Eastern Air Lines, Inc., New York, N.Y.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 28-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 592-597.

Discussion of the history of hijacking, the programs currently in use to deter hijackers, and equipment problems which are foreseen for the future. It is noted that problems of detecting hijackers and stopping once and for all acts of air piracy cannot be solved by laws alone and that industry must continue to seek better methods of detection and prevention. M.M.

A70-44499 Design achievements with the SIIIS-3 ejection seat escape system. Walter R. Peck and Robert J. Manzuk (Stencel Aero Engineering Corp., Asheville, N.C.). In: Survival and Flight Equipment Association, Annual Symposium, 8th, Las Vegas, Nev., September 29-October 1, 1970, Proceedings. Volume 2. Van Nuys, Calif., Survival and Flight Equipment Association, 1970, p. 621-662.

Discussion of an improved ejection seat escape system which will provide the user with state-of-the-art performance in a light

weight, minimum envelope, low cost system. The design philosophy followed encompassed four basic concepts: simplicity, modularization, multiple function device utilization, and redundant structure elimination. The design achievements are examined, and features of structural design which are responsible for the savings in weight are discussed. It is shown how configuration and size modifications resulted in a production cost which is remarkably low in comparison to other contemporary ejection seat systems. G.R.

A70-44515 # Investigation of the nonlinear flight dynamics of ordnance weapons. John D. Nicolaides, Charles W. Ingram, and Thomas A. Clare (Notre Dame, University, Notre Dame, Ind.). *(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 7th, New York, N.Y., Jan. 20-22, 1969, Paper 69-135.) Journal of Spacecraft and Rockets,* vol. 7, Oct. 1970, p. 1241-1243. 6 refs.

Investigation of the nonlinear aerodynamic characteristic of ordnance weapons. An extension of the method of Krylov and Bogoliubov is used to obtain an approximate analytic solution to the nonlinear differential equations of motion. This solution provides the necessary relationships to accurately determine from angular motions the aerodynamic stability coefficients as nonlinear functions of angle of attack. The weapons systems investigated include the Low Drag and Snakeye bomb configurations, and the Apache and 2.75 FFAR rockets. The investigation indicates that the nonlinear aeroballistic theory must be employed to completely predict the dynamic flight performance of these weapons systems even at small angles of attack. In particular, it was found that both nonlinear damping and Magnus stability coefficients can cause serious flight instabilities. (Author)

A70-44531 * # Effect of suspension line elasticity on parachute loads. John S. Preisser and George C. Greene (NASA, Langley Research Center, Hampton, Va.). *Journal of Spacecraft and Rockets,* vol. 7, Oct. 1970, p. 1278-1280.

Analysis of parachute loads through the use of a simple model which represents the payload, parachute, and suspension lines by a two-body spring-mass system. It is shown that a significant contribution to the overall load amplification can result from the elasticity of the parachute suspension lines. In addition, it is found that the atmospheric density is an important factor in determining how effectively load oscillations are damped out following full inflation. O.H.

A70-44538 Equipment design constraints for automated testing. Richard O. Barrett (Honeywell, Inc., Minneapolis, Minn.). In: National Electronic Packaging and Production Conference, Anaheim, Calif., February 10-12, 1970 and New York, N.Y., June 16-18, 1970, Proceedings of the Technical Program. Chicago, Industrial and Scientific Conference Management, Inc., 1970, p. 8-1 to 8-9.

Description of the general guidelines that should form a working base for designing avionics hardware compatible with automatic test equipment. To accomplish the levels of fault isolation in minimum time, it is indicated that primary consideration should be given to the following factors: (1) the impact of malfunction isolation, (2) the time allotted for testing, (3) building block requirements of the test equipment, (4) test program generation for utilization of automatic test equipment, (5) unit under test/test-equipment interface constraints, and (6) packaging configuration and complexity. Z.W.

A70-44542 Microelectronics packaging for high performance military aircraft. J. Ciccio (Raytheon Co., Missile Systems Div., Bedford, Mass.). In: National Electronic Packaging and Production Conference, Anaheim, Calif., February 10-12, 1970 and New York, N.Y., June 16-18, 1970, Proceedings of the Technical Program. Chicago, Industrial and Scientific Conference Management, Inc., 1970, p. 9-31 to 9-46.

Description of the packaging techniques employed on a signal data processor presently in production and on a proposed, next generation unit. The processor is intended to perform launch-control and signal command functions for a missile on a high performance aircraft. The packaging employed on the processor utilizes IC's and thick-film devices mounted on printed-circuit modules. Techniques are described which were employed to insure a dependable thermal-conduction path to a cold plate. The unit presently in production operates in a 131 deg C ambient temperature environment and passed the environmental requirements of MIL-E-5400. A proposed new design for a similar application features three techniques intended to further reduce weight and volume. These techniques are: (1) hybrid MSI devices and IC chips packaged on a standard planar lead carrier, (2) a section of the cold-plate built into each module, and (3) flexible polyimide cabling. The resulting unit, with 30% more circuitry, will weigh 25% less. Z.W.

A70-44543 The application of multiplexing techniques to large passenger airplanes. V. B. Hart (Boeing Co., Seattle, Wash.). In: National Electronic Packaging and Production Conference, Anaheim, Calif., February 10-12, 1970 and New York, N.Y., June 16-18, 1970, Proceedings of the Technical Program. Chicago, Industrial and Scientific Conference Management, Inc., 1970, p. 13-1 to 13-17.

Review of the wiring installation problems associated with the passenger entertainment and passenger service system controls as related to the Boeing 747 passenger aircraft. It is shown how the use of multiplexing techniques were used to improve the design and installation of these systems. Special attention is given to the controls to which each passenger has access: (1) the entertainment controls involving movie and stereoaudio, and (2) the passenger-service systems consisting of reading and call lights. It is concluded that the combination of large numbers of passengers, a two-aisle center seating configuration, the requirement for flexibility in seating arrangements, and passenger access to entertainment and other controls generated installation and weight problems which are best solved by the utilization of multiplexing techniques. Z.W.

A70-44544 Selection of cable and connectors for multiplexing system for the Boeing 747 airliner. Stephen M. Hatch (Boeing Co., Electrical Components Group, Seattle, Wash.). In: National Electronic Packaging and Production Conference, Anaheim, Calif., February 10-12, 1970 and New York, N.Y., June 16-18, 1970, Proceedings of the Technical Program. Chicago, Industrial and Scientific Conference Management, Inc., 1970, p. 13-18 to 13-28.

Description of the design approach and the resulting products for interconnecting the passenger seats for the passenger entertainment and service multiplex system. A cable assembly had to be developed for integrating the passenger seat groups in the Boeing 747 jetliner which could meet the extreme performance requirements expected during the service life. These objectives were accomplished by cabling MIL-W-81044/12 wire and 5026A1318 coax with a Dacron jacket, and terminating this cable to a plastic, spring-loaded, locking latch type connector. This cable assembly is performing efficiently in its installation and has resulted in an excellent cost-reduction over what could be obtained using existing standard hardware. Z.W.

A70-44545 Unique connectors developed for U.S. super jet airliners. Michael Lazar (Burndy Corp., Norwalk, Conn.). In: National Electronic Packaging and Production Conference, Anaheim, Calif., February 10-12, 1970 and New York, N.Y., June 16-18, 1970, Proceedings of the Technical Program. Chicago, Industrial and Scientific Conference Management, Inc., 1970, p. 13-29 to 13-36.

Review of the details of a number of recent connector developments designed specifically for a U.S. superjet airliner. Topics

discussed include the development of a power distribution connector, a modular terminal block for signal circuitry, and a self-ejecting push-button connector for passenger seat entertainment and service requirements. To aid the difficult logistics problems faced by airlines in maintaining many different types of aircraft, the pins and sockets used in the connectors are the standard crimp, snap-in contacts already in use on existing aircraft. Z.W.

A70-44548 * # Fatigue loadings on commercial transport airplanes. Thomas L. Coleman and Paul A. Hunter (NASA, Langley Research Center, Hampton, Va.). *U.S. Air Force Flight Dynamics and Materials Laboratories, Conference on Fatigue and Fracture of Aircraft Structure and Materials, Miami Beach, Fla., Dec. 15-18, 1969, Paper.* 35 p. 5 refs.

Updated summary of the results of the NASA VGH program for repeated loads on transport airplanes covering data on new types of aircraft collected since 1965. The summary extends to six types of turbojets and turbofans operating on U.S. domestic and international lines and foreign airlines. Repeated loads caused by gusts, operational maneuvers, check-flight maneuvers, landing impact and ground operations are evaluated. It is concluded that VGH data samples for roughly 400 flight hours during the four seasons of the year provide reliable estimates of the gust and operational-maneuver acceleration distributions. On the other hand, data samples of at least 1000 flight hours are required to obtain good estimates of check-flight maneuver acceleration experiences. V.Z.

A70-44556 * # Stability of dynamic systems with periodically varying parameters. Peter Crimi. (American Institute of Aeronautics and Astronautics, Structural Dynamics and Aeroelasticity Specialist Conference, New Orleans, La., April 16, 17, 1969, Proceedings, p. 153-161.) *AIAA Journal,* vol. 8, Oct. 1970, p. 1760-1764. 10 refs. Contract No. NAS 1-7411.

Description of a method for analyzing the stability of dynamic systems (such as spinning satellites in elliptic orbits and helicopter rotors in forward flight) which are represented by a coupled set of linear differential equations with periodically varying coefficients. The problem is formulated in terms of a Hill-type infinite determinant, which must vanish if a nontrivial solution is to exist. It is shown that the infinite determinant is equal to a finite sum of known hyperbolic functions. The characteristic polynomial of the system can be extracted from the sum of hyperbolic functions. Results of calculations of the aeroelastic stability of a helicopter rotor in forward flight are in qualitative agreement with experimental and numerically derived data. (Author)

A70-44564 # Unsteady aerodynamics of stationary elliptic cylinders in subcritical flow. V. J. Modi and E. Wiland (British Columbia, University, Vancouver, Canada). *(American Institute of Aeronautics and Astronautics and Canadian Aeronautics and Space Institute, Subsonic Aero- and Hydro-Dynamics Meeting, Ottawa, Canada, July 2, 3, 1969, AIAA Paper 69-745.)* *AIAA Journal,* vol. 8, Oct. 1970, p. 1814-1821. 23 refs. National Research Council Grant No. A-2181; Defence Research Board Grant No. 9550-38.

Experimental study of the aerodynamics of a set of two-dimensional elliptic cylinders (with eccentricities of 0.8 and 0.6) in the organized wake condition. The dynamic calibration of the transducer used for measurement of fluctuating pressures is described in detail. The data on Strouhal number, unsteady pressures, and wake geometry are presented as a function of angle of attack during a static condition of the models. The effect of Reynolds number on the fluctuating pressure is also examined. The results indicate a dependence of the unsteady forces on the Reynolds number at zero angle of attack. Basing the Strouhal number on projected width appears to reduce its dependence on the angle of attack of the models. The existence of a large phase angle between the fluctuating pressures is of interest. The wake geometry study indicates a gradual reduction in the ratio of the lateral to the longitudinal spacing with increasing angle of attack. (Author)

A70-44566 # Two-phase plume impingement effects. A. J. Laderman, C. H. Lewis, and S. R. Byron (Philco-Ford Corp., Newport Beach, Calif.). *AIAA Journal,* vol. 8, Oct. 1970, p. 1831-1839. 16 refs. Contract No. AF 04(694)-67-C-0051.

Experimental determination of the particle inpingement forces and damage produced on flat surface plate models located at several angles of impingement in a controlled two phase flow. Tests were conducted with a two phase, supersonic wind tunnel using helium carrier gas and micron-sized aluminum oxide particles accelerated to velocities ranging from 1300 to 2300 m/sec. The particle mass flux incident on the target ranged from 0.4 to 2.6 g/sq cm-sec which corresponds to conditions typical of the near field of solid-propellant motors. Target materials included stainless steel and several typical ablators. The most significant experimental result was the discovery that for this range of mass flux, a debris layer formed immediately ahead of the target, partially shielding it from subsequent impact by incoming particles. Z.W.

A70-44581 # Boundary-layer transition and dynamic sting interference. L. E. Ericsson and J. P. Reding (Lockheed Missiles and Space Co., Sunnyvale, Calif.). *AIAA Journal,* vol. 8, Oct. 1970, p. 1886-1888. 9 refs.

Discussion of boundary-layer transition and dynamic sting interference taking into consideration an investigation conducted by Wehrend (1963). Results obtained by Wehrend are examined and a study of Ericsson and Reding (1968) concerning the effect of a bulbous base is considered. Boundary-layer transition effects on sharp cone stability are shown and boundary-layer transition Reynolds numbers for cones are presented. G.R.

A70-44583 * # Flow with M(infinity) = 1 past thin airfoils. John R. Spreiter (Stanford University, Stanford, Calif.) and Stephen S. Stahara (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *AIAA Journal,* vol. 8, Oct. 1970, p. 1890-1893. 8 refs. Contract No. NAS 2-5410.

Discussion of pressure distributions for airfoils in flow with freestream Mach number equal to, or near, unity. Some expressions for the calculation of pressure which are convenient for numerical computation are presented. Results for the airfoils tested by Michel et al. (1953, 1954) using the exact equations to describe the airfoil ordinates are obtained. The discrepancies that appear near the investigated. The local value is determined by approximating the real field with conical flow on the local secant cone, plus a Prandtl-Meyer expression around the point to reach the local slope value. M.M.

A70-44584 # Determination of axial gradient effects in freejet flows. A. G. Keel, Jr. and R. N. Zapata (Virginia, University, Charlottesville, Va.). *AIAA Journal,* vol. 8, Oct. 1970, p. 1893-1895. Grant No. AF AFOSR 69-1798.

Description of an empirical technique for assessing the influence of axial flow gradients in free jets on the measurements of drag coefficients of slender blunted cones at zero angle of attack. Specific results obtained for low-density flows are used to predict the values of the drag coefficient for the case of a uniform flow characterized by the flow parameters at the nose of the cones. The proposed method for interpreting experimental results obtained with freejet flows in terms of equivalent uniform flows is considered to be far superior than attempting to correlate the data in terms of the average values of flow parameters. T.M.

A70-44596 New versions of TF41 designed. Michael L. Yaffee. *Aviation Week and Space Technology,* vol. 93, Oct. 19, 1970, p. 42, 43, 46, 47.

Description of the design features and performance of new improved-power and reduced-weight versions of the Allison/Rolls-

Royce TF41 turbofan engine. An advanced afterburning version designated Model 912-B23 offers a takeoff thrust of 25,000 lb compared with 15,000 lb for the nonafterburning TF41-A-2 turbofan engine that powers the Navy-LTV Aerospace A-7E attack aircraft. A new nonafterburning version of the advanced TF41 offers a takeoff thrust of 17,200 lb and is designated Model 912-B28. An alternative offered by the Model 912-B23 is a 5 to 8 per cent decrease in specific fuel consumption if the user accepts the present takeoff thrust of 15,000 lb. The final design weight of the Model 912-B23 is 3,439 lb with afterburner and thrust reverse. The reduced length and weight of the compressor sections permit an increase in fuel tankage in the B-28 version where no afterburner is used. Bypass ratios, airflows, compression ratios, temperatures, fuel consumption, and design details are examined. T.M.

A70-44610 * # New materials for manned spacecraft, aircraft, and other applications. Matthew I. Radnofsky (NASA, Manned Spacecraft Center, Houston, Tex.). *International Astronautical Federation, International Astronautical Congress, 21st, Konstanz, West Germany, Oct. 4-10, 1970, Paper.* 26 p. 8 refs.

Review of flame-resistant nonmetallic materials developed for manned space applications, aircraft and other applications. Although the overall objective of fireproofing a spacecraft cabin and an aircraft interior are similar, there are some significant differences. Thus spacecraft to date have operated with a 100-percent-oxygen environment, whereas most aircraft operate with an air environment. This circumstance permits the use in spacecraft of only those few materials that will not burn in oxygen. However, many important considerations for selection of materials for aircraft are of lesser importance to spacecraft. Foremost among these considerations are durability and esthetic quality. In this area, functional utility for the duration of a single mission is basically all that has been required for the spacecraft. With the advent of longer space missions, the differences in these requirements for aircraft and spacecraft become smaller. Many of the flame-resistant materials that have resulted from the Apollo program and from continuing studies appear to be particularly applicable to aircraft, ground vehicles, and house and building structures. The potential for combining several of the materials to obtain additional desirable properties remains virtually untapped. M.V.E.

A70-44623 * Space shuttle transition to cruising flight. Robert F. Stengel (MIT, Cambridge, Mass.). *International Astronautical Federation, International Astronautical Congress, 21st, Konstanz, West Germany, Oct. 4-10, 1970, Paper.* 36 p. 13 refs. Contract No. NAS 9-10268.

Investigation of the rotational control in the presence of pitchup instability of the space shuttle during transition to cruising flight. Using a steepest descent optimization, transition trajectories which minimize operation within an unstable region have been examined, and the results are used to study the problem of longitudinal rotational control. Angle of attack is the control variable for these trajectories. The control profile is chosen to minimize load factor and terminal-state cost, subject to a penalty in the unstable region. The problem of finding the elevator deflection which yields the right angle of attack is solved by computing the inverse rotational equation. This provides an elevator deflection which rotates the spacecraft to follow the desired angle of attack closely. Using this elevator deflection, the sensitivity of the trajectory to a number of parameters, including transition duration, moment of inertia, high-angle-of-attack constraint control, and initial condition errors is assessed. M.V.E.

A70-44648 # Microwave radiometry and its applications. Philip J. Caruso, Jr. (Spectran, Inc., Hollywood, Calif.). *International Astronautical Federation, International Astronautical Congress, 21st, Konstanz, West Germany, Oct. 4-10, 1970, Paper.* 29 p.

Discussion of microwave radiometry and its applications for aircraft navigation and landing aids, pollution surveillance, meteorology, and oceanology. It is pointed out that microwave radiometry is extremely sensitive to the composition of the material as well as its thermometric temperature. The apparent temperatures from various materials which might be observed when looking at the earth from a satellite are discussed. Examples of the application of microwave radiometry in space are considered, and a summary of the various uses of microwave radiometry for meteorological data is given. A completely designed multibeam scanner which could be used as a low-visibility landing aid is described. G.R.

A70-44668 # Investigation of a wave-rider at low Reynolds numbers (Untersuchung eines Wellenreiters bei kleinen Reynoldszahlen). G. Hefer (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *International Astronautical Federation, International Astronautical Congress, 21st, Konstanz, West Germany, Oct. 4-10, 1970, Paper.* 28 p. 8 refs. In German. (AVA-FB-7029)

Study of the effect of small Reynolds numbers on the aerodynamic properties of wave-riders taking into consideration tests with a Nonweiler-wing under rarefied flow conditions. Pitot pressure measurements in the flow field, static pressure measurements, and force measurements were conducted in the slip flow region at Mach numbers of about 11.5 and Reynolds numbers in the range from 5000 to 50,000. G.R.

A70-44733 # Influence of the turbulator element on the local heat transfer from a plate in a flow transition region (Vliianie turbuliziruiushchego elementa na lokal'nuiu teplootdachu plastiny v perekhodnoi oblasti techeniia). N. V. Zozulia and B. L. Kalinin (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). *Teplofizika i Teplotekhnika,* no. 17, 1970, p. 55-58. 9 refs. In Russian.

Experimental data for the drag and local heat transfer on a smooth plate with single flat rectangular baffle plates of different heights positioned within the flow transition region in the boundary layer. Measurements were made for incident flow velocities from 13.8 to 21.5 m/sec. The results show that the length of the separation region does not depend on the incident flow velocity. This is explained by the presence of several vortices behind the baffle which have relatively constant dimensions for different flow velocities. T.M.

A70-44735 # Comparison of different methods for calculating velocity fields in turbine stages (Sravnenie razlichnykh metodov rascheta polei skorostei v turbinnykh stupeniakh). Iu. I. Shvets (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) and Iu. N. Zdorenko (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR). *Teplofizika i Teplotekhnika,* no. 17, 1970, p. 72-77. In Russian.

Evaluation of different methods for solving systems of nonlinear partial differential equations describing the flow of gas through individual regions of the working section in jet and gas turbine engines. Attention is given to steady compressible axisymmetric flow in a region having a piecewise smooth boundary. Solutions are based on equations of motion, energy, state, and continuity, and methods of determining velocity fields are compared. The boundary value problem is solved using a semifixed grid. Methods based on previous specification of the stream line function are described, and ranges of validity of different techniques are delineated. T.M.

A70-44737 # Investigation of heat exchange processes in cooled gas turbine blades (Issledovanie protsessov teploobmena v okhlazhdaemykh lopatkakh gazovykh turbin). S. Z. Kopelev, S. V. Gurov, and M. V. Avilova-Shul'gina. *Teplofizika i Teplotekhnika,* no. 17, 1970, p. 97-104. 9 refs. In Russian.

Study of heat exchange processes at the trailing edges of air-cooled gas turbine blades over a wide range of blade wall

temperatures and gas and air Reynolds numbers and temperatures. It is shown that at gas Reynolds numbers (calculated on the basis of gas parameters in a narrow section of the interblade clearance with the blade chord taken as the characteristic linear dimension) decreasing below 500,000 the extent of the laminar boundary layer region on the blade profile increases significantly both on the convex and the concave sides; for nonseparated flow it can extend all the way to the trailing edge. Criterial relationships for heat exchange from the gas and air are given which can be used to determine the temperature of the trailing edge with an accuracy sufficient for practical applications. T.M.

A70-44742 # Temperature distribution in the cylinder of an aircraft internal combustion rotary engine with air cooling (Raspredelenie temperatur v tsilindre aviatsionnogo zvezdoobraznogo dvigatelia vnutrennego sgoraniia s vozdushnym okhlazhdeniem). V. A. Asmalovskii, I. M. Vedeneev, M. K. Iliukhin, V. I. Sachek, and M. V. Strodomskii (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). *Teplofizika i Teplotekhnika,* no. 17, 1970, p. 152-156. In Russian.

Experimental study of the temperature distribution in the cylinders of a four-cycle, nine-cylinder, air-cooled rotary piston engine on a test bed. The cooling air flow came from a fan followed by an orienting lattice and a diffusor. The largest number of thermocouples and air pressure sensors was mounted on the first cylinder; altogether, measurements involved 172 thermocouples and 33 sensors for air pressure and temperature and metal temperature. The efficiency of the cooling system for a stationary thermal regime was studied in a wide range of loads, rotor revolutions, ignition timing settings, and supercharging pressures. The results of measurements are given in the form of temperature fields plotted along both the contour and the cross section of cylinders. T.M.

A70-44744 # Effect of nonsteady avionic cooling air environments on electronic part reliability. Donald M. Cawthon (Martin Marietta Corp., Orlando, Fla.). In: Failure analysis; Institute of Electrical and Electronics Engineers, Annual Seminar, 3rd, University of Pennsylvania, Philadelphia, Pa., May 21, 1970, Proceedings. Philadelphia, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 1-9. 9 refs. Contract No. N 62269-68-C-0469.

Discussion of the results of a recently completed comprehensive test program carried out to determine the effect of avionic cooling air variations on the thermal and electrical parameters of electronic parts. The test program was conducted in a special facility that subjected sample parts to typical thermal environments of aircraft equipment for up to 4000 hr. The main objectives of the test program were to identify those test parameters that affect parts reliability, to identify the effect on parts reliability, and to identify which of those characterization parameters were the most indicative of impending part failure. The test results identified the key failure-indicating parameters of transistor components and show that parts operated at constant temperatures even 100 F higher than the maximums for temperature-cycled parts have a life expectancy six or seven times greater than that of the latter. Overall, the study indicates the need for more realistic specifications for high-reliability avionic parts and for improved cooling methods. O.H.

A70-44760 * Emerging trends in aeroelasticity. I. E. Garrick (NASA, Langley Research Center, Hampton, Va.). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 314-320. 16 refs.

Discussion of the various new aeroelastic and aerothermoelastic problems associated with the development of the winged, interorbital space shuttle vehicle. The few very briefly discussed topics include panel flutter, application of automatic steering and control systems for improving the aeroelastic and aerodynamic stability, and applications of nonstationary lifting surface theory. With respect to the latter theory, Houbolt's (1969) discrete lattice-type approach, Cunningham's (1966) flutter calculation using the supersonic kernel function method, and Landahl and Ashley's (1969) analysis of nonlinear effects at transonic and hypersonic speeds are briefly reviewed. M.V.E.

A70-44761 On the unsteady aerodynamic loading of wings with control surfaces. H. Ashley (Stanford, University, Stanford, Calif.) and W. S. Rowe (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 321-330. 35 refs. Contract No. AF 44(620)-68-C-036.

Problems and prospects are discussed for the solution of Küssner's integral equation of subsonic lifting surface theory, as it might be adapted to wings with control surfaces and other slope discontinuities. Guided by a recent theorem of Landahl formulae are given which should provide the basis for computer mechanization of the solution process. New results are developed to cover the special situation where the control hingeline extends to the tip of the lifting surface. An existing computer program is described which introduces the proper singularities into the unsteady loading problem in forms suggested by Landahl. Applications are presented to steadily-deflected full-span flaps, which include favorable comparisons both with test data and with the required hingeline singularities. An approximate scheme is suggested for improvement of the control surface pressure through introduction of the local velocities over the wing due to thickness effects. (Author)

A70-44762 Recent advances accomplished by ONERA in the field of aeroelasticity (Progrès récents effectués à l'ONERA dans le domaine de l'aéroelasticité). Gabriel Coupry (ONERA, Paris, France). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 330-338. 9 refs. In French.

Review of some recent activities of ONERA, Paris, in the field of aeroelasticity. The specific objects of these activities include the optimization of lifting surface calculation methods, development of a technique for calculating pressure fields induced by control surface vibrations, an improved method for calculating the transfer functions of an elastic aircraft in isotropic turbulence, and analyses of some panel flutter problems. The brief discussion of these topics provides an overall view of the philosophy of each new approach. The studies pertaining to this research are in variously advanced stages of progress. M.V.E.

A70-44763 High subsonic and transonic effects on pressure distributions measured for a swept wing with oscillating control surface. H. Bergh, H. Tijdeman, and R. J. Zwaan (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 339-347. 16 refs.

Discussion of measured pressure distributions in the transonic range on a swept wing model with a harmonically oscillating control surface. Special attention is given to the influence of Mach number, finite control surface span, and wing incidence on the unsteady pressure distribution. It is shown that, at high subsonic to low supersonic speeds and for the frequency (about 120 Hz) considered, the steady flow has a substantial influence on the unsteady pressure distribution. It is pointed out that, as the steady flow changes rapidly with free-stream Mach number and angle of attack, it is advisable to perform experiments at all values of interest, in order to include the essential factors of the pressure distribution. M.V.E.

A70-44764 Theoretical treatment of aeroelastically excited vibrations of circular cylindrical structures in the presence of periodic vortex excitation (Zur theoretischen Behandlung aeroelastisch erregter Schwingungen kreiszylindrischer Konstruktionen bei periodischer Wirbelanregung). Hans Förscher (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 347-359. 10 refs. In German.

Discussion of the theoretical principles underlying the analytical treatment of aeroelastic stability for three-dimensional structures with circular cross section at Reynolds numbers giving rise to periodic Kármán vortex excitation. The vibration-generating generalized forces are formulated on the basis of the aerodynamic strip theory with the aid of two-dimensional loft coefficients experimentally determined for cylinders, and the vibration problem is

treated as an aeroelastic resonance problem. The validity of the analytical treatment is in the process of corroboration by appropriate experimental investigations. M.V.E.

A70-44765 Interfering lifting surfaces in subsonic flow. Boris Laschka (Vereinigte Flugtechnische Werke-Fokker GmbH, Munich, West Germany). *(NATO, AGARD, Structures and Materials Panel Meeting, 29th, Istanbul, Turkey, Sept. 28-Oct. 8, 1969.) Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 359-368. 36 refs.

Consideration of the problems of analytical treatment of aerodynamic interferences elicited by lifting surfaces harmonically vibrating in a flow of subsonic speed range. Analytical solutions for a nonplanar lifting surface and for multiple interfering lifting surfaces are derived on the basis of the linearized unsteady lifting surface theory with the aid of the kernel function method. The practical application of the procedures involved is demonstrated by means of a few specific calculation examples. M.V.E.

A70-44766 Problem of orthogonality of the eigenmodes of aircraft vibrations (Zur Frage der Orthogonalität der Eigenschwingungsformen von Flugkörpern). Hans Försching and Karl Stolze (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *(Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 2nd, Bremen, West Germany, Sept. 22-24, 1969.) Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 368-375. 7 refs. In German.

Discussion of the orthogonality of the eigenmodes of aircraft vibrations, based on the results of ground vibration measurements carried out on an F 104 G aircraft. First, the complete matrix of the generalized masses is calculated with the aid of the theoretical mass distribution and the measured eigenmode amplitudes. The obtained results are then used for a detailed discussion of the orthogonality of the measured eigenmodes and an examination of the accuracy of the generalized masses. M.V.E.

A70-44767 Determination of the coupling terms and equations of motion for a flight structure composed of several elastomechanical subsystems (Bestimmung der Kopplungsglieder und der Bewegungsgleichungen einer aus mehreren elastomechanischen Teilsystemen zusammengesetzten Flugkonstruktion). Elmar Breitbach (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 376-385. 8 refs. In German.

The theoretical relations for the determination of the vibration behaviour of an elastomechanical system, for instance a flight construction, which is composed of several substructures, the dynamic parameters of which are known, are presented. The governing dynamic equations are formulated in terms of normal coordinates and the coupling terms appearing in the energy equations of the composite structure are derived first for the general case and after that for some practical important coupling conditions. The applicability of the described method is investigated for two examples, first for the elastic coupling of two simple two-degree-of-freedom systems and secondly for the problem of an elastic coupling of two tiptanks on the wings of an aircraft. (Author)

A70-44768 Measurements of pressure distributions about a harmonically vibrating sweptback wing with two control surfaces in incompressible flow (Druckverteilungsmessungen an einem harmonisch schwingenden Pfeilflügel mit zwei Rudern in inkompressibler Strömung). Hermann Triebstein and Joachim Wagener (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Sept.-Oct. 1970, p. 385-393. 12 refs. In German.

Discussion of the measurement results of unsteady pressure distributions obtained for a harmonically vibrating sweptback wing with two control surfaces in incompressible flow, in the 3-m subsonic wind tunnel of Göttingen. Special attention is devoted to the close examination of the pressure singularities at flap edges and the interferences between fixed and flap (i.e., control) surfaces that occurred following the numerous variations of vibration eigenmodes. M.V.E.

A70-44799 The H2 hypersonic wind tunnel of the DFVLR at Porz-Wahn (Der Hyperschallwindkanal H2 der DFVLR in Porz-Wahn). Alfred Heyser, Heinrich Pfeiffer, and Hermann-Josef Schepers (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Gasdynamik, Porz-Wahn, West Germany). In: Nordrhein-Westfalen, Landesamt für Forschung, Yearbook (Nordrhein-Westfalen, Landesamt für Forschung, Jahrbuch). Düsseldorf, Landesamt für Forschung, 1969, p. 301-332. 7 refs. In German. (DFVLR-SONDDR-19)

Description of the design of a new large hypersonic wind tunnel for the Mach number range from M = 5 to 12 and measurement times up to 120 sec. The diameter of the measurement section of the tunnel is 60 cm. The tunnel has three contoured nozzles for Mach numbers of 6.0, 8.7, and 11.2. The new tunnel is intended to supplement the existing flow-engineering test devices of the DFVLR (German Research and Testing Institute for Aero- and Astronautics) and will be used in fundamental investigations of hypersonic flows and in the development of hypersonic aircraft and recoverable booster systems. The initial results of functional tests of the wind tunnel are presented. A.B.K.

A70-44843 # A V/STOL guidance and control system with bad weather landing capability. Gerhard Schweizer and Günther Schmidt. *Dornier-Post* (English Edition), no. 3, 1970, p. 11-16.

Discussion of the required characteristics and operational functions of a V/STOL guidance and control system which can be used under adverse weather conditions. A general discussion is given on the constraints and demands imposed by the location of future V/STOL ports, integration into overall air traffic, military aspects, guidance procedures at terminal areas, airborne instrumentation, and manual and automatic controls. Landing approach patterns are discussed in terms of beacon locations and flight paths. Airborne display systems are considered, and additional automatic control functions required to augment manual operations are outlined. T.M.

A70-44851 * History of NACA/NASA rotating-wing aircraft research, 1915-1970. I. Frederic B. Gustafson (NASA, Langley Research Center, Flight Mechanics and Technology Div., Hampton, Va.). *VertiFlite,* vol. 16, June 1970, p. 4-11. 11 refs.

Review of rotating-wing aircraft research conducted by NACA/NASA during the time from 1915 to 1935 taking into consideration the development of the autogyro and the helicopter. Studies during the period from 1915 to 1930 are considered giving attention to aspects of dissatisfaction with the helicopter leading to autogyro developments. It is pointed out that the autogyro was in fact so successful as to largely displace the helicopter in NACA's work for about 15 years. Research during the period from 1931 to 1935 is discussed, and objectives in the development of the autogyro as a means to increase the safety of flight are examined. G.R.

A70-44852 * History of NACA/NASA rotating-wing aircraft research, 1915-1970. II. Frederic B. Gustafson (NASA, Langley Research Center, Flight Mechanics and Technology Div., Hampton, Va.). *VertiFlite,* vol. 16, July 1970, p. 10, 11, 14, 15.

Survey of research and development work conducted by NACA in the area of rotating-wing aircraft during the period from 1935 to 1940. Flight tests conducted with several models of autogyro aircraft are recounted, and cooperation with the industry toward the development of rotary-wing aircraft is outlined. Research on rotor blade dynamics is described, and the contemporary experience with hingeless (rigid) rotors is characterized. Detailed technical progress is illustrated with examples of conclusions gained from ground mea-

surements, flight tests, and theoretical research. Problems encountered with autogyro aircraft are explained to illustrate the reasons for a shift in interest toward helicopters. T.M.

A70-44853 * History of NACA/NASA rotating-wing aircraft research, 1915-1970. III. Frederic B. Gustafson (NASA, Langley Research Center, Flight Mechanics and Technology Div., Hampton, Va.). *VertiFlite,* vol. 16, Sept. 1970, p. 10, 11, 14, 15.

Discussion of NACA/NASA rotating-wing aircraft research conducted during the time from 1940 to 1955. It is pointed out that the research effort in this period had certain advantages compared to the early 1930s. One advantage was the availability, prior to even the wind-tunnel hardware, of advanced helicopter theory developed in-house. Another was the contact with the developing helicopter industry. Work connected with the exploration of rotor characteristics is discussed giving attention to the guiding theory involved and to the conduction of the full-scale tunnel tests. G.R.

A70-44854 SA-341 Gazelle. René Mouille (Société Nationale Industrielle Aérospatiale, Paris, France). *VertiFlite,* vol. 16, Oct. 1970, p. 2-6.

Discussion of the SA-341 Gazelle, a light and fast helicopter which was developed to fulfill French and British military requirements. Gazelle is a 3-bladed single-rotor helicopter equipped with a Turbomeca 600 hp Astazou III N engine mounted above the airframe aft of the rotor shaft. A shrouded tail rotor, an extremely distinguishing feature, provides the antitorque function. Performance, flight characteristics, technological particulars, and design features are discussed. G.R.

A70-44855 Weighing the eventuality of high-intensity conflict. H. I. Lukens (U.S. Army, Material Command, Washington, D. C.). *VertiFlite,* vol. 16, Oct. 1970, p. 8-11.

Discussion of the various functions aircraft would be required to perform for the army in the event of a battle in a high-intensity conflict in the 1975-85 timeframe. Demands for providing rapid transportation and improved airlines of communications are related to the wide dispersion and the great depth which would be characteristic for the future battlefield. Requirements for intelligence acquisition by Army aviation are considered. Organizational aspects including integration of aircraft into ground units are discussed. The characteristics of aircraft best capable to perform the various functions of Army aviation are examined. It is pointed out that the modern Army is justifiably impressed with the central importance of VTOL to Army tactical operations - both on the present and the future battlefield. It is stated, however, that high priority must be given to major improvements in the operational systems themselves as well as patterns of tactical employment. G.R.

A70-44856 * History of NACA/NASA rotating-wing aircraft research, 1915-1970. III Cont'd. Frederic B. Gustafson (NASA, Langley Research Center, Flight Mechanics and Technology Div., Hampton, Va.). *VertiFlite,* vol. 16, Oct. 1970, p. 14-18, 24. 8 refs.

Discussion of NACA/NASA rotating-wing aircraft research taking into consideration work in the field of rotor dynamics and investigations concerned with flying qualities of the aircraft. Hovering tests, rotor flow studies, and work on rotor airfoils are discussed. It is pointed out that important basic contributions were made in the field of rotor dynamics. Work on ground resonance, the development of dynamic models, and the investigation of loads, stresses, and design conditions are considered. The construction of a helicopter test tower is reported. G.R.

A70-44857 The development of columnar grain and single crystal high temperature materials through directional solidification. Francis L. Versnyder and M. E. Shank (United Aircraft Advanced Materials Research and Development Laboratory, Middletown, Conn.). *Materials Science and Engineering,* vol. 6, Oct. 1970, p. 213-247. 58 refs.

Discussion of a new precision casting technique using directional solidification in the production of columnar grain and alloy single crystal gas turbine components from high-temperature nickel-base materials. The advantages of products obtained by this technique are listed as a superior thermal shock resistance, a longer cyclic strain life, a longer creep life, a better intermediate temperature ductility, and good thin-wall properties. The developments in the field of this new technique covering a 7-year research and test period are reviewed. The engineering properties of the products, such as structure orientation and heat treatment, tensile, stress-rupture, fatigue, and creep properties, are discussed in detail. The engine simulation tests conducted are described. V.Z.

A70-44860 The MADAP air traffic control system (Le système de contrôle de trafic aérien 'MADAP'). Dominique Lauras (ECA - Automation). *Automatisme,* vol. 15, Sept. 1970, p. 416-422. In French.

Description of the proposed MADAP system designed for air traffic control over Belgium, Holland, and the Federal Republic of Germany. The MADAP system, with its eight computers, is designed to relieve the traffic controller of the routine part of his work, leaving him completely free to handle any situation requiring his experience and judgment. A detailed description is given of the passage of data through the various stages of this system, which will be one of the largest real-time data processing systems in Europe. The realization of a system of this magnitude requires the use of modular programming, with the total system being divided into subfunctions in such a way that each subfunction corresponds on the average to a programming module consisting of three to four thousand instructions. A.B.K.

A70-44991 # Analytical method for determining the aerodynamic shape of an axisymmetrical nozzle (Metodo analitico per la determinazione del profilo aerodinamico di un effusore a simmetria assiale). Nicola Bellomo (Torino, Politecnico, Turin, Italy). *L'Aerotecnica,* vol. 49, June-Dec. 1970, p. 47-53. In Italian.

Investigation of the problem of finding an analytical method for the design of the aerodynamic shape of an axisymmetrical nozzle. In particular, it was possible to determine, using the method of characteristics, the shape of a nozzle able to convert a conical flow from source 0 into an axially uniform flow. The method is valid even if the original flow is not conical. It is not possible to obtain an exact solution of the problem since the equations of characteristics have not yet been solved for the case of an axisymmetrical flow. Taking this fact into account within the range investigated, the change in direction of velocity can be neglected with respect to the changes in velocity itself and assuming consequently that the direction of velocity does not change along the characteristics. The results obtained are stated to be more accurate than those of previous studies. M.M.

A70-44993 # Integral equation for the aerodynamic calculation of propellers (Un'equazione integrale per il calcolo aerodinamico delle eliche). Vincenzo Giordano (Napoli, Università, Naples, Italy). *L'Aerotecnica,* vol. 49, June-Dec. 1970, p. 65-68. In Italian.

Investigation of the problem of calculating circulation along a propeller blade in hovering or at zero advance ratio. The difficulty of solving a singular integral equation has been obviated by reducing the original singular equation to a new nonsingular integral equation particularly suitable to solution by means of an electronic computer. M.M.

A70-45000 # Methods, equipments and facilities for aeromechanical measurements (Metode, aparate şi instalaţii de măsură în aeromecanică). Al. Marinescu. Bucharest, Editura Academiei Republicii Socialiste România, 1970. 352 p. 100 refs. In Rumanian.

A book dealing with the principal methods, equipments and facilities used in aeromechanical measurements is offered to aero-

nautical engineers, students, and researchers. Fundamental theoretical concepts of compressible and incompressible fluid flows are discussed, together with flight equipment flow. Concepts for the calculation and construction of an experimental facility used in aeromechanical measurements are described. The facility consists of subsonic, transonic, supersonic and hypersonic wind tunnels as well as shock tubes, aerodynamic shock tubes, adiabatic and ballistic facilities, and the like. Methods and equipments used for measuring current parameters in wind tunnels as well as current pressure, direction and velocity, Mach number, temperature, and degree of turbulence, are described. The principal methods for viewing fluid flows around bodies, and the implications of viewing in some measurers are discussed. An experimental determination of the aerodynamic forces and moments of bodies by means of pressure measurements and using aerodynamic balances, is described. A method and equipment for measuring some stability and control characteristics of flight equipment, as well as some aeroelastic characteristics of structures, are discussed. M.M.

A70-45019 Aerodynamic heating of lifting bodies (Aerodinamicheskoe nagrevanie nesushchikh tel). G. I. Maikapar (Akademiia Nauk SSSR, Moscow, USSR). In: International Astronautical Federation, Congress, 19th, New York, N.Y., October 13-19, 1968, Proceedings. Volume 3 - Propulsion re-entry physics. Edited by Michał Łunc. Oxford, Pergamon Press, Ltd.; Warsaw, Państwowe Wydawnictwo Naukowe, 1970, p. 325-335. 9 refs. In Russian.

Analysis of the thermal flux distribution on the surface of flight vehicles using aerodynamic lift. The dependence of maximum aerodynamic efficiency on drag and the Mach number at zero angle of attack is discussed. Experimental curves are plotted for thermal flux distribution over the cross section of an elliptical cone, over the plane surface section of a halfcone, over the cross section, upper surface and symmetry axis of a triangular plate, and over the upper surface of a pyramidal wedge. It is shown that at supersonic speed thermal flux maxima can occur on the lower surface of a flight body under slipstream conditions and on the upper surface when the airflow is separated. V.Z.

A70-45021 Bodies of revolution with a minimum head drag coefficient and low heat transfer at high supersonic flight speeds (Tela vrashcheniia s minimal'nym koeffitsientom lobovogo soprotivleniia i maloi teploperedachei pri bol'shikh sverkhzvukovykh skorostiakh poleta). G. L. Grodzovskii (Akademiia Nauk SSSR, Moscow, USSR). In: International Astronautical Federation, Congress, 19th, New York, N.Y., October 13-19, 1968, Proceedings. Volume 3 - Propulsion re-entry physics. Edited by Michał Łunc. Oxford, Pergamon Press, Ltd.; Warsaw, Państwowe Wydawnictwo Naukowe, 1970, p. 441-454. 32 refs. In Russian.

Application of a modified Newtonian theory and the theory of self-similar hypersonic flows to a study of the optimal geometrical configuration of bodies of revolution in terms of a minimum head drag coefficient at hypersonic speeds. The geometry of a body of revolution with minimum drag is determined and discussed. Heat transfer from a hypersonic flow into a body of revolution of exponential geometry is studied. It is found that the heat transfer coefficients of bodies of revolution with exponential geometry is much lower than that of a comparable cone. Experiments indicate that the results of this study are valid also at moderately supersonic flight speeds. V.Z.

A70-45044 An economical approach to advanced air traffic control processing and display. James Perry (Cutler-Hammer, Inc., Deer Park, N.Y.). *Interavia,* vol. 25, Oct. 1970, p. 1262-1264.

Description of the equipment and operational functions of some low-cost ATC processing and display systems for unprocessed prime radar data and secondary surveillance radar (SSR) data. The purpose of the new system is to provide the air controller with improved display of data from prime radar and SSR inputs. The SSR data provides the controller with the aircraft identity and altitude displayed numerically in association with the target position symbol. Center marked position symbols and target trail history are synthetically generated for both the primary and SSR inputs. Map data can be provided by optical rear-port projection through the CRT to very tight registration tolerances. The system will process all targets within coverage up to several thousand aircraft. A typical system consists of a dual SSR interrogator receiver, synchronizer coder, defruiter (interference blanker), azimuth digitizer, primary radar digitizer (extractor), SSR digitizer (extractor), correlator and output unit, display processor, computer interface, and display consoles. T.M.

A70-45093 # Measurement of spatial flow and of the blade pressures in an axial compressor, taking into consideration the flow close to the wall, with the aid of digital data processing and test guidance (Messung der räumlichen Strömung und der Schaufeldrücke in einem Axialverdichter unter Berücksichtigung der wandnahen Strömung mit Hilfe einer digitalen Datenerfassung und Versuchsablaufsteuerung). Karl Rubner. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 196 p. 26 refs. In German.

Discussion of experimental investigations of the three-dimensional flow and the blade pressure in an axial-flow compressor which were conducted in order to examine the correctness of certain assumptions made by Bitterlich (1969) and Keusenhoff (1966) concerning the blade forces directly at the wall of the casing. The design of the experimental compressor used is described and devices employed for making the measurements are considered. The advantages of using a digital system for processing the data obtained in the investigation are discussed and problems of programming and test control are considered. The results obtained confirm the correctness of the approaches used by Bitterlich. Information regarding the three-dimensional flow and the pressure distribution at the turbine blades is presented. G.R.

A70-45095 # Studies of strongly deflecting supersonic retardation cascades and the possibilities of employing them in an axial-flow compressor stage (Untersuchungen an stark umlenkenden Überschallverzögerungsgittern und deren Einsatzmöglichkeiten in der Axialverdichterstufe). Bernard Becker. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 165 p. 54 refs. In German.

An investigation is made of a tandem cascade consisting of two, partly interlocking rows of blades serving, respectively, for supersonic deflection and flow retardation. In considering the further development of this tandem cascade, theoretical and experimental studies are made of the variation of the throttle state, the incident Mach number, the angle of incidence, and several geometrical parameters. A schlieren-optical method is described which makes it possible to visualize and simultaneously distinguish between density gradients of arbitrary direction in the flow by means of a combination of a schlieren diaphragm and color filters. A calculation is made of the application possibilities of the tandem cascade on the basis of an evaluation of hitherto published experimental results regarding supersonic axial-flow compressors. It is shown that by means of a more uniform separation of the compressor into rotor and stator and through the use of the tandem cascade as a stator blade cascade the performance characteristics of an axial-flow compressor stage can be considerably improved. A.B.K.

A70-45096 # Effect of casing and hub wall friction on the three-dimensional flow in axial-flow compressors in compressible working media at subsonic speeds (Der Einfluss der Gehäuse- und Nabenwandreibung auf die räumliche Strömung in Axialverdichtern bei kompressiblem Arbeitsmedium im Unterschall). Walter Bitterlich. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 222 p. 9 refs. In German.

A study is made of the effect of side wall friction on the

three-dimensional flow in axial-flow compressors in compressible working fluids moving at subsonic speeds. It is shown how the casing and hub wall friction affect the three-dimensional flow in axial-flow compressors, how this effect can be described formally with the aid of a few simplifying assumptions, and how even in the presence of a working medium of variable density numerical results can be obtained with tolerable computational labor. For three model stages which are analyzed with respect to the potential vortex numerical solutions are presented and discussed. In addition, the measurement results for a single-stage axial-flow compressor are compared with the values calculated according to the proposed procedure, and in this connection good agreement is obtained. A.B.K.

A70-45097 # **Calculation of aerodynamic coefficients of airfoils and wings on the basis of linear theory with the aid of an analog computer (Berechnung aerodynamischer Beiwerte von Profilen und Flügeln auf der Grundlage der linearen Theorie mit Hilfe des Analogrechners).** Dieter Volk. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 150 p. 26 refs. In German. Research supported by the Landesamt für Forschung des Landes Nordrhein-Westfalen.

The advantages of the analog computer over the digital computer in design calculations of airfoils and wings are illustrated. It is shown that the analog computer lends itself very well to the calculation of aerodynamic coefficients involving the solution of linear and double integrals on the basis of singularity theory. It is further shown how the so-called distance functions figuring in the integrals for the potential and the pressure coefficient can be well represented approximately in spite of the narrowly limited number range of the analog computer. These values can then be directly represented on oscillographs or recording devices and can be evaluated immediately. A.B.K.

A70-45147 # **Torsion of thin-walled elastic structures (Torsiunea structurilor elastice cu pereţi subţiri).** G. V. Vasiliev. Bucharest, Editura Academiei Republicii Socialiste România, 1970. 235 p. 68 refs. In Rumanian.

A theoretical study is made of methods of calculating the strength of thin-walled caisson structures and shells of constant and variable cross section such as aircraft wings. The basic premises of the theory of thin-walled rods of variable cross section and conical shells are outlined, as well as the fundamentals of the calculus of variations required for subsequent development of methods of calculation. A description is given of methods of calculating torsion of box-shaped caisson structures with a skin subjected only to shear. A detailed account is given of a method of calculating conical and cylindrical shells and caissons of arbitrary cross section with allowance for the effect of longitudinal constrained-torsion forces on the skin. A.B.K.

A70-45151 **Life with the boom. II.** D. N. May. *Flight International,* vol. 98, Oct. 8, 1970, p. 563-565.

Survey of recent research on sonic boom generation and propagation, and discussion of observed effects on structures. Boom simulation studies conducted with point-source explosions and line-shaped charges are discussed in terms of observed structural effects on buildings ranging from greenhouses to cathedrals. Measurements taken during the Concorde SST overflights are recounted, and sociopsychological factors of community response are evaluated. T.M.

A70-45154 **Kinematically consistent unsteady aerodynamic coefficients in supersonic flow.** Kari Appa (National Aeronautical Laboratory, Bangalore, India). *International Journal for Numerical Methods in Engineering,* vol. 2, Oct.-Dec. 1970, p. 495-507. 28 refs. Research supported by the National Aeronautical Laboratory.

A finite element method to determine unsteady aerodynamic coefficients, consistent with the stiffness and inertia properties of a lifting surface in supersonic flow, is described. This is basically a kinematic method, which reduces the dynamical equations of a nonconservative system to a simple and elegant form. It is illustrated by application to a delta wing using triangular elements to calculate steady and unsteady lift and moment coefficients. Throughout the calculations only a coarse grid system has been employed and the answers have been compared with available results. (Author)

A70-45192 # **The terrestrial thermal radio-emission field.** A. E. Basharinov, A. S. Gurvich, L. T. Tuchkov, and K. S. Shifrin (Akademiia Nauk SSSR, Institut Fiziki Atmosfery and Institut Okeanologii, Moscow, USSR). (*Akademiia Nauk SSSR, Izvestiia, Fizika Atmosfery i Okeana,* vol. 6, Apr. 1970, p. 366-380.) *Academy of Sciences, USSR, Izvestiya, Atmospheric and Oceanic Physics,* vol. 6, Apr. 1970, p. 210-218. 39 refs. Translation.

Results of theoretical calculations of the outgoing microwave radiation of the earth/atmosphere system. The possibilities of obtaining geophysical data from measurements of microwave radiation from satellites and aircraft are analyzed. A survey is made of the results of aircraft and satellite measurements at the wavelengths of 8.5, 3.4, 1.35, and 0.8 cm in the USSR. A.B.K.

A70-45266 * **Diffraction and reflection of sonic boom waves.** Balusu M. Rao (Texas A & M University, College Station, Tex.) and Glen W. Zumwalt (Wichita State University, Wichita, Kan.). *Journal de Mécanique,* vol. 9, June 1970, p. 309-324. 12 refs. Grant No. NGR-37-002-037.

Development of an analytical method for predicting the pressure-time history of diffracted and reflected sonic boom waves in the vicinity of walls and corners. The feasibility and practical application of this method are demonstrated by applying it to a specific problem offered by a broken window under a roof canopy, broken during a sonic boom test. M.V.E.

A70-45268 **The fundamental equation of aerodynamic noise theory for the case of surfaces in uniform translation motion (L'équation fondamentale de la théorie du bruit aérodynamique dans le cas de surfaces en mouvement de translation uniforme).** Henri Viviand (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Journal de Mécanique,* vol. 9, June 1970, p. 335-350. 17 refs. In French.

Discussion of the theoretical foundations underlying Lighthill's (1952) aerodynamic noise equation giving the density in the acoustic field. The case of flow-bounding surfaces that are stationary in relation to the nonperturbed atmosphere is studied, and Curle's (1955) fundamental equation form for this case is recovered. The same calculation method is applied to the case of surfaces in uniform translation motion, and the fundamental equation pertaining to this case is obtained. It is shown that Kirchhoff's theorem is implicitly contained in this calculation method. M.V.E.

A70-45269 **Ducted propellers - Determination of streamlines in rotational flows (Hélice carénée - Détermination de lignes de jets dans des écoulements rotationnels).** Roland Maria-Sube (CNRS, Centre de Calcul Analogique, Orsay, Essonne, France). *Journal de Mécanique,* vol. 9, June 1970, p. 351-373. 9 refs. In French. Research supported by the Direction des Recherches et Moyens d'Essais.

Description of a method for the solution of the second-order nonlinear partial differential equation involved in the fundamental equation governing rotational subsonic flow through ducted propellers, and for the computation of the free surface downstream

of the shroud. The method needs no linearizing assumptions. It has been tested on two-dimensional problems and applied to axisymmetric flows. M.V.E.

A70-45298 Advanced manufacturing technology in the aero-engine industry. A. H. Meleka (Rolls-Royce, Ltd., Bristol, England). In: International Conference on Product Development and Manufacturing Technology, 1st, University of Strathclyde, Glasgow, Scotland, September 3-5, 1969, Proceedings. Edited by D. S. Ross. London, Macdonald and Co., Ltd., 1970, p. 105-112.

The introduction of modern design concepts involving the use of advanced materials requires corresponding development of manufacturing methods. The conventional techniques of metal cutting, metal forming, and fastening and joining processes are compared with electrochemical machining and electron-beam welding, both of which typify advanced processes of manufacture. The problems associated with the economics of such processes are considered. (Author)

A70-45299 Computer-aided production engineering at Rolls-Royce. S. B. L. Wilson (Rolls-Royce, Ltd., Derby, England). In: International Conference on Product Development and Manufacturing Technology, 1st, University of Strathclyde, Glasgow, Scotland, September 3-5, 1969, Proceedings. Edited by D. S. Ross. London, Macdonald and Co., Ltd., 1970, p. 113-121. 5 refs.

Discussion of the potential involved in the use of numerically controlled machines for controlling the manufacturing process from concept to finished product. The history of computing support for numerically controlled machines in an aeroengine division is described. It is concluded that real computer-aided production engineering is yet to be born: Looking to the future, it is shown that the computer, together with the newer associated devices available (e.g., the graphical display screen) can provide another management tool not only to assist and control the design and manufacture of the product but to bridge the gap between design and production. Z.W.

A70-45349 Plane man's guide through the sky. Peter Lowry (Elliott Flight Automation, Ltd., Rochester, Kent, England). *New Scientist,* vol. 47, Sept. 24, 1970, p. 640, 641.

Description of a binocular head-up display which makes it possible for the pilot to look through the windscreen and, at the same time, to watch instrument and guidance information interposed in his line of sight. The instrument and information are extracted from the appropriate systems in the aircraft and converted by an electronic waveform generator into a moving pattern of lines, symbols, and figures, which are designed to be instinctively understood and harmonize to some extent with the outside scene. The development history and potential applications of this display device outside the aircraft industry are described. Z.W.

A70-45420 # Atmospheric gusts - A review of the results of some recent research at the Royal Aircraft Establishment. J. Burnham (Royal Aircraft Establishment, Bedford, England). *Monthly Weather Review,* vol. 98, Oct. 1970, p. 723-734. 5 refs.

Recent Royal Aircraft Establishment research on gusts has been particularly concerned with severe gusts and the situations in which they occur. In the stratosphere, mountain wave conditions and the vicinity of thunderstorm tops have been investigated. At lower altitudes, gusts in and near thunderstorms have also been studied, as have wind and gust effects likely to be significant during takeoff and landing. The mathematical modeling of severe gusts relevant to aircraft design is described, and the effects of pilot control activity during flight through gusts are considered briefly. Particular emphasis has been placed on two aspects of the work: (1) the study of possible means by which severe gusts might be avoided in aircraft operations and (2) the limitations of existing mathematical models of gusts that are used in aircraft design. Suggestions are made for models that may prove to be both more accurate and more physically plausible. (Author)

A70-45421 # On the possibility of weather modification by aircraft contrails. Wallace B. Murcray (Alaska, University, College, Alaska). *Monthly Weather Review,* vol. 98, Oct. 1970, p. 745-748. 11 refs. NSF Grant No. GA-19475.

The possible effect of contrails in modifying the weather is reconsidered in the light of information obtained from ground-level contrails in Alaska. It appears likely that inadvertent cloud seeding by jet aircraft may be of the same order of magnitude as that attained in commercial cloud seeding operations. Further investigation is needed; but in the meantime, the possibility of contrail contamination should be kept in mind when evaluating the results of seeding operations. (Author)

A70-45428 Naval fluidic applications - Present and future. H. B. Welk, Jr. (U.S. Naval Material Command, Naval Air Development Center, Johnsville, Pa.). *(National Fluid Power Association and Fluid Power Society, Conference on Fluidics, Chicago, Ill., Nov. 1968.) Fluidics Quarterly,* vol. 2, no. 2, 1970, p. 9-16.

Discussion of the development and flight tests of a three-axis stability augmentation system for a CH-46A helicopter and of an approach power compensator for carrier-based aircraft. Both are systems which do not require communication with any other airborne system for operation, and which therefore avoid fluidic-to-electronic interface problems. Several other systems which, however, do communicate with other airborne systems, and which have been selected as candidate systems for fluidic development and integration are also considered. F.R.L.

A70-45436 # Trim changes (O tíživosti). Vlastimil Pokorný. *Zpravodaj VZLÚ,* no. 3, 1969, p. 11-13. In Czech.

Discussion of the exact meaning of the term 'trim changes' with the objective to obtain its accurate definition. A comparison of several definitions is made which shows that the present interpretation of this term does not cover the whole problem area. Based on this analysis, an attempt is made to present an exact definition. O.H.

A70-45437 # Effect of changes in the aircraft geometry on the calculations of some flight characteristics (Vliv změn geometrie letounů na výpočty některých letových vlastností). Vlastimil Pokorný. *Zpravodaj VZLÚ,* no. 3, 1969, p. 15-19. In Czech.

Discussion of some problems involved in calculating longitudinal flight characteristics which are associated with changes in geometry of modern aircraft. It is shown that greater deviations from the 'classical shapes,' such as a decrease in the wing aspect ratio, increase in the horizontal tail, and decrease of its arm, which can be encountered in many modern aircraft, can be a source of inaccurate results obtained by standard methods of computation, as these methods are often based on assumptions which are valid for 'classical geometry' only. O.H.

A70-45438 # Forces and torque acting on an aerofoil in a potential jet (Síly a moment působící na profil v potenciálním paprsku). Zdeněk Škoda. *Zpravodaj VZLÚ,* no. 3, 1969, p. 21-27. 7 refs. In Czech.

Description of a method for determining the flow about an aerofoil in a potential jet by means of electrical analogy. The forces and the torque acting on the aerofoil are determined from the position of the asymptotes of the boundaries of the bent jet. A

method of solving the flow about an aerofoil in a nonhomogeneous vertical stream by means of electrical analogy with a varying depth of the electrolyte is proposed. O.H.

A70-45439 # **Effect of mixing of a jet with the ambient air on an aerofoil with a jet flap (Vliv mísení paprsku s okolním vzduchem na profil s tryskovou klapkou).** Zdeněk Škoda. *Zpravodaj VZLÚ,* no. 3, 1969, p. 29-32. 8 refs. In Czech.

Investigation of the effect of mixing of a jet with the ambient air on the characteristics of the flow around an aerofoil with a jet flap. The problem is solved on the basis of the theory of thin aerofoils and the mixing of the jet with the ambient air is replaced by the equivalent distribution of sinks on the projection of the jet axis on to the x-axis. The variations in the circulation around the aerofoil are found to be very small. Based on experimental measurements, it is shown that mixing causes a change of the sum of velocities above and below the aerofoil. If the linearized theory is used, then this change does not depend on the aerofoil shape and depends on the jet momentum coefficient only. The actual aerofoil with a jet flap is found to be equivalent to a thicker aerofoil, the flow around which is not influenced by the mixing of the jet with the ambient air. O.H.

A70-45441 # **Contribution to the design optimization of aircraft driving units (Příspěvek k optimalizaci konstrukce leteckých pohonných jednotek).** Zdeněk Huječek. *Zpravodaj VZLÚ,* no. 4, 1969, p. 7-16. 7 refs. In Czech.

Discussion of a new method of selection of a propeller for a given engine and aircraft. A method is described which makes it possible to find from the various types of propellers the optimum one which is characterized by minimum dimensions, minimum noise, and maximum performance. The prerequisite for the application of this method is shown to be the knowledge of the basic aerodynamic, acoustic, and other characteristics of different types of propellers. The method is principally applicable, in addition, to other blade machines, if the necessary characteristics of blades or cascades of blades are known. O.H.

A70-45442 # **Determination and simulation of the dynamics of a two-shaft bypass jet engine (Identifikace a simulace dynamiky dvouhřídelového dvouproudového motoru).** Jaroslav Müller. *Zpravodaj VZLÚ,* no. 4, 1969, p. 17-26. In Czech.

Discussion of a method for the mathematical description of the properties of a two-shaft jet engine. By means of this method, the dependence of the angular acceleration on the angular velocity and fuel consumption is determined from the acceleration record of the engine. This dependence is then utilized for direct analog modeling to simulate the engine properties and the combination jet engine-governor. The advantages of this method of expressing the characteristics of the engine are compared to the hitherto used method of description by means of a differential equation. A method of calculation of the coefficients of the differential equation from a derived function of mathematical description of the engine dynamics is also presented. O.H.

A70-45443 # **Stationary aeroelastic cases in the subsonic velocity range (Stacionární aeroelastické případy v podzvukové oblasti rychlostí).** Igor Forman. *Zpravodaj VZLÚ,* no. 5, 1969, p. 7-17. 5 refs. In Czech.

Analysis of stationary aeroelastic cases in the range of the subsonic flow, carried out to provide criteria necessary for designing modern aircraft having the required flight characteristics. To obtain a complex and quantitative determination of these stationary aeroelastic cases, the linearized lifting surface theory is used, and the rigidity of the structure is expressed in terms of influence coefficients. A method of calculating all aeroelastic cases in the subsonic flow range by means of a computer is explained in detail. O.H.

A70-45444 # **Application of a method of flow visualization in combustion chambers to an annular combustion chamber (Aplikace metody zviditelnění proudění ve spalovacích komorách na prstencovou komoru).** Oldřich Schůrek. *Zpravodaj VZLÚ,* no. 5, 1969, p. 19-25. 7 refs. In Czech.

Analysis of the conditions of modeling the various physical and chemical processes taking place in the combustion chamber of a jet engine, with particular attention to a visualization of the flow in this chamber. The experimental work in this field is shown to indicate that simulating makes it possible to obtain information on the pressure loss and the velocity field, and to determine the pattern of flow in the chamber and in the region of maximum temperature gradient behind the chamber. To obtain a realistic flow pattern, it is necessary to use a suitable tracing material which would not distort the streamlines due to its gravitational or inertial forces and which is suitable for taking flow photographs. A modification of an annular combustion chamber for modeling by means of flow visualization is described. O.H.

A70-45446 # **Calculation of the pressure loss of a combustion chamber (K výpočtu tlakové ztráty spalovací komory).** Oldřich Schůrek. *Zpravodaj VZLÚ,* no. 6, 1969, p. 9-26. In Czech.

Description of a simplified method of calculating the pressure loss, flow velocity through the holes of a flare tube, and the law of air supply into the combustion chamber of a jet engine. The method is adapted to the use of a digital computer which enables a more detailed analysis of the flow in combustion chambers to be made. Several examples illustrating the method are presented, and the results are compared with experimental data measured in an annular combustion chamber with fuel spraying by means of a rotating disk. The compared values are found to be in a good agreement. O.H.

A70-45448 # **On aircraft longitudinal motion after boundary layer control system failure during take-off and landing.** Vladimír Šilhánek. *Zpráva VZLÚ,* Oct. 1969. 28 p. 8 refs.

Study of the aircraft longitudinal motion during takeoff and landing, caused by a sudden loss of lift as a result of a failure of the boundary layer control (BLC) system. The critical altitude of BLC failure is first theoretically estimated, and the effect of some parameters is critically analyzed. The problem is solved as a nonclassical variational problem by applying Pontriagin's principle of the maximum. In addition, some experimental results of flight measurements carried out on a test aircraft with BLC by blowing, in which the BLC system failure was simulated, are presented. These experimental results are then compared with the respective results obtained theoretically. O.H.

A70-45500 # **Numerical analysis of combustion in supersonic flows.** P. I. Chushkin (Akademiia Nauk SSSR, Vychislitel'nyi Tsentr, Moscow, USSR). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-52.* 13 p. 13 refs.

The numerical investigation of combustion in supersonic stationary flows of hydrogen-air mixture past bodies is carried out. A two-component model with direct and inverse reaction is assumed for kinetics. The numerical method using characteristic compatibility relations is applied for computations. The structure of combustion zone and the distributions of physical parameters in a flowfield are studied in various cases (cone at zero and nonzero angle of attack, point-nose cylinder, nozzle). (Author)

A70-45504 # **Variable aerodynamic forces in a turbine stage induced by a vane cascade in the wake of a preceding cascade (Peremennye aerodinamicheskie sily v turbinnoi reshetke, vozbuzh-**

daemye posleduiushchim lopatochnym apparatom). A. S. Laskin and I. N. Afanas'eva. *Energomashinostroenie,* vol. 16, July 1970, p. 45, 46. In Russian.

Experimental and theoretical study of the aerodynamic forces produced in a turbine stage by each subsequent vane cascade of a cascade series. Experimental oscillograms are given to show the pressure pulsations and pulsation amplitude variations on the concave and convex surfaces of a cascade sequence. The complex nature of variations in the aerodynamic forces resulting from the interaction between two succesive vane cascades is discussed. V.Z.

A70-45505 # **Calculation of initial deflections in naturally twisted turbine engine blades (Raschet nachal'nykh pogibov estestvenno zakruchennykh lopatok turbomashin).** M. P. Ziuz'ko, V. P. Sukhinin, and L. A. Shor. *Energomashinostroenie,* vol. 16, July 1970, p. 46, 47. 9 refs. In Russian.

Analysis of the deformation of turbine engine blades caused by centrifugal and aerodynamic forces during turbine operation. A theory of twisted rods developed by Shor (1960) is applied to define blade designs with blade cross sections completely free of bending stresses on the axis of the minimum moment of inertia. The results of this study are applicable to turbine blades regardless of the manufacturing technology. V.Z.

A70-45563 **Analysis of the behavior modes of turbine components by means of holographic interferometry (Analyse der Verhaltensweisen von Turbinenteilen mittels holographischer interferometrie).** W. Alwang, L. Cavanaugh, R. Burr, and E. Sammartino (United Aircraft Corp., East Hartford, Conn.). *Laser,* vol. 2, Sept. 1970, p. 33. In German.

Illustration of the use of holographic interferometry in experimental investigations of the static and dynamic behavior of certain turbine components. Holograms of the vibration modes of a small compressor blade are presented, as well as holograms showing the distribution of the vibration amplitude of an internally cooled turbine blade. The distribution of the vibration amplitude in the original blade of a high-pressure compressor is compared with that of a redesigned blade. The distribution of material fatigue in a test specimen is illustrated. A.B.K.

A70-45571 # **Ultrasonic inspection of fastener holes protects C-5 wings.** W. P. Lanier (Lockheed-Georgia Co., Marietta, Ga.). *American Society for Nondestructive Testing, Fall Conference, Cleveland, Ohio, Oct. 19-22, 1970, Paper.* 15 p.

Description of an ultrasonic inspection method developed to detect cracks in the fastener hole areas under fastener heads in the C-5A wings. Through the ultrasonic system, tiny cracks are detected around the fastener hole even before they spread beyond the fastener heads, without defueling the aircraft. This speeds up inspection and increases reliability by finding cracks in the beginning stages. The adapter fittings, standards, accuracy, equipment, and test variables are described. The inspection is performed on the aircraft with the fasteners intact. F.R.L.

A70-45586 **National Conference on Applied Mechanics, Bucharest, Rumania, June 23-27, 1969, Proceedings (Conférence Nationale de Mécanique Appliquée, Bucharest, Rumania, June 23-27, 1969, Proceedings).** *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée,* vol. 15, no. 4, 1970. 261 p. In French, English, Russian, and German.

Contents:

Dynamic stability of a pendulum under parametric excitation. J. Dugundji and C. K. Chhatpar (MIT, Cambridge, Mass.), p. 741-763. 7 refs.

Supersonic flutter of laminar cylindrical shells (Sverkhzvukovoi flatter tsilindricheskikh sloistykh obolochek). Iu. V. Vasil'ev (Institut Mekhaniki Zhidkosti i Gaza, Bucharest, Rumania), p. 765-802. 35 refs.

Solution of some new problems in the theory of elasticity of an anisotropic (nonorthotropic) body (Reshenie nekotorykh novykh zadach teorii uprugosti anizotropnogo /neortotropnogo/ tela). V. S. Sarkisian (Erevanskii Gosudarstvennyi Universitet, Yerevan, Armenian SSR), p. 803-825. 32 refs.

Birefringence phenomena in plasticized high polymers. P. S. Theocaris and Chr. Hadjijoseph (Athens, National Technical University, Athens, Greece), p. 875-884. 16 refs.

The measurement of a high frequency pulsating air flow using a sharp-edged orifice meter. G. A. Karim (Calgary, University, Calgary, Alberta, Canada) and M. Rashidi (Imperial College of Science and Technology, London, England), p. 885-897.

Oscillations of wings fitted with conical bodies of arbitrary cross-section in supersonic flow. E. Carafoli and D. Mateescu (Academia Română, Bucharest, Rumania), p. 899-911. 8 refs.

On the possibility of the generalization of geometrical aspects in existence proofs to magnetohydrodynamics. M. Z. v. Krzywoblocki (Michigan State University, East Lansing, Mich.), p. 913-934. 14 refs.

A method for the study of the three-dimensional laminar boundary layer in the unsteady regime in a flow of an incompressible fluid (Sur une méthode d'étude de la couche limite laminaire en régime instationnaire dans un écoulement en fluide incompressible à trois dimensions). R. Asković, p. 935-949. 5 refs.

Surface béhavior of refractory solids during friction (Comportement superficiel des solides réfractaires au cours du frottement). J. Ayel (Institut Français du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France) and L. Pons (Caen, Université, Caen, France), p. 967-994. 16 refs.

A70-45592 # **Oscillations of wings fitted with conical bodies of arbitrary cross-section in supersonic flow.** Elie Carafoli and Dan Mateescu (Academia Română, Institutul de Mecanică Fluidelor, Bucharest, Rumania). *(Conférence Nationale de Mécanique Appliquée, Bucharest, Rumania, June 23-27, 1969.) Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée,* vol. 15, no. 4, 1970, p. 899-911. 8 refs.

Theoretical study of the oscillatory motion of wing-shaped triangular protrusions jutting from cones of arbitrary cross sections into unsteady supersonic gas flows. The interference of the dynamic behavior of such delta wings and associated conical bodies is discussed. Special attention is given to the yaw and pitch of such systems as functions of the flow potential. The problem of the dynamic behavior of such systems is reduced to an equivalent problem with steady supersonic flows. V.Z.

A70-45644 # **Analysis of collisions between aircraft and birds (Analiz stolknovenii samoletov s ptitsami).** V. E. Iakobi (Akademiia Nauk SSSR, Institut Evoliutsionnoi Morfologii i Ekologii Zhivotnykh, Moscow, USSR). *Priroda,* no. 9, 1970, p. 99, 100. In Russian.

Description of several cases of collisions between Soviet civil aircraft and birds in recent years. The birds involved include Turdus viscivorus, Athene noctua, ducks, and geese. A table of collisions near Shosseinaia airport of Leningrad is given. Observations indicate that bird migration in that area begins in early August and reaches a peak in mid-September. The importance of bird identifications after collisions for collision hazard forecasts and prevention is pointed out. V.Z.

A70-45676 **International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session A - General problems of nondestructive testing.** Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970. 158 p. In English and German. Price of fourteen volumes, $40.

Contents:

Non-destructive testing for maintenance. A. R. Bond (British European Airways Corp., Feltham, Middx., England), p. 65-74.

The impact of NDT technology on military aircraft maintenance practices. M. Chamberland (Canadian Armed Forces, Ottawa, Canada) and J. Zirnhelt (Canadian Armed Forces, Trenton, Ontario, Canada), p. 75-87. 9 refs.

The designer and NDT inspection. L. Mullins (Kodak, Ltd., Harrow, Middx., England), p. 115-124.

A70-45677 **Non-destructive testing for maintenance.** A. R. Bond (British European Airways Corp., Feltham, Middx., England). In: International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session A - General problems of nondestructive testing. Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970, p. 65-74.

Examination and illustration of the economics of the use of nondestructive testing in maintenance work. Some of the disadvantages of visual inspection are indicated. Examples are cited showing how the maintenance time required for aircraft structures which historically have been examined visually has been substantially reduced with the aid of radiographic methods. A.B.K.

A70-45678 **The impact of NDT technology on military aircraft maintenance practices.** M. Chamberland (Canadian Armed Forces, Ottawa, Canada) and J. Zirnhelt (Canadian Armed Forces, Trenton, Ontario, Canada). In: International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session A - General problems of nondestructive testing. Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970, p. 75-87. 9 refs.

Review of the advantages to be gained by the integration of nondestructive testing technology into aircraft maintenance practices. The training of experienced aircraft mechanics to be NDT specialists is described, and a balanced approach of formal and on-the-job (practical) training is explained. Specific applications are discussed to illustrate the benefits arising from the use of nondestructive testing methods. Some of the obstacles in the way of efficient use of nondestructive testing technology are cited. A.B.K.

A70-45681 **A new method for wall thickness measurements down to 0.2 mm with an accuracy of better than 10 micrometers (Neuartiges Wandstärkenmessverfahren für Wandstärken bis herab zu 0,2 mm bei einer Messgenauigkeit besser 10 micrometers).** W. Kaule (Dr. J. und H. Krautkrämer, Cologne, West Germany) and K. E. Wetzlar (Deutsche Edelstahlwerke AG, Krefeld, West Germany). In: International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session B - Ultrasound 1: Instruments, methods, defect evaluation. Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970, p. 1-11. In German.

Discussion of a new supersonic testing method on a resonance basis for determining wall thicknesses from 0.15 to 5 mm with an accuracy greater than 10 micrometers. Basic supersonic testing methods suitable for wall thickness determinations are discussed. It is found that the resonance method gives the most accurate results. An optimum in measurement accuracy can be obtained by determining the highest point on the resonance curve. An approach which makes such determinations of the highest point possible is considered, and an instrument utilizing this approach is described. G.R.

A70-45717 **International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session E - Determination of material properties 1.** Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970. 146 p. In English, German, and French. Price of fourteen volumes, $40.

Contents:

Ultrasonic crack detection on specimens subjected to alternating bending (Rissermittlung an Wechselbiegeproben mit Ultraschall). K. Wellinger and U. Betz (Stuttgart, Universität, Stuttgart, West Germany), p. 25-35.

Utilization of nondestructive testing as a means of extending aircraft service life (Anwendung zerstörungsfreier Werkstoffprüfung zur Ermöglichung verlängerter Lebensdauer von Flugzeugen). H. Widmer (Eidgenössisches Flugzeugwerk, Emmen, Switzerland), p. 99-108.

Nondestructive testing of plastics (Zerstörungsfreie Prüfung von Kunststoffen). H. Schaper (Gerling Institut, Cologne, West Germany) and H.-A. Stelling (Hannover, Technische Universität, Hanover, West Germany), p. 111-122. 8 refs.

Measurement of treatment penetration depths (Mesure des profondeurs de traitements). F. Leleux and C. Flambard (Centre Technique des Industries Mécaniques, Saint-Quen, Hauts-de-Seine, France), p. 137-148.

A70-45719 **Utilization of nondestructive testing as a means of extending aircraft service life (Anwendung zerstörungsfreier Werkstoffprüfung zur Ermöglichung verlängerter Lebensdauer von Flugzeugen).** Hans Widmer (Eidgenössisches Flugzeugwerk, Emmen, Switzerland). In: International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session E - Determination of material properties 1. Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970, p. 99-108. In German.

Discussion of a test program initiated to increase the service life of Swiss military aircraft. The program included full-scale fatigue tests with each type of aircraft, determination of critical zones susceptible to fatigue-crack formation, checking of crack formation in the critical zones with a special X-ray television system (applied to an entire fleet), fatigue tests performed with rods, and application of eddy-current crack detectors to the determination of the onset of cracks in the material. A method developed for predicting aircraft service life from the processed data is described. V.P.

A70-45725 **Aircraft inspection by Ir-192 and Tm-170 gamma-ray radiography.** M. Kobayashi, S. Enomoto, S. Maeda (Japan Atomic Energy Research Institute, Ibaraki, Japan), S. Shiraishi, Y. Matsuo, and K. Watanabe (Japan Air Lines Co., Ltd., Tokyo, Japan). In: International Conference on Nondestructive Testing, 6th, Hanover, West Germany, June 1-5, 1970, Proceedings. Session F - Radiography 2: Applications; Electric and magnetic methods 2: Stray flux. Berlin, Deutsche Gesellschaft für Zerstörungsfreie Prüfverfahren, 1970, p. 77-86.

Description of the use of gamma radiography for testing different parts of aircraft engines and structures in order to estimate their service life. The characteristics of Ir-192 and Tm-170 as gamma-ray sources for radiography purposes are examined. The procedures used in NDT of JT8D and JT3D jet engines using Ir-192 are described. Inspection of the bowing of the first stage nozzle guide vanes in the JT3D/3B engine is detailed. The results obtained in an experimental inspection of wings and body of a DC-8 aircraft are presented. The development of the production of radiographic gamma-ray sources in Japan is described. Z.W.

A70-45786 **Notes on the current knowledge of sonic boom (Nota sulle attuali conoscenze relative al 'sonic boom').** Giuseppe D'Amato. *Rivista Aeronautica,* vol. 46, Sept. 1970, p.

1581-1594. 7 refs. In Italian.

Description of the sonic boom phenomenon and its characteristic regimes of flow. The intensity of the sonic boom is discussed, together with approaches to the solution of the problem of the sonic boom, results of surveys and tests of the effects of sonic boom on buildings and animals, and human reactions to sonic boom. M.M.

A70-45826 # Study of the short-term creep of the OT-4 alloy in high-speed air flows under aerodynamic vibrations (Issledovanie kratkovremennoi polzuchesti splava OT-4 v skorostnykh vozdushnykh potokakh pri nalichii aerodinamicheskikh kolebanii). I. N. Bogachev, Iu. G. Veksler, and V. G. Sorokin. *Akademiia Nauk SSSR, Izvestiia, Metally,* Sept.-Oct. 1970, p. 137-142. 5 refs. In Russian.

Description of equipment and a technique for testing mechanical properties and erosion resistance of metallic materials exposed to a high-speed air flow. Special attention is given to the role played by vibrations induced in samples during different test conditions. It is found that the short-term creep behavior of the OT-4 alloy is completely different from that in motionless air. A statistical analysis is made of random stresses due to aerodynamical vibrations at different test conditions. Some regularities in stress distribution are determined taking into consideration the flow rate, angle of incidence, and temperature. It is concluded that the creep properties of the OT-4 alloy are much less affected by vibrations than by corrosion and erosion due to high-speed air flow. Z.W.

A70-45853 Development of a hybrid fluidic damper control for an aircraft yaw axis. D. R. Cooper, G. R. Wells, and S. R. Bluhm (Bendix Aerospace-Electronics Co., Electrodynamics Div., North Hollywood, Calif.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700794.* 9 p. Members, $1.00; nonmembers, $1.50.

This paper describes the concept and development of an all fluid (hydraulic) system for yaw axis stability augmentation of a commercial jet aircraft. This unique system uses a fluidic accelerometer as a sensor, a bellows actuated flapper nozzle circuit for signal amplification, and a conventional spool type power stage driving an actuator with mechanical position feedback. The system replaces a rate sensor and differentiation network and most of the signal amplification stages found in more conventional fluidic stability augmentation systems. A complete analog simulation, along with prototype testing, was performed to insure the required performance of the final design. Also included in the paper is a summary of system performance testing. (Author)

A70-45854 Hydrofluidic flight controls. W. M. Posingies (Honeywell, Inc., Minneapolis, Minn.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700793.* 8 p. 5 refs. Members, $1.00; nonmembers, $1.50.

This paper describes the application of hydrofluidics to stability augmentation systems. Criteria for selecting fluidics for a specific application are presented. A typical hydrofluidic system is presented to show principles of operation, transfer functions, and component performance. A brief description of the power supply system shows how this system is integrated into existing aircraft without extensive modifications to the hydraulic power supply. Major problem areas of noise, leakage, and contamination are discussed. (Author)

A70-45858 A fluidically controlled aircraft fuel transfer system. R. W. McGregor (Vought Aeronautics Co., Dallas, Tex.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700786.* 7 p. Members, $1.00; nonmembers, $1.50.

Feasibility study for exploring the application of fluidics to an aircraft fuel transfer system. The objective was to construct a general three-tank model system for exploring concept feasibility. Although a single medium fuel approach was sought, the interim model used a pneumatic logic and sensing system for fuel control. The laboratory model effectively demonstrated fuel level control, diversion of fuel transfer at the command of an automatic logic system, and pilot override. A trade study showed gains in reliability and maintainability over the current method of aircraft fuel transfer control. The advantages were: no dependence on electric or hydraulic power, ease of maintenance, and fail-safe operation. M.M.

A70-45859 A fluidically-augmented artificial feel system for high performance aircraft. Tor W. Jansen and Walter W. Kaniuka (U.S. Naval Material Command, Naval Air Development Center, Johnsville, Pa.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700785.* 17 p. 5 refs. Members, $1.00; nonmembers, $1.50.

Description of the improved type of artificial feel system for aircraft characterized by the use of fluidic devices, developed by the Naval Air Development Center. It is shown that of the several types of pitch axis artificial feel systems currently in use in fighter and attack aircraft, the most common is the bobweight, spring, and viscous damper type, and variations of it. The improvement described consists in introducing air-operated fluidic devices controlled by interactions of moving fluids which augment forces at the control stick generated by the conventional bobweights and feel spring. The advantages of this improved type of artificial feel system are demonstrated. It is shown that such augmentation will improve the handling qualities of aircraft by reducing variations in stick force for a given maneuvering response, reduce the weight and inertia of the feel system, and permit tailoring of the feel system performance over the flight envelope. O.H.

A70-45860 New developments in fluidics for aircraft high-pressure hydraulic system applications. David H. Smith and Royce F. Church (Boeing Co., Commercial Airplane Div., Renton, Wash.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700784.* 12 p. Members, $1.00; nonmembers, $1.50.

Investigation of the feasibility of applying new systems of hydraulic fluidics to airplane hydraulic flight systems. The new technology of hydraulic fluidics has been applied to control of aircraft hydraulic systems in three areas - namely, hydraulic circuit damage isolation, control column artificial feel computation, and the sequencing of landing gear motion. Successful development is demonstrated, and hydraulic fluidics are shown to produce considerable improvement of hardware in specific instances. O.H.

A70-45870 The use of space systems to support the growth of international air transportation. E. J. Martin (Communications Satellite Corp., Washington, D.C.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700760.* 8 p. Members, $1.00; nonmembers, $1.50.

Discussion of the nature and magnitude of the anticipated air traffic and operational control requirements, and alternative concepts involving space systems and major factors related to planning and the implementation of these plans. Satellite techniques are shown to provide the only rational alternative for improving the quality and capacity of air traffic and airline operational communications in the over-ocean areas in the future. UHF satellite research and

development programs should concentrate on large, multiple beam antennas using either phased array techniques or multiple feeds on a single large antenna aperture. O.H.

A70-45875 Advanced bonding for large aircraft. J. Hong (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700863.* 18 p. Members, $1.00; nonmembers, $1.50.

Description of the design and manufacture of the airframe of the new generation of wide-bodied, advanced technology jet transports. Adhesive bonding of aircraft skin panels, as developed for the L-1011 TriStar, has established a number of improvements that were unattainable in purely riveted structures. The carefully controlled and detailed tests that accompanied this development have verified repeatedly the results sought by the design and manufacturing teams. Reliability of the fuselage and resistance to fatigue and corrosion were uppermost among the desired goals, and these have been proven conclusively through conventional and more recently developed test techniques. Further testing is expected to develop additional information, derived primarily from flight and simulated flight programs. M.M.

A70-45876 Impact of noise on subsonic transport design. Harry Drell (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700806.* 8 p. Members, $1.00; nonmembers, $1.50.

The impact of noise regulations on the design and configuration development aspects of subsonic jet transports is examined for an aircraft which carries a prescribed payload a given range and operates within a given fixed field length. The normal design process used to select wing loading, thrust loading, and aspect ratio is first reviewed without consideration for noise, and then examined considering noise. The sensitivity of these parameters for noise reduction is developed and compared to the noise reductions available through design of the engine and acoustic treatment of the powerplants. Finally, the overall trade-off in takeoff gross weight or payload per PNdB reduction for each of the design parameters is evaluated. (Author)

A70-45877 Minimum noise pod design. J. R. Thompson (Lockheed-California Co., Burbank, Calif.) and M. J. T. Smith (Rolls-Royce, Ltd., Derby, England). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700805.* 14 p. Members, $1.00; nonmembers, $1.50.

Summary of the technical considerations and design procedures used to ensure the attainment of the low-noise objectives for the Lockheed L-1011 Trijet wide-bodied transport. It is shown that the Rolls-Royce RB.211 engine selected for the L-1011 incorporates the latest state of the art noise reduction features, including the novel shaft-slowing provision. The additional noise reduction required to satisfy the low community noise objective is attained by incorporation of advanced noise suppression materials into an efficient propulsion pod design. The technology, design restraints, and system requirements which must be combined into the practical optimum minimum noise pod design are described. G.R.

A70-45878 Power plant design for noise suppression. C. L. Bagby (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700804.* 9 p. 8 refs. Members, $1.00; nonmembers, $1.50.

Description of the design evolution of the installation of the General Electric CF6 high-bypass ratio engine in the McDonnell Douglas DC-10 as it was influenced by the need for noise suppression measures. The three candidate alternatives and the basic trade-off criteria leading to the selected configuration are characterized. The configuration selected is shown to be the 3/4-length fan duct having acoustical treatment applied to the inlet duct and the inner and outer walls of the fan exhaust duct, and with the accessories located external to the fan case. Details of the material and construction selected for each of the acoustically treated sections in the DC-10 engine installation are discussed. O.H.

A70-45882 Honeycomb fastening. C. H. Walker (General Dynamics Corp., Fort Worth, Tex.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700850.* 12 p. 6 refs. Members, $1.00; nonmembers, $1.50.

Attachment of honeycomb sandwich structure has been an important design consideration in the aerospace field since the early 50's when bonded sandwich was first used extensively as covering for the wings and tail of the supersonic B-58. Since then, virtually all military and an increasing number of commercial aircraft and space vehicles utilize honeycomb sandwich as primary structure. This paper illustrates the basic approaches to sandwich panel attachment and the variety of typical solutions. Successful honeycomb fastening design concepts from B-58, B-57F, and F-111 production programs at General Dynamics are illustrated. Sealing of sandwich joints for use as integral fuel tanks and application of specialty fasteners for honeycomb sandwich are discussed. Structural efficiency of 'fastened' stepped-down edge concepts versus full-depth panel edges is compared. A full-depth panel edge design with a stud and plug with spliceplate is currently an attractive design for fastening both metallic and composite-faced sandwich. (Author)

A70-45883 Designing the OV-10A forward air control and light attack aircraft. Jack E. Wagner and Richard J. Arnold (North American Rockwell Corp., El Segundo, Calif.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700837.* 17 p. 6 refs. Members, $1.00; nonmembers, $1.50.

The design of the OV-10A accepted the challenge of interpreting basic concepts founded on counterinsurgency experience and developing a weapon system, which would provide effective air support for COIN and other low intensity operations. Maximum reliability and survivability were required in a low cost machine that must be easy to operate and maintain. The North American Rockwell OV-10A Bronco exemplifies the results of the purposeful program to integrate the experience and knowledge from many disciplines toward a common goal. The degree to which this effort was effective is shown by its highly successful performance in Southeast Asia. (Author)

A70-45889 Aerospace pyrotechnics. V. W. Orexelius (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700831.* 8 p. 6 refs. Members, $1.00; nonmembers, $1.50.

Pyrotechnic applications in the aerospace industry have multiplied in scope and function since introduction in personnel escape systems in 1947. An overview of significant advances in design, application and testing is presented. Emphasis is placed on the engineering approach rather than the 'black magic' aspect so frequently found in early developments. A pressure-controlled propellant-actuated device is discussed along with new test techniques for performance evaluation. A look into the crystal ball concerning the future aspects of pyrotechnics is also presented. (Author)

A70-45890 Helicopter personnel escape and survival system. Ryland D. Wiseman, Jr. (U.S. Naval Material Command, Naval Weapons Laboratory, Dahlgren, Va.). *Society of Automotive Engi-*

neers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Clif., Oct. 5-9, 1970, Paper 700832. 10 p. Members, $1.00; nonmembers, $1.50.

The feasibility of a personnel escape capsule system for helicopters is shown. This feasibility was demonstrated by incorporating an escape system into an UH-25B helicopter and conducting tie-down, drop, and drone tests. The present status of designing this type of system into an operational helicopter such as the CH-46 and UH-1 helicopter is outlined. (Author)

A70-45891 747 flight test certification. Donald D. Archer (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700828.* 17 p. Members, $1.00; nonmembers, $1.50.

The 747 flight test certification program was initiated with the first flight of the No. 1 airplane on Feb. 9, 1969. Five test airplanes were used in an intensive test program involving 1443 flight hr and 36-1/4 airplane months, with the last certification flight on Dec. 23, 1969. Full type certification approval was granted by the FAA on Dec. 30, 1969 after a total of 10-2/3 months of flight testing. These statistics compare very well with the original program estimates, which were based on Boeing's extensive experience with development and certification testing of commercial transport airplanes. The success of this test program was not due to any great advancements in flight test techniques specifically for the 747, but was due to the tried and proven test methods developed during past certification programs at Boeing. This is not meant to imply that some new methods were not used, but to emphasize that test techniques evolve with experience. This paper will discuss both the test methods and the data systems used during the test program. (Author)

A70-45892 Propulsion system control requirements, capabilities and opportunities. Charles E. Bentz (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700827.* 8 p. 8 refs. Members, $1.00; nonmembers, $1.50.

Discussion of the important functional and environmental requirements of engine mounted control components, and the opportunities new control technologies have for consideration on future propulsion systems. It is shown that propulsion system controls have been steadily increasing in complexity to meet the regulation and limiting requirements of current and future turbine engines. With the need to provide improved transient and steady state engine performance during all phases of flight operations, the control functions of the inlet, engine and exhaust nozzle must be integrated to ensure engine-airframe compatibility and stability. This requirement further increases the sensing, computational, and regulatory functions of the propulsion system control. In the past, electronic controls have played a subordinate role because of the severe turbine engine flight environment, and the computational needs of the engine could usually be met by hydromechanical components. With future trends for increased complexity and system integration, the computational capabilities of electronic controls will find increased utilization to optimize thrust and fuel consumption and to maintain inlet-engine compatibility. O.H.

A70-45893 Engine control concepts for the augmented turbofan. M. W. French (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700826.* 12 p. Members, $1.00; nonmembers, $1.50.

The augmented turbofan engine, currently being developed for several advanced military applications, presents new challenges to the control designer. A fresh approach to the engine control design is necessary to exploit the promising characteristics of this propulsion system in the far-ranging areas of the flight spectrum. The General Electric Company has been developing an integrated electrical/hydromechanical control system designed expressly for this new breed of propulsion system. This paper discusses the requirements for the system, the results of control mode studies, and the highlights of the resulting control design. Special features of the control, including new sensing requirements, are discussed. (Author)

A70-45894 Jet engine control systems - Their evolution, future requirements and potential limitations. Philip G. Dooley (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700825.* 9 p. Members, $1.00; nonmembers, $1.50.

The evolution of Pratt and Whitney Aircraft turbojet and turbofan engine control systems is reviewed to provide an understanding of their ability to handle the increasing number of variables being incorporated in modern engines, as well as their potential limitations in this respect. Future engine designs are expected to require more precise control of even more engine operating variables such as inlet guide vane angle, and jet, turbine vane, and duct nozzle areas. To provide pilots with the degree of automation consistent with today's technology, the use of an overall power management system separate from the engine control is foreseen. (Author)

A70-45895 Control system requirements and considerations for high temperature engines. Richard D. McLain (General Motors Corp., Allison Div., Indianapolis, Ind.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700823.* 10 p. 9 refs. Members, $1.00; nonmembers, $1.50.

As a result of technological advances in materials and cooling techniques, the stoichiometric or maximum temperature engine is now on the horizon. The high turbine inlet temperature makes possible improvements in engine performance and reductions in size and weight. Simultaneously, it poses new considerations in the selection of an engine control system. Not only are temperature levels higher and flow ranges wider, but perhaps most significant is the stoichiometric fuel air ratio. The impact of potential fuel rich combustor mixtures must be thoroughly considered in selecting a control mode. This paper deals with some of these considerations and the resulting requirements which will influence the selection and design of a high temperature engine control system. Its purpose is not to provide specific answers, but rather to suggest areas in which additional study should be conducted. (Author)

A70-45896 Direct drive accessories, feasible by 1980. Edward F. Esmeier and James R. Tracy (United Aircraft Florida Research and Development Center, West Palm Beach, Fla.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700821.* 6 p. Members, $1.00; nonmembers, $1.50.

Direct drive turbine engine control components and airframe accessories are expected to be feasible by 1980. A comparison between a currently operational engine and a projected 1980 engine indicates a weight reduction of 11% and a frontal area reduction of 30% can be achieved by the use of direct drive components and accessories. Instead of a gearbox, the projected engine uses a combination of engine-rotor-driven components (fuel pump, oil pumps, and starter) and hot-gas-turbine-driven accessories (electric generator and hydraulic pump). The technological advancements that must be accomplished during this decade to realize the projected engine improvement are discussed. (Author)

A70-45898 Programmed engine maintenance - C5A Malfunction Detection Analysis and Recording System (MADARS). E. W. Horne, L. R. Price (USAF, Wright-Patterson AFB, Ohio), and M. S. Edwards (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700820.* 12 p. Members, $1.00; nonmembers, $1.50.

The C-5 Malfunction Detection Analysis and Recording (MADAR) subsystem performs these on-board functions for selected subsystems, including the TF39-GE-1 engine. Studies were made by General Electric, the engine manufacturer, to define the extent of detection, analysis, and recording necessary for the TF39. These studies, together with the selected maintenance philosophy, defined a number of line replaceable units (LRUs) associated with the engine. The selected LRUs then determined the parameters to be monitored for the engines. Further studies defined the instrumentation requirements for obtaining the parameters. The computer programs for on-board fault isolation and incipient malfunction detection have been partially defined. Further analysis to establish limits and correlation procedures is to be completed. In addition, recorded information is analyzed in a central data bank (CDB) in a ground processing system (GPS), where refined prediction programs are being developed. The ground processing system, together with the MADAR system form a complete maintenance information system for the C-5. Future expansion of the MADAR/GPS concept would allow individual C-5s to be monitored instantaneously from a maintenance information central with all the advantages such a concept implies. (Author)

A70-45899 Propulsion control integration for power management. T. A. Flanders and W. Britnell (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700818.* 13 p. 15 refs. Members, $1.00; nonmembers, $1.50.

Integration of propulsion controls can simplify the task of aircraft power management. Not only can integration ease the pilot's problem of adjusting engine power settings according to the flight mode, but it also enables improved propulsion system performance to be achieved and extends the regions of safe and stable operation. Such improvements to the inlet/engine compatibility by themselves warrant the use of control system integration, but once the controls are adapted for ease of data exchange they can easily accommodate power management functions and the processing of parameters for a maintenance monitor. One possible method of implementation is described utilizing state-of-the-art hardware. (Author)

A70-45900 Concorde thrust management. C. E. G. Payne and A. M. Lewis (Rolls-Royce, Ltd., Bristol, England). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700817.* 12 p. Members, $1.00; nonmembers, $1.50.

The Rolls-Royce/S.N.E.C.M.A. Olympus 593 employs a variable area primary nozzle and has a reheat system - both novelties to civil aviation. The main purpose of this paper is to show that these innovations are accommodated without generating crew work load problems. Consequently the paper is aimed primarily at the airline user rather than the control system specialist. A brief description is given of the basic engine electrical control and its interface with the intake system. The flight deck mounted thrust management controls and indicators are identified and their use described during the course of a typical flight. The subject of engine mechanical condition monitoring is also examined. (Author)

A70-45901 APU selection - An airline viewpoint. L. H. Allen and W. P. Frey (Pan American World Airways, Inc., New York, N.Y.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700816.* 12 p. Members, $1.00; nonmembers, $1.50.

An APU installation is considered essential for all transport aircraft due to many attractive benefits including high capacity airconditioning during all ground operation, plus increased flexibility for terminal and maintenance activities. For an effective installation, high goals of reliability and utility must be established in the selection and design process. (Author)

A70-45902 TSCP700 auxiliary power unit for the DC-10 aircraft. Donald A. Malohn (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700815.* 6 p. Members, $1.00; nonmembers, $1.50.

The model TSCP700 discussed in this paper is a new advanced-technology auxiliary power unit currently under development at AiResearch. The design provides the most favorable fuel consumption characteristics possible with the current state-of-the-art and the excellent maintainability characteristics required for airline auxiliary power unit operation. This optimization is accomplished by a twinspool, coaxial, high-pressure-ratio cycle with interstage bleed from the low-pressure spool and shaft power extraction from the constant-speed high-pressure spool. Variable turbine nozzles, at the first-stage of the low-pressure spool, control pneumatic output to satisfy the environmental control system requirements (on a demand basis) and, thus, minimize the fuel consumption. (Author)

A70-45903 The evolutionary development and current status of the augmentor wing concept. J. E. Middlebrooks, H. C. Tinney (Boeing Co., Seattle, Wash.), and D. C. Whittley (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700812.* 11 p. 9 refs. Members, $1.00; nonmembers, $1.50.

A review is made of previously reported status of the augmentor wing concept, including test work of the Havilland Aircraft of Canada and the NASA Ames Research Center. More recent NASA data which formed the basis for proceeding with a flight research vehicle program on the Buffalo CV-7A are discussed. This background is used to show potential application to a turbofan-powered production airplane concept whose highly integrated propulsion and aerodynamics show promise for a very quiet STOL. Proposed future augmentor wing development programs are also briefly discussed. (Author)

A70-45904 An initial look at management and design considerations for commercial STOL propulsion systems. G. P. Sallee (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700810.* 4 p. Members, $1.00; nonmembers, $1.50.

A STOL aircraft requires a level of design and performance integration beyond that currently involved in commercial transport aircraft. Each vehicle concept uses the propulsion system to provide a substantial portion of the low speed aerodynamic lift. This fact makes engine dynamic performance have a strong influence on the handling qualities and performance of the aircraft, as does the aerodynamics on the proper engine cycle for the best mission performance. The airlines equally have requirements which place demands on the technical ingenuity of the designer. These requirements may be overlooked in initial design studies. To preclude this oversight, the airlines' powerplant requirements are discussed from an airline point of view with major emphasis placed on propulsion subsystem design responsibility, engine selection, thrust deterioration, and maintainability. (Author)

A70-45905 **Planning the evolution of V/STOL powerplants.** A. G. Newton and S. C. Miller (Rolls-Royce, Ltd., Aero Engine Div., Derby, England). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700809.* 15 p. Members, $1.00; nonmembers, $1.50.

It seems likely that a STOL system with 100- to 150-passenger aircraft will be established in the second half of the 1970's, and that, from it, a VTOL system will evolve in the 1980's. Prior demonstration of the feasibility of all aspects of these systems is vital if the final commitment is to be made without high risk. Achievement of the necessary levels of confidence in the engines for these aircraft will result only from a carefully planned program. The paper reviews the various alternative powerplant proposals for the first large STOL aircraft and describes the current and future programs of work which form this planned evolutionary process. (Author)

A70-45906 **The design of the U.S. SST for low community noise.** J. D. Vachal and B. H. Florsheim (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700808.* 8 p. Members, $1.00; nonmembers, $1.50.

The need for achievement of low community noise levels has had a major influence on the configuration selected for the United States Supersonic Transport (Boeing 2707-300). The selection and development of design features which affect community noise are presented. The configuration has a relatively large span delta wing of moderate sweep and wing loading, with full span leading and trailing edge flaps. An all moving horizontal tail with geared flap is used for trim and control. The use of an unusually far aft center of gravity range is achieved through a fulltime stability augmentation system. All of these design features contribute to low drag at high lift, resulting in high takeoff performance and low levels of thrust required during flight over the community during both takeoff and landing. The resulting airplane has the versatility to use operational techniques which further reduce noise. Noise characteristics of various power plant types are not treated, but the effect on noise of engine-airframe matching is discussed. (Author)

A70-45907 **Noise considerations in the design of advanced subsonic transport turbofan engines.** R. E. Neitzel and M. J. Benzakein (General Electric Co., New York, N.Y.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700807.* 13 p. Members, $1.00; nonmembers, $1.50.

The problems and choices in the design of an advanced subsonic transport turbofan for reduced noise and improved aircraft performance are examined in this paper. The effects of bypass ratio, fan pressure ratio, and fan tip speed on jet noise, fan noise, and acoustic treatment suppression are described. The results do not indicate a clear optimum bypass ratio considering the effects upon installed engine performance and weight as well as acoustic performance. Low fan tip speed designs with the associated high aerodynamic loading are compared to high tip speed low loading designs. Other factors affecting noise such as the installation and other noise sources are discussed. The long duct installation is indicated to have potential advantages over the short duct separate flow installation. The problem of assuring that growth models of an engine also have low noise is discussed. (Author)

A70-45914 # **VTOL short haul systems.** Merrick Hellyar (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1243.* 12 p. Members, $1.50; nonmembers, $2.00.

Discussion of the feasibility of a solution to the short haul congestion problems by means of VTOL aircraft. To overcome airport and airways congestion, it is suggested, as the only feasible solution, to conduct the short haul portion of the air transportation system where the demand is - i.e., between city center facilities. Only VTOL ground facilities are shown to be feasible for location at the demand centers, so that the only feasible aircraft to serve this demand is the VTOL aircraft. Detailed characteristics are presented of the VTOL system proposed for this purpose - i.e., a system based upon the use of the Sikorsky S-65-40 helicopter and S-65-200 compound aircraft. Particular emphasis is placed on the description of the aircraft performance, ground facilities, system operation, and system economics. O.H.

A70-45915 # **Western region short haul air transportation program - Definition phase summary.** Earl R. Hinz (Aerospace Corp., El Segundo, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1284.* 16 p. 6 refs. Members, $1.50; nonmembers, $2.00.

This study defines a long term program to perform research, development, and demonstrations leading to more effective haul (under 500 miles) regional air transportation systems. Included are studies of transportation demand and modal split, and technological state of the art with emphasis on vertical and/or short takeoff and landing aircraft, related avionics, and ground systems. Case studies are made of select metropolitan and rural short haul demonstration arenas to identify technical, demographic, and operational factors in demonstration service planning. A program plan is developed defining subsequent phases, identifying the roles of the participants, and establishing schedules and funding requirements. (Author)

A70-45916 # **A low risk approach to development of a quiet V/STOL transport aircraft.** Lloyd R. Novak (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1409.* 11 p. Members, $1.50; nonmembers, $2.00.

The feasibility of modifying an existing aircraft into a quiet, V/STOL transport research vehicle was determined. The DC-9-10 was selected from several aircraft considered because the size is compatible with available advanced engines and it has inherent characteristics that are especially suitable for conducting a low risk, V/STOL transport 'proof of concept' program. Emphasis is placed on control system and propulsion system interfaces, design for low noise, and aircraft flight characteristics including high in-flight deceleration capability. Projections are made of V/STOL transports employing advanced technology systems applicable to the early 1980 time period. (Author)

A70-45917 * # **Frontiers in aircraft structural design.** R. R. Heldenfels (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1232.* 11 p. 24 refs. Members, $1.50; nonmembers, $2.00.

New aircraft requirements and intense competition in the industry have created a very difficult structual design task of achieving low structural weights without jeopardizing the integrity or life of the aircraft. The result has been underestimation of structural weight required and costly structural failures. Technical and managerial aspects of this situation are reviewed. Some promising technical improvements are considered, including applications of new materials and structural concepts and consolidation and automation of structural design technology in an integrated system of computer programs. (Author)

A70-45918 * # **Aeronautical vehicles - 1970 and beyond.** Laurence K. Loftin, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22,*

1970, Paper 70-1262. 18 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Review of the broad spectrum of the present and future air vehicle types. Air vehicles under the following categories are considered: general aviation; short haul systems, including STOL, helicopter, and V/STOL aircraft; and long haul systems, including subsonic, supersonic, and hypersonic aircraft. In each instance, the present and projected importance of a particular class of vehicle is examined in relation to the transportation system. Future directions of vehicle development and use are discussed, and areas in which new technology appears to offer promise of significant vehicle improvement are indicated. O.H.

A70-45920 # **Airport development or redevelopment - Financial considerations.** John H. Baker and Kenneth S. Caldwell (Ernst and Ernst, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1267.* 10 p. Members, $1.50; nonmembers, $2.00.

Discussion of methods through which airports may gain additional funds for redevelopment and expansion by supporting their own financing. The economic and political framework within which most airports operate is outlined, and it is noted that an airport should be considered as an economic generator rather than a mere physical air transportation complex. New airport facilities enhance industrial and commercial growth of a community, and the latter should be a source of revenue for the required expenditures. Attention is given to the planning elements which airport authorities and municipalities must consider to ensure the financial success of their development programs. In future planning, more emphasis should be placed on the overall economics of the proposed project, and a planning process must be initiated which involves coordination of the required efforts, including marketing and financial inputs. T.M.

A70-45921 # **What is an optimum airport system.** James Gagnon (Hudgins, Thompson, Ball and Associates, Inc., Aviation Services Div., Oklahoma City, Okla.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1266.* 6 p. Members, $1.50; nonmembers, $2.00.

Discussion of the basic criteria which are fundamental to the optimum airport system. By definition, an airport system is shown to be a regularly interacting or interdependent group of airports forming a unified whole which, under prevailing conditions, attains the greatest degree of efficiency possible in satisfying the demand for public convenience and necessity in air transportation. This definition suggests five basic elements characterizing the optimum airport system: (1) a group of airports, (2) regular interaction and interdependence, (3) unified whole, (4) prevailing conditions, and (5) greatest efficiency in satisfying needs. In discussing each of these elements, it is shown that the development of aviation facilities to serve major metropolitan areas or regions entails not only consideration for the operational and physical characteristics of airports themselves, but must extend into long-range developmental planning for other modes of transportation, environmental compatibility, land use planning, population centers, physical and socioeconomic characteristics of the region or area to be served, and examination of fiscal and financial capacities to implement the system. Major systems must be compatible in terms of demand and facilitation for air carriers, general aviation, and surface transportation. Anticipation of future technological development in air transportation is also an inherent part of optimum system planning to assure the development of flexible, economical, and adequate airport system growth. O.H.

A70-45922 # **Satellite aid to airplanes - An overview.** Siegbert B. Poritzky and Frank C. White (Air Transport Association of America, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1301.* 5 p. Members, $1.50; nonmembers, $2.00.

Discussion of the services satellites can provide for air traffic, taking into consideration the position of the U.S. airlines. Aid provided by satellites regarding ATC communications over water and undeveloped land areas is considered. Other areas of application of satellite technology include operational communications regarding flight safety, altimetry, and ATC surveillance over water. Satellite navigation and a new ATC data acquisition system are other subjects which are explored. G.R.

A70-45924 # **Airport design - Long term outlook.** Benjamin F. L. Darden (FAA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1264.* 72 p. 14 refs. Members, $1.50; nonmembers, $2.00.

Discussion of a goals-oriented approach to airport planning and design. Areas of concern related to the high growth rate of air traffic are investigated. Peak hour delays typical of high density airports are explored and problems posed by aircraft noise are considered. Present trends in airport development are critically examined, and the advantages of a goals-oriented approach are shown. National goals are discussed and aspects of applying the goals principle are investigated. Aircraft and aircraft technology, airports and airport capacity, airport environment and airport access are considered.

A70-45926 # **Planning airports to serve air transportation in underdeveloped and emerging nations.** Winfield H. Arata, Jr. (Northrop Corp., Beverly Hills, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1268.* 6 p. Members, $1.50; nonmembers, $2.00.

Discussion of some of the significant factors in planning airports to serve air transportation in underdeveloped and emerging nations. Economic, financial, technical and operational factors are reviewed. It is shown that airports are more than just a link in an air transportation system. The many by-product or secondary advantages that an airport can provide to a nation are pointed out. M.V.E.

A70-45927 # **Short range transportation - A system engineering challenge.** P. M. Brodie (Singer-General Precision, Inc., Wayne, N.J.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1281.* 7 p. Members, $1.50; nonmembers, $2.00.

For the major metropolitan airports, the problems of quantity of traffic are becoming increasingly acute. Short haul systems offer the airlines a potential alternate means of avoiding a major part of this problem and in turn may help alleviate airport terminal congestion. This paper discusses the advantages of applying techniques of system engineering as a unifying technology to the problems of short haul transportation. By exploring the blending of recent advances in avionics with an overall philosophy of weighting or balancing both air and ground traffic, the short haul system can be put to its best advantage. (Author)

A70-45929 # **Role of general aviation as it influences the airway systems.** Richard H. McFarland (Ohio University, Athens, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1314.* 6 p. 10 refs. Members, $1.50; nonmembers, $2.00.

General aviation which constitutes 77% of the aircraft operating today will, through the new user charge legislation, pay its fair share of the costs of needed federal airways systems. After identification of some characteristics peculiar to the general aviation aircraft, a discussion is presented to indicate how advantage may be taken of these characteristics to obtain greater utility of current systems and

concepts now used only by a few. Examples are area navigation, Omega navigation, and Category II operations. The influence of general aviation in bringing these systems and concepts to greater usefulness is stressed. (Author)

A70-45930 # Satellite-based navigation/air traffic control systems for short range aircraft. Malcolm J. Abzug, John H. Craigie, and Naoji Morishita (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1338.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00.

A complete satellite-based navigation/air traffic control system for short-range (STOL) air carrier aircraft should provide identification and surveillance (data acquisition) for ATC centers, data for area navigation and landing approach, integrated avionics, and growth capability as the full satellite system is gradually deployed. For satellite ATC surveillance only a 60-foot horizontal CEP is compatible with a reduction in IFR runway spacing to 2500 feet. If satellite navigation and closed-loop guidance is used as well as ATC surveillance, 60 to 300 foot horizontal CEP could provide enroute parallel track spacing of 1 to 3 n mi. Category IIA operation without ground radio aids requires a 60-foot horizontal CEP. This accuracy level is avialable with a proposed 6 or 7 satellite system. Integration of the satellite system's avionics with the flight control system of an advanced STOL transport is straightforward. (Author)

A70-45932 # Radar independent landing monitors. B. Bechtel (Texas Instruments, Inc., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1336.* 13 p. Members, $1.50; nonmembers, $2.00.

A radar system operating independently of ground-based electronic equipment has been developed which provides the pilot an on-board sensor to monitor runway alignment during approach, touchdown, and roll-out phases of Category II and III landings. The system features a real-world display providing a true-to-life perspective presentation of the runway. The system and preliminary flight-test results in the form of perspective display photographs are presented. Stimulated by a Lockheed-California request for proposal in late 1968, Texas Instruments, on internal funds, designed and carried out development and preliminary flight test during 1969. (Author)

A70-45934 # STOL guidance and control operating techniques. T. Oakes and R. W. Howlett (Eastern Air Lines, Inc., Miami, Fla.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1334.* 5 p. Members, $1.50; nonmembers, $2.00.

A uniquely simple method of utilizing area navigation techniques for STOL guidance and control has been developed which provides for the definition of a finite number of standardized waypoints and approach and departure fixes. This concept calls for overlaying a 'clockface' on all VOR/DME stations along with imaginary concentric circles starting at eight miles radius and extending outward. The intersection of these circles with each of the hour clock positions defines the 'set' of waypoints for each site. The utilization of these standard waypoints to define standard multiple airways, coupled with data link communications with ground ATC computers can permit the operation of an effective STOL transport system. (Author)

A70-45935 * # VTOL instrument flight research relating to aircraft requirements and operating characteristics for the terminal area. Robert J. Tapscott, John F. Garren, Jr., Henry L. Kelley, and Robert E. Shanks (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1333.* 10 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Description of instrument-flight studies of VTOL aircraft in the terminal area conducted for the purpose of defining requirements and operating characteristics pertinent to the use of the vertical and low speed capabilities of these vehicles. The studies were performed along three basically separate lines to obtain results applicable to terminal area tasks. One involved the use of a generalized VTOL aircraft with in-flight simulation capability to establish requirements for basic handling qualities, stability augmentation concepts, and automation requirements. Another approach used fundamentally different VTOL configurations to define configuration-oriented problems, and the third direction of research involved cockpit display concepts to establish their suitability for specific tasks. Results obtained indicate that flight-director information is required to perform precision approaches at angles steeper than 6 deg. For these approaches to become routine operations, stability and control augmentation will be required in all the controlled degrees of freedom. T.M.

A70-45936 # Low speed handling characteristics of the STOL aircraft. M. D. Marks and D. O. Carpenter (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1332.* 16 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Description of the STOL aircraft, its historical background, design philosophy, and operating characteristics exhibited from over 6000 STOL operations with the prototype and production McDonnell Douglas 188/Brequet 941 STOL vehicles. The powered lift and control concepts are explained in terms of thrust and drag curves and control function illustrations. Low-speed operational characteristics are described by means of approach and landing profiles, power requirements, wind effects, sideslip and bank angle requirements, and gust sensitivity. T.M.

A70-45937 # Development of airworthiness standards and certification rules for STOL. Charles E. Chapman (FAA, Engineering and Manufacturing Div., Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1331.* 6 p. Members, $1.50; nonmembers, $2.00.

Existing transport category aircraft standards are, in many respects, inappropriate to the new generation of STOL aircraft by virtue of the wide variety of novel methods being utilized for obtaining lift and control from engines. The FAA, together with industry, has developed comprehensive, tentative standards specifically orientated toward powered lift aircraft. These standards have been released to the aviation community and are intended for trial application in new STOL type certification projects. Once sufficient experience is obtained implementing these standards and appropriate refinements are incorporated, formal rulemaking processing will be initiated towards adopting the standards as new Federal Aviation Regulations. (Author)

A70-45942 # On alleviation of the sonic boom by thermal means. S. B. Batdorf (Aerospace Corp., San Bernardino, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1323.* 9 p. 26 refs. Members, $1.50; nonmembers, $2.00.

Previous studies suggest that reduction of SST sonic boom noise to levels acceptable to the public requires elimination of shocks and creation of pressure rise times of 10 msec or more at the ground. Since achieving this by lengthening the aircraft appears impracticable, a feasibility investigation of the use of heat to simulate a long body was undertaken. The large power requirement dictates use of direct combustion of cheap fuel for this purpose, and practical

considerations motivate off-axis heating. This can be accomplished in principle with either a 'thermal spike' with axis parallel to the airstream or a 'thermal keel' extending downward from the aircraft. (Author)

A70-45943 # **Time-dependent computation of transonic flows.** B. Grossman (Grumman Aerospace Corp., Bethpage, N.Y.) and G. Moretti (Brooklyn, Polytechnic Institute, Farmingdale, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1322.* 7 p. 9 refs. Members, $1.50; nonmembers, $2.00.

A numerical procedure has been developed which determines the time-dependent transonic flow field about various two-dimensional and axisymmetric aircraft sections. Particular emphasis is placed upon the proper physical representation of the flow field. The inviscid flow is produced by a body which accelerates from a state of rest to a constant transonic speed in a gas at rest. New methods have been developed which predict the formation of imbedded shock waves and calculate them as discontinuities satisfying the Rankine-Hugoniot relations. Results for several geometries including boattail configurations are presented and shown to be in agreement with experimental data. (Author)

A70-45945 # **Exploratory study into the development of an air traffic control computer simulation model.** C. W. Burlin (United Aircraft Research Laboratories, East Hartford, Conn.), J. Reitman (United Aircraft Corp., Norden Div., Norwalk, Conn.), and D. Ingerman. *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1316.* 7 p. Members, $1.50; nonmembers, $2.00.

The problem of simulating the flow of air traffic in the United States to evaluate alternative air traffic control concepts was studied. A simplified fast-time digital computer simulation model was developed in the GPSS/360-Norden language. Discrete aircraft traffic flow was used on established air routes through a ten-airport network. Departure, en route, and arrival phases were included under constraints of collision avoidance, weather effects, and flow control. Four parametrically varied computer runs were made, and statistical aircraft operating data were gathered. The results indicate several ATC concepts can be evaluated using straightforward extensions of this model. (Author)

A70-45946 # **The FAA program for increased airport and airway capacity.** Gustav E. Lundquist (FAA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1315.* 9 p. Members, $1.50; nonmembers, $2.00.

This program will provide the increased capacity required in the next two decades and places emphasis on meeting the demands of the high density areas. It will be managed by the newly formed System Engineering Management Staff of FAA. Airport improvements include new runway-taxiway configurations, automation of the surface guidance and control functions, new terminal designs, and improved access-egress systems. Airways improvements include improved area navigation; a new approach, departure, and landing system; upgrading the present ATC radar beacon system to provide more accurate aircraft position data and digital data link communications; and substantial increases in automation. (Author)

A70-45947 # **V/STOLport accessibility considerations.** John R. Wiley (Port of New York Authority, New York, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1311.* 5 p. Members, $1.50; nonmembers, $2.00.

Consideration of the significance of airport accessibility in planning landing facilities for V/STOL aircraft. The advantages of STOL and VTOL flights are their potential of bringing aircraft closer to the passenger's true origin and destination and reducing point-to-point travel time. Data on percentages of estimated total average daily airport passengers originating in central business districts and on typical mileages and approximate travel times between airports and central business districts during peak and off-peak hours are presented. These data provide a glimpse of the vast inter-city mass travel market that seems to warrant every effort toward realization of the potentialities of short-haul STOL and VTOL flight service. Some of the difficulties of achieving this goal are discussed. M.V.E.

A70-45953 # **Future trends in general aviation.** L. Pazmany (San Diego Aircraft Engineering, Inc., San Diego, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1220.* 9 p. 8 refs. Members, $1.50; nonmembers, $2.00.

The expansion and competitive position of General Aviation, in the field of transportation, depends upon improving the safety and utility of light airplanes, while at the same time effecting cost reductions. It is the purpose of this paper to forecast the trends in several technologies which will affect the shape, performance, and costs of light airplanes. The predictions enumerated are based on previous studies related to General Aviation. As far as possible, they were tempered or modified by the comments of leading manufacturers of airframes, engines, and accessories. In addition, the advice and opinions of related government agencies were also used. (Author)

A70-45957 * # **Hypersonic transport preliminary performance estimates for an all-body configuration.** Thomas J. Gregory, Mark D. Ardema, and Mark H. Waters (NASA, Office of Advanced Research and Technology, Mission Analysis Div., Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1224.* 10 p. 19 refs. Members, $1.50; nonmembers, $2.00.

Analysis of an all-body hypersonic cruise aircraft, using a computer synthesis program. The all-body shape, which evolved after studies of wing-body vehicles and the volume requirements of liquid-hydrogen-fueled vehicles, was perturbed in shape and size to determine the effects on mission performance. The effects of vehicle cruise speed and sonic boom constraint were also evaluated. The results suggest that a vehicle with a high-sweep body (77 deg), a forebody length ratio of approximately 0.73, and a maximum cross section to plan area ratio of approximately 0.076 gives maximum payload ratio. The best cruise speed for the subsonic-burning, ramjet-powered vehicles depends upon the degree of exhaust-gas chemical freezing and the cooling requirements of the engine system. The present results suggest a cruise speed between Mach 5 and 7. (Scramjet-powered vehicles were not considered.) Vehicles weighing from 0.3 to 0.9 million pounds were synthesized; the larger vehicles showed a moderate performance advantage. It was found that sonic boom constraints in the transonic region impose severe payload penalties on the nominal vehicle considered. A rocket assist during transonic acceleration alleviates the problem somewhat, but the penalties are still significant. (Author)

A70-45959 # **The physics of short takeoff and landing (STOL).** D. O. Carpenter and P. Gotlieb (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1238.* 8 p. Members, $1.50; nonmembers, $2.00.

Discussion of the physical aspects of takeoff and landing, and review of some analytical techniques used to identify the critical

design characteristics of commercial STOL aircraft. Data are presented parametrically, in order to provide guidance to the engineer and aircraft operator. Where required, powered lift characteristics are based upon wind tunnel and flight test information.
M.V.E.

A70-45960 # **STOL definition and field length criteria.** R. K. Ransone (American Airlines, Inc., New York, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1240.* 8 p. Members, $1.50; nonmembers, $2.00.

The effective use of STOL in the efficient door to door transportation of people is dependent upon special capabilities which allow the aircraft to operate safely in restricted areas. A definition of STOL must therefore be in terms meaningful to the problem, but permitting full realization of STOL operational benefits. This paper describes STOL field length, terminal area performance and minimum handling qualities requirements which are considered essential for safe, efficient STOL operations. They are expected to provide an improved level of safety over present CTOL operations and allow full utilization of STOL aircraft capabilities. Field length assurance criteria includes no arbitrary factors whatever, but provides for a rational/statistical approach for certification, a reliable means for the pilot to continually compare his situation to the certification conditions, and a predetermined course of action for any problem during takeoff or landing. These specifications are meant only to distinguish between STOL and CTOL aircraft, and are not intended to replace other specifications or regulations needed to ensure air-worthiness or handling qualities. An aircraft should only be called 'STOL' if it meets these requirements. (Author)

A70-45961 # **Intercity V/STOL service and the businessman traveler.** Alexis N. Sommers (New Haven College, West Haven, Conn.) and Douglas C. Jeng (Vitro Laboratories, Silver Spring, Md.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1241.* 13 p. 12 refs. Members, $1.50; nonmembers, $2.00.

Nondemographic data, including attitudinal and preference structures, are generated for a demand analysis of two feasible V/STOL systems assumed to be suitable for operation in a business travel market composed of New York, Philadelphia, and Washington, D.C. A sample of frequent or potential businessman travelers was surveyed by a comprehensive questionnaire, the results serving as input to a linear, nondemographic factor, mode choice-market share model designed to predict modal splits in a future environment. The model is applied to the selected V/STOL designs and the resulting predictions are assessed with respect to technological planning.
(Author)

A70-45969 # **Air traffic control in the 70's.** William M. Flener (FAA, Air Traffic Service, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1263.* 5 p. Members, $1.50; nonmembers, $2.00.

The National Airspace System will undergo substantial improvements in the Seventies as a result of the phenomenal growth in air transportation during the preceding decade. Today's manually operated system is entering a new realm of technology by fully interfacing an automated computerized subsystem. Constraints imposed by the present system on future growth of air commerce will be relaxed, consistent with the implementation of more suitable methods of enhancing safety and reducing congestion. Discussion will reveal the major problems confronting the system and offer feasible programs for correcting its deficiencies. (Author)

A70-45970 # **Impact of the next two aircraft generations on airport design.** Roy Callahan (Airline Facilities Corporation of America, New York, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1269.* 7 p. 11 refs. Members, $1.50; nonmembers, $2.00.

Discussion of the revolutionary changes in airport design and design criteria expected in the early years of the era of wide-bodied and supersonic aircraft. It is expected that airport decisions will give substantial weight to economic, social, and environmental considerations. Substantial changes will result from technical decisions of engineering considerations and architectural treatments. These changes are likely to include altered relationships between runways and airplane parking positions, modified subsystems for servicing aircraft, and new concepts for interface with other transportation modes (including off-airport transportation subsystems). Overshadowing these changes, however, will be those caused by management decisions predicated upon economic considerations. A controlling test of facility feasibility will be that of cost effectiveness. Development of facilities will progress only after master planning has prescribed tolerable economic parameters and after implementing procedures shall have reasonably insured satisfactory controls. It is expected that this will be an era when management will exercise control of facilities development from concept planning through construction and utilization, to insure that technical deliberations do not override acceptable economic guidelines. M.V.E.

A70-45971 # **An airline pilot's view of airline flying versus STOL flying.** C. C. Shafer (American Airlines, Inc., New York, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1282.* 5 p. Members, $1.50; nonmembers, $2.00.

Discussion of the changes in high speed jet pilot techniques required for operating STOL aircraft. It is shown how the design of a highlift wing type and a blown wing type slow speed STOL aircraft and their instrumentation and navigation equipment differ from those of a high speed jet transport. The pilot retraining requirements resulting from the ability of STOL aircraft to operate and maneuver in considerably reduced air and ground space and the subsequent necessity of different pilot concepts about glide and climb slopes, and arrivals and departures, are pointed out. M.V.E.

A70-45972 # **Operational constraints for STOL aircraft.** R. K. Schaefer and K. R. Velten (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1283.* 8 p. Members, $1.50; nonmembers, $2.00.

The STOL transportation system has been proposed as a solution to short-haul transportation congestion, because it: (1) operates independently of the existing CTOL (Conventional Takeoff and Landing) system; (2) offers more convenience to short haul travelers; and (3) relieves congestion at major airports. However, the STOL transportation system encounters operational constraints which differ from current CTOL aircraft. These constraints are: economics, short-haul market characteristics, operating environment, and community acceptance. This paper discusses how these constraints influence the STOL aircraft's size, speed, propulsion system, takeoff/landing performance, and maneuverability. (Author)

A70-45973 # **Airport and air traffic requirements for Short Haul Air Transportation.** Arvin O. Basnight (FAA, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1288.* 8 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A viable Short Haul Air Transportation System requires a new approach to air traffic control, air navigation facilities and airport design. Specific problems of the present system are identified, such as: separation of low speed smaller capacity aircraft from high speed large jets, simultaneous instrument operation at airports, specific focus on mixture of short haul and trunk line aircraft in high density

terminal areas, and others. Possible solutions are presented covering both system capacity and adequate safety. System requirements are presented with new concepts of design for airports, air traffic control and navigation to meet the challenge. (Author)

A70-45979 * An airborne measurement of the salinity variations of the Mississippi River outflow. J. D. Droppleman, R. A. Mennella (Lockheed Aircraft Corp., Houston, Tex.), and D. E. Evans (NASA, Manned Spacecraft Center, Houston, Tex.). *Journal of Geophysical Research*, vol. 75, Oct. 20, 1970, p. 5909-5913.

Passive microwave radiometric measurement of salinity variations at the south and southwest passes of the Mississippi River on Sept. 27, 1969. The passive microwave system mounted on the NASA/MSC P3A aircraft can measure radiometric energy in four bands centered on 1.4, 10.6, 22.2, and 31.4 GHz. No radiometric temperature change (within instrumental limits) was observed with the 10.6-, 22.2-, or the 31.4-GHz radiometers. However, a radiometric change of 13 to 18 K was observed with the 1.4-GHz radiometer. This observed change and the absence of an observed change by the other channels agrees (within experimental limits) with the theoretically predicted radiometric temperature variation for water at 25 C. This measurement demonstrates that an airborne passive microwave radiometer operating at 1 to 1.5 GHz can rapidly measure salinity and variations in salinity over large areas. (Author)

A70-46012 # Analytical investigation of radial inflow turbine design geometry. Akira Nishi and Teruo Sawada (Osaka Prefecture, University, Sakai, Japan). *Osaka Prefecture, University, Bulletin, Series A - Engineering and Natural Sciences*, vol. 18, no. 2, 1969, p. 347-363. 10 refs.

Radial inflow turbine is investigated analytically in order to determine the optimum design geometry for various applications such as small gas turbine, turbo-charger and space power systems. In the present analysis the efficiency is expressed by four independent variables and two dependent variables, as well as the losses of nozzle and rotor, which are obtained experimentally and involve a good many geometrical parameters of nozzle and rotor. Equations of continuity and definition of relative velocity angle at rotor exit are introduced to determine the dependent variables. And for the combinations of independent variables, efficiencies are calculated by a high-speed digital computer and in these calculations the optimum efficiencies are obtained for the various nozzle angles. As well as the efficiencies, the specific works are calculated for individual cases and the design examples for the maximum efficiency is presented. This method is useful for the predesign of the radial inflow turbine. (Author)

A70-46050 # Sharp slopes of pressure surface at SST altitudes. Arthur J. Kantor (USAF, Cambridge Research Laboratories, Bedford, Mass.). *American Meteorological Society, Bulletin*, vol. 51, Sept. 1970, p. 867, 868. 5 refs.

Study of sharp slopes of pressure surfaces by means of inspection of temperature gradients. Potential temperatures were applied to the barometric equation as shown in the U.S. Standard Atmosphere, 1962, to calculate altitude differences that would theoretically have been encountered over 4 n mi. An SST flying at a constant-pressure altitude of 64,000 ft and a speed of Mach 3 would change altitude by 272 ft over this 4-n mi stretch in about 8 sec. This change is roughly equivalent to an acceleration of 0.25 g, and would cause passenger discomfort. F.R.L.

A70-46068 Propagation of jet engine noise near a porous surface. P. B. Oncley (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Journal of Sound and Vibration*, vol. 13, Sept. 1970, p. 27-35. 14 refs.

Acoustic measurements, except those made in anechoic chambers, are often complicated by the characteristics of bounding surfaces. For example, in jet aircraft engine noise measurements, a frequency-dependent pattern of maxima and minima results from interference of direct and reflected waves. When the surface is hard, like concrete, this pattern is readily computed, but over dirt and grass rather puzzling results are often obtained. It is shown that these apparently anomalous effects, sometimes called 'ground absorption' or 'extra-atmospheric attenuation' can be explained by adding to conventional interference frequency computations the phase delay introduced on near-grazing reflection. This phase delay can be computed after the analysis of Rudnick or Ingard if impedance and propagation constants are known. (Author)

A70-46069 Experimental studies of discrete tone noise from an axial flow fan. N. Chandrashekhara (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 13, Sept. 1970, p. 43-49. 5 refs. Research supported by the Fighting Vehicles Research and Development Establishment.

Some measurements of discrete tone radiation from an axial flow fan are presented here in the form of tone directivity. These are explained from the established theory relating them. The effect of cut-off is explained. The measured discrete tone power at blade passing frequency and harmonics are presented. These are compared with the radiation efficiency of corresponding modes. (Author)

A70-46092 A U.T.A. inertial flight - Paris, Lagos, Douala, with the Carrousel IV system (Un vol inertiel U.T.A. - Paris, Lagos, Douala avec le système Carrousel IV). *Navigation* (Paris), vol. 18, Oct. 1970, p. 350-364. In French.

Account of a Union de Transports Aeriens (U.T.A.) flight accomplished by a super DC-8 on the Paris-Brazzaville line within the framework of an experimental program bearing on navigation control with the help of a Carrousel IV platform. The system consists of a digital computer combined with the inertial platform and related electronics, a control indicator for the use of the pilot, a mode selector, and provision for emergency backup. The flight was accomplished nearly perfectly, but in general service it is considered that navigation could be affected by slow drift of the system, and by malfunctions which could be of major or minor importance, or could occur suddenly or be permanent. F.R.L.

A70-46093 Detection of clear air turbulence by infrared radiometry (Détection des turbulences en ciel clair par radiométrie infrarouge). G. Broussaud, P. Conjeaud, and C. Tinet (Thomson-CSF, Paris, France). *Navigation* (Paris), vol. 18, Oct. 1970, p. 409-418. In French.

Description of a clear air turbulence detector based on distant measurement of thermal gradients by infrared radiometry. Experimental flights were made with an Air France Boeing 707. The apparatus uses four receivers staggered on one of the sides of the 15 micrometer line of carbon dioxide, and makes possible a panoramic visualization of clear air turbulence. F.R.L.

A70-46125 A statistical analysis of aircraft maintenance costs. Herman L. Gilster (U.S. Air Force Academy, Colorado Springs, Colo.). *Operations Research*, vol. 18, Sept.-Oct. 1970, p. 904-917. 6 refs.

This paper outlines the merits of the recursive regression model in analyzing aircraft-failure and manhour-cost data. The parameters of this model are estimated from maintenance data generated by the entire Boeing B-52 fleet during the period August 1965 to August 1966. Failure rates and manhours of repair are found to be a significant function of the calender age of the aircraft, the length of the missions flown, the time spent in low-altitude flight, and the technological developments in newer aircraft. The estimated parameters are used to develop a marginal cost analysis that can be used by the decision maker in evaluating his maintenance operation. Although the paper is based on a specific military operation, the method outlined can be used to determine maintenance costs for any large jet aircraft. (Author)

A70-46150 **Thermal propulsion systems for aircraft (Thermische Antriebe für Luftfahrzeuge).** Sigurd Hufnagel (Technische Akademie der Luftwaffe, Munich, West Germany). Darmstadt, Wehr und Wissen Verlagsgesellschaft mbH, 1970. 244 p. 14 refs. In German. $9.50.

This book is intended for engineers, technicians and students who are interested in the fields of aeronautics, astronautics, defense technology, and in piston, turbine and jet engines. The book explains the principles of operation of all types of propulsion systems of aircraft taking into account also the propulsion system elements. The description is based in the main on the laws of the thermodynamics of flowing media. The book provides also the basic information for the calculation, design, and evaluation of propulsion systems. The principles of thermodynamics are reviewed, and the properties and the composition of the atmosphere are considered. Elements of propulsion systems including nozzle, compressor, gas turbine, combustion chambers, and propellers are discussed. Various types of turbine propulsion systems, propeller-piston systems, jet engines and rocket motors are examined. G.R.

A70-46203 # **Manoeuvre demand control for aircraft.** G. T. Shanks (Royal Aircraft Establishment, Farnborough, Hants., England). *Institute of Navigation, Journal,* vol. 23, Oct. 1970, p. 492-504. 6 refs.

Discussion of aspects of maneuver demand control for aircraft taking into consideration the benefits to be gained by using feedback control techniques in the primary flight controls and work done in the Avro 707C aircraft and in the Hunter Mk. 12 aircraft. Conventional mechanical control systems are briefly considered and some current aircraft flight control systems are reviewed. The current electric signaling feedback control technique in the form of an integrated maneuver demand system is compared to the present design approach of using a collection of dissimilar subsystems. G.R.

A70-46204 # **The distribution of wind and temperature on theoretical routes at Concorde cruising level.** H. P. Jeffreys (British Overseas Airways Corp., London Airport, Hounslow, Middx., England). *Institute of Navigation, Journal,* vol. 23, Oct. 1970, p. 505-521.

Discussion of the sources of meteorological information and of the results of a recent airline study of environmental conditions at Concorde cruising levels on a selection of routes. Charts available for estimating the ambient temperature deviations likely to be encountered at Concorde cruising levels are considered. It is pointed out that in recent years the electronic computer has revolutionized information handling and flight planning techniques. A 100-mb level study and a correlation of North Atlantic conditions at 100-mb level are discussed. G.R.

A70-46214 **Electronic unit to control inlet for SST.** Benjamin M. Elson. *Aviation Week and Space Technology,* vol. 93, Nov. 2, 1970, p. 44-46.

Description of an automatic control system for the variable geometry engine air intakes on the Boeing supersonic transport. The intent is to optimize engine performance and to control noise propagation from the engine compressors. The transducers and the electronic controller are described. The inlet and inlet control system have been optimized around the Mach 2.7 cruise point. The system has been designed to capture just the right amount of air for this operating point. F.R.L.

A70-46228 # **Viggen is tested - Methods of measurement (Viggen provas - Mätmetoder).** Lars Sjödin (Saab-Scania, Flugdivisionen, Linköping, Sweden). *Teknisk Tidskrift,* vol. 100, Oct. 15, 1970, p. 35-37. In Swedish.

Description of the measurement system used for testing flight properties of the 37 Viggen aircraft prototype. A detailed explanation of the design and operation of a measurement system based on various different principles of measurement and recording of both analog and digital type, installed aboard the aircraft, is given and illustrated by a simplified block diagram. The basic principles of the preprogrammed system control used are also reviewed. Environmental and operational testing of the system prior to and after its onboard installation is briefly outlined. Finally, the overall system efficiency is evaluated. O.H.

A70-46229 # **Viggen is tested - Evaluation (Viggen provas - Utvärdering).** Sven Sandin (Saab-Scania, Linköping, Sweden). *Teknisk Tidskrift,* vol. 100, Oct. 15, 1970, p. 37, 38, 40. In Swedish.

Description of the equipment and methods used for evaluating test data measured by the measurement system aboard the prototype of 37 Viggen aircraft. The principles underlying the operation of the so-called Sapuc system designed to evaluate data from the Viggen measurement system for their further processing are explained. The data processing equipment, referred to as system Salut, is also described. The overall efficiency of the combined Sapuc-Salut system is evaluated. O.H.

A70-46238 # **MADAP - A description of the technical features of the Maastricht Upper Air Space Control Centre Automatic Data Processing and Display (MADAP) System.** *Eurocontrol,* vol. 2, no. 2, 1970, p. 4-10, 32.

Description of the automatic data processing and display system that is being installed at the Upper Air Space Control Centre of Maastricht, Holland. The system is intended to perform: (1) the processing of flight plan data received from neighboring air traffic service units or from aircraft through the air/ground voice communication system; (2) the processing of radar information received from a number of remote primary and secondary surveillance radar stations; and (3) the correlation, storage, updating, and arrangement of data for display as required at a number of operating positions. The system contains eight computers, over 80 operating and training positions, and approximately 140 display units. It can deal simultaneously with an estimated number of 200 active flight plans and 250 processed tracks. M.V.E.

A70-46239 # **Aircraft trajectories - An approach to the calculation of aircraft trajectories for possible application in air traffic control.** A. Benoît, Y. Charvet, R. H. G. Martin (EUROCONTROL, Brussels, Belgium), and P. Kuypers (Groupe d'Etudes de Technologie Spatiale, Brussels, Belgium). *Eurocontrol,* vol. 2, no. 2, 1970, p. 11-17. 11 refs.

Development of a method for computing aircraft trajectories with particular reference to climb and descent. Analytical expressions are defined which can be used to provide good approximations of the actual trajectories at a restriction in the amount of numerical data required to a limit compatible with smooth operation of the air traffic control process. The influence of each of the parameters employed by the method is examined. Results obtained from a preliminary series of trials are presented in the form of a comparison of trajectories derived from actual flight observation with trajectories computed in accordance with the method described. M.V.E.

A70-46240 # **DVOR - Testing of new radio-navigation facilities.** W. Feyer (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *Eurocontrol,* vol. 2, no. 2, 1970, p. 18-24. Translation.

Description of a recent technical development in the area of very high frequency omnidirectional radio range (VOR) which provides instrument readings used by pilots for following the prescribed route from airport of departure to airport of destination. The described development consists essentially in an integration of the Doppler effect with the conventional VOR installation, converting the latter into a Doppler very high frequency omnidirectional radio range (DVOR) system. This system achieves a considerable improvement in the navigational information transmitted to pilots in that it eliminates VOR's tendency to combine correct and erroneous

directional information in the airborne VOR receivers when signals radiated on vhf frequencies in the 108-118 MHz range undergo reflections from artificial or natural obstacles. M.V.E.

A70-46245 # **The calculation of inviscid hypersonic flow past the lower surface of a delta wing.** E. A. Akinrelere (Ife, University, Ibadan, Nigeria). *Journal of Fluid Mechanics,* vol. 44, Oct. 21, 1970, p. 113-127. 13 refs.

Kennett (1963) calculated the hypersonic flow fields past the lower (compression) surface of a delta wing, using the one-strip approximation of the method of integral relations. He obtained solutions only for wings with detached shocks. In this paper his solutions are extended to wings with attached shocks. Here, the sonic point is inboard of the leading edge which makes the problem mixed. The solutions compare very well with the numerical solutions of the full equations by Babaev (1963a) both in the shock shapes and pressure distributions for various Mach numbers. (Author)

A70-46251 # **Forty years of the aircraft gas turbine.** Kenneth Fulton. *Aircraft Engineering,* vol. 42, Oct. 1970, p. 18-20, 25, 32.

Review of the progress made since the inception of the gas turbine as a prime mover for aircraft. Following an outline of the early types of centrifugal and axial compressor engines constructed during and after World War II, the development of the various types of turbofan, turbojet, and turboprop engines is described in detail. Finally, gas turbine engines so far developed for propulsion of VTOL aircraft are discussed. O.H.

A70-46257 # **Positron annihilation in quenched cadmium metal.** D. C. Connors, V. H. C. Crisp, and R. N. West (East Anglia, University, Norwich, England). *Physics Letters,* vol. 33A, Oct. 19, 1970, p. 180, 181. Research supported by the Science Research Council.

Calculation of the radar backscatter intensities from an over-simplified aircraft model. The intensities are compared with measurements in the anechoic chamber. The experimental intensities and the theoretical points are shown. M.M.

A70-46327 # **Military test program application to commercial operations.** W. H. Ross (U.S. Naval Air Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1242.* 8 p. Members, $1.50; nonmembers, $2.00.

Review of the basic nature of the close relationship between commercial and military helicopter design and development. This relationship is shown to have worked to the advantage of both military and civilian users of the helicopter. A tabulation of military and civilian market acceptance of 22 major helicopter types that have been in operation since 1942 indicates that: (1) there is a high degree of commonality of acceptance of a given VTOL model by both markets; (2) with the exception of the largest transports, models achieve acceptance by both markets at about the same time; and (3) prototypes that have failed to find a home in either market are capable of being developed into forms acceptable to both. These patterns are not expected to change significantly in the foreseeable future. M.V.E.

A70-46328 **Thrustmeter takes direct reading of output from any jet engine.** Daniel G. Russ (Telectro-Mek, Fort Wayne, Ind.). *SAE Journal of Automotive Engineering,* vol. 78, Nov. 1970, p. 21-23.

Description of a thrustmeter system which requires only a few measured pressures to determine the thrust developed by a jet engine. Both stream and total pressures are needed from each port that produces drag or thrust. Inlets and outlets must be considered separately. Simple computers manipulate these primary data to obtain ratios of pressures. Nonlinear elements find invariant aerodynamic functions of the pressure ratios which apply to all jet engines. It is then a relatively simple matter to factor in the constant which represents the fixed area of the port, ambient pressure, and air speed to get thrust or drag. Taking the difference between the gross thrust generated at the exhaust nozzle and the ram drag from the inlet port gives the net useable thrust. From the nature of the measurements, variable geometry has no effect on the accuracy of the thrust value. T.M.

A70-46383 **The helicopter - Hazardous at any height.** W. H. Baker (U.S. Navy, Naval Weapons Laboratory, Dahlgren, Va.). *U.S. Naval Institute Proceedings,* vol. 96, Oct. 1970, p. 57-61.

Discussion of the comparatively great hazards involved in the use of helicopters and of approaches to eliminate these hazards. The various factors responsible for fatal helicopter accidents and the fatalities suffered in these accidents are examined. A proposal in support of a program designed to eliminate the major deficiencies in overall helicopter safety is discussed. Specifically, the proposed system would include crash-resistant fuel systems, flotation devices, redesigned seats, lightweight armor, impact-attenuation equipment, and the in-flight escape capability. Depending on the type of helicopter, the latter would most likely be either a 'capsule' escape system, or an upward ejection system. G.R.

A70-46387 # **Cleaner skies from the jets.** Gerald R. Daly. *Bee-Hive,* vol. 45, Summer 1970, p. 18-23.

Discussion of an intensive research and development program initiated by Pratt and Whitney Aircraft in the mid 1960s with the aim of reducing the smoke emitted from jet engines in flight. The complexity of the problems involved in designing reduced-smoke combustion chambers is demonstrated, and the various tests and test equipments developed for this purpose are described. Among other tests, some 465 different combustion chamber designs were tested in both 'single-can' and 'nine-can' rigs, and 140 tests were run in full-scale JT8D engines. Air flow patterns within the chamber were studied with plexiglass models. The resulting modified low-smoke combustion chambers ('burner cans'), which are to be installed in all existing JT8D engines by the end of 1972, are illustrated and discussed. The experience obtained during the smoke reduction program made it possible to use a low smoke level as a major design objective for the JT9D turbofan which powers the Boeing 747 and the McDonnell Douglas DC-10. V.P.

A70-46398 # **Flight research engineers seek methods to 'birdproof' aircraft (Vers des avions résistant aux impacts d'oiseaux).** *Science Dimension,* vol. 2, Oct. 1970, p. 11-15. In English and French.

Discussion of a birdproofing research program conducted with equipment including a pneumatic cannon that fires chicken carcasses and simulated birds at speeds up to 620 miles an hour. The cannon forms the core of a flight impact simulator designed and operated by the Structures and Materials Laboratory of NRC's National Aeronautical Establishment. It has been used for birdproofing studies on tail assembly sections and windshields, employing real and simulated bird carcasses in the four- and eight-pound weight sizes. G.R.

STAR ENTRIES

N70-32004*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALYSIS OF SUPERSONIC CONICAL FLOWS
C. W. Chiang and Richard D. Wagner Jr. Washington Jul. 1970 35 p refs
(NASA-TN-D-5884; L-7082) Avail: CFSTI CSCL 20D

An analytical technique is described for conical flow-field predictions for a particular class of flows. Problems of accelerating and decelerating supersonic cross flows are considered; the accelerating cross flow is produced when the free stream is normal to the conical axis of symmetry (a fin or stabilizer), and the decelerating cross flow is produced when the free stream is in the plane of symmetry (delta wing). For the first problem the solution is complete; for the latter only the solution for the supersonic cross-flow region is presented. The fundamental differential equations are transformed into a dimensionless conical coordinate system. Since the partial differential equations governing a conical flow field are of hyperbolic type in regions of supersonic cross flow, the method of characteristics can be applied. The characteristic equations and compatibility equations are derived. Numerical computations are performed, starting from the leading edge and proceeding to the central portion of the wing. Author

N70-32047*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF AN AUXILIARY INLET EJECTOR NOZZLE WITH FIXED INLET DOORS AND TRIPLE-HINGE TRAILING-EDGE FLAP
Albert L. Johns and Fred W. Steffen Washington Jul. 1970 68 p refs
(NASA-TM-X-2034; E-5497) Avail: CFSTI CSCL 21H

An auxiliary inlet ejector nozzle appropriate for a supersonic-cruise aircraft was evaluated over a range of free-stream Mach numbers from 0 to 1.20. Two primary throat areas were used: one to simulate nonreheat operation, and the other for reheat operation. The shroud was fixed in a closed position for subsonic operation. The projected boattail area was 47 percent of the simulated nacelle area. Variation in auxiliary inlets included door type (single and double hinge) and values of tertiary flow area (controlled with fixed-position doors) from 0 to 71.5 percent of the shroud exit area. During subsonic cruise and dry acceleration, the maximum nozzle efficiency was obtained with the double-hinge door configuration. At the reheat power settings, the maximum nozzle efficiency was obtained with the doors closed at Mach 0.60 and higher. Author

N70-32051*# AiResearch Mfg. Co., Los Angeles, Calif.
INVESTIGATION AND DEVELOPMENT OF NEW CONCEPTS FOR IMPROVEMENT OF AIRCRAFT ELECTRICAL POWER SYSTEMS Quarterly Progress Report
C. H. Lee 23 Jan. 1970 101 p refs
(Contract NAS12-659)
(NASA-CR-86410; Rept-68-4176(6); QPR-6) Avail: CFSTI CSCL 10B

CONTENTS:
1. OPTIMUM SUPPLY TO AIRCRAFT ELECTRICALLY OPERATED EQUIPMENT 21 p
2. COMPARISON OF HYDRAULIC, PNEUMATIC, AND ELECTRIC POWER FOR AIRCRAFT ACTUATION SYSTEMS 21 p
3. MAINTAINABILITY AND ITS TRADEOFFS WITH EQUIPMENT COST AND WEIGHT 12 p
4. APPROACH TO DEFINE RELATIVE WEIGHTED FACTORS WHICH DETERMINE SYSTEM EFFECTIVENESS 9 p
5. FAILURE PREDICTION, DETECTION, AND COMPENSATION 25 p

N70-32052*# AiResearch Mfg. Co., Los Angeles, Calif.
OPTIMUM SUPPLY TO AIRCRAFT ELECTRICALLY OPERATED EQUIPMENT
In its Invest. and Develop. of New Concepts for Improvement of Aircraft Elec. Power Systems 23 Jan. 1970 21 p
Avail: CFSTI CSCL 10B

The study on optimum methods of applying electric power to loads was concluded. The loads considered were electric drives for hydraulic pumps and secondary flight controls, electronic loads, lighting loads, and thermoelectric refrigeration loads. Author

N70-32053*# AiResearch Mfg. Co., Los Angeles, Calif.
COMPARISON OF HYDRAULIC, PNEUMATIC, AND ELECTRIC POWER FOR AIRCRAFT ACTUATION SYSTEMS
In its Invest. and Develop. of New Concepts for Improvement of Aircraft Elec. Power Systems 23 Jan. 1970 21 p
Avail: CFSTI CSCL 01C

The three types of actuation systems (hydraulic, pneumatic, and electric) are further compared and the dynamic capability of each system is briefly discussed. Some of the component characteristics of the various systems are investigated since the development of components directly affects system capability. Author

N70-32054*# AiResearch Mfg. Co., Los Angeles, Calif.
MAINTAINABILITY AND ITS TRADEOFFS WITH EQUIPMENT COST AND WEIGHT
In its Invest. and Develop. of New Concepts for Improvement of Aircraft Elec. Power Systems 23 Jan. 1970 12 p
Avail: CFSTI CSCL 01C

The factors which affect maintenance cost are presented. Maintainability and prediction and demonstration techniques are discussed with maintainability design steps to be taken during the design and development period. For the electrical equipment, possible tradeoff areas between maintainability and cost and weight are investigated and illustrated. Author

N70-32055*# AiResearch Mfg. Co., Los Angeles, Calif.
APPROACH TO DEFINE RELATIVE WEIGHTED FACTORS WHICH DETERMINE SYSTEM EFFECTIVENESS
In its Invest. and Develop. of New Concepts for Improvement of Aircraft Elec. Power Systems 23 Jan. 1970 9 p

Avail: CFSTI CSCL 01B

Relative weighted factors that determine system effectiveness are examined as well as aircraft electric equipment weight criteria. Author

N70-32056*# AiResearch Mfg. Co., Los Angeles, Calif.
FAILURE PREDICTION, DETECTION, AND COMPENSATION
In its Invest. and Develop. of New Concepts for Improvement of Aircraft Elec. Power Systems 23 Jan. 1970 25 p

Avail: CFSTI CSCL 01B

The advantages of using failure prediction and detection for electrical equipment are presented. The failure mode of the system components and the possible techniques of detecting and predicting these failures are evaluated. Different types of recording systems, display techniques, and sensors are also briefly discussed. Author

N70-32069# Serendipity Associates, Los Angeles, Calif.
CORRECTION OF HOVER FLIGHT TEST RESULTS TAKEN IN WIND
W. Mc Intyre, R. Begley, and M. Brown Mar. 1970 158 p refs
(Contract DAAJ01-69-C-0215)
(AD-704349; TR-70-2) Avail: CFSTI CSCL 1/2

This report presents a procedure for analytically correcting for the effect of wind (dewinding) on a hovering helicopter. This procedure will be much more cost effective than the current method which requires lengthy delays until the wind speed drops below two knots. Dewinding is accomplished by application of the equations of motion and consideration of control changes to flight test data recorded on an incremental digital recording system. An experimental program is outlined to determine first the effective wind acting on a hovering helicopter and second the effect this wind has on the helicopter. Author (TAB)

N70-32090# ARO, Inc., Arnold Air Force Station, Tenn.
AN EXPERIMENTAL INVESTIGATION OF THE SUPERSONIC COMBUSTION OF VITIATED AIR-HYDROGEN MIXTURES Final Report, 13 May 1968 – 30 Jun. 1969
R. E. Davis AEDC May 1970 36 p refs
(Contract F40600-69-C-0001)
(AD-705129; AEDC-TR-70-60) Avail: CFSTI CSCL 21/5

Tests were conducted utilizing an arc heater as a high enthalpy air source to determine the effects of water vapor contamination on a hydrogen-air supersonic combustion process. A flow apparatus was constructed to permit vitiated, arc-heated airflow to mix coaxially with hydrogen in a constant area duct. The hydrogen was injected at the exit of the vitiated air nozzle which was designed for M = 2.8. Data were obtained in the form of wall pressure distributions and impact pressures and gas samples obtained from nonquenching pitot probes. The enthalpy of the mixture was varied from 1360 to 1860 Btu/lbm and the water vapor mass percent in the vitiated air was varied from 0 to 23. Author (TAB)

N70-32106*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
KINETICS AND THERMODYNAMICS IN HIGH-TEMPERATURE GASES
Washington 1970 150 p refs Conf. held at Cleveland, 19 Mar. 1970
(NASA-SP-239) Avail: CFSTI CSCL 20M

CONTENTS:

1. COMPLEX CHEMICAL EQUILIBRIUM CALCULATIONS S. Gordon p 1–15 refs (See N70-32107 17-06)
2. CALCULATIONS OF THE EQUILIBRIUM PROPERTIES OF PLASMAS S. Heimel p 17–29 refs
3. THERMODYNAMICS OF THE INTERNAL COMBUSTION ENGINE F. J. Zeleznik p 31–40 refs
4. TRANSPORT PROPERTIES OF HIGH TEMPERATURE GASES R. S. Brokaw p 41–62 refs
5. EXPERIMENTAL MEASUREMENTS OF DIFFUSION COEFFICIENTS FOR ATOMIC OXYGEN C. E. Baker p 63–74 refs
6. TRANSPORT PROPERTIES OF COMPLEX MIXTURES R. A. Svehla p 75–88 refs
7. COMBUSTION CHEMISTRY F. E. Belles p 89–104 refs
8. RATE CONSTANTS FROM IGNITION STUDIES OF THE H2-CO-02 SYSTEM T. A. Brabbs, F. E. Belles, and R. S. Brokaw p 105–117 refs
9. KINETICS OF THE DISSOCIATION OF BROMINE M. Warshay p 119–132 refs
10. CHEMICAL KINETIC COMPUTATIONS IN MULTIREACTION SYSTEMS D. A. Bittker p 133–146 refs

N70-32148# Royal Aircraft Establishment, Farnborough (England).
COMMENTS ON THE APPROXIMATE SOLUTION OF THE CLASSICAL FLUTTER PROBLEM [BEMERKUNGEN ZU DER ANGENAEHERTEN LOESUNG DES KLASSISCHEN FLATTERPROBLEMS]
H. G. Natke Jul. 1969 22 p refs Transl. into ENGLISH from Z. Flugwiss. (Germany), v. 15, no. 11, 1967 p 425–437
(RAE-Lib-Trans-1296) Avail: CFSTI

Solution possibilities for the flutter problem as applied in practice are briefly reviewed and discussed without using a special aerodynamic theory. The relations between different solutions for a system with n degrees of freedom are given and demonstrated with an example. Author

N70-32151# Advisory Group for Aerospace Research and Development, Paris (France).
TESTING OF AIRBORNE AVIONICS SYSTEMS Conference Proceedings
Mar. 1970 473 p refs Mostly in ENGLISH; partly in FRENCH
Presented at AGARD Avionics Panel 18th Tech. Symp., Tonsberg, Norway, 6-9 Oct. 1969
(AGARD-CP-51) Avail: CFSTI

The conference papers presented pertain to operational requirements, avionics system testing concepts, built-in test equipment, onboard test equipment, automatic test equipment, and automatic test equipment software.

N70-32152# Department of the Air Force, Washington, D.C.
THE TESTING OF AIRBORNE AVIONICS SYSTEMS: THE

OPERATIONAL REQUIREMENT
Archie T. Iddings *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 6 p
Avail: CFSTI

A nontechnical overview of the Air Force operational requirement for automatic test equipment (ATE) and aircraft integrated data systems (AIDS) is presented. The Air Force requirements process is discussed briefly to provide an understanding of the problems encountered in taking a 'paper' requirement, particularly a support requirement, through the various stage of 'advocacy' to actual hardware. Various requirements for AIDS, ATE, and related equipment are viewed and discussion is given to the formative process which led to and AIDS program. Air Force philosophy regarding the relationship between inflight and ground checkout equipment is discussed and addresses the question of standardized versus peculiar test equipment. Author

N70-32153# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
DYNAMIC INTEGRATED FLIGHT LINE CHECKOUT OF AVIONICS SYSTEMS
D. E. Brown and E. W. Buebel, Jr. (AAI Corp.) *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 9 p

Avail: CFSTI

Integrated dynamic tests at flight line maintenance echelon for weapon systems are proposed. Built-in tests are recognized as essential to the weapon system. It is concluded that built-in tests cannot functionally replace the ground based tester. Both dynamic and integrated tests are required to thoroughly test the system. The alternatives to the proposed test concept are static and subsystem tests. These alternatives fail to evaluate the system as the system operates on mission. The tester used to implement the concept must have an automatic mode with ample provisions for operator intervention. The automatic program must be flexible so that it can be easily changed to track system changes. The concept has had varying degrees of application on the F-101, F-102, F-104, F-106, and F4 weapon systems with good results. It is included in the test concepts for the A-7 and F-15. Author

N70-32154# Ministry of Defence, London (England).
THE IMPACT ON MANAGEMENT OF AUTOMATIC TEST EQUIPMENT IN THE AVIONICS REPAIR ORGANIZATION: THE MANAGER'S VIEW
E. P. Folland *In* AGARD Testing of Airborne Avionics Systems Mar. 1970
Avail: CFSTI

A survey to forwarn the prospective automatic test equipment (ATE) purchaser of the problems awaiting him is presented from the manager's viewpoint. The difficulties of selecting line replaceable units for ATE testing, and then obtaining the test data are fully described because they are fundamental to ATE procurement. Author

N70-32155# Bendix Corp., Detroit, Mich. Navigation and Control Div.
AUTOMATED PRODUCTION TESTING AND TROUBLESHOOTING OF AVIONICS PRODUCTS
Mario Antonazzi *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 14 p
Avail: CFSTI

A study of the application of automated testing and troubleshooting in an electronic manufacturing plant is presented. A major facility, based on the AN/GJQ-9 Programmer-Comparator was established; its development and operation over the past five years has generated a store of practical experience which was of considerable value in directing further automatic test equipment development and application. An automatic fault isolation test system for circuit boards was completed and is in operation. This computer-controlled system uses guarded measurements and a novel test fixture for making in-circuit component tests. The system concept is based on a trade off of troubleshooting cost savings versus recurring costs (software, adapters). A facility being planned will incorporate the computer-controlled automatic test equipment as the key element in an overall plan to minimize redundant development of equipment, programming and troubleshooting techniques between factory, aircraft manufacturer and maintenance shop. Author

N70-32156# Polhemus Navigation Sciences, Inc., Burlington, Va. Director of Engineering.
A TECHNIQUE FOR ESTABLISHING THE COST-EFFECTIVENESS OF AVIONICS SYSTEM TESTING CONCEPTS
Donald W. Richardson *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 17 p Sponsored in part by Hughes Aircraft Co.
Avail: CFSTI

A tool is provided for the major airframe/avionics system contractor. This tool is a technique of analysis of the effective feasibility of the elements of the avionics system on an aircraft, as achieved by a variety of test approaches such as off-board ATE, on-board computers, BITE, etc. The results of this analysis will provide the major systems contractor with preliminary information upon which to base his major decisions regarding the maintainability concept to be implemented into the prime vehicle (and perhaps also into the overall operational maintenance environment). However, the level of this analysis is not specifically constrained to an evaluation of the technical details of particular avionics test concepts. In actuality, the major systems designer must make his decision based on the total cost effectiveness of any particular concept. The expansion of the original testability analysis into an overall cost effectiveness analysis of the implementation of any candidate testing concept into an operational situation is treated. The conclusion presents a suggested set of guidelines and procedures for the performance of a cost effectiveness analysis of various concepts of testing avionics systems. Recommendations are made concerning the utility of this technique for making initial decisions early in the design cycle of a project. Author

N70-32157# Royal Air Force, Farnborough (England).
AIRBORNE INTEGRATED DATA SYSTEMS (AIDS) FOR AIRCRAFT MANAGEMENT
M. C. Whiteley *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 15 p refs
Avail: CFSTI

The concept of real time measurement of aircraft parameters as part of an airborne integrated data system (AIDS) to improve aircraft management is introduced. The application of AIDS to improve aircraft maintenance and mission performance is examined with particular emphasis on determining the likely benefits of AIDS in improved aircraft availability. Special consideration is given to examining the cost flow of defects in obtaining a mathematical model of the maintenance of aircraft based on reliability theory. The means of assessing the effectiveness of AIDS as a maintenance tool and its relationship to built-in test equipment (BITE) and automatic test equipment (ATE) is discussed. The future importance of AIDS as a means of assessing mission effectiveness and its role as an overall management tool for both civil and military aircraft is examined. Author

N70-32158# British Aircraft Corp., Preston (England).
THE INTERDEPENDENCE OF 'BUILT IN', 'ON BOARD' AND 'GROUND BASED' TEST FACILITIES
A. S. Delahunty and A. G. Hayes *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 15 p
Avail: CFSTI

Testing is carried out to enable a decision to be taken: either to use an aircraft, system or avionic unit, or to repair or replace it. When the decision is to repair, diagnostic testing is then necessary to locate the fault, and subsequently performance testing is required to ensure that the repair was effective. The ground equipment is either manual or automatic (or both) and again the best economic mix must be chosen for the particular application and for each echelon of servicing. As an example, a logistic exercise on an aircraft is described, to show the flow diagram of a particular type of fault finding procedure to illustrate clearly the part that each test system plays in the maintenance of the aircraft. Difficult areas are highlighted, for instance those associated with certain types of inertial component. Author

N70-32159# Radio Corp. of America, Needham, Mass.
INTERRELATION OF ON-BOARD AND GROUND ATE IN ACHIEVING THE MOST EFFECTIVE OVERALL SUPPORT SYSTEM
O. T. Carver *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 14 p refs
Avail: CFSTI

In order to evaluate alternate concepts for on-board and ground test systems, their effect on the total support system must be measurable. This points to a need for quantitative measures of effectiveness for the overall support system. Measures of support system effectiveness are developed relating prime equipment availability as a function of the support system and the total cost of providing that support. Simulation models, applied to the support system, are used to test alternate methods of support during early development so that trade-offs can be made between the prime and support system as well as within the support system. A number of examples are used to illustrate the use of support system models. Author

N70-32160# Bendix Corp., Teterboro, N.J. Navigation and Control Div.
BUILT IN TEST EQUIPMENT FOR ADVANCED FLIGHT GUIDANCE SYSTEMS
Martin Feintuch *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 9 p
Avail: CFSTI

A comprehensive discussion of built-in test equipment is presented including: 1) its advantages and disadvantages compared to automatic and on board test equipment, 2) the necessity for testing only the least reliable components, 3) the need for employing a fail safe testing technique, and 4) the advantages and disadvantages of end to end testing compared to sub-module testing. The critical reliability considerations are discussed including: 1) the reliability of the test equipment versus that of the object system, 2) the failure rate of the object circuits compared to the time between overhauls, and 3) the selection of those object circuits which must be tested in order to meet a specified testing confidence. The implementation of fail safe hybrid testing circuitry is presented. In addition, sample testing programs are presented which represent tests of a single channel and a dual channel automatic flight control system. A comparison of the difficulty in testing single, dual, and triple channel systems is also made. Author

N70-32161# Philco-Ford Corp., Blue Bell, Pa. Communications and Technical Services Div.
BUILT-IN TEST EQUIPMENT USING AUTOMATED DIAGNOSTIC PROCEDURES
J. A. Jurenko and J. W. Mc Nabb *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 12 p ref
Avail: CFSTI

A method is presented for designing and incorporating automatic Built-In-Test-Equipment (BITE) into avionics communications equipment that is both efficient in terms of fault location as well as low cost relative to the overall hardware. This presentation includes basic design philosophy, specific design techniques, and a discussion of implementation of BITE. Since BITE can also be used to great advantage in production and inspection, this aspect is considered during the original design. Recent advances in the art of BITE were made through application to a new line of avionics communications equipments. Several types of communications equipments have been designed with BITE which includes a Fault Location Facility (FLF). The FLF provides a means for isolating faults to printed circuit board level or module level by testing all active circuits. In designing equipment, many electronic functions which were previously considered practical only in analog form, are now performed quite readily utilizing digital techniques. These techniques lend themselves to the incorporation of BITE and FLF as an integral part of the equipment. Two types of FLF can be incorporated into equipment and these are described. The first test feature, which exercises the equipment in real time, permits automatic detection of equipment failure. The second test feature, which is an off line test, provides the means for isolation of faults to the printed circuit board or replaceable module level. All active components are tested by this procedure. Author

N70-32162# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
INDIVIDUALLY BUILT-IN SELF TEST TECHNIQUES AS APPLIED TO TERRAIN-FOLLOWING RADAR SYSTEMS
Fred H. Behrens and Charles C. Freeny (Gen. Dyn., Fort Worth, Tex.) *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 13 p refs
Avail: CFSTI

The BIT design considerations are discussed in terms of primary and secondary BIT problems. The primary problems are those directly related to flight safety and the secondary problems are those normally associated with avionics BIT design (malfunction isolation). TFR BIT design tradeoff techniques are discussed relative to basic signal tests (continuous versus sampled) and failure reaction requirements (automatic versus manual). The basic BIT parameter design selected for the F-111 is presented in terms of the above mentioned BIT signal properties and failure reaction categories. Analysis, simulation, and flight test techniques for developing the test tolerances needed to assure safe flight over a wide spectrum of terrain variation flight loads, and flight velocities are discussed. Resultant BIT performance is expressed in terms of probability of false alarm versus probability of terrain clobber. An associated system design concept is presented, which allows the BIT complexity to change when the mission requirements change. An extension of current BIT techniques, wherein comparison is made with independent reference signals, is suggested, although the extension would require parameter reliability weighting, so as to not increase the falsealarm rate. Author

N70-32163# Elliott Flight Automation, Ltd., Rochester (England).
SYSTEM INTEGRITY AND FAULT ISOLATION VIA BITE
L. E. Handley *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 13 p
Avail: CFSTI

The role of B.I.T.E. in performance monitoring and fault detection is discussed. The benefits of B.I.T.E. are considered and there is a detailed consideration of the operational penalties associated with B.I.T.E. as well as the problems of implementation. System design of B.I.T.E. for particular types of equipment is considered and a head-up display system is selected to show an example of the application of B.I.T.E. The importance of careful consideration of all factors at the system design stage to obtain the most cost effective solution is stressed. Author

N70-32164# Elliott Flight Automation, Ltd., Rochester (England).
THE INTERNAL AVIONICS: TEST EQUIPMENT INTERFACE
R. C. Bareham *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 14 p
Avail: CFSTI

It is shown that by orienting the design in a suitable manner it is possible to achieve a high level of BITE with the minimum additions of hardware. The techniques are divided between analogue equipment and digital equipment. Details of techniques best suited to either a hardware or software approach are discussed. Throughout the paper detailed examples are given where the principles proposed have been successfully applied. In addition it is shown that by careful design, BITE may also be used as an invaluable aid during commissioning. The operational value of an end to end confidence check is illustrated for the case where the final output may be assessed by either pilot or aircrew. Author

N70-32165# Smiths Industries, Ltd., Cheltenham (England). Aviation Div.
THE INFLUENCE OF TESTING REQUIREMENTS ON CIRCUIT AND SYSTEM DESIGN OF AVIONICS EQUIPMENT
A. G. Studd *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 18 p
Copyright. Avail: CFSTI

The constraints placed on circuit and system design by the various testing situations encountered during the life of avionics equipment are discussed. A big improvement in the efficiency of flight line testing is required and this is one of the major goals of the next decade. The trend towards including BITE features continues even in relatively simple systems such as those provided for engine parameter measurements as well as in more sophisticated systems such as those provided for flight control. It is inevitable that there will be much more integration of these various BITE features in the future. Unit testing requirements by both manufacturer and user lead to modular forms of construction using planar assemblies where possible. Subassemblies should be functional as well as physical entities with simple input-output interfaces and interchangeable without consequential adjustments. Test points should be provided to assist in fault location to subassembly and component level. Author

N70-32166# Polhemus Navigation Sciences, Inc., Burlington, Vt. Director of Engineering.
WHAT PRICE ON-BOARD TESTING: IMPACT ON TACTICAL AIRCRAFT AVIONICS
Donald W. Richardson *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 12 p Sponsored in part by Hughes Aircraft Co., Culver City, Calif.
Avail: CFSTI

The trade-offs between various configurations of on-board fault detection and fault isolation systems with particular emphasis on the critical parameters of weight, volume, power, and cost are considered. Since the majority of tactical weapons systems envisioned in the 1970-1975 time era utilize one or more digital computational elements in either a federated (multiple computer) system or an integrated (central computer) system configuration. For a given set of system requirements (number of test parameters, number of line replaceable units, number of functional subsystems), the following on-board test system configurations were investigated within the framework of a typical advanced tactical/fighter type aircraft: (a) use of the existing central computer in an integrated system concept as a testing device, (b) addition of a system testing function to one or more of the existing multiple computers in a federated system concept, and (c) addition of a separate computer system whose primary function is on-board testing and fault isolation. Each of the above alternate configurations were investigated as to the increase in system volume, weight, power, and cost incurred by inclusion of the particular on-board testing concept into the existing base-line avionics system configuration. Author

N70-32167# Grumman Aircraft Engineering Corp., Bethpage, N.Y.
SYSTEMS APPROACH TO ON-BOARD CHECKOUT
W. Butler and L. McDonough *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 9 p
Avail: CFSTI

Two on-board checkout (OBC) systems are described, each of which features a different approach to avionic systems self-test. Both approaches utilize the capability of an on-board computer and CRT display. A comparison of these systems and development tradeoffs are presented. The first OBC approach is applicable to equipments having either continuous built-in test (BIT) or command actuated BIT capability. Continuous BIT can report a NO-GO status at any time during flight. Command-actuated BIT reports a NO-GO status only as a result of an operator or program command. In either case, the report of a NO-GO status causes the executive program to branch to the OBC subroutine. During this subroutine, the computer steps a multiplexer to establish the identity of the failed equipment, which is displayed to the flight crew. The second OBC approach includes checking equipments which only provide monitor points. Under control of the OBC program, which is accessed several times during the flight, a multiplexer-converter is activated and performance data is stored in memory. A program analysis of the data is performed, which results in a GO/NO-GO evaluation of each equipment and a display of each failed equipment. These two approaches are complementary and, therefore, there is no conflict in applying both to any weapons systems. Author

N70-32168# Rolls-Royce, Ltd., Bristol (England). Engine Div.
DIGITAL CONTROL SYSTEMS SELF-CHECK
E. Roberts *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 12 p
Avail: CFSTI

Checkout methods in a digital control system, using the control computer as a test-set are described. This approach, which can be applied to most digital control systems, results in very fast checkout with low cost and weight penalties. The principles and objectives of checkout of a jet engine control system are discussed, and the methods and their application to an experimental control installation are described. In this installation the fully automatic pre-flight check took about 10 seconds, while the partly automatic 'once per day' check took less than 30 seconds. Extension of the methods to a 4-engined variable geometry installation (with eight control lanes) is described. The pre-flight checkout time for such

an installation is estimated at less than 1 minute, while the additional equipment mainly comprises a simple control panel, several hundred 'words' of computer storage, and about 0.1% increase in the volume of electronics. Author

N70-32169# IBM France S. A., Paris
TESTING OF ON BOARD AVIONIC SYSTEMS [ESSAIS DE SYSTEMES AVIONIQUES DE BORD]
B. Bachelot *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 22 p In FRENCH
Avail: CFSTI

A number of solutions that were proposed for the testing of equipment onboard modern aircraft are considered. A synthetic table of the different philosophies is considered along with an analysis of the advantages and disadvantages of these concepts. Emphasis is placed on treatment of the onboard information and the interface problem of flight maintenance. Transl. by J.M.C.

N70-32170# Hawker Siddley Dynamics, Ltd., Hatfield (England). Electronic Equipment Dept.
TESTING AVIONIC SYSTEMS AUTOMATICALLY: THE ECONOMICS SCOPE AND ESSENTIALS
A. H. Parker *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 30 p
Avail: CFSTI

The feasibility of automatically testing avionic systems is considered with emphasis on the advantages of the automatic system as opposed to the manual system. Practical economic and essential considerations are given the system configurations in terms of increasing the speed and reliability of the testing method. Additional theoretical data are appended. J.M.C.

N70-32171# Messerschmitt-Boelkow G.m.b.H., Munich (West Germany).
AUTOMATIC TEST EQUIPMENT: HARDWARE AND SOFTWARE EXAMPLES; POSSIBLE CLASSIFICATION
Horst Reimann *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 12 p
Avail: CFSTI

The concepts of the automatic test equipment are presented for: the experimental Eldo 3rd stage, the Azur sounding rockets, the operational Eldo 3rd stage, a ground to ground missile system, the orbital operations system for satellites, and a hybrid automatic test system. A brief discussion of SCOPE (simple checkout oriented program language) is followed by a classification of the presented automatic test equipment. Author

N70-32172# McDonnell Aircraft Corp., St. Louis, Mo.
AUTOMATIC TEST EQUIPMENT IMPLEMENTATION TECHNIQUES TO REALIZE COST EFFECTIVE SUPPORT
James L. Brierton *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 16 p
Avail: CFSTI

The techniques and procedures used to successfully adopt ATE for U.S. Air Force depot applications are explained. Implementation plans must be formulated early in an ATE program to realize cost effective support. Trade-off studies to determine comparative testing technique costs were improved using mathematical models. Specifications were also developed defining avionic suppliers' responsibilities for supplying detailed documentation of test definitions, ATE capabilities, and interface hardware, tapes, tape manuals, and avionics. Finally, procedures were developed to demonstrate hardware and software compatibility to the customer's satisfaction. Author

N70-32173# Elliott Flight Automation, Ltd., Rochester (England). Automatic Test Equipment Div.
THE SPECIFICATIONS OF THE COMPUTER FOR ATE
J. A. Hill *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 9 p
Avail: CFSTI

Specifications for the computer for the automatic test equipment are considered with emphasis on the following features: work length and structure; instruction code and format; addressing system; register system; core store size and performance; input-output system; and special features of both hardware and software. Author

N70-32174# Autonetics, Anaheim, Calif.
APPLICATIONS OF A PROGRAMMER-COMPARATOR TO AVIONICS SYSTEMS OFF-LINE TESTING
John L. Hastie *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 11 p refs
Avail: CFSTI

The automatic testing features and characteristics of a programmer-comparator with the conventional approach to testing utilizing manual test equipment are contrasted. Attention is focused on the economic and technical advantages to be realized using programmer-comparator-controlled test stations to perform avionics systems off-line testing. Data are presented which illustrate the significant advantages realized through the use of programmer-controlled automatic test equipment (ATE) in the areas of testing accuracy, validity, reliability, and test repeatability. Additionally, the test time savings and aircraft availability factors are reviewed. These data confirm the testing objectivity, consistency, and thoroughness, regardless of changes in the operator/equipment environment over a prolonged time period. Reviewed also are the present and anticipated states-of-the-art of ATE, illustrating the introduction of a microminiature version of the programmer-comparator test center and evaluating the application of computers within the ATE environment. Author

N70-32175# Advisory Group for Aerospace Research and Development, Paris (France).
TESTING OF AIRBORNE AVIONICS SYSTEMS: A SIMPLIFIED PROGRAMMING SYSTEM USING COMPUTER SUB-ROUTINES
E. W. Carr and M. E. Walker *In its* Testing of Airborne Avionics Systems Mar. 1970 22 p
Avail: CFSTI

It is shown how computer subroutine techniques can be used in automatic test equipment to reduce the delays inherent in off-line programming by making it possible for a test engineer to create his own test program directly on the automatic tester. The subroutines are called MACRO's in this particular application since they consist of a series of discrete machine instructions designed

to operate the automatic tester in a particular way but unlike subroutines the program instructions are incomplete and require that certain variables be specified by the operator to suit his particular test needs before the MACRO will operate the automatic tester completely. Using this type of automatic tester the operator has at his fingertips all the programming expertise of the test engineers and computer engineers who designed the automatic tester without the need to study the machine code programming in great depth. At the same time the cost and complications of a high level language compiler are avoided. Author

N70-32176# Aerojet-General Corp., Covina, Calif.
TEST TECHNIQUES EMPLOYED FOR STATE-OF-THE-ART AIRBORNE INFRARED EQUIPMENT
Eugene W. Mc Callion *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 6 p
Avail: CFSTI

A brief review of test equipment and techniques employed with operational infrared equipment is made. Infrared systems currently in advanced stages of development require a different approach and equipment to provide a rapid and meaningful method of evaluation. A proposed technique and the associated equipment are described. The basis of the technique is the application of the modulation transfer function to the individual components or the whole system to provide determination of the prime criteria, thermal and spatial resolution. Author

N70-32177# Standard Electrik Lorenz A. G., Stuttgart (West Germany).
AUTOMATIC TEST EQUIPMENT FOR ORTAC, A VTOL AIRCRAFT MOBILE LANDING AID
Manfred Boehm *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 17 p
Avail: CFSTI

Following basic considerations on the test philosophy, a system for automatic testing of a landing aid for VTOL aircraft is described. This system is to be used in the flight line before each mission. The landing aid consists of ground and airborne equipment. The test system autonomous to be used on ground only - much allow detailed drift measurements as well as go-no-go tests. Another requirement is simple fault location. Operation is to be computer controlled, but antonomous operation shall also be possible. Environmental conditions are specified in MIL-STD-810B. Following a review of solutions possible in principle, the chosen configuration is described. Type and number of parameters to be tested, and reasonable equipment effort are compared with one another. Advantages and shortcomings of a standardized building block system as well as cost effectiveness are discussed. In conclusion, ideas on the desirable future trends in BITE, flight line, and shop level testing are given. Author

N70-32178 Sud-Aviation, Toulouse (France).
DESIGN STUDY FOR AN ADVANCED AUTOMATIC TEST EQUIPMENT (ATE)
M. R. Coppee *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 5 p
Avail: CFSTI

The system presented is a general purpose automatic equipment used to test any kind of aircraft units at the overhaul shop. The requirements, the test philosophy and the solutions, as studied and developed in an advanced automatic test equipment complex are discussed. Author

N70-32179# Siemans A.G., Munich (West Germany).
TEST EQUIPMENT FOR AIRBORNE IFF INTERROGATORS AND TRANSPONDERS
Dietmar E. Haensch *In* AGARD Testing of Airborne Avionics Systems Mar. 1970 13 p
Avail: CFSTI

The present IFF system, Mark X-SIF, used in the NATO countries makes it possible to distinguish whether a radar target is a friend or foe; the former sends out a special reply code upon interrogation. Since an undetected fault in the interrogator or transponder can lead to a friend being mistaken as an enemy target, extensive tests on the IFF equipment are of particular importance. In the present generation of IFF equipment the test concept still rests largely upon manual testing. Add-on devices fitted later permit service supervision during flight. The modern generation of IFF airborne equipment has built-in test equipment (BITE), for performance tests during a mission. A more exact test of the whole IFF system is carried out on the ground with the aid of automatic test equipment. Author

N70-32235# Advisory Group for Aerospace Research and Development, Paris (France).
VHF ATMOSPHERIC STUDIES AND COMMUNICATIONS AND NAVIGATION SYSTEMS
John P. Mullen *In its* A Survey of Scintillation Data and its Relationship to Satellite Commun. Aug. 1969 p 1-2 ref

Avail: CFSTI

The use of communication satellites for onboard navigation, and air traffic control over the North Atlantic are discussed. The expected improvement in navigation would increase the number of tracks and permit more nearly optimal crossings resulting in fuel savings. F.O.S.

N70-32246# Naval Air Propulsion Test Center, Trenton, N.J. Aeronautical Turbine Dept.
PERFORMANCE ANALYSIS OF A ROTARY NOZZLE UTILIZING A 30 DEG SPIN ANGLE ROTOR
Lawrence J. Palcza Apr. 1970 21 p refs
(AD-705057; NAPTC-ATD-184) Avail: CFSTI CSCL 21/5

Static thrust augmentation experiments have been performed with a rotary nozzle induction device to determine the effect of a large spin angle on performance. A 30 deg spin angle rotor with a shroud area to primary nozzle exit area ratio of 19.6 was tested over a primary to secondary pressure range of 1.2 to 1.8 at a primary-secondary temperature ratio of 1.0. Author (TAB)

N70-32259*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DETERMINATION OF INFLATED SHAPE AND INERTIAL PROPERTIES OF AN ALL-FLEXIBLE PARAWING
Blair B. Gloss Washington Jul. 1970 33 p refs
(NASA-TN-D-5900; L-6906) Avail: CFSTI CSCL 01C

The inflated shape of a single-keel, all-flexible parawing

with a 45° leading-edge sweep and a 5-foot keel length has been determined by using photogrammetric technique. The shape of this parawing was determined at lift-drag ratios of 2.13, 2.24, and 2.43 with the wing in tethered flight in a wind tunnel. The shape data for the inflated parawing showed a 3.0 percent increase in the span and a 3.0 percent decrease in the keel length when the lift-drag ratio increased from 2.13 to 2.43. The nondimensional inertial properties and center of gravity locations of the parawing structure were calculated from the shape data. The inertial properties and center of gravity locations calculated for a geometrically similar parawing with a 24-foot keel length were in excellent agreement with measured values obtained from pendulum tests. Author

N70-32265# Franklin Inst., Philadelphia, Pa. Research Labs.
SURVEY OF THE STATE-OF-THE-ART FOR THE DESIGN OF HIGH SPEED ROLLING ELEMENT BEARINGS USED IN GAS TURBINE ENGINES: VOLUME 1 Final Report
John H. Raumbarger and James D. Dunfee Mary 1969 55 p
(Contract N00156-68-C-0330)
(AD-705127; F-C2138-Vol-1) Avail: CFSTI CSCL 13/9

The state-of-the-art for the design of high-speed rolling element bearings used for gas turbine engine mainshafts is reviewed. Recommendations are made for research and development needed to satisfy future U. S. Navy requirements especially pertaining to rolling element bearing technology. Six American engine manufacturers were visited and contributed to the review. The survey report, Volume I, includes design criteria, design theory, *materials, and performance parameters pertaining to bearing design* for engines over the past ten years and those currently in design. Author (TAB)

N70-32266# Franklin Inst., Philadelphia, Pa. Research Labs.
SURVEY OF THE STATE-OF-THE-ART FOR THE DESIGN OF HIGH SPEED ROLLING ELEMENT BEARINGS USED IN GAS TURBINE ENGINES. VOLUME 2: LITERATURE REVIEW Final Report
John H. Rumbarger and James D. Dunfee Feb. 1969 71 p refs
(Contract N00156-68-C-0330)
(AD-705128; F-C2138-1-Vol-2) Avail: CFSTI CSCL 13/9

This volume II of the final report contains a comprehensive listing of published work in rolling element bearing technology related to gas turbine mainshaft bearing design from the years 1950 through 1968. Also included are some classical theory and analysis papers dating back to 1901. For convenience in locating a reference, the citations (with abstract when available) are arranged into nine categories designated index code A through I. Under each index, the author(s) name is listed first chronologically by year of publication, and then alphabetically in each year. An author index, with cross reference to the citations with abstracts is also included. Author (TAB)

N70-32317# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
IFR FORMATION FLIGHT DISPLAY/SYSTEM REQUIREMENTS FOR ADVANCED ROTARY-WING AND JET-FIGHTER AIRCRAFT Final Technical Report, Jun. 1968–Jun. 1969
Paul A. Anderson, Myrna L. Toivanen, and R. B. Hoppe Mar. 1970 315 p refs
(Contract N00014-66-C-0362)
(AD-705133; Honeywell-12543-FR5; JANAIR-690616) Avail: CFSTI CSCL 1/4

The study was conducted to investigate information and display requirements for a manual IFR formation flight system for an advanced rotary-wing and a high-performance jet fighter. This investigation included the study of the effects of varying the rate at which new information is available for display and the level of measurement noise in the information presented. Two alternative vertical situation display formats were selected for evaluation. Systematic man-in-the-loop simulations were conducted to collect pilot performance data for these two display formats at three levels of the data update rate and measurement noise variables. Performance measures recorded included the follower aircrafts deviations from the assigned command position, rates of pilot control input activity, and frequency of aircraft control losses. Author (TAB)

N70-32335*# Aztec School of Languages, Inc., Maynard, Mass. Research Translation Div.
A THREE-DIMENSIONAL BOUNDARY LAYER
In its Laminar Boundary Layer in the Presence of Suction Jun. 1970 p 92–112 refs
Avail: CFSTI CSCL 20D

The problem of a spatial boundary layer on a movable wing, on a body of revolution, and on prolate bodies of arbitrary shape is considered. Streamlining with the slip of a flat plate of infinite length in the presence of fluid suction from a laminar boundary layer by a uniform flow of viscous incompressible fluid is also examined. Author

N70-32338# Boeing Co., Seattle, Wash. Military Airplane Systems Div.
COCKPIT GEOMETRY EVALUATION. PHASE 1. VOLUME 2: HUMAN DATA Final Report, 15 Jan.–31 Dec. 1968
Wayne E. Springer and Patrick W. Ryan Jan. 1969 309 p refs
(Contract N00014-68-C-0289)
(AD-703268; D162-10126-1; JANAIR-690102) Avail: CFSTI CSCL 5/5

A computerized dynamic man-model is being developed as part of a contract administered by the Office of Naval Research (ONR) through the auspices of the Joint Army Navy Aircraft Instrumentation Research (JANAIR) Program Working Group. The baseline man-model to be developed in the first year of the proposed six-year program is a 23-joint articulated link stick-man. The anthropometric, joint angular limit, mass, and visual characteristics used for the initial man-model (BOEMAN-I) are listed in this document. Present literature has been used whenever possible to provide these data. Boeing researchers have supplemented the literature information to complete that needed for BOEMAN-I. Author (TAB)

N70-32339# Boeing Co., Seattle, Wash. Military Airplane Systems Div.
COCKPIT GEOMETRY EVALUATION, PHASE 1. VOLUME 3: COMPUTER PROGRAM Final Report, 1 Jan.–31 Dec. 1968
Robert Katz, Michael J. Healy, and Gary O. Meeker 20 Jan. 1969 261 p refs
(Contract N00014-68-C-0289)
(AD-703269; D162-10127-1; JANAIR-690103) Avail: CFSTI

CSCL 5/5

A computer program for the evaluation of cockpit configurations using a 23 pin-joint articulated stick-man (BOEMAN-I) is presented. This program utilized an updatable bank of anthropological and environmental data, and simulates the motion of a real pilot performing tasks in a crewstation. The program provides information concerning reach capability, locations and orientations of joints, pilot-cockpit visual interferences, numerical performance indicators on joint displacement and deflection, and mass displacements. The program provides also a statistical validation when comparing real pilot and BOEMAN-I paths of motion. Author (TAB)

N70-32340# Boeing Co., Seattle, Wash. Military Airplane Systems Div.

COCKPIT GEOMETRY EVALUATION, PHASE 1. VOLUME 4: MATHEMATICAL MODELS Final Report, 15 Jan.–31 Dec. 1968

Michael J. Healy and Robert Katz Jan. 1969 101 p refs

(Contract N00014-68-C-0289)

(AD-703270; D162-10128-1; JANAIR-960104) Avail: CFSTI CSCL 5/5

A mathematical model that positions and moves a variable sized 23-pin joint articulated stick-man in a crewstation environment is presented. The model simulates the motion of pilots in a given cockpit configuration considering gross reach capability required by a task. It utilizes a non-linear optimization technique to position and orient the joints, analyzes the viewing capability after the operation and detects body intersections with the seatback during the task. Author (TAB)

N70-32341# Boeing Co., Seattle, Wash. Military Airplane Systems Div.

COCKPIT GEOMETRY EVALUATION, PHASE 1. VOLUME 5: VALIDATION Final Report 15 Jan.–31 Dec. 1968

Patrick W. Ryan Jan. 1969 99 p refs

(Contract N00014-68-C-0289)

(AD-703271; D162-10129-1; JANAIR-690105) Avail: CFSTI CSCL 5/5

A baseline 23-joint variable link length man-model was developed. Three-space movement of the upper torso has been developed utilizing mathematical and computer techniques. Rigorous validation criteria developed held that the model must closely simulate the joint movement paths and the maximum reach envelopes of any sized human operator workstation. Human joint movement data was obtained using a multiple camera technique. Seven seated subjects repeatedly performed movements in an open space and in a multimission flight simulator. A rigorous statistical analysis compared the synthesized arm joint locations of the man-model with those of the subjects. The comparisons were made at joint locations of each task where the greatest discrepancies between the model and the subjects were expected to occur. In general, the results indicated that statistical differences occur; however, practically, they appear negligible. Therefore, the concept of a mathematical man-model appears feasible and future efforts should continue to refine and improve the model as well as the validation criteria and methods. Author (TAB)

N70-32344*# AiResearch Mfg. Co., Los Angeles, Calif.

INVESTIGATION AND DEVELOPMENT OF NEW CONCEPTS FOR IMPROVEMENT OF AIRCRAFT ELECTRICAL POWER SYSTEMS. 1: A REVIEW OF THE ELECTRICAL POWER SYSTEMS AND EQUIPMENT IN EXISTING COMMERCIAL AIRCRAFT Interim Technical Report

C. H. Lee and J. J. Brandner Aug. 1969 292 p refs

(Contract NAS12-659)

(NASA-CR-110693; Rept-69-5193) Avail: CFSTI CSCL 10A

Information pertaining to the electrical power systems and components on existing commercial aircraft is reviewed to devise optimum electrical power systems for advanced aircraft. Subjects discussed include: configurations and performance requirements, electrical loads and parametric data, distribution systems, generation subsystems, and heat transfer techniques. F.O.S.

N70-32346# Technische Hogeschool, Eindhoven (Netherlands). Heat Transfer Section

AN EXPERIMENTAL DETERMINATION OF THE TURBULENT PRANDTL NUMBER IN A DEVELOPING TEMPERATURE BOUNDARY LAYER

Johannes Blom (Ph.D. Thesis) 12 May 1970 123 p refs

Avail: CFSTI

Heat transfer in a turbulent boundary layer was investigated in a wind tunnel with air flowing over a partially heated, aerodynamically smooth flat plate. Existing theories concerning the velocity field together with momentum transfer implied are discussed with emphasis on applications of large computers for solving the equations of motion. Existing theories concerning the temperature field and heat transfer based on a known solution of the velocity field are considered. The distributions of turbulent Prandtl number in the thermal boundary layer are given. Author

N70-32361# Federal Aviation Administration, Washington, D.C. Information and Statistics Div.

FAA AIR TRAFFIC ACTIVITY, FISCAL YEAR 1969

Viola W. Patterson Aug. 1969 228 p refs

Avail: SOD $1.75

The fiscal year 1969 issue of FAA Air Traffic Activity contains tables and charts which show activity at the FAA-operated facilities. These data reflect the trends and patterns in aviation in the United States and U.S. areas. A summary of the data is shown. Author

N70-32365# Douglas Aircraft Co., Long Beach, Calif.

A STUDY OF THE COMPATIBILITY OF A FOUR ENGINE COMMERCIAL JET TRANSPORT AIRCRAFT FUEL SYSTEM WITH GELLED AND EMULSIFIED FUELS Final Report

A. T. Peacock, R. F. Hazelton, L. S. Gresko, and L. D. Christensen Apr. 1970 193 p refs

(Contract FA-68-NF-273)

(NA-70-11; DS-70-1) Avail: CFSTI

The rheological and physical properties of four gelled and three emulsified turbine fuels were evaluated. One gelled and one emulsified fuel were selected for further test and analysis in a compatibility study with a four engine commercial jet transport aircraft fuel system. Full scale testing of system components was performed. Penalties and problem areas associated with using the fuels were identified by an analysis of the fuel system. A full-scale ground test program to evaluate an aircraft fuel system's performance on thickened fuels was outlined. Results show significant decreases in available fuel and large increases in system weights are associated with the use of the thickened fuels described. Substantial fuel development is indicated before application to commercial aircraft. Author

N70-32366# Language Service Bureau, Inc., Washington, D.C.
ECONOMIC STUDIES AND SOME TEST RESULTS FROM FOG DISSIPATION SYSTEMS IN FRANCE Final Report
Apr. 1970 64 p Transl. into ENGLISH of Secretar. Gen. a l'Aviation Reports No. 1, 2, 3, and 4 Prepared for FAA
(FAA-RD-70-16; Rept-1; Rept-2; Rept-3; Rept-4) Avail: CFSTI

This report consists of the following four separate studies: (1) fog dispersal operations on supercooled fog (temperature less than 0 C) at Orly confirmed that 0 C is the efficiency threshold for a ground base device utilizing liquid propane sprayers; (2) description of past and present installations at Orly for dispersing positive fog (temperature greater than 0 C) using the French turboclair method; (3) economic factors to demonstrate that the present installation at Orly for dispersing positive fog can be profitable; and (4) economic factors to demonstrate that future turboclair installations can be profitable. Author

N70-32393# Atomic Weapons Research Establishment, Aldermaston (England). Radiation Measurement Section.
A RECOMBINATION IONIZATION CHAMBER SYSTEM AS A SENSITIVE, THREE CHANNEL LET INDICATOR FOR STRATOSPHERIC USE
I. J. Wilson *In* EURATOM Proc. of the 2d Symp. on Microdosimetry Jan. 1970 p 343–362 refs

Avail: CFSTI HC$10.00/MF$0.65

In the development of the Concorde in-flight radiation warning meter, a system was required to indicate the different qualities of stratospheric radiation encountered at different altitudes during a single flight. As proportional counter LET spectrometers lack the necessary sensitivity, a system of three recombination ionization chambers was developed to operate in dose rates of 0.1-1 millirad/hr with a response time of a few minutes. The chambers are calibrated by collection efficiency measurements made with low LET (gamma), and medium LET (recoil proton) and high LET (internal alpha) radiations and three distinct polarizing voltages were selected for operational purposes. The chambers were used to measure the stratospheric radiation levels on ascent to and descent from 30,000 m during balloon flights. The three chamber system is to be compared with a transportable LET spectrometer in mixed radiations simulating stratospheric situations resulting from cosmic and solar flare protons interacting with the earth's atmosphere. Author

N70-32420# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENT IN EXPERIMENTAL ADJUSTMENT OF GAS TURBINE ASSEMBLY GT-6-750 TMZ ON PLANT STAND
M. M. Kovalevskii 24 Sep. 1969 20 p refs Transl. into ENGLISH from Energomashinostr. (Moscow), No. 11, 1965 p 40–44
(AD-701986; FTD-MT-24-146-69) Avail: CFSTI CSCL 21/5

A description is given on basic stages and results of finishing bench tests of a pilot model of gas turbine plant GT-6-750. Author (TAB)

N70-32466*# Stanford Univ., Calif. Thermosciences Div.
EXPERIMENTAL HYDRODYNAMICS OF THE ACCELERATED TURBULENT BOUNDARY LAYER WITH AND WITHOUT MASS INJECTION
H. L. Julien, W. M. Kays, and R. J. Moffat Mar. 1970 34 p refs
(Grant NGR-05-020-134)
(NASA-CR-110650; HMT-10) Avail; CFSTI CSCL 20D

Mean velocity profile data are reported for blown, unblown, and sucked accelerated turbulent boundary layers. The pressure gradients investigated are those corresponding to constant values. For each pressure gradient, the surface boundary conditions cover a range of constant blowing and sucking fractions from F = −0.002 to +0.004. Velocity profiles corresponding to these accelerated flows are shown to differ substantially from those characteristic of zero pressure gradient flows. For each case of a constant acceleration, sequential values of the momentum thickness Reynolds number approach a specific constant, and the velocity distributions near the wall are similar in both wall coordinates and outer coordinates. Results obtained here can be reproduced by a numerical integration of the boundary layer equations using a modification of the Van Driest damping factor, A(+), derived from the data presented here. The A(+) correlation is presented. Author

N70-32481# Lincoln Lab., Mass. Inst. of Tech., Lexington.
VHF ANTENNA SYSTEM FOR AIRCRAFT
Milton L. Rosenthal 12 Mar. 1970 45 p refs
(Contract AF 19(628)-5167)
(AD-705170; ESD-TR-70-53; TN-1970-8) Avail: CFSTI CSCL 9/5

Presented are the initial results of a theoretical investigation of crossed-slot antenna elements arrayed on an aircraft to provide communications with satellites in the 225 to 400 MHz frequency range. Calculations indicate that two four-element array antennas can approximate the desired performance of covering the hemisphere above the aircraft with more than 6 dB directive gain. Including the polarization loss between the elliptically polarized aircraft antenna and the circularly polarized satellite antenna, coverage is provided over about 90 percent of the desired area. Author (TAB)

N70-32490# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MATCHING COMPRESSORS AND TURBINE PARAMETERS IN GAS TURBINE AIRCRAFT ENGINES
K. V. Kholshchevnikov 2 Dec. 1969 207 p refs Transl. into ENGLISH of the book "Soglasovanie Parametroy Kompressora i Turbiny Aviatsionnykh Gazoturbinnykh Dvigatelyakh" Moscow, Izv-Vo Mash Nostr., 1965 p 1-200
(AD-701978; FTD-HT-23-637-68) Avail: CFSTI CSCL 21/5

Contents: Turbojet engine with a single-spool axial compressor; Turbojet engine with a axial twin-spool compressor; Turbojet engine with centrifugal compressor; Bypass turbojet engine; The turbo-prop engine; and Closed-circuit gas-turbine plants. TAB

N70-32530# National Aviation Facilities Experimental Center, Atlantic City, N.J.
EVALUATION OF A LOW-COST VISUAL APPROACH SLOPE INDICATOR (VASI) AS A PILOT TRAINING AID Final Report, Jun.–Dec. 1969
Warren G. Crook May 1970 29 p
(FAA-DS-70-4; FAA-NA-70-18) Avail: CFSTI

The effectiveness of a simple low-cost Visual Approach Slope Indicator (VASI) in developing and reenforcing proper aircraft control technique during approach and landing under actual pilot training conditions is determined. A simplified two-box, single-lamp system was evaluated at two pilot training schools which summarized the results of training given to comparable groups of

student pilots instructed with and without the use of the abbreviated VASI. Results showed that the simplified VASI made flight instruction easier enabling the students to quickly grasp the fundamentals of final approach glide path control. VASI-trained students made better, safer approaches earlier in their training than the regular students trained without it and had no trouble subsequently landing without benefit of the system during daylight or nighttime approaches. The system provided reliable visual guidance and good sensitivity for glide path control within its design capability of 1 to 1.5 miles. Maximum benefit of the system appeared to be derived during night approaches where judgment of altitude is difficult. Author

N70-32533*# Scripta Technica, Inc., Washington, D.C.
A METHOD OF CALCULATING SUPERSONIC FLOW AROUND BLUNTED BODIES WITH DETACHED SHOCK WAVES [METOD RASCHETA SVERKHZVUKOVOGO OBTEKANIYA ZATUPLENNYKH TEL S OTOSHEDSHEY UDARNOY VOLNOY]
S. M. Gilinskiy et al NASA Jul. 1970 35 p refs Transl. into ENGLISH from Sb. Rab. Vychisl. Tsent. (Moscow), no. 6, 1967 p 173–205
(Contract NASw-2036)
(NASA-TT-F-13026) Avail: CFSTI CSCL 20D

The problem of the supersonic flow past bodies with a detached shock wave is formulated on the basis of an analysis of the properties of solutions of linear equations of elliptic and mixed types. A numerical method for solving the nonlinear problem is described. Telenin's method is applied to the solution of various problems involving flows past bodies with a detached shock wave. Author

N70-32535*# Scientific Translation Service, Santa Barbara, Calif.
HOT GAS RECIRCULATION MEASUREMENTS ON FOUR DIFFERENT-SIZE MODELS OF A SIMPLE VTOL CONFIGURATION [HEISSGAS-REZIRKULATIONSMESSUNGEN AN VIER VERSCHIEDEN GROSSEN MODELLEN EINER EINFACHEN VTOL-KONFIGURATION]
R. Jenny Washington NASA Jul. 1970 21 p refs Transl. into ENGLISH from 6th ICAS Congr., Munich, 9–13 Sep. 1968, Paper 68-12 p 1–10
(Contract NASw-2035)
(NASA-TT-F-12604) Avail: CFSTI CSCL 20D

Investigation of the influence of the size of the wind tunnel and the temperature of the jet stream on the recirculation behavior of a VTOL configuration. It is found that the relationship between the sizes of the wind tunnel and the VTOL model is quite critical. Author

N70-32546# National Aviation Facilities Experimental Center, Atlantic City, N.J.
SIMULATION STUDY OF TWO SITES FOR A THIRD CHICAGO METROPOLITAN AIRPORT Final Report
Sidney B. Rossiter Jul. 1970 114 p refs
(FAA-RD-70-25; FAA-NA-70-34) Avail: CFSTI

A dynamic simulation study to assess the relative merits of two proposed sites for a third major airport in the Chicago area was conducted. Considered were the traffic flows of the three major airports and either of the proposed sites, under three different landing/takeoff directions. It was concluded that on a system vs. system basis, there was no statistical preference for either site when the three wind configurations were considered equal in weight. The land site system was less efficient than the lake site system in the arrival operation of the Northeast configuration. The lake site system was less efficient than the land site system in both the arrival and departure operations of the Southeast configuration. It was further concluded that on a system basis, in all configurations tested, the airspace as employed by both site plans was able to accommodate the amount of traffic which could be generated by the three airports. Author

N70-32556# Rochester Applied Science Associates, Inc., N.Y.
STUDY OF MODIFICATION OF ROTOR TIP VORTEX BY AERODYNAMIC MEANS Interim Technical Report, 1 Feb. 1969–31 Jan. 1970
Stephen A. Rinehart Jan. 1970 56 p refs
(Contract N00014-69-C-0169)
(AD-704804; RASA-70-02) Avail: CFSTI CSCL 1/3

Numerous research efforts have been conducted by different investigators to alter the characteristics of the tip vortex generated by a helicopter blade in order to alleviate the blade-vortex interaction problem as well as the noise problem associated with impulsive loading. The analytical investigation shows that it should be possible to significantly alter the characteristics of the trailing tip vortex for all flight conditions in a beneficial manner by injecting an airstream directly into the forming tip vortex. Analytical expressions were developed for the initial and final states of the vortex in order to evaluate the effects of mass flow injection on the vortex strength, swirl velocity distribution, vortex core pressure, vortex core size and the induced drag on the blade. On the basis of the results that were obtained, it was shown that the required mass flow may be obtained from centrifugal pumping action by venting the blade and therefore the desired modification can be obtained apparently without significant performance penalties which would be unacceptable. Author (TAB)

N70-32560# Lockheed-California Co., Burbank.
AIRCRAFT DYNAMIC WHEEL LOAD EFFECTS ON AIRPORT PAVEMENTS Final Report, May 1969–May 1970
J. E. Wignot, P. C. Durup, G. Wittlin, R. B. Scott, and M. A. Gamon May 1970 437 p refs
(Contract FA-69-WA-2143)
(FAA-RD-70-19; LR-23307) Avail: CFSTI

The study included scaled pavement tests, analyses to determine airplane imposed loads on pavement and pavement response, correlation between empirical data and analyses, and a literature review. The results of the investigation indicate that the two distinguishable effects that influence the stress on pavements are airplane induced loads and moving load phenomenon. For a given level of runway unevenness the loads that will be imposed on the pavement can be accurately defined for various ground operations performed. However, the pavement response to a moving load can vary substantially depending upon the kinds of materials and types of construction used. To obtain proper assessment of moving load effects, full scale pavement tests are considered necessary to provides needed data. Two test plans are presented. One approach involves operational statistical tests and depends upon a heavy statistical sample of data. The alternate approach involves moving load track tests and provides data for point-by-point correlation using analytical data under carefully controlled conditions and configurations. Author

N70-32571*# Techtran Corp., Glen Burnie, Md.
AERODYNAMIC COEFFICIENTS FOR CONTROL SURFACE-TAB COUPLING IN SUBSONIC, BIDIMENSIONAL,

UNSTEADY FLOW [COEFFICIENTS AERODYNAMIQUES DE COUPLAGE GOUVERNE-TAB, EN ECOULEMENT SUBSONIQUE BIDIMENSIONNEL INSTATIONNAIRE]

R. Dat et al Washington NASA Feb. 1970 8 p refs Transl. into ENGLISH from Rech. Aerosp. (France), no. 129, Mar.–Apr. 1969 p 60–63

(Contract NASw-1695)

(NASA-TT-F-12829) Avail: CFSTI CSCL 20D

An approximate method of calculation of the aerodynamic coefficients in question is presented and the results are compared with figures from tables based on an exact theory. The results are found to be extremely close in incompressible flow and satisfactory, though more divergent, for compressible flow. Author

N70-32575# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADIO NAVIGATION OF AIRCRAFT

V. A. Odintsov 23 Jan. 1970 542 p refs Transl. into ENGLISH of the book 'Radionavigatsiya Letatelnykh Apparatov' Moscow, Izd-Vo Mashinostroyeniye, 1968 p 1–408

(AD-704025; FTD-MT-24-251-69) Avail: CFSTI CSCL 17/7

The report outlines theoretical fundamentals of radio navigation and there are shown possibilities of application of radio navigational aids in flight on contemporary aircraft. There is given a general method of evaluating radio navigational aids. There are given solutions of problems of guiding an aircraft to a predetermined point of the field of working region and determination of navigational elements with the help of nonautonomous and autonomous radio navigational aids. Furthermore, there is examined the application of electronic navigation systems during air traffic control and during landing of aircraft. There are covered questions of space radio navigation and there is evaluated navigation possibilities of radio navigational systems based on artificial earth satellites. Author (TAB)

N70-32610*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL LIFT INTERFERENCE ON SWEPTBACK WINGS IN RECTANGULAR TEST SECTIONS WITH SLOTTED SIDE WALLS

Ray H. Wright and James D. Keller Washington Jul. 1970 17 p refs

(NASA-TR-R-344; L-7138) Avail: CFSTI CSCL 14B

A theory is presented for the boundary-induced upwash interference on a sweptback wing mounted in a rectangular wind-tunnel test section with closed top and bottom walls and slotted side walls. The interference factor can be computed at any point in the test section. In an example, the interference with slotted side walls is compared with that with slotted top and bottom walls. Author

N70-32641# Air Force System Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMAL METHOD OF MEASUREMENT OF TURBULENCE IN WIND TUNNELS

B. Ya. Trubchikov 11 Mar. 1970 81 p refs Transl. into ENGLISH from Tr. Tsentr. Aerogidrodinamicheskii Inst. (USSR), no. 372, 1938 p 1–44

(AD-704773; FTD-MT-24-419-69) Avail: CFSTI CSCL 20/4

The report discusses the general theory of diffusion in a turbulent flow and forms the basis of the method of measurement of turbulence in wind tunnels by studying the diffusion of heat behind a thin heated wire. Cited are results of measurements of temperature of velocity fields behind a round cylinder, conducted with a wide range of changes of relative distance from the cylinder. A description is given of the measuring equipment and basic results of investigations, connected with development of the method and technology of the experiment. Results of measurements by the thermal method are compared with other methods. In conclusion there are cited results of investigation of turbulence of flow in a number of wind tunnels by the thermal method. (Author) TAB

N70-32650# Naval Postgraduate School, Monterey, Calif.

DEVELOPMENT OF A SIMULATOR FOR THE EVALUATION OF RIGID AND MOVABLE AIRCRAFT CONTROLS

David White Caswell (M.S. Thesis) Jun. 1969 49 p refs

(AD-703638) Avail: CFSTI CSCL 1/3

A simulator was constructed with two sets of aircraft controls; one set was movable and one set was rigid. The control output signals were integrated into an analog computer circuit to provide the desired aerodynamic characteristics. A repeatable, random input voltage to an oscilloscope was used as a basis for a tracking exercise in which the test subject, by manipulation of the control stick, attempted to cancel the random signal. A scoring method was devised which utilized an electronic counter and signal comparator to evaluate pilot performance with each of the four control sticks. Author (TAB)

N70-32721*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ACOUSTIC AND AERODYNAMIC PERFORMANCE OF A 6-FOOT-DIAMETER FAN FOR TURBOFAN ENGINES. 1: DESIGN OF FACILITY AND QF-1 FAN

Bruce R. Leonard, Ralph F. Schmiedlin, Edward G. Stakolich, and Harvey E. Neumann Washington Jul. 1970 32 p refs

(NASA-TN-D-5877; E-5594) Avail: CFSTI CSCL 21E

A ground test facility was designed and built for conducting acoustic research on full-scale prototype fans to obtain fundamental fan noise information and to establish design technology for development of subsonic aircraft engines which will produce a minimum of noise. The objectives, design features, and instrumentation of the test facility are discussed and the design is described of the first model to be tested; a 72-inch diameter, 1.5-pressure-ratio fan operating over 60 to 90 percent of its cruise design corrected speed of 3533 rpm. Author

N70-32760*# Aerophysics Research Corp., Bellevue, Wash.

APPLICATION OF THE VARIATIONAL STEEPEST-DESCENT METHOD TO HIGH PERFORMANCE AIRCRAFT TRAJECTORY OPTIMIZATION

Donald S. Hague [1970] 80 p refs

(Contract NAS2-5383)

(NASA-CR-73366) Avail: CFSTI CSCL 01C

The variational steepest-descent method is applied to a variety of aircraft and aircraft performance problems. Vehicle types employed in the calculations consist of a typical next-generation hypersonic research aircraft and a supersonic transport configuration. Performance problems considered include minimum time-to-climb, minimum fuel ascents, maximum range, and minimum range (the return to base problem). Solutions are obtained for a variety of terminal constraints including velocity, altitude, and flight path angle. In several cases, in-flight inequality constraints are imposed on vehicle state and control functions including maximum altitude, throttle setting, acceleration, and flight path angle. The inequality

constraints are imposed either separately or in combination. Control variables employed include angle-of-attack, pitch angle, bank-angle, and throttle setting. Convergence to the optimal solution is obtained automatically by a second-order step-size criteria in combination with artificial intelligence in the form of programmed logical decisions. The program employed was subject to the limitations of a single vehicle (or at most two vehicles, one of which is in a prespecified circular planetary orbit) and to employment of stages at fixed times. Author

N70-32770*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

EVALUATION OF THE EFFECT OF A YAW-RATE DAMPER ON THE FLYING QUALITIES OF A LIGHT TWIN-ENGINE AIRPLANE

Calvin R. Jarvis, Paul C. Loschke, and Einar K. Enevoldson Washington Jul. 1970 47 p refs

(NASA-TN-D-5890; H-584) Avail: CFSTI CSCL 01C

A flight-test program was conducted with a light twin-engine airplane to determine the effect of a parallel yaw damper and aileron-to-rudder interconnect on the flying qualities of this class of aircraft. Both quantitative and qualitative results are presented for several flight tasks and conditions, including flight in turbulence. Airplane handling qualities and ride qualities are summarized. The effect of the yaw damper on the stall and post-stall motions of the test airplane and the motions resulting from sudden engine failure are also discussed. Author

N70-32783# Naval Postgraduate School, Monterey, Calif. Dept. of Operations Analysis.

A STATISTICAL STUDY OF SPECTROMETRIC OIL ANALYSIS DATA FROM THE NAVAL OIL ANALYSIS PROGRAM

John Patrick Riceman (M.S. Thesis) Oct. 1969 88 p refs

(AD-704522) Avail: CFSTI CSCL 11/8

The thesis examines spectrometric oil analysis data from two sources in an attempt to formulate a statistical model which will be useful in monitoring aircraft engines in the Naval Oil Analysis Program. Initially, experimental data, gathered for an Air Force study, was used to determine if the measurement error inherent in the monitoring procedure is normally distributed and if correlations exist between measurements for different wear metals. Based on the results of this investigation, a study was made of operational data from Wright reciprocating engines of the R1820-82 type. The investigation leads to the conclusion that a multivariate regression model is useful in estimating the parameters of the distribution of analyses from properly operating engines of this type. A procedure is suggested which would employ the readings from past oil analyses from a particular engine to determine its present condition. Author (TAB)

N70-32827*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC INTERFERENCE EFFECTS ON HALF-CONE BODIES WITH THIN WINGS AT MACH 10.03

James C. Townsend Washington Jul. 1970 25 p refs

(NASA-TN-D-5898; L-6487) Avail: CFSTI CSCL 20D

Halves of cone bodies having fineness ratios of 2, 4, or 6 were tested with thin flat wings at Mach 10.03 and Reynolds numbers of 1.2, 1.5, or 1.8 million. Several wing planforms designed empirically or theoretically to match the shape of the shock wave about the body were investigated for each fineness ratio. Tests were also made with thick wings and with wings having various leading edge shapes. The wing planforms which matched the actual shock shape provide the highest lift-drag ratios. Increasing the fineness ratio of the half-cone body increases the lift-drag ratio but decreases the lift coefficient. Effects of wing thickness and leading edge shape were very small. Author

N70-32828*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HEAT-TRANSFER MEASUREMENTS AT MACH 8 ON A FLAT PLATE WITH DEFLECTED TRAILING-EDGE FLAP WITH EFFECTS OF TRANSITION INCLUDED

Charles B. Johnson Washington Jul. 1970 54 p refs

(NASA-TN-D-5899; L-6349) Avail: CFSTI CSCL 20D

An experimental heat transfer investigation was made on a flat plate model with a short trailing edge flap deflected at angles of 10, 20, and 30 deg, relative to the plate surface. The tests were conducted at a nominal free stream Mach number of 8, and the nominal free stream unit Reynolds number was varied from 0.72 to 35.8 million per meter. The heat transfer and schlieren results indicated that transition first occurred for the largest flap angle in the separated region at a unit Reynolds number approximately an order of magnitude lower than that for an undisturbed flat plate. Various theories for laminar flow are applied for separated-and attached-flow conditions, and various theories for turbulent flow are applied to the flow over the flap. The heating near flow reattachment on the flap for transitional separation was as much as two times greater than the theoretical prediction for turbulent flow. Author

N70-32844*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC AND DEPLOYMENT CHARACTERISTICS OF SINGLE-KEEL SOLID AND SINGLE-KEEL SLOTTED PERSONNEL PARAWINGS

Harry L. Morgan, Jr. and Charles F. Bradshaw Washington Jul. 1970 36 p refs

(NASA-TN-D-5911; L-6590) Avail: CFSTI CSCL 01C

Wind-tunnel and free-flight tests were performed to determine the gliding-flight and deployment characteristics of single-keel solid and single-keel slotted parawings of suitable size for use in personnel recovery systems. The tunnel tests showed that both wings had almost identical maximum lift-drag ratios and modulations of lift-drag ratio and that the slotted wing had slightly lower values and less modulation of resultant-force coefficient than the solid wing. Free-flight deployment tests of solid and slotted personnel parawings equipped with 235-pound torso dummies showed that the maximum deployment loads were lower and the canopy inflation times were longer for the slotted wing than for the solid wing over a range of pack opening velocities. A comparison of the deployment loads of the two personnel parawings and a currently used personnel parachute showed that the parawings had much greater deployment loads than the parachute. Author

N70-32870# Polytechnic Inst. of Brooklyn, Farmingdale, N.Y. Dept. of Aerospace Engineering and Applied Mechanics.

SLINGSHOT: AN ADVANCED AERODYNAMIC TEST FACILITY

M. H. Bloom, R. J. Cresci, G. Moretti, and J. Librizzi Jun. 1969 30 p ref Presented at the 7th Intern. Shock Tube Symp.,

Toronto, 23-25 Jun. 1969
(Nonr-839(38); ARPA Order 529; Proj. Strategic Technol.)
(AD-702052; PIBAL-69-24) Avail: CFSTI CSCL 14/2

A conceptual view is presented of the SLINGSHOT method of mechanically setting fluids or other materials into motion with respect to models. In the special context of gas-dynamic testing, unpre-processed test gas is made available at high Reynolds numbers and high Mach numbers with fixed models. Performance in regimes now inaccessible with fixed models is theoretically possible; however, practical implementation may require significant effort. Exploratory experiments made with the simplest conceivable apparatus show agreement with estimated model pressures and running times. The basic setup now consists of a gas-gun accelerated capsule containing the test gas, 2 in. dia. x 12 in length, which has been driven to 3600 fps. An analysis of the internal wave behavior agrees with the experimental observation indicating the absence of shocks within the test gas. Among the main problems are running-time limits, booster simplicity, and disposal of capsule debris. Examination of somewhat higher performance conditions appears warranted. Author (TAB)

N70-32884*# Goodyear Aerospace Corp., Akron, Ohio.
DESIGN OF DISK-GAP-BAND AND MODIFIED RINGSAIL PARACHUTES AND DEVELOPMENT OF BALLUTE APEX INLET FOR SUPERSONIC APPLICATION
G. L. Faurote 6 Apr. 1970 109 p refs
(Contract NAS1-8564)
(NASA-CR-66909; GER-14657) Avail: CFSTI CSCL 01C

The design and fabrication of flexible wind-tunnel decelerator configurations for use by NASA Langley Research Center in its Ground Test Decelerator Program is presented. The models included fabric disk-gap-band and ring-sail parachutes and ram-air-inflated towed Ballutes. In addition, the design of disk-gap-band and Ballute solid pressure models is presented. All configurations were designed for test in a supersonic-flow regime. Author

N70-32893*# New York Univ., N.Y. Dept. of Aeronautics and Astronautics.
REFLECTION AND FOCUSING OF SONIC BOOMS BY TWO-DIMENSIONAL CURVED SURFACES
Jack Werner Apr. 1970 55 p refs
(Grant NGL-33-016-119)
(NASA-CR-110727; NYU-AA-69-35) Avail: CFSTI CSCL 20A

An integral relation has been derived describing the pressure due to the reflection of a plane acoustic wave of arbitrary wave form incident on a two dimensional curved surface with plane asymptotes. The results were applied to the problem of sonic boom incident over a reflecting hyperbolic surface. It was found that singularities or focal points occur at which the pressure becomes infinite according to linear theory. A criterion for these focal points to occur was developed and the locus of singularities was determined. The pressure disturbances in the neighborhood of these focal points was investigated for incident step function, linear and N-wave forms. It was found that in the case of the N-wave the major contribution to the disturbance near the focal points comes from the reflection of the discontinuities at the leading and trailing edges of the incident wave. Author

N70-32895*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
EVALUATION OF RANGE AND DISTRIBUTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC STAGES
V. L. Doyle and C. C. Koch 23 Jul. 1970 124 p refs
(Contract NAS3-11157)
(NASA-CR-72720; GE-R70-AEG-223) Avail: CFSTI CSCL 21E

Two transonic single-stage compressors were designed to investigate the efficiency, weight flow range, and distortion tolerance of high-tip-speed ten stages and to determine the ability of variable-geometry blading to improve off-design performance. The first compressor, the Task I Stage, used an existing 1400 ft/sec-tip-speed, multiple-circular-arc rotor and a new matching stator. The Task II Stage consisted of a variable-camber inlet guide vane, a 1500-ft/sec-tip-speed rotor and a variable-stagger stator. Both stages had a rotor inlet tip diameter of 36.5 inches and a rotor inlet hub; tip radius ratio of 0.5. Both stages used the same stator vanes, had identical flowpaths, and used many of the same test vehicle components. The Task I Stage design total-pressure ratio was 1.617 at a weight flow of 219.4 lbs/sec; the Task II Stage design total-pressure ratio was 1.659 at a weight flow of 226 lbs/sec. Author

N70-32902# Joint Publications Research Service, Washington, D.C.
STUB AND FRAME ANTENNAS FOR FLIGHT VEHICLES
G. B. Reznikov 9 Jun. 1970 24 p Transl. into ENGLISH from the publ. "Antenny Letalelnykh Apparatov," Chapter 7 Moscow, 1967 p 274–295
(JPRS-50690) Avail: CFSTI

Stub and frame antennas are considered in terms of installation and principles of action. Emphasis is placed on the calculation and experimental investigation of the input impedance of the stub antenna. Formulas are given for the determination of the radiation field and the Poynting vector in the wave zone. J.M.C.

N70-32921# Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.
A STUDY OF AN ADAPTIVE AIRCRAFT CONTROL SYSTEM IN A SELF-ORGANIZING CONFIGURATION
Henry Morgan Richarde, Jr. (M.S. Thesis) Oct. 1969 51 p refs
(AD-703656) Avail: CFSTI CSCL 1/3

An adaptive control scheme may provide the best approach to the problem of accommodating automatic flight control systems to the variations of dynamic characteristics encountered over the flight envelope of the aircraft. The C*-Criterion for aircraft time response provides a basis for the design of such a system. To provide a margin of safety, all control systems have redundant channels for emergency use. An adaptive control system can be designed to be self-organizing, and in such a configuration can provide its own failure monitoring, resulting in a simpler and more efficient system. This study shows that such a system is feasible, that the response of the system is within the limits set forth in the C*-Criterion, and that the self-organizing characteristics provide reliable operation over the whole range of flight operations. Author (TAB)

N70-32947*# Scientific Translation Service, Santa Barbara, Calif.
DETERMINATION OF THE FIELD OF SOUND PRODUCED BY A JET AIRCRAFT IN MOTION [DETERMINATION DU CHAMP SONORE PRODUIT PAR L'EVOLUTION DES AVIONS A REACTION]

M. Kobrynski Washington NASA Jul. 1970 22 p refs Transl. into ENGLISH of French Report ONERA-TP-687 Presented at AGARD Meeting on Aircraft and Sonic Boom Noise, Saint-Louis, France, 27–30 May 1969
(Contract NASw-2035)
(NASA-TT-F-13096; ONERA-TP-687) Avail: CFSTI CSCL 20A

The relation between the global sound pressure field generated by an axisymmetrical stationary jet and that produced by a moving jet, observed from a fixed point on the ground, is studied through the introduction, in the generalized sound pressure equation, of a new convection parameter derived from the Ribner expression. This new equation confirms the known results in the maximum sound direction and gives a better value in the other directions. The results of the analytical study, confirmed by many experimental results, show that, in the directions other than that of maximum pressure, the relative speed is not the significant parameter for determining the local total sound pressure level. Author

N70-32985# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE DESIGN OF ELEMENTS OF COMPONENTS AND SUBASSEMBLIES OF AIRCRAFT ENGINES
Yu. M. Nikitin 21 Jan. 1970 418 p refs Transl. into ENGLISH of the book 'Konstruirovanie Elementov Detaley i Uzlov Aviadigateley' Moscow, Izd-Vo Mashinostroyeniye, 1968 p 1–324
(AD-704730; FTD-MT-24-434-69) Avail: CFSTI CSCL 21/5

This is a textbook for course work and diploma projects in the field of aircraft engine building. It can also be used by students in institutes of higher education and technical schools of other machine building specialties, as well as by engineering and technical personnel working in the field of aircraft engine building and gas turbine building. The various design solutions used in the design of aircraft engine parts and units are examined. In each chapter are discussed the general requirements on the examined design elements, and recommendations are given on the basis of experience gained in industry. After an over all evaluation of the given design procedure, actual examples are given of various solutions of some problem taken from the practice of aircraft engine building. Based on examples of the design of several units of gas turbine engines, the relationship is shown between the design solutions for separate elements of the unit according to the technical requirements the accepted and design scheme of a unit and an engine as a whole. Author (TAB)

N70-33066*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL WINDAGE LOSSES FOR CLOSE CLEARANCE ROTATING CYLINDERS IN THE TURBULENT FLOW REGIME
Sol H. Gorland, Erwin E. Kempke, Jr., and Stacey Lumannick Jun. 1970 21 p refs
(NASA-TM-X-52851; E-5786) Avail: CFSTI CSCL 20D

Viscous torque (windage) of a 12-inch diameter, 5.9-inch long cylinder rotating within a stationary concentric housing was measured at speeds up to 24,000 rpm. Three housings were mounted on a reaction torque measuring device which eliminated any disc type end effects. Reynolds numbers (Re) in excess of 100,000 were produced using the gap thickness as the characteristic dimension. It was found that above a Re of 15,000 the curves of drag coefficient vs Re for all three gaps coincided within five percent. Author

N70-33103*# Honeywell, Inc., Lexington, Mass. Radiation Center.
SYSTEM DESIGN STUDY FOR AN OPTIMAL REMOTE OCULOMETER FOR USE IN OPERATIONAL AIRCRAFT
John Merchant, Ronald Wilson, and Kenneth A. Mason Washington NASA Jul. 1970 198 p refs
(Contracts NASw-1159; NAS12-531)
(NASA-CR-1562) Avail: CFSTI CSCL 17H

The results are presented of a design study for a remote configuration oculometer suitable for measuring the eye direction of a pilot, without causing any interference to his normal activities. The principle feature of the oculometer is the utilization of a method which does not require that the device be clamped, or otherwise fixed to the subject. The material presented includes an analysis of the basic design factors, system descriptions, and a performance summary. D.L.G.

N70-33150*# Michigan Univ., Ann Arbor.
COMPARISON OF CORD LOADS WITH A 24 × 7.7 TYPE 7 AIRCRAFT TIRE ON GROOVED AND SMOOTH RUNWAY SURFACES
S. K. Clark and R. N. Dodge Washington NASA Jul. 1970 16 p refs
(Grant NGL-23-005-010)
(NASA-CR-1627) Avail: CFSTI CSCL 13F

In recent years several comprehensive research programs have investigated the effectiveness of runway grooving as a means for increasing tire traction under operational conditions. The results of these studies have shown that pavement grooves provide greatly increased aircraft braking and steering capability for wet, flooded, and slush covered runways. To further investigate the effects of grooved surfaces on tire performance, some experimental measurements of tire cord loads developed on both grooved and ungrooved surfaces are discussed. The groove configurations used were all rectangular or chambered grooves ranging from 3/16 inch by 3/16 inch on 1 inch centers to 3/8 inch on 1 inch centers. Based on test results obtained with a 24×7.7 10 pr Type 7 tire, under slow rolling conditions, tire cord loads are not effected to any significant extent by running on a grooved surface. Author

N70-33230*# Scientific Translation Service, Santa Barbara, Calif.
PROPULSIVE EVALUATION OF A RAMJET INSTALLED UNDER A WING UP TO MACH 7 [BILAN PROPULSIF, JUSQU'A MACH 7, D'UN STATOREACTEUR MONTE SOUS UNE AILE]
C. Huet Washington NASA May 1970 26 p refs Transl. into ENGLISH from Rech. Aerospatiale (Chatillon-sous-Bagneux), no. 133, Nov.–Dec. 1969 p 3–14
(Contract NASw-2035)
(NASA-TT-F-12951) Avail: CFSTI CSCL 20D

Taking advantage of the compression of the air under the lower surface of a lifting wing leads to the improvement of a ramjet, and makes easier the solution of technological problems. With such a design it is possible to make do a fixed geometry engine between Mach 3 and Mach 7. The air intake takes place without incidence and at a lower Mach number ($2.8 < M < 5$). The main flight mechanics equations applicable in this case are given. The notion of induced thrust, due to the flight incidence, is introduced. On a numerical example, the performance increase due to this ramjet position is analyzed; it is shown, in particular, that with this design the engine cross section can be reduced two to threefold. Author

N70-33233# Israel Program for Scientific Translations, Ltd., Jerusalem.
AVIATION CLIMATOLOGY

G. Ya. Narovlyanskii 1970 215 p refs Transl. into ENGLISH of the book "Aviatsionnaya Klimatologiya" Leningrad, Gidrometeorologicheskoe, Izd., 1968 Prepared for ESSA and NSF (TT-69-55100) Avail: CFSTI

An applied science dealing with the influence of climatic factors on aviation technology and aviation activity, and specifically intended to develop methods of providing aviation with climatological data is discussed. An attempt is made to systemize and generalize the investigations carried out both in our country and abroad in the field of aviation climatology. Special importance is attached to the description of a calculation technique for various aviation-climatic indices which characterize flying conditions and which are allowed for in the design and operation of airports. The principles of the preparation technique of aviation-climatic descriptions are given. A brief characterization of the aviation-climatic conditions on certain international air routes is presented. Author

N70-33249# Sandia Corp., Albuquerque, N. Mex. Library Operations Div.

THERMAL LOAD OF AN AERODYNAMIC REENTRY BODY AND THE RESULTING OPTIMIZATION AND DESIGN CRITERIA

W. F. Zimi et al 21 Apr. 1970 28 p refs Transl. into ENGLISH from Ann. Conv. of the Ger. Soc. for Aeron. and Astronautics (DGLR), Bremen, 22-24 Sep. 1969

(SC-T-70-4015; CONF-690950-1) Avail: CFSTI

Starting from the description of the physical process of the aerodynamic heating, the computation methods aimed at determining the heat transfer are sketched. The example of the LB 10 elucidates the procedure for the approximated analytical determination of the complex geometric form of a reentry body. The maximal heat load is situated in an altitude velocity area where the boundary layer is laminar in the vicinity of the ram point. For this reason, it is possible to solve the heat transfer by employing an exact integration of the boundary layer equations for simple bodies. Among the conceivable heat protection possibilities, such as ablation, active cooling, radiative cooling, the passive radiation-cooled multiple-layer insulation provides the most favorable insulating type for a reusable missile. An insulation coefficient is derived which makes it possible to classify various materials in terms of their serviceability as insulants. Author

N70-33255* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VARIABLE SWEEP WING CONFIGURATION Patent

William J. Alford, Jr. and Edward C. Polhamus, inventors (to NASA) Issued 11 Sep. 1962 (Filed 7 Jul. 1960) 5 p Cl. 244-43

(NASA-Case-XLA-00230; US-Patent-3,053,484;

US-Patent-Appl-SN-41455) Avail: US Patent Office CSCL 01C

The design of an improved variable sweep wing planform for a supersonic aircraft is described. The variable aspect ratio wing is designed for use in an aircraft having a conventional fuselage including a conventional aft empennage assembly and fuselage carried propulsion engines, wings projecting from the sides of the fuselage including fixed swept inboard panels constituting about 20 percent of the total wing area, with about one half of the area of the fixed panels being located forward of the aircraft center of gravity, and outboard panels extending outwardly from the fixed inboard panels and pivotally connected for rotation in the wing areal plane to vary the leading edge sweep between a small angle of about 25 degrees and a large angle of about 75-80 degrees. A.L.

N70-33266* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VARIABLE SWEEP WING AIRCRAFT Patent

Thomas A. Toll, inventor (to NASA) Issued 20 Nov. 1962 (Filed 23 Aug. 1960) 6 p Cl. 244-46

(NASA-Case-XLA-00221; US-Patent-3,064,928;

US-Patent-Appl-SN-51473) Avail: US Patent Office CSCL 01C

Variable aspect ratio and variable sweep delta wing planforms are discussed for supersonic aircraft. The aspect ratio of the delta wing can be varied without affecting the control and stability characteristics of the aircraft. The design configuration provides maximum aspect ratio for subsonic takeoff, climb, cruise, descent, and landing. The supersonic performance of the aircraft is also improved by altering the sweep of the wing during supersonic cruise. R.B.

N70-33268*# New York Univ. N.Y. Dept. of Aeronautics and Astronautics.

ACTIVE COOLING OF HYPERSONIC AIRPLANES

Antonio Ferri, Herbert Fox, and Walter Hoydysh Jan. 1970 75 p refs

(Grant NGR-33-016-131)

(NASA-CR-66930) Avail: CFSTI CSCL 01C

A combined turbine-compressor system is discussed for application to active cooling of hypersonic airplanes. The basic system analysis is discussed and performance variation analyzed. The various parameters of importance are discussed with their pertinent effects on the system operation displayed. The penalties of the system are shown to be smaller than with other active cooling systems. Author

N70-33274# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

THE DETERMINATION OF UNSTEADY AERODYNAMICS OF A TWO-DIMENSIONALJET-FLAP WING Final Technical Report, Apr. 1966 - Mar. 1970

Andrew R. Trenka and John C. Erickson, Jr. Apr. 1970 97 p refs

(Contract DA 31-124-ARO(D)-459)

(AD-704722; CAL-AC-2260-S-1) Avail: CFSTI CSCL 1/3

One of the purposes of the study was to conduct wind-tunnel tests on a two-dimensional, oscillating, jet-flap airfoil to determine the unsteady forces, moments, and pressure distributions. These tests were to (1) provide data for testing the validity of the theoretical results, and (2) to furnish guide-lines for the further development of unsteady jet-flap airfoil theory. The study was also to extend the solutions to the general theoretical equations describing the unsteady motions of a jet-flapped airfoil executing simple harmonic pitching motions. The attainment of these objectives was pursued in three phases. The first consisted of the development, calibration and testing of the model and its recording system. The second phase dealt with the theoretical effort required to allow computation of the lift and moment acting on a two-dimensional jet-flap airfoil executing harmonic pitching motions. The third and final phase consisted of the correlation of theory and experiment and the assessment of the theory. Author (TAB)

N70-33275# Cornell Aeronautical Lab., Inc., Buffalo, N.Y. Aerodynamic Research Dept.

RESEARCH ON SURFACE CATALYSIS IN NONEQUILIBRIUM FLOWS Final Report, Sep. 1967 - Sep. 1969

John A. Bartz and Robert J. Vidal Arnold AF Sta., Tenn. AEDC Apr. 1970 62 p refs

(Contracts F40600-68-C-0001; F40600-69-C-0005)

(AD-704814; CAL-AF-2753-A-2; AEDC-TR-70-111) Avail: CFSTI CSCL 14/2

The report describes the results of a program of research to develop a catalytic probe with a discontinuous catalytic surface.

The ultimate objective is to use the probe to measure the ambient oxygen atom concentrations in high-temperature wind tunnel facilities, and a discontinuous catalytic surface was used to increase the probe sensitivity to small atom concentrations. The report first reviews the theoretical basis for this probe configuration, and then presents experimental data obtained with the probe in air and simulated air. The accuracy of existing theory for a probe with a discontinuous catalytic surface was demonstrated in equilibrium flow experiments in a shock tube using simulated air with a single reactant. SSubsequent equilibrium flow experiments in real air indicated that oxygen atom recombination is the only important reaction occurring on the surface and thereby demonstrated the utility of the probe as a diagnostic in high-temperature air flows. It was concluded that the discrepancies could result from a weak wave system in the nozzle and from uncertainties in the chemical rate data used in the theoretical prediction of the nozzle flow.
Author (TAB)

N70-33286* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LANDING ARRANGEMENT FOR AERIAL VEHICLES Patent
John M. Riebe and Vernard E. Lockwood, inventors (to NASA) Issued 3 Apr. 1962 (Filed 2 May 1960) 7 p Cl. 244-46
(NASA-Case-XLA-00142; US-Patent-3, 028, 122; US-Patent-Appl-SN-26375) Avail: US Patent Office CSCL 01C

Details are presented on a configuration which is capable of being positioned in a low aspect ratio attitude for high speed flight and also in a high aspect ratio attitude for low speed flight, takeoff, or landing. The planform configuration is characterized by large in-flight aspect ratio variation capabilities, and aerodynamic lift capabilities exceeding in the increase in lift obtainable by increasing the aspect ratio. These are provided by an elongated fuselage or hull section, jet means for yawing the fuselage section, and means of increasing aerodynamic lift.
N.E.N.

N70-33332* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
JET AIRCRAFT CONFIGURATION Patent
Francis M. Rogallo, John M. Riebe, and John G. Lowry, inventors (to NASA) Issued 11 Jul. 1961 (Filed 6 May 1959) 4 p Cl. 244-12
(NASA-Case-XLA-00087; US-Patent-2, 991, 961; US-Patent-Appl-SN-811509) Avail: US Patent Office CSCL 01C

An upper surface external flow, jet-flap configuration for a high wing airplane, with improved noise suppression characteristics, is described. The flap is defined as an arrangement for simulating a flap by a jet sheet which augments the lift capabilities of wing section by inducing circulation of the stream around the wing. The design also reduces the danger of trash ingestion, diminishes the ground effect on the lift, and improves the slow speed performance of jet aircraft.
N.E.N

N70-33426# National Research Council of Canada, Ottawa (Ontario).
DETERMINATION OF THE BUFFET BOUNDARIES OF AIRCRAFT WINGS IN THE TRANSONIC VELOCITY REGIME [DIE ERMITTLUNG DER SCHUETTELGRENZEN VON TRAGFLUEGELN IM TRANSSONISCHEN GESCHWINDIGKEITSBEREICH]
Fred Thomas 1970 43 p refs Transl. into ENGLISH from Jahrb. der WGLR (West Germany), 1966 p 126 – 144
(NRC-TT-1408) Avail: CFSTI

A method based on boundary layer theory is described by which the buffet boundaries may be calculated without empirical criteria. The transonic pressure distribution with compression shock is determined. Using laminar and turbulent compressible boundary layer calculation, the corresponding separation points are determined from the transonic velocity distributions. The onset of buffeting and the effect of Reynolds number on the position of the buffet boundaries are discussed. Good agreement was found between the theoretical results and those from wind tunnel and flight tests.
N.E.N.

N70-33442# Boeing Scientific Research Labs., Seattle, Wash.
JOULE HEATING OF A PLATE ELECTRODE IN A FREE ARC DISCHARGE
F. Edward Ehlers and Donald F. Winter Dec. 1969 31 p refs *Its* Mathematical Note 636
(AD-705645; D1-82-0942) Avail: CFSTI CSCL 20/13

To estimate the heating of an airplane wing from a lightning stroke, the Joule heating in an infinite plate was analyzed. From experiments with argon arcs, it has been observed that the surface current density from an arc in which the plate acts as anode is approximated closely by a Gaussian distribution. With this boundary condition on one surface, the quasi-steady current distribution inside the plate was found from a solution of Maxwells equations. By the use of a simple approximation of the interior current density distribution for plates which are thin compared with the arc radius as the source term in the heat equation, the solution to the temperature enhancement in the plate was found by means of the Bessel and Laplace transforms. A solution for thick plates also was obtained by using an approximation to the current in the plate in the neighborhood of the arc axis where most of the heating occurs.
Author (TAB)

N70-33519# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
THE INFLUENCE OF SURFACE MELTING OR SURFACE VAPORIZATION ON THE TEMPERATURE DISTRIBUTION IN A PLATE
F. Edward Ehlers Jan. 1970 23 p refs *Its* Mathematical Note 637
(AD-705640) Avail: CFSTI CSCL 20/13

During a lightning stroke on the wing of an airplane, the surface may become heated until melting or vaporization of the metal occurs. To gain some insight into the significance of this melting or vaporization on the temperature of the inner surface of the wing near the fuel, an approximate solution was obtained for the temperature in a plate when one surface is heated uniformly at a constant rate sufficiently long that melting occurs. It was assumed that the melted material is removed as soon as it reaches the melting temperature. The resulting equation of the conservation of heat flux at the melting surface, which includes the absorption of energy from the latent heat of melting, and the heat equation with appropriate moving boundary conditions yields a coupled system of differential equations to be solved for the amount of melt and for the temperature in the plate. An iteration procedure was developed and the first approximation obtained.
Author (TAB)

N70-33607# Indian Inst. of Science, Bangalore. Dept. of Aeronautical Engineering.
A METHOD FOR CALCULATION OF FREQUENCIES AND MODES USING AN IMPROVED INERTIA MATRIX
S. Durvasula, P. Bhatia, K. Kalyana Raman, and S. S. Jagirdar Jun. 1970 36 p refs Presented at 21st Annual Gen. Meeting of the Aeron. Soc. of India, Madras, 4-6 Apr. 1969
(AE-276-S) Avail: CFSTI

A method of obtaining an improved mass matrix in a discrete approximation of a continuous elastic system is outlined. The

modified mass matrix is constructed by using an appropriate displacement distribution over the entire structure and expressing the kinetic energy in terms of the velocities of the grid points and constitutes a distinct improvement on the simple lumped mass method widely used in practice. The improvement that is possible in the determination of natural frequencies and mode shapes by the use of this modified mass matrix together with the measured flexibility matrix over the normal practice of using the diagonal lumped mass matrix and measured flexibility matrix is demonstrated with respect to a few representative examples. Author

N70-33636# Naval Civil Engineering Lab., Port Hueneme, Calif.
TIRE-PAVEMENT FRICTION COEFFICIENTS Technical Report, Jul. 1967 - Nov. 1968
Hisao Tomita Apr. 1970 107 p refs
(AD-705987; NCEL-TR-672) Avail: CFSTI CSCL 1/5

An investigation consisting mainly of a literature review and a review of current research done outside NCEL was conducted to determine the methods needed to provide safe, skid-resistant surfaces on Navy and Marine Corps airfield pavements. Much of the information reported herein serves to update the information contained in NCEL Technical Report R-303 (AD-602 930). For example, new information is included on friction-measuring methods, correlation of the measuring methods, factors affecting friction coefficients, minimum requirements for skid resistance, and methods of improving the skid resistance of slippery pavements. However, some new topics which are of recent interest are also discussed in detail. These topics include hydroplaning, the mechanism of rubber friction, the friction associated with various operating modes of aircraft tires, the relationship of friction coefficients to pavement surface texture and to surface drainage of water, and the effects of pavement grooving on hydroplaning and on friction coefficients. All the information from the investigation is summarized, and recommendations are given for research and development efforts needed to provide safe, skid-resistant surfaces for airfield pavements. Author (TAB)

N70-33644# Ohio Univ., Athens. Dept. of Electrical Engineering.
VOR PROPAGATION AND STABILITY STUDY Final Report, Feb. 1967 - Dec. 1969
Richard H. Mc Farland, Fred Kiko, and G. E. Smith Jan. 1970 271 p refs
(Contract FA-67-WA-1721)
(AD-705079; EER-11-3; FAA-RD-69-44) Avail: CFSTI CSCL 17/7

Results of a theoretical and experimental investigation of propagation effects on VOR course accuracies and stability are presented. Fixed point measurements show propagation errors to be minimal, less than 0.2 degree with a two sigma probability. Effects of VOR receivers, meteorological fronts, tropospheric ducts, vertical polarization, and multipath due to aircraft, on course accuracy are identified and discussed. Evidence gathered from this research clearly indicates that the receiver is the major contributor to indicated course error and when this condition is improved, a factor of five improvement in VOR system accuracy can be available. Thus, the VOR has the potential for providing the increased navigational capability needed for a more dense airway structure for use in an area navigation concept. Special experiments were conducted using conventional and doppler-type VORs as well as a VOT to determine the effect of overflying aircraft on the course information presented in a user aircraft. Results show that the receiver design is critical in determining the magnitude of the perturbation that results. Data from long term, line-of-sight monitoring, accomplished at a range of 40 miles has been reduced and discussions of the identification and classification of significant course errors produced by propagation are provided. Laboratory simulation of propagation and other spurious effects is shown to be one means of aiding in receiver redesign to minimize the receiver response to such signals. Author (TAB)

N70-33651# National Research Council of Canada, Ottawa (Ontario).
THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT Quarterly Bulletin, 1 Oct. - 31 Dec. 1969
31 Dec. 1969 106 p refs
(DM-/NAE-1969(4)) Avail: CFSTI

CONTENTS:

1. NEW DEVELOPMENTS IN THE FINITE ELEMENT ANALYSIS OF SHELLS G. M. Lindberg, M. D. Olson, and G. R. Cowper p 1 - 38 refs
2. PRODUCTION OF PRECISION FOAM PLASTIC PRODUCTS BY PRESSURE MOLDING OF FOAM SLABS IN A HOT MOLD D. A. Baker p 39 - 45
3. NAE FLIGHT IMPACT SIMULATOR J. W. Noonan and J. B. R. Heath p 47 - 68 refs
4. CURRENT PROJECTS p 71 - 99

N70-33653# National Research Council of Canada, Ottawa (Ontario). Flight Research Lab.
PRODUCTION OF PRECISION FOAM PLASTIC PRODUCTS BY PRESSURE MOLDING OF FOAM SLABS IN A HOT MOLD
D. A. Baker *In its* The Div. of Mech. Eng. and the Natl. Aeron. Estab. 31 Dec. 1969 p 39 - 45
Avail: CFSTI

A method is described for molding model crash position indicators, which will be used in supersonic wind tunnel tests, from blocks of styrofoam. It also briefly describes methods that were tried before reaching a satisfactory one, and lists a few areas where this type of manufacture might prove valuable. Author

N70-33654# National Research Council of Canada, Ottawa (Ontario). Structures and Materials Lab.
NAE FLIGHT IMPACT SIMULATOR
J. W. Noonan and J. B. R. Heath *In its* The Div. of Mech. Eng. and The Natl. Aeron. Estab. 31 Dec. 1969 p 47 - 68 refs

Avail: CFSTI

The simulation of bird impact during flight is investigated to bird proof aircraft against bird hazards. The bird gun, bird types, firing sequence, instrumentation, photography, and performance are described. It is concluded that the flight impact simulator is a reliable impact loading tool operating through a velocity range from 250 to 700 ft/sec, using 4 and 8 lb birds as projectiles. F.O.S.

N70-33655# National Research Council of Canada, Ottawa (Ontario).
CURRENT PROJECTS
In its The Div. of Mech. Eng. and The Natl. Aeron. Estab. 31 Dec. 1969 p 71 - 99
Avail: CFSTI

The current studies and available facilities of Canadian laboratories are listed. F.O.S.

N70-33670# Massachusetts Univ., Amherst. School of Engineering.
DUCTED PROPELLERS: A REVIEW AND DESCRIPTION OF CURRENT INVESTIGATION
Ronald J. Weetman and Duane E. Cromack Jan. 1970 78 p refs
(Contract N00014-68-A-0146; Proj. Themis)
(AD-705524; THEMIS-UM-70-1) Avail: CFSTI CSCL 1/3

The paper describes the past theoretical and experimental work on ducted propellers. Also included is a discussion of the limitations of these past investigations. Since the ducted propeller is used parimarily for low speed applications (i.e., deep sea submersibles, tugboats and VTOLs) the theoretical and experimental development for low speed and static conditions is obviously needed. A description of the current and proposed theoretical and experimental investigation for these conditions is presented. Author (TAB)

N70-33674# Martin Co., Baltimore, Md.
FLIGHT TEST AND EVALUATION OF AIRBORNE COLLISION AVOIDANCE SYSTEMS Summary Report
20 Mar. 1970 39 p Supported in part by the Air Transport Assoc of Am.
(AD-705529) Avail: CFSTI CSCL 17/7

Contents: Aircraft used in program; Instrumentation; Cockpit displays; Airspace protection envelopes; Tau zone boundaries; Final 60 seconds of countdown to intercept; Range alarms at low rates of closure; Aircraft separation at minimum range; Operational results; and Technical results. TAB

N70-33677# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
RAPID ASSESSMENT OF SOIL STRENGTH AT AIRCRAFT LANDING SITES Instruction Report
G. N. Hammitt, II Apr. 1970 14 p refs
(AD-705572; S-70-1) Avail: CFSTI CSCL 1/5

The report presents a method of rapidly assessing the ability of an area to support aircraft operations. The method involves no special equipment or specially trained personnel, but is based on the interrelation of the response of ground surfaces of various strengths to vehicular and aircraft traffic. Data that allow the forecasting of the ability of an area to support aircraft traffic are tabulated herein. This ability is based on the rut depth occurring in a soil after one pass of a standard military vehicle. Author (TAB)

N70-33694# Air Force Flight Test Center, Edwards AFB, Calif.
PERFORMANCE Final Report
Feb. 1970 432 p refs
(AD-705584; FTC-TIH-70-1001) Avail: CFSTI CSCL 1/3

Contents: The atmosphere; Aerodynamics introduction; Subsonic aerodynamics; Supersonic aerodynamics; Hypersonic aerodynamics; Pitot-static system; Non-steady state performance; Steady state performance; Turning performance; Takeoff and Landing; Fuel flow corrections; Calibration tests; Climb tests; Cruise performance tests; Turning performance tests; and Takeoff and landing performance tests. TAB

N70-33724# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
SIMULATION OF RANDOM LOAD FATIGUE IN LABORATORY TESTING
T. J. Ravishankar Mar. 1970 109 p refs
(UTIAS-29) Avail: CFSTI

The methods used in laboratory simulation of random service load conditions, that lead in practice to fatigue failure if e.g. aircraft structures, are reviewed. First, the interrelation of the atmospheric turbulence with the resulting loads on the aircraft are discussed. Then follows an analysis and interpretation of service load histories and a review and comparison of the methods in use for simulating service load spectra of arbitrary and random load sequences. Both random loading, using discrete load levels or analogous random process testing, are discussed. Full scale testing is also reviewed. In appendices, stationary random processes and fewer spectral density functions an evaluation of probability distributions of RMS gust velocities and some damage theories are presented. Author

N70-33746*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF INLET AIR VITIATION ON THE PERFORMANCE OF A MODULAR COMBUSTOR BURNING NATURAL GAS FUEL
Arthur M. Trout and Nicholas R. Marchionna 31 Oct. 1969 15 p refs
(NASA-TM-X-52711) Avail: CFSTI CSCL 21E

An advanced turbojet combustor design was tested with natural gas fuel at a pressure of 45 psia (31 N/sq cm) and inlet air temperature of 540 F (556 K). The inlet air was heated using both nonvitiating and vitiating preheaters. Combustion efficiency of the test combustor substantially decreased when the vitiating preheater was used. The combustion efficiency decreased most at high reference velocities and low fuel-air ratios. Author

N70-33771*# Pratt and Whitney Aircraft, West Palm Beach, Fla.
A 90 DEGREE SECTOR DEVELOPMENT OF A SHORT LENGTH COMBUSTOR FOR A SUPERSONIC CRUISE TURBOFAN ENGINE Interim Report, Jun. 1968 - Mar. 1970
T. R. Clements 6 Aug. 1970 90 p refs
(Contract NAS3-11159)
(NASA-CR-72734; PWA-FR-3790) Avail: CFSTI CSCL 21E

Results of a performance development program are presented on an advanced short length combustor for operation at flight speeds up to Mach 3.0. The combustor has an outer diameter of 40 inches and a length of 12 inches. The overall diffuser-combustor length is 20 inches. Performance data were obtained in a 90-degree sector rig at a pressure level of 16 psia. Inlet temperature and Mach number simulated sea level take-off operation. Various combustor and diffuser configurations were investigated to simplify design and to improve performance. At a combustor temperature rise of 1640 F good outlet temperature pattern factor (TPF = 0.14), radial profile, and combustion efficiency (100%) were obtained. The combined diffuser-combustor total pressure loss was 5.6%. Author

N70-33773*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOW-NOISE PROPULSION SYSTEMS FOR SUBSONIC TRANSPORTS
James J. Kramer, Bruce R. Leanord, and Charles E. Feiler 21 Nov. 1969 26 p refs Presented at the Symp. on Machinery Noise Los Angeles, 16-21 Nov. 1969; Sponsored by ASME
(NASA-TM-X-52640) Avail: CFSTI CSCL 21E

A brief review of the preliminary design studies which led to a definition of specifications for a low-noise output turbofan engine for use on long-range subsonic transport aircraft is presented. Data on low-speed fans with and without acoustic treatment in the fan ducting are presented. These data indicate that overall noise output of four-engine long-range transport aircraft can be reduced 20 perceived noise decibels by appropriate fan design and the use of nacelle acoustic treatment. Author

N70-33795# Defense Documentation Center, Alexandria, Va.
PRESSURE VESSELS, VOLUME 1 A DDC BIBLIOGRAPHY, Jan. 1963-Jun. 1969
Mar. 1970 118 p refs
(AD-702600; DDC-TAS-70-22-I) Avail: CFSTI CSCL 13/4

The annotated bibliography comprises citations of unclassified reports dealing with tests and applications of pressure vessels used for tanks (containers) submarine hulls, rocket cases, ramjet engines and guided missiles. Author

N70-33798# National Aviation Facilities Experimental Center, Atlantic City, N.J.
FIRE TEST CRITERIA FOR RECORDERS Final Report
Thomas Rust, Jr. and Paul N. Boris Jul. 1970 44 p refs
(FAA-NA-70-25; FAA-DS-70-16) Avail: CFSTI

Tests were conducted to investigate fire test criteria as applied to flight data and cockpit voice recorder systems and material. Studies were made to determine the effect of elevated temperature on various types of recording tapes and highly conspicuous exterior coatings which could be applied to recorder covers. Open flaming and enclosed furnace tests were performed on complete recording units in order to obtain data for formulating improved standardized laboratory test methods suitable for evaluating survivability of flight data and cockpit voice recorders in a crash-fire environment. Author

N70-33804# Weather Wing (1st), San Francisco, Calif.
FORECASTING SNOWSHOWERS AT MISAWA AIR BASE, JAPAN
George Taniguchi Feb. 1970 34 p refs *Its* Tech. Study 20
(AD-705567) Avail: CFSTI CSCL 4/2

The study describes various snowshower forecast methods that have been attempted at Misawa AB, Japan. A brief summary of each method is presented. Conclusion, at the present state of the art only favorable conditions for snowshowers can be predicted. Author (TAB)

N70-33808*# Translation Consultants, Ltd., Arlington, Va.
WALL EFFECT ON A HELICOPTER ROTOR IN A CLOSED CIRCULAR TUNNEL: INCOMPRESSIBLE FLOW AROUND A DOUBLET PLACED IN A CLOSED CIRCULAR TUNNEL [EFFET DE PAROI SUR UN ROTOR D'HELICOPTERE EN VEINE FERMEE DE SECTION CIRCULAIRE: ECOULEMENT INCOMPRESSIBLE AUTOUR D'UN DOUBLET PLACE DANS UNE VEINE FERMEE CIRCULAIRE]
P. Michel Washington NASA Jul. 1970 98 p refs Transl. into ENGLISH from French report
(Contract NASw-2038)
(NASA-TT-F-13155) Avail: CFSTI CSCL 20D

A method of calculating the interaction of a cylindrical wall with a circular straight section with the flow from a doublet placed in any way in this wall is described. This method is designed to be used in testing helicopter rotors. Included are descriptions of conditions to be satisfied by complementary potential, calculation principle of complementary potential, development of Fourier series for function, calculations of complementary potential and velocities induced by doublet D. Annexes contain descriptions of Euler, hypergeometric Gauss and modified Bessel functions, as well as reference citations. Author

N70-33864*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
SONIC BOOM SIMULATION BY MEANS OF LOW-PRESSURE SOURCES
Ulrich J. Kurze, Richard E. Hayden, Richard Madden, Clay H. Allen, and Eric E. Ungar Mar. 1970 135 p refs
(Contract NAS1-9312)
(NASA-CR-66969) Avail: CFSTI CSCL 20A

Theoretical and experimental results are presented which indicate that N-waves approximating full-scale sonic booms can be obtained from low-pressure pulses applied at the throat of a horn. Conical horns are shown to be optimum and to confine radiation of waves with sharp pressure discontinuities to within the cone angle. It is determined that exposures of a 1000 ft diameter test site to a simulated sonic boom requires a horn which is roughly 1000 ft long, and has a 300 ft mouth diameter and a throat diameter of about 20 ft, and is located so that its mouth is 2500 ft from the edge of the test site. Peak velocities in the throat corresponding to Mach numbers below 0.5 then can produce N-waves with amplitudes of 140 to 148 dB. Author

N70-33880# Federal Aviation Administration, Washington, D.C.
A SUGGESTED ACTION PROGRAM FOR THE RELIEF OF AIRFIELD CONGESTION AT SELECTED AIRPORTS, SUPPLEMENT
L. N. Million, E. Aikman, J. M. Copeland, and W. C. Keepers 19 Feb. 1970 111 p
(AD-702777) Avail: CFSTI CSCL 1/5

The report separately identifies and analyzes the possible improvements needed to prevent or reduce aircraft delays at ten high density airports with pending congestion problems. The original report dated April 1969 provided analysis for eighteen of the nation's highest density airports which were experiencing serious congestion. Discussion is presented on the causes contributing to aeronautical congestion and on the current operational status of each airport. The supplemental report is concerned primarily with physical construction projects which will enhance the particular airports airfield capacity such as high-speed exit taxiways, parallel runways, and navigational aids. It also examines certain procedural improvements such as intersection takeoffs and part-time use of taxiways as VFR runways. Each airport improvement, where possible, has been evaluated from a cost vs. delay benefit savings viewpoint. The result is a series of recommended actions for each surveyed airport with emphasis given to those items which can be constructed or implemented and placed in operation within one to four years. Author (TAB)

N70-33910# *FluiDyne Engineering Corp., Minneapolis, Minn.*
STUDY OF AN UNCOOLED NOZZLE THROAT FOR A LARGE HYPERSONIC WIND TUNNEL Final Report
P. B. Hasselquist, K. W. Smith, and D. G. De Coursin May 1970 137 p refs
(Contract AF 40(600)-1186)
(AD-705577; AEDC-TR-70-92) Avail: CFSTI CSCL 14/2

A study was made of the feasibility of an uncooled throat for a large hypersonic wind tunnel facility using currently available materials. Maximum fullscale stagnation conditions would be 2000psi, 4400R, 1500 lb/sec air flow, and throat diameter 10.5-inches. The basic throat concept was that of a ceramic insulation layer, composed of small pieces, that would form a protective liner within a metal structure. High resistance to thermal spalling was the material characteristic of greatest importance. Tests were made of several zirconia materials and two zirconium diboride compositions by exposing them to hot air flow in a sonic throat at maximum conditions of 800 psi and 3550R. Behavior of the zirconia materials ranged from minor cracking to complete fragmentation. The zirconium-diborides did not crack and were oxidation resistant at these conditions. In addition, the thermal stress distribution was studied for the individual blocks that would

form the throat insulation. For this purpose the three-dimensional stress distribution was calculated for mechanically unrestrained blocks having one-dimensional temperature distributions. Effects of temperature distribution, block size and block shape were determined. The computer program is included with the report. It was concluded that currently available materials are not satisfactory for a throat that would be used with no cooling. Author (TAB)

N70-33952# Pioneer Parachute Co., Inc., Manchester, Conn.
PROTOTYPE CLUSTER-PARACHUTE RECOVERY SYSTEM FOR A 50,000 POUND UNIT LOAD. VOLUME 1: DESIGN STUDY Final Report, May 1968–Jan. 1969
Royce A. Toni, Wolfgang R. Mueller, Milan M. Knorr, and Marcia C. Wood Jan. 1969 214 p refs
(Contract DAAG17-68-C-0142)
(AD-701004; USA-NLABS-TR-69-82-AD) Avail: CFSTI CSCL 1/3

The report covers a research and development program to design and fabricate a prototype cargo-recovery parachute assembly for airdropping heavy unit loads in the order of 50,000 lb. The design study covers the trade-off analysis and cost effectiveness aspects for a complete parachute assembly. From these studies, a design analysis and complete detailed design were made based on the specified performance and design requirements. Use of data reduction on full-scale cargo drops with G-11A parachutes with vent-pull down configuration, scale model wind tunnel tests and parametric studies determined that it is feasible to use a cargo parachute of 135 ft. diam. with a vent-pull down in a cluster of six to recover a load unit of 50,000 lb. Author (TAB)

N70-33962*# National Aeronautics and Space Administration, Washington, D.C.
TWENTY-FIRST SEMIANNUAL REPORT TO CONGRESS, 1 JANUARY–30 JUNE 1969
G. B. De Gennaro, H. H. Milton, and W. E. Boardman, eds. 30 Jun. 1969 258 p
(NASA-TM-X-64292) Avail: SOD $1.25; CFSTI CSCL 05D

Activities of the 6-month period are reported on manned space flight, space science, satellite observations, advanced research and technology, NERVA program, tracking and data acquisition, international affairs, university programs, informational and educational programs, and supporting activities. Highlights of the period are identified as the Apollo 9 and 10 demonstrations of the lunar module ability; studies of the regions surrounding the earth, moon, and sun; orbiting of a biosatellite; operation of sophisticated weather satellites and advanced commercial communications spacecraft; and progress in avoinics with studies of air traffic control, collision avoidance, and use of satellites for aviation navigation and communications. N.E.N.

N70-33974# School of Aerospace Medicine, Brooks AFB, Tex.
COCKPIT NOISE EXPOSURES ASSOCIATED WITH THE OPERATION OF FIXED AND ROTARY WING AIRCRAFT Final Report, Jul. 1966–Jul. 1969
Donald C. Gasaway Apr. 1970 22 p refs
(AD-705964; SAM-TR-70-21) Avail: CFSTI CSCL 20/1

Noise levels measured within the cockpits of 126 fixed- and rotary-wing aircraft were tabulated and arranged into stereotyped sets of exposure envelopes. The noise data from which these envelopes were derived represent typical unprotected exposures encountered within 12 different categories of fixed- and rotary-wing aircraft during conditions of normal cruise. Extreme or unique noise exposures were deleted from the study. Author (TAB)

N70-34001# Firestone Coated Fabrics Co., Akron, Ohio.
AN ENGINEERING INVESTIGATION AND ANALYSIS OF CRASH-FIRE RESISTANT FUEL TANKS Final Report
Merritt M. Yancey and Richard T. Headrick Jul. 1970 18 p refs
(Contract FA-67-NF-245)
(NA-69-43; DS-69-7) Avail: CFSTI

Use of available rubber, plastic and other materials to reduce probability of fire in fuel tanks during and after survivable crashes was studied. Techniques investigated apply to integral tanks and bladder cells as well. General contributions include prevention of original penetration, containment of penetration, maintenance of fuel integrity even with failure of above two systems; change in characteristics of fuel expulsion from major wound to non-vapor, low flow liquid leak; flame and explosion suppression and surge attenuation. Proper selection of "building blocks" to optimize desired performance characteristics indicates a major contribution is available with slight, almost unmeasurable displacement of usable fuel and addition of weight. Structures so protected may be inspected. Author

N70-34002# Mc Donnell-Douglas Co., Long Beach, Calif.
ECONOMIC ANALYSIS OF THE USE OF GELLED FUELS IN JET TRANSPORT AIRCRAFT Final Report
H. D. Whallon, A. T. Peacock, and L. D. Christensen Jul. 1970 64 p refs
(Contract FA-68-NF-273)
(FAA-NA-70-45; FAA-DS-70-13) Avail: CFSTI

A previous study examined the technical aspects of using gelled or emulsified fuel in a DC-8-62 commercial jet transport and identified associated problems. This study examined the economics of jet fleet conversion to the use of 2 percent gelled fuel. Based on the technical findings, a DC-8-62 analysis, it was estimated that conversion and operation for the ten years 1972-81 of all U.S. air carrier jet passenger airplanes would add about four billion dollars to their operating costs for the decade. This is approximately a 4.5 percent increase to total operating costs. Author

N70-34004*# North American Rockwell Corp., Los Angeles, Calif.
XB-70 STRUCTURAL MODE CONTROL SYSTEM DESIGN AND PERFORMANCE ANALYSES
John H. Wykes, Louis U. Nardi, and Alva S. Mori Washington NASA Jul. 1970 163 p refs
(Contract NAS4-1175)
(NASA-CR-1557) Avail: CFSTI CSCL 20K

A system to suppress the structural motion of flexible airframes was designed for installation and flight test on the XB-70 airplane. The system was constrained to controlling only the symmetric structural modes using the existing elevons as force generators. The minimum-change design operates through the existing pitch augmentation servo. Analytical evaluation shows that the system is stable and effective in controlling motion of the first three structural modes without degrading basic handling qualities. Author

N70-34015*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TURBINE AERODYNAMIC AND COOLING REQUIREMENTS FOR A TURBOJET POWERED MACH 3 TRANSPORT USING METHANE FUEL
David G. Evans, Keith A. Furgalus, and Francis S. Stepka Washington Aug. 1970 80 p refs
(NASA-TN-D-5928; E-5602) Avail: CFSTI CSCL 21E

An analysis is presented of two-state air-cooled turbines designed for a series of afterburning and nonafterburning turbojet engines. The study considers the effects of turbine inlet temperature, takeoff jet noise, blade thermal cooling effectiveness, wall cooling, and precooling of the cooling air on turbine aerodynamic design and cooling airflow requirements. Blade and wall cooling requirements increased rapidly with increasing turbine inlet temperature. As a result, essentially no increase in turbine exit temperature or pressure was possible beyond a turbine inlet temperature of approximately 2500 F for the compressor pressure ratios, turbine metal temperatures, and turbine cooling methods considered. Author

N70-34016*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVERSE-METHOD SOLUTION FOR RADIATING, NONADIABATIC, EQUILIBRIUM INVISCID FLOW OVER A BLUNT BODY

Ralph A. Falanga and Edward M. Sullivan Washington Aug. 1970 35 p refs

(NASA-TN-D-5907; L-7209) Avail: CFSTI CSCL 20D

An inverse flow-field program capable of making calculations with an equilibrium air gas model and a realistic radiation model has been developed. The program is capable of calculating the inviscid flow field on a blunt body over a large range of conditions. The primary restrictions are that the assumed shock be analytic in shape and that the postshock temperature be between 10,000 K and 15,000 K. Comparisons are presented which show substantial agreement between the results from the present program, results from a direct-method program, and results from a time-asymptotic-method program for a nonadiabatic flow field. The inverse method can be operated with 8 to 24 rays and 5, 7, 9, or 11 radiative-flux calculations along each ray. A brief study has shown that a nominal set of 14 rays and 9 radiative flux calculations will produce accurate results over the entire range of applicability of the program. Author

N70-34017*# National Aeronautics and Space Administration, Washington, D.C.

GUST EFFECTS ON THE DYNAMICS OF AIRCRAFT DURING LANDING APPROACH

P. Hamel et al May 1970 30 p refs Transl. into ENGLISH of DGLR Ann. Meeting Rept-52 Conf. held at Bremen, 22-24 Sep. 1969

(NASA-TT-F-12751) Avail: CFSTI CSCL 01C

An investigation was made of the dynamic behavior of a slender delta-wing aircraft under the influence of vertical and lateral gusts; particularly during landing approach. The results indicate that: (1) an aerodynamic coupling phenomenon considerably alters the characteristics of angle-of-attack oscillations and of aperiodic rolling motions; (2) gradients of surface boundary layers raise the gust sensitivity of lateral motions; and (3) it is possible to reduce gust sensitivity and the effects of surface boundary layer gradients by means of specified aerodynamic adjustments. Author

N70-34028*# National Aeronautics and Space Administration, Washington, D.C.

HELICOPTER TESTING IN A WIND TUNNEL [BADANIA SMIGLOWCOW W TUNELU AERODYNAMICZNYM]

Zdzislaw Brodzki Jul. 1970 8 p Transl. into ENGLISH from Biol. Inform. Inst. Lotnictwa, v. 5, May-Jun. 1968 p 7-11

Avail: CFSTI CSCL 01C

Problems encountered in wind tunnel testing of helicopters are described. Possible solutions in terms of test procedures and adopted test-bed equipment are proposed. A summary is given of the helicopter wind tunnel test program conducted in Poland for the domestic helicopter industry. Author

N70-34048*# National Aeronautics and Space Administration, Washington, D.C.

IMPLUSE OF FORCES AND MOMENTS EXPERIENCED BY A SLENDER WING IN UNSTEADY FLOW [OB IMPULSE SIL I MOMENTOV SOOBSHCHAEMYKH TONKOMU KRYLU PRI NESTATSIONARNOM OBTEKANII]

A. I. Golubinskii Aug. 1970 6 p Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza (Moscow), no. 6, Nov.-Dec. 1968 p 114-117

(NASA-TT-F-13066) Avail: CFSTI CSCL 20D

An analysis is presented showing that the lifting force and the moments acting on a slender wing of finite span and arbitrary planform moving at a constant mean velocity in gas can be determined from the quasi-stationary theory which assumes that at any moment of time, the flow is steady and that the steady values of the flow parameters are equal to their instantaneous values. This result is obtained on the basis of certain implications which are derived from the flow reversibility theorem. Author

N70-34072# Boeing Co., Renton, Wash. Commercial Airplane Div.

EVALUATION AND TEST ON FLAT CONDUCTOR FEEDERS

J. P. Morris May 1970 59 p

(AD-705969; T6-5605) Avail: CFSTI CSCL 9/1

The test was conducted to determine if flat conductor cable (FCC) could meet the electrical requirements of a 3 phase AC power feeder system. Flat cable feeders were designed, procured and tested for capability of transmitting 90KVA power in an installation simulating routing for the 747 APU feeder system. Thermal and impedance characteristics tests were conducted on existing APU round wire feeders for comparison with the FCC under study. Author (TAB)

N70-34073*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECTS OF ANGLE OF ATTACK AND BLUNTNESS ON THE HYPERSONIC FLOW OVER A 15 DEG SEMIAPEX CONE IN HELIUM

Joseph W. Cleary and Charles E. Duller Washington Aug. 1970 43 p refs

(NASA-TN-D-5903; A-3566) Avail: CFSTI CSCL 20D

Effects of angle of attack and bluntness on the hypersonic flow over a 15 deg semiapex cone were experimentally investigated for the limiting specific-heat ratio 1.67. Results are presented from wind tunnel tests in helium at a free-stream Mach number of 14.9 and Reynolds number based on base radius of 860,000. Included are measurements of surface pressure and heat transfer coefficients, shadowgraphs of shock-wave shape, and limiting streamlines adjacent to the surface. The tests spanned angles of attack from 0 deg to 30 deg and cone-bluntness ratios from 0 to 0.4. Comparisons of measurements with theory indicate generally good agreement. Author

N70-34087# Boeing Co., Renton, Wash. Commercial Airplane Div.

HYBRID MICROCIRCUIT DESIGN AND PROCUREMENT GUIDE

J. W. Thornell, Warren A. Fahley, and W. L. Alexander May 1970

390 p refs
(AD-705974; D6-24576) Avail: CFSTI CSCL 9/5

The document has been prepared to serve as an interim guide to the system/circuit designers for the specification, selection design, procurement and evaluation of hybrid microcircuits for Avionics and Aerospace applications. Author (TAB)

N70-34100*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND-TUNNEL INVESTIGATION OF A V/STOL TRANSPORT MODEL WITH FOUR POD-MOUNTED LIFT FANS
William A. Newsom, Jr. Washington Aug. 1970 103 p refs
(NASA-TN-D-5942; L-7199) Avail: CFSTI CSCL 01C

The investigation included force and moment measurements over a range of angles of attack and sideslip through the transition speed range for several power conditions. The static longitudinal, lateral, and directional stability characteristics were determined for several configurations, and lift-fan thrust performance was measured. The model had an increase in lift with increasing airspeed and showed lateral and directional stability for all test conditions but longitudinal stability for only the higher test speeds. Flow conditions at the tail for the powered-lift condition were similar to those of conventional airplanes in terms of dynamic pressure and downwash factor, but there was a decidedly adverse sidewash effect. The adverse sidewash was compensated to a considerable extent, however, by the fact that the model was about neutrally stable, rather than unstable, with the vertical tail off. Author

N70-34152*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STATIC TESTS OF 4-INCH OUTSIDE-DIAMETER FRANGIBLE TUBE ENERGY ABSORBERS FOR NUCLEAR AIRCRAFT
Klaus Gumto and Richard Puthoff [1970] 22 p refs
(NASA-TM-X-52847; E-5778) Avail: CFSTI CSCL 18J

Ten frangible tubes with outside diameters more than 3-1/2 inches (9 cm) were statically tested on a tensile machine. Five tubes failed to frange, while the results of the remaining five correlated with previous experiments. Problems were traced to load angle sensitivity, slow testing speed, and large tolerances of the as-received tubes. Author

N70-34160* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NOSE GEAR STEERING SYSTEM FOR VEHICLE WITH MAIN SKIDS Patent
Upshur T. Joyner, inventor (to NASA) Issued 28 Sep. 1965 (filed 20 Mar. 1964) 10 p Cl. 244-50
(NASA-Case-XLA-01804; US-Patent-3,208,694;
US-Patent-Appl-SN-353637) Avail: US Patent Office CSCL 01C

A system is described for providing directional stability to a vehicle by applying a limited torque about the axis of a swiveling nose gear which causes the nose wheel to be skewed in the direction of travel of the vehicle, thereby establishing a ground reaction force. A steering wheel or equivalent means is provided for initiating the amount and direction of torque to be applied about the swivel axis of the nose gear. The system provides high-speed aircraft and reentry space vehicles with a flexibility of choice of landing sites. R.B.

N70-34166*# Raytheon Co., Sudbury, Mass.
SPACE GEODESY ALTIMETRY: PULSE COMPRESSION RADAR STUDY
Washington NASA Jul. 1970 164 p refs
(Contract NASw-1709)
(NASA-CR-1605; R69-4346) Avail: CFSTI CSCL 17I

A study was conducted to establish the applicability of pulse compression to satellite altimetry. Parametric trade offs were made and experimental results presented. The study concludes that if 10 cms measurement accuracy is to be achieved a pulse compression system can achieve it with less size, weight and power than can a system that relies solely on a short pulse for its accuracy. Author

N70-34178* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VARIABLE-SPAN AIRCRAFT Patent
John G. Lowry, inventor (to NASA) Issued 30 Apr. 1963 (Filed 25 Jan. 1961) 5 p Cl. 244-46
(NASA-Case-XLA-00166; US-Patent-3,087,692;
US-Patent-Appl-SN-84961) Avail: US Patent Office CSCL 01C

The development of an aircraft having variable aspect ratio, variable sweep wings is described such that variation of the sweep angle does not require a complex or heavy mechanism or cause a significant shift in the relative position of the aircraft center of gravity and the aerodynamic center. The configuration provides for a substantial inboard fixed 'swallowtail' wing portion to which is connected a smaller outboard pivotal 'swallowtail' wing portion. The proposed configuration maximizes aspect ratio for subsonic takeoff, climb, cruise, descent, and landing, while minimizing aspect ratio during supersonic cruise. R.B.

N70-34182*# Translation Consultants, Ltd., Arlington, Va.
THE PROBLEM OF OSCILLATIONS OF A THIN PROFILE IN A SUBSONIC FLOW NEAR A RIGID BOUNDARY [K ZADACHE O KOLEBANIYAKH TONKOGO PROFILYA V DOZVUKOVOM POTOKE VBLIZI TVERDOY GRANITSY]
I. I. Yefremov Washington NASA May 1970 6 p refs Transl. into ENGLISH from Prikl. Mekh. (Kiev), v. 5, no. 7, 1969 p 119-121
(Contract NASw-2038)
(NASA-TT-F-12966) Avail: CFSTI CSCL 20D

Subsonic flow calculations over a thin profile with chord length 2c moving with small harmonic oscillations with frequency omega near a rigid boundary are revised. Author

N70-34218*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
THE COMBINED EFFECT OF GRAVITY GRADIENT AND AERODYNAMIC TORQUES ON THE ATTITUDE CONTROL OF THE APOLLO/S-4B IN A CIRCULAR ORBIT ABOUT THE EARTH
Kenneth L. Lindsay 14 Feb. 1964 61 p refs *Its* Program Apollo Working Paper No. 1107
(NASA-TM-X-64300) Avail: CFSTI CSCL 17G

An analysis of the combined effect of aerodynamic and gravity gradient torques on the attitude control of the Apollo/S-4B configuration during the earth parking orbit phase of a lunar landing mission is described. Aerodynamic torques are determined by means of free molecule impact theory, commonly referred to as specular reflection. The equations utilized in the analysis were programed on the IBM 7094 computer using an assumed orbit altitude of 100 nautical miles. The effects of the disturbance torques on the limit cycle characteristics of the vehicle were determined using the S-4B attitude control system to maintain the vehicle at various pitch, yaw, and roll attitudes relative to the local horizontal

within specified deadbands. Pure pitch attitudes of 0, 45, and 90 degrees relative to the local horizontal were simulated using specified deadbands varying from + or − 0.5 degrees to + or − 5 degrees. At all commanded attitudes, the vehicle damped to a steady state limit cycle on one side of the pitch deadband instead of traversing the entire deadband as desired. The frequencies of these limit cycles were considerably higher than those which would exist in the absence of disturbing torques, resulting in increased control system fuel consumption. Author

N70-34253*# Stanford Research Inst., Menlo Park, Calif.
INFORMATION REQUIREMENTS FOR SUPERSONIC TRANSPORT OPERATION Final Report
Lewis Meier, Charles H. Wells, Sidney Serebreny, David M. Salmon, and John Peschon Washington NASA Jul. 1970 260 p refs
(Contract NAS2-5069)
(NASA-CR-1570) Avail: CFSTI CSCL 01C

An investigation is described of the effect of atmospheric changes and errors in the measurements used to determine these changes on the vertical flight performance of an SST. Included in the report are descriptions of the models (engine, instruments, aerodynamics, atmosphere) and the optimal control theory (deterministic and stochastic) needed to determine optimal SST trajectories and their sensitivity to atmospheric variations and measurement errors. Descriptions are also given of computer programs for SST trajectory optimization and sensitivity analysis. Author

N70-34255# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
SRDS PROGRAM: GOALS, ACHIEVEMENTS, TRENDS, 1 APRIL 1969–31 MARCH 1970
31 Mar. 1970 155 p
(AD-704475) Avail: CFSTI CSCL 17/7

Contents: Air traffic control activity; Navigation; and Aviation weather. TAB

N70-34263# Naval Air Engineering Center, Philadelphia, Pa.
AIRFIELD ARRESTING GEAR EXPLORATORY DEVELOPMENT Final Report
L. Logan, L. Maier, and S. Puglisi 1969 83 p refs
(AD-701331; NAEC-ENG-7563) Avail: CFSTI CSCL 1/5

The report presents the results of investigations concerning the feasibility of various arresting gear system concepts for potential runway use at a maximum capacity of one hundred million foot pounds. In addition to existing and proposed complete systems, consideration is given to the integration of components from various systems to produce a new arrangement having desirable characteristics. A discussion of other factors related to airfield arresting systems is included. Author (TAB)

N70-34290# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
LEADING EDGE SEPARATION ON AN AIRFOIL DURING DYNAMIC STALL
Stephen A. Patay Oct. 1969 56 p refs
(Contract N00019-68-C-0081)
(AD-701771; ASRL-TR-156-1) Avail: CFSTI CSCL 1/3

To obtain a better understanding of the leading edge separation mechanism on a wing pitching upward with a constant angular velocity, an unsteady boundary layer calculation is performed. The analysis considers a potential flow about a Joukowsky airfoil, which then forms a basis for the boundary layer calculations. An integral technique which is similar to the Karman-Pohlhausen method is used to determine the viscous flow. The movement of the separation point is calculated for several pitching rates. A comparison with some experimental data was made for both the static and dynamic case. It was determined that the point of boundary layer separation coincides with the formation of a separation bubble for the dynamic cases considered. Author (TAB)

N70-34312*# Techtran Corp., Glen Burnie, Md.
INDIRECT METHOD OF DETERMINING AIR FLOW THROUGH INSIDE CHANNEL AND GAS TEMPERATURE IN FRONT OF DOUBLE FLOW TURBINE [KOSVENNYY METOD OPREDELENIYA RASKHODA VOZDUKHA CHEREZ VNUTRENNIY KONTUR I TEMPERATURY GAZA PERED TURBONOY DVUKHKONTURNOGO DVIGATELYA]
N. V. Pervyshin et al Washington NASA 9 p Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn. (Kazan), no. 1, 1969 p 93–98
(Contract NASw-2037)
(NASA-TT-F-12982) Avail: CFSTI CSCL 20D

An indirect method is presented for determining the air flow through the inner channel of a double flow turbojet engine and for measuring the gas temperature in front of the turbine on the basis of measurements of temperature and pressure behind the high-pressure compressor and fuel flow through the engine; this method possesses universality. The method can also be used for determining the air flow and temperature for turbojet (single flow) engines in which the first stage of the turbine operates at the critical pressure drop. Author

N70-34350*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
JET-PLUME-INDUCED FLOW SEPARATION ON AXISYMMETRIC BODIES AT MACH NUMBERS OF 3.00, 4.50, AND 6.00
Robert J. Mc Ghee Washington Aug. 1970 39 p refs
(NASA-TM-X-2059; L-7000) Avail: CFSTI CSCL 20D

Some effects of jet-plume-induced flow separation were investigated at free-stream Mach numbers of 3.00, 4.50, and 6.00 on several axisymmetric bodies with various forebody and afterbody geometries. The investigation showed that increasing the jet-pressure ratio resulted in boundary layer separation over large regions of the test models at free-stream Mach numbers of 4.50 and 6.00. Only small amounts of flow separation occurred at a free-stream Mach number of 3.00 for which the test-pressure ratios were considerably smaller than those for the higher Mach numbers. The separation angle measured at an angle of attack of 0 deg showed a primary dependency on jet-pressure ratio and was a weak function of model geometry. The separation length measured along the model surfaces was a function of both jet-pressure ratio and model geometry. Increasing the angle of attack resulted in decreases in both separation angle and separation length on the windward surface of the models. This result may be partially due to local Reynolds number changes, which cause changes in the type of separation. The local-surface-pressure coefficients in the separated-flow region compared reasonably well with the theoretical inviscid values for a cone at high jet-pressure ratios. Author

N70-34385*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

FULL-SCALE WIND-TUNNEL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF THE X-24A LIFTING BODY AIRCRAFT

Kenneth W. Mort and Michael D. Falarski (Army Aeron. Res. Lab., Moffett Field, Calif.) Washington Aug. 1970 58 p refs
(NASA-TN-D-5932; A-2823) Avail: CFSTI CSCL 01C

The aerodynamic characteristics of the X-24A aircraft were investigated in a 40- by 80-foot wind tunnel. The aircraft was tested over an angle-of-attack range of −4 deg to +32 deg, an angle-of-sideslip range of −6 deg to +6 deg, for several longitudinal, lateral, and directional control settings, and for Reynolds numbers ranging from 20.7×1000000 to 41.6×1000000. Results were obtained with the landing gear both up and down. With the landing gear up the maximum lift-to-drag ratio achieved was 5.2 untrimmed and 4.4 trimmed. With the landing gear down the maximum trimmed L/D was lower by an amount which varied from 0.8 to 1.8, depending on the upper flap deflection. In flight, lowering the landing gear would require a longitudinal control change of 7 deg to 10 deg, depending on the angle of attack, to maintain a constant lift coefficient or forward velocity. A limited comparison with 1/5 scale-model longitudinal results showed very good agreement. Author

N70-34399*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF A 1/2-SCALE MODEL OF AN EJECTION SEAT WITH A RIGID-WING RECOVERY SYSTEM

Sanger M. Burk, Jr. Washington Aug. 1970 39 p refs
(NASA-TN-D-5922; L-7185) Avail: CFSTI CSCL 01C

A wind-tunnel investigation has been conducted in the Langley full-scale tunnel to determine the static longitudinal and lateral characteristics of a model of an ejection seat equipped with a rigid-wing recovery system. Several wing and vertical-tail arrangements were tested as well as various configurations of the ejection seat alone, ranging from unfaired to completely faired seats. Author

N70-34499# Human Engineering Labs., Aberdeen Proving Ground, Md.

TACTICAL UTILITY HELICOPTER INFORMATION TRANSFER STUDY

John A. Barnes Mar. 1970 103 p refs
(AD-705594; HEL-TM-7-70) Avail: CFSTI CSCL 1/3

The task requirements of the Tactical Utility Helicopter Mission were enumerated and experienced pilots have indicated the instrumentation they feel is necessary to perform these tasks. Film of eye movement was taken for two of the pilots while they were flying missions that encorporated these tasks. The film and the pilot replies were analyzed to provide the information transfer requirements for the Tactical Utility Helicopter flight instrumentation. Author (TAB)

N70-34525# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

BRIEFS OF ACCIDENTS INVOLVING CORPORATE/EXECUTIVE AIRCRAFT, US GENERAL AVIATION, 1967

[1970] 51 p
(PB-190409) Avail: CFSTI CSCL 01B

This report contains the briefs of accidents involving corporate/executive aircraft occurring in 1967. There were 119 accidents involving this kind of flying out of a total of 6,115 general aviation accidents in 1967. Collisions between aircraft are treated as one accident. A complete analysis and coding is done on each aircraft involved in collisions. This produces two aircraft accident records, one for each aircraft involved in the collision. Consequently, when compiling information on accidents involving collisions between aircraft, the number of accident records will exceed the number of accidents. The injury and cause/related tables show the number of accidents. All analytic tables show both records and accidents. Author (USGRDR)

N70-34532*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF NEWTONIAN STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF BODIES OF REVOLUTION WITH VARIOUS HEAT-SHIELD CURVATURES, AFTERBODY ANGLES, AND CORNER-EDGE RADII

Edward A. Mayo and Thomas L. Blakemore 28 Jun. 1961 37 p */ts* Program Apollo Working Paper No. 1021
(NASA-TM-X-64332) Avail: CFSTI CSCL 20D

Newtonian aerodynamic coefficients are presented for preliminary prediction of the static stability characteristics of bluff reentry bodies with various heat-shield curvatures, afterbody angles, and corner-edge radii. An example of the usefulness of these design curves is presented in the appendix where the aerodynamics characteristics are computed for several configurations of equal volume. Author

N70-34533*# Bell Aerospace Co., Buffalo, N.Y.

THE EFFECT OF EXHAUST CONDITIONS, SURFACE WINDS, AND GEOMETRIC SCALE ON HOT GAS INGESTION FOR TWO JET VTOL CONFIGURATIONS

Patrick E. Ryan and Wayne J. Cosgrove 1969 114 p refs
(Contract NAS1-9584)
(NASA-CR-66965) Avail: CFSTI CSCL 01C

The main objective of this program was to determine whether there was an effect of geometric model scale on the inlet temperature rise caused by recirculating hot exhaust gases from VTOL lift jet engines in static proximity to ground. The approach used was to conduct small-scale tests in which ITR was measured over a range of exhaust pressure ratio, exhaust gas temperature and surface wind velocity for two configurations of a jet VTOL fighter-type model containing four lift jets and comparing the results with large-scale data of similar configurations. The small-scale tests provided a range of simulated inlet and exhaust conditions which included those typical of full-scale turbojet engines. Author

N70-34571# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

BRIEFS OF ACCIDENTS INVOLVING MISSING AIRCRAFT; US GENERAL AVIATION, 1967

[1970] 61 p
(PB-190412) Avail: CFSTI CSCL 01B

This report contains the briefs of accidents involving missing aircraft occurring in 1967. There were 22 accidents involving this type of accident out of a total of 6,115 general aviation accidents in 1967. Collisions between aircraft are treated as one accident. A complete analysis and coding is done on each aircraft involved in collisions. This produces two aircraft accident records, one for each aircraft involved in the collision. Consequently, when compiling information on accidents involving collisions between aircraft, the number of accidents records will exceed the number of accidents.

The injury and cause/related tables show the number of accidents. All analytic tables show both records and accidents.
Author (USGRDR)

N70-34576# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS INVOLVING ALCOHOL AS A CAUSE/FACTOR, US GENERAL AVIATION, 1967
[1970] 15 p
(PB-190413) Avail: CFSTI CSCL 01B

This report contains the briefs of accidents involving alcohol as a cause/factor occurring in 1967. There were 49 accidents involving this cause factor out of a total of 6,115 general aviation accidents in 1967. Collisions between aircraft are treated as one accident. A complete analysis and coding is done on each aircraft involved in collisions. This produces two aircraft accident records, one for each aircraft involved in the collision. Consequently, when compiling information on accidents involving collisions between aircraft, the number of accidents records will exceed the number of accidents. The injury and cause/related tables show the number of accidents. All analytic tables show both records and accidents.
Author (USGRDR)

N70-34622# TRW Systems Group, Washington, D.C.
TRANSOP MODEL METHODOLOGY Final Report
J. R. Vadeboncoeur, T. W. Smith, and D. S. Adamson Dec. 1969 129 p
(Contract DOT-C-353-66)
(PB-190936; TRW-06818-W009-R0-00; NECTP-216) Avail: CFSTI CSCL 13B

The TRANSOP computer program was developed in order to assist in the determination of transportation equilibrium supply and demand levels for the Northeast Corridor Transporation Project. The program is built upon a proprietary optimization and simultaneous equation-solving algorithm (SLANG) developed by TW Systems Group. Applications of the TRANSOP program have included investigation of the competitive position of ground modes such as high speed rail, tracked air cushion vehicles, and tube vehicle systems. The program has also been utilized to examine similar systems in other U.S. corridors. Author (USGRDR)

N70-34630# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS INVOLVING AMATEUR/HOME BUILT AIRCRAFT, US GENERAL AVIATION, 1967
[1970] 331 p
(PB-190410) Avail: CFSTI CSCL 01B

Briefs of Accidents involving Amateur/Home Built aircraft occurring in 1967 are reported. There were 63 accidents involving this model aircraft out of a total of 6,115 General Aviation accidents in 1967. Collisions between aircraft are treated as one accident. A complete analysis and coding is done on each aircraft involved in collisions. This produces two aircraft accident records, one for each aircraft involved in the collision. Consequently, when compiling information on accidents involving collisions between aircraft, the number of accident records will exceed the number of accidents. The injury and cause/related tables show the number of accidents. All analytic tables show both records and accidents.
Author (USGRDR)

N70-34643# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
REVIEW OF CORPORATE/EXECUTIVE AIRCRAFT ACCIDENTS: A STATISTICAL SUMMARY OF A SPECIAL/SEGMENT OF US GENERAL AVIATION, 1964 1968
12 Mar. 1970 140 p
(PB-190408) Avail: CFSTI CSCL 01B

Information in the review was developed from a special file of 439 corporate/executive aircraft accidents that occurred during the period 1964 - 1968. Criteria used in the selection of these accidents were: Each aircraft was corporate owned or operated; each accident involved a corporate/executive operation; i.e., flown in a corporate operation by a professional pilot; the pilot-in-command was a holder of a commercial or airline transport pilot certificate; and the aircraft was of U.S. registry. The review contains analytic tables in matrix form comparing selected accident information, and cause/related factor tables and injury tables covering various segments of the entire file. Author (USGRDR)

N70-34644# TRW Systems Group, Washington, D.C.
HSGT MODE SERVICE ANALYSIS IN THE NORTHEAST CORRIDOR Final Report
J. R. Vadeboncoeur and T. W. Smith Dec. 1969 145 p
(Contract DOT-C-353-66)
(PB-190934; TRW-06818-W007-R0-00; NECTP-214) Avail: CFSTI CSCL 13B

The report describes the analysis of High Speed Ground Transporation service in the U. S. Northeast Corridor. In the analysis, three HSGT systems were established; a 150-mph High Speed Rail system (HSRC), and a Traced Air Cushion Vehicle system (TACV). Each of these was analyzed in competition with auto, bus, conventional air (C-TOL), short takeoff and landing (STOL), and vertical takeoff and landing (VTOL) modes. Author (USGRDR)

N70-34648# Office of High Speed Ground Transportation, Washington, D.C. Northeast Corridor Transportation Project.
NORTHEAST CORRIDOR TRANSPORTATION PROJECT REPORT
Robert A. Nelson, Paul W. Shuldiner, Myron Miller, Robert L. Winestone, Philip J. Barbato et al Apr. 1970 242 p refs
(PB-190929; NECTP-209) Avail: CFSTI CSCL 13B

The Northeast Corridor Transportation Project was charged to determine the intercity transportation facility requirements of the Northeast Corridor through 1980. A comparative analysis of the transportation alternatives as to their technical feasibility, economic costs and benefits and other impacts in the year 1975; A discussion of the actions required to implement the transportation alternatives; An examination of possible financing and management of new modes included in the alternatives; Include advantages and disadvantages of various organizational alternatives, population growth patterns and the Corridor transportation system, methodology, description of the alternative systems, and exploratory studies and sensitivity tests. Author (USGRDR)

N70-34684# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS ON ACCIDENTS INVOLVING MIDAIR COLLISIONS, U.S. GENERAL AVIATION, 1967
[1970] 28 p
(PB-190411) Avail: CFSTI CSCL 01B

This report contains the Briefs of Accidents involving midair collisions occurring in 1967. There were 26 accidents involving this type of accident out of a total of 6,115 general aviation accidents in 1967. There are no accident rates compiled for this type of accident due to unavailability of exposure data. Collisions between aircraft are treated as one accident. A complete analysis and coding is done on each aircraft involved in collisions. This produces two aircraft accident records, one for each aircraft involved in the collision. Consequently, when compiling information accidents involving collisions between aircraft, the number of accidents records

will exceed the number of accidents. The injury and cause/related tables show the number of accidents. All analytic tables show both records and accidents. Author (USGRDR)

N70-34691# Peat, Marwick, Livingston and Co., Washington, D.C.
NORTHEAST CORRIDOR TRANSPORTATION FACTS AND STATISTICS Final Report
M. J. Rothenberg Dec. 1969 155 p refs
(Contract DOT-FR-9-0017)
(PB-190932; NECTP-212) Avail: CFSTI CSCL 13B

The material presented in the document is meant to provide basic information on the intercity transportation system and other select regional characteristics of the Northeast Corridor. Primary attention is given to the status of the existing transportation system and the magnitude and characteristics of system usage. Author (USGRDR)

N70-34693*# Techtran Corp., Glen Burnie, Md.
METHOD OF ESTIMATING AERODYNAMIC PROPERTIES OF AN AIRFOIL WITH A HINGED FLAP AND SPOILER [O NACHINU ODREDJIVANJA AERODINAMICHKIKH SVOJSTAVA AEROPROFILA S OBORENIM ZAKRILTSEM I SPOJLEROM]
S. Pivko Washington NASA Aug. 1970 14 p refs Transl. into ENGLISH from Srpska Akad. Nauka i Umetnosti, Glas, Odelenje Tekhnichkikh Nauka, v. 7, no. 266, 1966 p 53–63
(Contract NASw-2037)
(NASA-TT-F-13131) Avail: CFSTI CSCL 20D

A method of estimating the aerodynamic properties of a thin airplane wing with a hinged flap and a spoiler is presented. The method is based on previous studies given in the bibliography. Approximate formulas deal with the effects of the hinged flap and spoiler on the air flow around the wing. Author

N70-34741# Peat, Marwick, Livingston and Co., Washington, D.C.
STATUS OF THE TRANSPORTATION SYSTEM AND PLANS FOR IMPROVING INTECITY TRANSPORTATION IN THE NORTHEAST CORRIDOR Final Report
Dec. 1969 189 p refs
(Contract DOT-F-9-0017)
(PB-190931; NECTP-211) Avail: CFSTI CSCL 13B

The report provides background information on the Northeast corridor, its geographic and demographic characteristics in general, and the characteristics of its travelers, in particular. Also it describes the existing corridor highway system, the rail passenger system, and the scheduled air transportation system. Author (USGRDR)

N70-34769 National Lending Library for Science and Technology, Boston Spa (England).
THE SHAPE OF INTERBLADE CHANNELS IN THE IMPELLERS OF STATIONARY COMPRESSORS [O FORME MEZHLOPATONALOV KOLES STATSIONARNYKH KOMPRESSOROV]
K. P. Seleznev et al Jun. 1970 19 p refs Transl. into ENGLISH from Energomashinostroenie (Moscow), no. 5, 1969 p 23–27
(NLL-RTS-5564) Avail: Natl. Lending Library, Boston Spa, Engl.: 36s or 6 NLL photocopy coupons

Experimental studies and computer calculations of quasi-three-dimensional flow are reported for the design of interblade channels in the runners of stationary centrifugal compressors which differ either in the shape of blade camber line or in the configuration of the shroud. Results are analyzed for differences in radial distribution of pressure variations between pressure and suction surfaces of the blades (or load). A simple approximation method for designing interblade channels from a given load distribution law is proposed. G.G.

N70-34788* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INLET DEFLECTOR FOR JET ENGINES Patent
Walter T. Olson, inventor (to NASA) Issued 27 Jul. 1965 (filed 31 Oct. 1962) 4 p Cl. 55-306
(NASA-Case-XLE-00388; US-Patent-3,196,598;
US-Patent-Appl-SN-234568) Avail: US Patent Office CSCL 21E

A deflector for obstructing the entry of birds and other foreign objects into aircraft jet engines during ground and flight operations is described. The deflector is composed of rods projecting forward in a conical shape, at an angle to the nacelle as axis, and with the base ahead of the inlet. The projected area is greater than the opening in the inlet and deflects objects out of the air stream as they approach the inlet. Air can pass between the deflector base and nacelle inlet even if a substantial portion of the deflector surface is momentarily covered with debris. N.E.N.

N70-34805# Army Electronics Command, Fort Monmouth, N.J.
A GUIDE FOR SELECTION OF SIMULATION PROJECTS
Henry R. Chambers Mar. 1970 12 p refs
(AD-703843; ECOM-3237) Avail: CFSTI CSCL 1/3

The report provides a guide for the preparation and selection of projects that are proposed for a large hybrid computing facility oriented toward simulation of real-time man-in-the-loop avionics systems. It considers an evaluation of a typical project that has been simulated by the facility and provides a questionnaire to be answered by potential users of the facility. Author (TAB)

N70-34816* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIFFERENTIAL PRESSURE CELL Patent
John Dimeff and Murray S. Gardner, inventors (to NASA) Issued 27 Feb. 1962 (Filed 12 May 1958) 4 p Cl. 73-398
(NASA-Case-XAC-00042; US-Patent-3,022,672;
US-Patent-Appl-SN-734805) Avail: US Patent Office CSCL 14B

A high-precision fluid pressure measuring device which is relatively insensitive to changes in ambient temperature, and which is so constructed that its accuracy remains substantially unaffected by momentary conditions of extreme overload is described. Since the device yields a voltage directly proportional to the applied pressure, the output therefrom can be monitored by conventional voltage indicating and recording apparatus, or can be coupled directly to the input of an analog-to-digital converter. The device has wide application capability in aircraft development and/or testing, wind tunnel research, and oil and gas refinery operations. It is sturdy, possesses unusually fast response, and is inexpensive to manufacture. E.M.C.

N70-34849# Army Electronics Command, Fort Monmouth, N.J. Avionics Lab
ANALYSIS OF DATA ACQUIRED DURING SIMULATION OF A V STOL TACTICAL LANDING SYSTEM FOR HELICOPTERS
Wayne Bryan and Louise V. Canevari Jan. 1970 136 p
(AD-704324; ECOM-3217) Avail: CFSTI CSCL 17/7

The report describes a set of FORTRAN IV programs developed for use on an EAI-8400 digital computer. General-purpose programs

discussed include a three-way classification Analysis of Variance (ANOVA), Duncans multiple range test, Chi-square test, and trend analysis. The remaining programs are special-purpose ones to meet the specific needs of this experiment. The output of these programs provides a means of statistically analyzing data acquired during simulation of an idealized IFR tactical landing system. The results, in terms of the relationships of various system parameters, form the basic guidelines for actual flight testing of a landing system known as A-SCAN. Author (TAB)

N70-34850* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FRANGIBLE TUBE ENERGY DISSIPATION Patent

John R. McGehee, Melvin E. Hathaway, and Edmond J. Zavada, inventors (to NASA) Issued 4 Aug. 1964 (Filed 12 Jul. 1962) 9 p Cl. 244-100

(NASA-Case-XLA-00754; US-Patent-3,143,321; US-Patent-Appl-SN-209479) Avail: US Patent Office CSCL 13I

Described is a shock absorber system wherein frangible tube members are adapted to be fragmented by a moving body to dissipate the load energy forces generated thereby for arresting movement of the moving body. The described energy dissipation system can be used in land recovery systems for payloads, for braking moving vehicles, in landing gear assemblies of aerial vehicles, or as a one-shot shock absorber system for moving bodies. G.G.

N70-34856* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PROPELLER BLADE LOADING CONTROL Patent

Vernon L. Rogallo, inventor (to NASA) Issued 18 Aug. 1964 (Filed 24 Jan. 1962) 6 p Cl. 244-51

(NASA-Case-XAC-00139; US-Patent-3,144,999; US-Patent-Appl-SN-168560) Avail: US Patent Office CSCL 01C

Propeller blade loading control is achieved by directing a fluid stream laterally against the flow down through the propeller. Thus, the fluid flow through the propeller is forced toward the tip of the propeller where it is worked upon by the efficient portion of the propeller so that drag is not increased, but rather decreased. The lateral fluid stream can be directed through a nozzle arrangement. G.G.

N70-34858* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LANDING ARRANGEMENT FOR AERIAL VEHICLE Patent

John M. Riebe and Vernard E. Lockwood, inventors (to NASA) Issued 23 Feb. 1965 (Filed 22 Mar. 1962) 4 p Cl. 244-46 Continuation-in-part of US Patent Appl. SN-26375, Filed 2 May 1960

(NASA-Case-XLA-00806; US-Patent-3,170,657; US-Patent-Appl-SN-181828; US-Patent-Appl-SN-26375) Avail: US Patent Office CSCL 01C

An aerodynamic configuration for an aircraft is described having a planform variable in flight between a low aspect ratio attitude for high speed flight, and a high aspect ratio attitude with high aerodynamic lift and low drag for low speed takeoff or landing of such aircraft. It is further directed to the provision of means for increasing the aerodynamic lift of the aircraft when positioned in such high aspect ratio attitude. The design difficulties of aerial vehicles capable of very high speed flight within the earth's atmosphere and also having low speed flight capabilities for takeoff from and landing upon presently existing airfields is resolved. E.M.C.

N70-34862# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DESIGN HANDBOOKS FOR THE SOVIET MINISTRY OF AVIATION INDUSTRY

A. S. Yakovlev 4 Feb. 1970 8 p Transl. into ENGLISH from the publ. '50 Let Sovetskogo Samoletostroyeniya' Moscow, Nauka, 1968 p 49-52

(AD-704280; FTD-HT-23-539-69) Avail: CFSTI CSCL 1/3

The article describes the three volume Manual for Designers in eleven parts: Aerodynamics, Hydromechanics, Endurance, Flight tests of an aircraft and its equipment, Engine equipment, Aircraft equipment, Aircraft armament, Landing gear, and Mechanisms, Standard systems, Materials, Semifinished products. Author (TAB)

N70-34876*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC CHARACTERISTICS OF A HYPERSONIC TRANSPORT CONFIGURATION AT MACH 6.86

William J. Small, Frank S. Kirkham, and David E. Fetterman Washington Jun. 1970 25 p refs

(NASA-TN-D-5885; L-6803) Avail: CFSTI CSCL 20D

An investigation of a model representative of a hypersonic transport was conducted at a Mach number of 6.86 over a range of Reynolds numbers, based on body length, of one million to six million. The configuration was a low-wing, distinct wing-body arrangement with a body-mounted vertical tail and an underwing propulsion system. The complete vehicle and the contribution of its components are analyzed in order to evaluate the performance of this class of vehicle. Present methods of predicting aerodynamic performance were also evaluated. Author

N70-34878# Naval Research Lab., Washington, D.C.

ON THE REDUCTION OF INTERFERENCE BETWEEN TWO SEQUENCES OF EVENTS

Walton B. Bishop Jan. 1970 15 p refs

(AD-702734; NRL-MR-2087) Avail: CFSTI CSCL 17/9

The outline of a proof for a rather obvious theorem and two corollaries concerning two sequences of periodic events is provided. It is then shown that this theorem and its corollaries can be used to select the periods between periodic events in two sequences so that when interference between events does occur, such interference cannot be repeated in fewer than a specified number of repetition periods. The advantages to be gained by this method of selecting event repetition periods in sets of periodic sequences are discussed briefly. Author (TAB)

N70-34885# Joint Publications Research Service, Washington, D.C.

METEOROLOGY

In its Soviet Bloc Res. in Geophys. Astronomy, and Space, No. 231 26 Jun. 1970 p 12-15 refs

Avail: CFSTI

A survey of clouds and backgrounds made from aircraft laboratories in spectral ranges 2.7 to 5.8 and 4.3 to 0.15 microns is reviewed. An aircraft electronic phase marker with a direct flow tube mounted in front of the fuselage was found more reliable than the trapping method for crystalline measurements in clouds. A news release on meteorological satellites is also presented, along with abstracts from other meteorological literature. J.A.M.

N70-34923# Naval Postgraduate School, Monterey, Calif.

THE EXTENSION OF AN ADAPTIVE AIRCRAFT CONTROL CONCEPT TO HELICOPTERS

John Mc Coy Hood, Jr. (M.S. Thesis) Oct. 1969 59 p refs

(AD-703231) Avail: CFSTI CSCL 1/3

A basic adaptive control scheme for fixed-wing aircraft was modified for use in controlling the longitudinal motion of helciopters. The modification required the addition of two additional feedback variables. Control was applied only to the cyclic pitch input and not to the collective input. It was assumed that a coefficient, the cyclic-pitch control effectiveness, would not change sign throughout the flight envelope. Analog computer simulation showed that the modified system was capable of stabilizing the model used. The handling qualities of the system were not completely satisfactory and further work is necessary. Author (TAB)

N70-34925 Federal Aviation Administration, Washington, D.C. Aviation Forecast Div.

AVIATION FORECASTS, FISCAL YEARS 1970 - 1981

Jan. 1970 51 p

(AD-704842) Avail: CFSTI CSCL 1/2

Contents: Highlights of fiscal year 1969; Aviation industry forecasts (Air carrier traffic, Air carrier fleet, General aviation flying and aircraft fleet, Domestic aviation fuel consumption, Civil aircraft and engine production); FAA air traffic activity forecasts (Aircraft operations at airports with FAA traffic control service, FAA en route traffic control activity, FAA flight services); Airmen forecasts (Number of active pilots). TAB

N70-34928# National Physical Lab., Teddington (England). Aerodynamics Div.

SCALE EFFECTS ON OSCILLATORY CONTROL-SURFACE DERIVATIVES

A. W. Moore Jul. 1969 44 p refs

(NPL-AERO-1283; ARC-31368) Copyright. Avail: CFSTI

The limited evidence available concerning scale effects on control-surface derivatives suggests a general tendency for in-phase hinge-moment derivatives to increase when Reynolds number increases but to decrease sharply when boundary-layer transition is artificially fixed. Damping (in-quadrature) derivatives in two-dimensional tests seem to follow a similar pattern, but with three-dimensional models, neither an increase in Reynolds number nor fixing boundary-layer transition appears to have any significant effect. It is tentatively concluded that provided boundary-layer separation is not a feature of the flow, wind-tunnel tests should be done without fixing boundary-layer transition. However, it is emphasized that this conclusion is based on results from a limited number of papers and further measurements should be made, in which Reynolds number is systematically varied over a wide range with and without a means for fixing boundary-layer transition. Author (ESRO)

N70-34929# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

PERFORMANCE PREDICTION OF TRANSONIC BLADINGS WITH HIGH DEFLECTION AND LOW ASPECT RATIO [PREDICTION DES PERFORMANCES DES GRILLES D'AUBES TRANSSONIQUES A HAUTE DEFLEXION ET FAIBLE ALLONGEMENT]

Hartmut Griepentrog Dec. 1969 243 p refs In FRENCH; ENGLISH summary

(VKI-TN-59) Avail: CFSTI

This report concerns methods for predicting the performance of high turning transonic bladings to be used in advanced axial compressors. The method describes the real flow effects by investigation of the two-dimensional and the secondary flows. The superposition of these two flow effects gives the three-dimensional flow picture. For the description of the two-dimensional transonic flow field a method is presented which can be adapted to blading with a high camber angle and high solidity. The secondary flow effects are predicted with a semiempirical method and can be applied to small hubtip ratio blades used in modern small gas turbines. The prediction methods were applied to a cascade of high cambered blades with blunted trailing edges. The tests were performed in a high-speed blow-down tunnel and experimental and theoretical values are compared. Author (ESRO)

N70-34941# National Physical Lab., Teddington (England). Aerodynamics Div.

SOME WIND-PRESSURE MEASUREMENTS ON A MODEL OF A GROUP OF CLOSELY-SPACED CYLINDRICAL SILOS

P. J. Ponsford Jan. 1970 24 p refs

(NPL-AERO-NOTE-1088) Copyright. Avail: CFSTI

External surface wind pressures have been measured on a line of five silos, in an attempt to provide elementary data from which designers can assess the significance of the stresses. These initial tests have indicated the need for further tests at high Reynolds number. Author (ESRO)

N70-34957# Stanford Univ., Calif. Stanford Electronics Labs.

THEORY OF FUNCTIONAL NETWORKS AND MICROSYSTEMS FOR AVIONICS SYSTEM Final Report, Nov. 1969 - Mar. 1970

R. W. Newcomb Mar. 1970 7 p refs

(Contract F44620-67-C-0001)

(AD-705677; AFOSR-70-1187TR) Avail: CFSTI CSCL 9/5

Research endeavors on the micromotor are discussed during the stated period as well as the completion of a time-variable calculus, a scattering matrix routine for HF interconnections, and a method of nonlinear analysis via the computer. Author (TAB)

N70-34978# Rutgers Univ., New Brunswick, N.J. Dept. of Mechanical and Aerospace Engineering.

THE TURBULENT NEAR-WAKE OF AN AXISYMMETRIC BODY AT SUBSONIC SPEEDS

Donald P. Mc Erlean and Christian E. G. Przirembel Feb. 1970 127 p refs

(Contract F44620-68-C-0018)

(AD-705687; RU-TR-132-MAE-F; AFOSR-70-0449TR) Avail: CFSTI CSCL 20/4

The subsonic near wake of a blunt based, right circular cylinder immersed in a uniform subsonic flow was studied. A special open circuit steady flow wind tunnel with a closed jet test section was utilized for the experimental program. A model support system contained entirely within the tunnel settling chamber eliminated the usual downstream support stings. The boundary layer prior to the base was turbulent and the test section Reynolds number was 100,000/ft. Detailed pressure measurements were made in all regions of the wake as well as in the approaching flow and on the body surfaces. The rear stagnation point was located using the intersection of the centerline static and total pressure distributions. Complete shear layer and recirculation region velocity profiles were obtained. The flow was found to be quite insensitive to changes in free stream velocity with respect to the base pressure coefficient and the location of the rear stagnation point. The influence of the separation corner was found to extend approximately two base diameters upstream on the body. The dividing streamline, found by graphical integration of the shear layer and recirculation region velocity profiles, was nearly elliptical in shape. Author (TAB)

N70-35049# Purdue Univ., Lafayette, Ind. Krannert Graduate School of Industrial Administration.

A LINEAR PROGRAMMING APPROACH TO AIRPORT CONGESTION

Donald W. Kiefer 25 Mar. 1970 41 p

(Contract N00014-67-A-0226-0006)

(AD-703621) Avail: CFSTI CSCL 1/5

The paper is an attempt to develop a linear programming framework which will arrive at solutions to the problem of airport congestion at a given airport. The landing fee charged to aircraft for landing at the airport is used as a price mechanism to allocate airport facilities to potential users. Several models are developed in which the demand for and supply of airport facilities are equated within different policy frameworks. The policy frameworks include (1) allowing market forces to work without constraint, (2) passenger maximization, (3) a general framework in which various pricing schemes can be used, (4) profit maximization and (5) a multi-time period model in which a controlled level of congestion is allowed. TAB

N70-35068# National Physical Lab., Teddington (England). Aerodynamics Div.

PROPAGATION OF FINITE-AMPLITUDE SOUND WAVES IN TUBES

D. F. Pernet and R. C. Payne Nov. 1969 54 p refs

(NPL-AERO-Ac-43) Copyright. Avail: CFSTI

The non-linear distortion produced when a moderately intense sinusoidal signal propagates over a considerable distance in a tube is developed for an arbitrary relationship between attenuation and frequency. Experimental data support the predicted growth and decay of the harmonic components for sinusoidal signals propagating over 60 m. An increase in the energy converted into harmonic components occurs when a noise signal of equal energy is substituted for a sinusoidal signal. Experimental support is established for the magnitudes of the increase for low-order harmonic components, using noise signals up to one octave in bandwidth. Author (ESRO)

N70-35080# Boeing Co., Renton, Wash. Commercial Airplane Div.

EVALUATION TESTS ON BOULTON-PAUL VC-10 AILERON INTEGRATED FLIGHT CONTROL ACTUATOR

Allan F. Damp 10 Mar. 1970 49 p refs

(AD-703471; D6-25527) Avail: CFSTI CSCL 1/3

The results are presented of tests conducted on a Boulton Paul Aircraft integrated electro-hydraulic actuator of the type used on the British Aircraft Corporation VC-10 commercial airplane flight control surfaces. The tests include frequency response with manual and autopilot inputs, response to step input, steady state operating temperatures, and a number of function tests. The results obtained are compared with those obtained by Boulton Paul on the same actuator, and with allowable deviation limits specified in the overhaul manual. Author (TAB)

N70-35137# Lockheed Missiles and Space Co., Palo Alto, Calif.

NUMERICAL SOLUTION OF THE PROBLEM OF SUPERSONIC GAS FLOW AROUND A TRIANGULAR WING SURFACE IN THE COMPRESSION DOMAIN

G. P. Voskresenskii [1970] 13 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. i Gaza (USSR), no. 4, 1968 p 134 142

Avail: National Translations Center, John Crerar Library, Chicago, Ill. 60616

A numerical method of computing the supersonic flow around an arbitrary triangular wing surface in the flow compression domain is presented. The wing leading edge may even not be rectilinear, but the shock should be attached everywhere. The gas mixture flowing around the wing is assumed inviscid, however, physico-chemical processes such as dissociation, ionization, and the formation of new compounds, can occur at high temperatures. A problem with initial conditions in some plane, boundary conditions on the wing surface, and the unknown shock surface, is posed for the nonlinear system of gasdynamics equations. The difference system of equations approximating the initial system of differential equations in a mesh is solved by an iteration scheme. Author

N70-35142# National Research Council of Canada, Ottawa (Ontario).

EXPERIMENTAL INVESTIGATION OF SLOTTED ENGINE INTAKES IN THE UPPER SURFACE OF A THICK WING

R. A. Tyler and R. G. Williamson Dec. 1968 36 p refs

(LR-526) Avail: CFSTI

The effects of flow rates appropriate to engine requirements through slotted intakes in the rear upper surface of a thick wing were investigated. The basic test configuration incorporated a 31.5 percent thick aerofoil of 3-ft chord and 4-ft span. The aerofoil was equipped with a wide (5 percent chord), full span intake slot, located at 65 percent chord, and operated at values of suction coefficient up to 0.20. Measured results relating to aerofoil force characteristics and intake losses are presented and discussed. Author

N70-35169*# Aztec School of Languages, Inc., Maynard, Mass. Research Translation Div.

PROBLEM OF THE OPERATIONAL RELIABILITY OF FLIGHT CONTROL SYSTEMS AND AUTOMATIC PILOTING OF AIRCRAFT [ZUM PROBLEM DER TECHNISCHEN ZUVERLAESSIGKEIT VON FLUGREGELUNGS-SYSTEMEN SOWIE DER AUTOMATISIERUNG DER FLUEGFUHRUNG VON LUFTFAHRZEUGEN]

Olaf Peters (Ph.D. Thesis—Tech. Univ., Berlin, 1967) Washington NASA Aug. 1970 142 p refs Transl. into ENGLISH from German dissertation

(Contract NASw-1692)

(NASA-TT-F-610) Avail: CFSTI CSCL 17G

The operational reliability of the currently used manual and automatic aircraft control systems and their components are discussed in the light of the instrumental malfunction and repair estimated statistically by commercial airlines. It is found that the automatic control system malfunction probability derived from the statistics does not meet reasonable reliability standards. Cost estimates are given for the redundant components required to provide adequate air traffic safety standards. Author

N70-35198# National Aeronautical Lab., Bangalore (India).

NATIONAL AERONAUTICAL LABORATORY Annual Report, 1968 - 1969

1969 110 p

Avail: CFSTI

Research activities in aerodynamics, structural sciences, materials science, propulsion, electronics, instrumentation, and mathematics are summarized, highlighted by the commissioning and calibrating of a trisonic four-foot wind tunnel facility. The establishment of a pilot plant for fabrication of digital systems and components is reviewed, and statements are given on collaboration with other organizations, sponsored projects, technical assistance and papers published. J.M.

N70-35204# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATING THE PLIABILITY OF ELASTIC BEARINGS FOR TURBOMACHINES
Ye. A. Artemov 3 Oct. 1969 14 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Mashinostr. (Moscow), no. 7, 1968 p 48 54
(AD-700690; FTD-HT-23-383-69) Avail: CFSTI CSCL 13/9

The calculation of the flexibility of elastic supports of turbomachines is discussed. It is shown that the flexibility of these supports, which consist of an assembly of elastic rings with attachments welded to them, significantly affects the spectrum of the resonance frequencies of the coupled vibrations. Therefore, to calculate the vibrations of the rotor-support-housing system, the flexibility of the supports must be determined. Formulas were derived for determining the proper members of the support structure with a desired flexibility. Author (TAB)

N70-35288# Naval Postgraduate School, Monterey, Calif.
AN INVESTIGATION OF THE LONGITUDINAL HANDLING QUALITIES OF A VARIABLE STABILITY FLIGHT SIMULATOR
Leo Joseph Willetts, Jr. Jun. 1969 47 p refs
(AD-703225) Avail: CFSTI CSCL 14/2

An investigation of the longitudinal handling qualities of the variable stability flight simulator, converted from a C-11B Instrument Flight Trainer, found the qualities to be an unrealistic representation of aircraft motion. Nonlinearities found in the dc servo drive circuits were caused by the dc servo drive motors starting voltage, striction, misalinement of the motor and reduction gear axles, potentiometer resolution, and gearing backlash. The equations of motion for the T-33 aircraft were simulated with the analog portion of a hybrid computer. Author (TAB)

N70-35305# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MODELING OF CIRCULATION FLOWS, CHAPTER 15
G. A. Ryazanov 2 Jan. 1970 43 p refs Transl. into ENGLISH from the publ. 'Elektricheskoye Modelirovaniye s Primeneniyem Vikrevykh Poley' Moscow, 1969 p 295 320
(AD-702863; FTD-MT-24-331-69) Avail: CFSTI CSCL 1/3

The chapter presents a method of simulating two-dimensional flow around airfoils at various angles of attack for the purpose of determining several aerodynamic conditions and coefficients. Basically the experimental method is as follows: a hole in the shape of an airfoil cross section is cut in metal foil or other suitable conducting sheet. The winding of a toroidal electromagnet is passed through the hole perpendicular to the plane of the foil. After adjustment of the currents through the foil and winding it is possible by means of a probe and measuring instrument to map out the field grid of the simulated flow around the airfoil for identification of critical points, the boundary layer, fulfillment of the Chaplygin-Joukowski condition, etc. It is stated that the method is ideally adapted to lecture presentation and laboratory study. Author (TAB)

N70-35309# Defense Documentation Center, Alexandria, Va.
GROUND EFFECT MACHINES (GEM), VOLUME 1 Report Bibliography, Jan. 1960 - Sep. 1969
Apr. 1970 193 p refs
(AD-704800; DDC-TAS-70-40-1-Vol-1) Avail: CFSTI CSCL 1/3

The annotated bibliography contains unclassified and unlimited references on Ground Effect Machines (GEM). These 144 references deal with aerodynamic characteristics, propulsion, design, configurations, performance capabilities, and research and development. Corporate Author-Monitoring Agency, Subject, Title, Personal Author indexes are included. Author (TAB)

N70-35342# Weather Wing (4th), Ent AFB, Colo. Aerospace Sciences Div.
THE VALUE OF STATIC AND TREND PERSISTENCE IN THE ONE-HOUR PREDICTION OF CEILING AND VISIBILITY
Joe S. Restivo and Franklin R. Hartranft Feb. 1970 82 p refs
(AD-703305; Rept-70-1) Avail: CFSTI CSCL 4/2

The paper describes some of the various applications of persistence by different meteorological agencies; identifies certain areas of confusion clarifies the definition of the general term persistence; and presents a full-scale statistical evaluation of static and trend persistence based upon the period of record at seven terminals. The results of this evaluation provide a reliable estimate of the value of static and trend persistence in the one-hour prediction of ceiling and visibility. Author (TAB)

N70-35374# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
LOAD TRANSFER AND LOAD DIFFUSION IN ELASTOSTATICS
Eli Sternberg Feb. 1970 73 p refs
(Contract Nonr-220(58))
(AD-703641; TR-21) Avail: CFSTI CSCL 20/11

The paper summarizes a recent sequence of theoretical investigations of plane and spatial load-transfer problems in linear elastostatics. Whereas the two-dimensional problems dealt with here have a particular relevance to aircraft structures, those concerning the transfer of load between a bar and a three-dimensional elastic medium are primarily of interest in connection with civil-engineering structures and have a bearing on the mechanics of fiber-reinforced materials. An attempt is made to assess the role of alternative mathematical models in the treatment of the physical problems under consideration, to sketch the essential features of the required analysis, and to discuss the principal results obtained. Author (TAB)

N70-35380 Civil Aeronautics Board, Washington, D.C. Costs and Statistics Div.
AIRCRAFT OPERATING COST AND PERFORMANCE REPORT, 1967 AND 1968, VOLUME 3
Aug. 1969 281 p
Avail: SOD $2.25

Unit cost and performance data are presented for transport aircraft operated by certified route air carriers in the United States during 1967 and 1968. Unit operating cost and performance data for turbine aircraft operated by U. S. supplemental air carriers during 1968 are also presented. The data is divided into three parts according to equipment group by carrier group, equipment type by carrier group, and equipment type by individual carrier. Author

N70-35446# Resource Management Corp., Inc., Bethesda, Md.
COST ANALYSES FOR NECTP. VOLUME 1: HIGH SPEED GROUND MODES
Paul F. Dienemann and Joe P. Large Office of High Speed Ground Transportation Dec. 1969 77 p refs
(Contract DOT-7-35297)
(PB-190942; NECTP-222) Avail: CFSTI CSCL 13B

The report documents the cost analysis of high speed

ground transportation modes, including rail and tracked air cushion vehicles, performed for the Northeast Corridor Transportation Project of the U.S. Department of Transportation. It presents descriptions of each mode, the derivation of research and development, investment and operating costs, and an appraisal of results.
Author (USGRDR)

N70-35487# IIT Research Inst., Chicago, Ill. Heat Transfer and Fire Research Section.
AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE SYSTEMS: CURRENT TECHNOLOGY REVIEW Final Report, Jun. – Oct. 1969
F. Salzberg and J. Campbell 22 Oct. 1969 138 p refs
(Contract F33657-69-C-1183)
(AD-703393; AGFSRS-70-1) Avail: CFSTI CSCL 1/2

The study gives an overview of the state-of-the-art of aircraft ground fire suppression and rescue. Subjects considered include; hostile characteristics of liquid fuel fires, effectiveness of suppression agents, and fire suppression equipment. Current research related to aircraft ground fire suppression and rescue is identified.
Author (TAB)

N70-35499# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PREVENTION AND ELIMINATION OF VIBRATION OF ROTARY MACHINES
S. I. Lipsman et al 3 Dec. 1969 237 p refs Transl. into ENGLISH of the book 'Preduprezhdeniye i Ustraneniye Vibratsii Rotornykh Mashin' Kiev, Izd. Tekhn., 1968 p 1 – 196
(AD-703063; FTD-MT-24-191-69) Avail: CFSTI CSCL 13/10

The book is a practical manual on the prevention and elimination of vibration in various types of pumps, ventilators, exhaust fans, turbo-compressors, blowers, electric generators and motors, steam, gas, and hydraulic turbines, centrifugal machines and separators, crushers, high-speed mills, etc. Information is given on the sources of vibration and the methods and means of preventing vibration. Most of the practical data is published for the first time.
Author (TAB)

N70-35524*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A STACKED ARRAY OF OMNIDIRECTIONAL ANTENNAS Patent Application
Marion C. Bailey and William F. Croswell, inventors (to NASA) Filed 24 Apr. 1970 8 p
(NASA-Case-LAR-10545-1; US-Patent-Appl-SN-31703) Avail: CFSTI CSCL 09E

A stacked vertically polarized collinear array of a plurality of independently fed omnidirectional antennas operating at different frequencies is described. Each antenna consists of an array of five circumferential slots in the outer conductor of a dielectric filled shorted coaxial transmission line with a hollow center conductor for feed leads to pass through.
NASA

N70-35540# Metaalinstituut TNO, Delft (Netherlands).
INVESTIGATION ON ROTOR MATERIAL SOLUBILITY, 1. ANALYSIS OF A LIGHT METAL SAMPLE, 2 [ONDERZOEK NAAR DE LASBAARHEID VAN ROTORASMATERIAAL, 1. ANALYSE VAN EEN STUKJE LICHTMETAAL, 2]
D. v. d. Torre 24 Feb. 1970 6 p In DUTCH
(M70-111-Rom/vdT/Nat) Avail: CFSTI

A chromium-molybdenum-vanadium steel was studied for its mechanical strength and compatibility as welding alloy. Weld seams indicated the necessity to use a special joining material. Chemical analysis of a light metal piece, consisting of an aliminum alloy with about 3% magnesium, indicates that this compound is suitable for filler material.
Transl. by G.G.

N70-35551# National Aeronautical Establishment, Ottawa (Ontario).
AN EXPERIMENTAL INVESTIGATION BY FORCE AND SURFACE PRESSURE MEASUREMENTS OF A WING IMMERSED IN A PROPELLER SLIPSTREAM. PART 2: SURFACE PRESSURE MEASUREMENTS
Y. Nishimura Natl. Res. Council Jun. 1969 66 p refs
(NAE-LR-525; NRC-11062) Avail: CFSTI

Measurements of wing surface pressures were made in the 6 ft × 9 ft low speed wind tunnel for wings immersed in a propeller slipstream. Three wing semispan configurations were tested with different flap deflections and propeller thrust coefficients. Representative data are presented to illustrate the chordwise pressure distributions, the spanwise load distributions and the overal wing force coefficients. The pressure distributions indicate strong influence of slipstream rotation on the wing loading. Because of the slipstream detachment from the wing surface at high angles of attack and low thrust, the results show the importance of the longitudinal and vertical positioning of the propeller. Comparison of integrated pressure measurements with balance measurements, after subtraction of isolated propeller forces, showed good agreement.
Author

N70-35597*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A PRESSURE OPERATED ELECTRICAL SWITCH Patent Application
Frederick W. Gibson, inventor (to NASA) Filed 1 Dec. 1969 8 p
(NASA-Case-LAR-10137-1; US-Patent-Appl-SN-881041) Avail: CFSTI CSCL 09A

A pressure operated electrical switch is described which has a device to hold the switch closed until the pressure increases to a first predetermined value and then decreases to a second predetermined value at which time the holding device is released and the switch is opened. The holding device consists of a rod pivoted at one end with a tension spring attached near the other end. The releasing mechanism includes a pawl attached to the other end of the rod, a compression spring subjected to the pressure, a second rod with one of its ends attached to the compression spring and with a hook on its other end to slip over the pawl and pull the pivoted rod away from the switch.
NASA

N70-35621*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
COMPUTER PROGRAM TO PREDICT THE NEWTONIAN AERODYNAMICS OF GENERAL BODIES APPROXIMATED BY FLAT PLATES
Ralph E. Graham, Robert H. Lamb, and Paul O. Romere 11 Aug. 1965 26 p *Its* General Working Paper No. 10054
(NASA-TM-X-64431) Avail: CFSTI CSCL 20D

Equations for computing the Newtonian aerodynamics of a body composed of flat plate segments were derived and incorporated into a digital computer program. A complete description of the computer program is included, and the use of the program is demonstrated by predicting the Newtonian aerodynamics of an example configuration consisting of four flat plates.
Author

N70-35626# Congress. House. Committee on Interstate and Foreign Commerce.
AVIATION FACILITIES MAINTENANCE AND DEVELOPMENT, PART 1
Washington GPO 1969 429 p refs Hearings on H.R. 12374 and H.R. 12780 before the Comm. on Interstate and Foreign Com., 91st Congr., 1st Sess., 21–25, 28–31 Jul.; 9–10 Sep. 1970 *Its* Serial No. 91-22
Avail: Comm. on Interstate and Foreign Com.

Hearings testimony, statements, and additional material submitted for the record are presented on legislation for expanding and improving airport and airway facilities. E.C.

N70-35627# Congress. House. Committee on Interstate and Foreign Commerce.
AVIATION FACILITIES MAINTENANCE AND DEVELOPMENT, PART 2
Washington GPO 1969 348 p refs Hearings on H.R. 12374 and H.R. 12780 before the Comm. on Interstate and Foreign Com., 91st Congr., 1st Sess., 21–25, 28–31 Jul.; 9–10 Sep. 1970 *Its* Serial No. 91-23
Avail: Comm. on Interstate and Foreign Com.

N70-35650# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE CRITERION OF TECHNICAL STABILITY OF MOTION OF A WING NEAR THE INTERFACE OF TWO MEDIA
A. N. Golubentsev et al 12 Dec. 1969 12 p refs Transl. into ENGLISH from Gidrodinamika Bolshikh Skorostey, Akad. Nauk Ukr. SSR (Ukrainian SSR), no. 4, 1968 p 69–76
(AD-702836; FTD-HT-23-517-69) Avail: CFSTI CSCL 1/3

Utilizing a system of equations, calculations are made of the nonlinear oscillations of a wing in a vertical plane when it moves with a constant horizontal velocity component near the interface of two media, assuming that the angle between the wing chord and the interface does not change with time. Author (TAB)

N70-35659*# North American Rockwell Corp., Los Angeles, Calif.
THEORETICAL FREQUENCY RESPONSE FUNCTIONS AND POWER SPECTRA OF THE XB-70 RESPONSE TO ATMOSPHERIC TURBULENCE
Thomas E. Stenton Washington NASA Aug. 1970 119 p refs
(Contract NAS1-7805)
(NASA-CR-1621) Avail: CFSTI CSCL 01C

Responses include normal accelerations at eight locations on the airplane, pitch rate at the center of gravity, a representative fuselage bending moment, and wing tip hinge moment. Calculated results are presented for eight different flight conditions with respect to weight, Mach number, and altitude. Generalized aerodynamic forces on the wing due to motion and sinusoidal gust field were determined from unsteady lifting surface theory. The theoretical frequency responses and spectra are compared with experimental results for one flight condition and with theoretical results obtained by another method. Author

N70-35662*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
AIRCRAFT SIMULATION OF LUNAR LANDING APPROACH TRAJECTORIES
Joseph F. Stegall 9 Feb. 1965 41 p refs *Its* Program Apollo Working Paper No. 1159
(NASA-TM-X-64433) Avail: CFSTI CSCL 22C

An aircraft simulation of Lunar Excursion Module (LEM) landing approach trajectories was conducted. The basic program objectives were to study pilot visibility problems under earthshine conditions and pilot capability to detect off-nominal approaches under both sunshine and earthshine conditions. A standard T-33 aircraft was used to provide a free flight simulation of LEM approach velocities between 15,000 and 1500 feet above the terrain. The approaches were flown by the rear seat pilot while the front seat pilot provided data on detection of terrain features, motion with respect to the terrain and off-nominal approach conditions. Study results indicate the minimum acceptable reflected earthshine on the LEM approach for both terrain avoidance and safe pilot control of the trajectory is approximately 0.02 ft-L. On off-nominal low approaches under sunshine, the pilot could recognize the need for correction at a safe altitude, but on similar approaches under low values of reflected earthshine such recognition did not occur until safe recovery would have been marginal. Author

N70-35676*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
WIND TUNNEL TEST SECTION Patent Application
John W. Davis and Olen E. Hill, inventors (to NASA) Filed 31 Dec. 1969 15 p
(NASA-Case-MFS-20509; US-Patent-Appl-SN-889557) Avail: CFSTI CSCL 14B

A test section is described for use in a short duration wind tunnel capable of simulating very high Reynolds numbers over the transonic speed range. An exterior circular tube contains a perforated concentrically disposed sleeve assembly forming an annular flow plenum between the exterior tube and the sleeve assembly. The main flow stream through the wind tunnel is through the sleeve assembly with suction from the main flow stream occurring through the holes in the walls of the sleeve assembly into the plenum. Flow into the plenum is adjustable to obtain the desired main stream flow velocity and the optimum cancellation of shock and expansion waves produced when the gas flow strikes the test model in the test section. The plenum flow is controlled by a rotatable ring at the downstream end of the test section. NASA

N70-35678*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VARIABLE GEOMETRY WIND TUNNELS Patent Application
Harry H. Heyson, inventor (to NASA) Filed 20 Oct. 1969 12 p
(NASA-Case-XLA-7430; US-Patent-Appl-SN-867841) Avail: CFSTI CSCL 14B

A variable geometry wind tunnel is described for testing aircraft models in subsonic tests representing the low speed phases of flight. The system provides for variation of the test section of the tunnel during a test and reduces the corrections needed in data obtained in subsonic wind tunnel tests. The system is computerized to attain optimum test conditions. NASA

N70-35693*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
DRAG CHARACTERISTICS OBTAINED FROM SEVERAL CONFIGURATIONS OF THE MODIFIED X-15-2 AIRPLANE UP TO MACH 6.7
Lawrence C. Montoya Washington NASA Aug. 1970 29 p refs
(NASA-TM-X-2056; H-598) Avail: CFSTI CSCL 01C

Flight tests were made with and without the lower ventral fin, dummy ramjet (including the modified fixed ventral fin), and ablative coating over the entire wetted area. Supersonic flight results showed an increase in drag coefficient caused by the ablative coating of 0.008 at a lift coefficient of 0 and 0.022 at a lift coefficient of 0.3. At subsonic speeds the average increase in drag coefficient was about 0.013 for lift coefficients of 0.3 and 0.4. The average incremental increase in drag coefficient caused by the lower ventral fin and dummy ramjet was about 0.010 at subsonic speeds at a lift coefficient of about 0.3. The flight incremental increase in drag coefficient of the lower ventral fin between Mach 3.8 and 4.9 was about 0.006 at a lift coefficient of 0.1 and 0.014 at a lift coefficient of 0.3. Author

N70-35694*# Stanford Research Inst., Menlo Park, Calif. Sensory Sciences Research Inst.

ATTENUATION OF AIRCRAFT NOISE BY WOOD-SIDED AND BRICK-VENEERED FRAME HOUSES

J. R. Young Washington NASA Aug. 1970 36 p refs
(Contract NAS1-6885)
(NASA-CR-1637) Avail: CFSTI CSCL 20A

Indoor and outdoor noise data were obtained by using a Convair CV-880 aircraft and a Lockheed 1049G aircraft as sound sources. Indoor noises were recorded using a pre-emphasis filter network which permitted improved recovery of low-intensity, high-frequency data in the indoor channels. Aircraft noise attenuation characteristics based on a 1/3 octave band frequency analysis were computed from recorded noise measurements for four interior locations in each house. The effect of house and room structures on externally generated aircraft noise as measured indoors was also expressed by tabulating the differences between outdoor and indoor noise levels in thirty-six standard noise measures, and a comparison between estimated and actual values showed that the attenuation data are useful for indoor noise prediction purposes. Author

N70-35713*# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.

AN APPRAISAL OF PROBLEMS IN THE AIR TRAFFIC CONTROL SYSTEM

William B. Rouse Mar. 1970 59 p refs
(Grant NGL-22-009-002)
(NASA-CR-109980; DSR-70283-12) Avail: CFSTI CSCL 17G

A study was made of the air traffic control system with emphasis on the areas of management, operations research, and design. The current system is described and research work that has been performed is discussed. A discussion of the need for a decision making model is presented and used to conclude how future air directions for air traffic control research should be determined. Author

N70-35740# Congress. Senate. Committee on Commerce.

AIRPORT/AIRWAYS DEVELOPMENT, PART 1

Washington GPO 1969 449 p refs Hearings before Comm. on Com., 91st Congr., 1st Sess., 17–19, 24–26 Jun. 1969 *Its* No. 91–13 Avail: Subcomm. on Aviation

The results of hearings are reported on proposed government action in development of airports and airways. Testimony is presented on moneys required to improve airport and terminal facilities, with emphasis on air safety and increased Federal aid for training air traffic controllers and improvement of control facilities. Methods of raising revenues to offset the expenses of airport and airway development are discussed. R.B.

N70-35760# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: ALLEGHENY AIRLINES INC., ALLISON PROP JET CONVAIR 440, N5825 NEAR BRADFORD, PENNSYLVANIA, JANUARY 6, 1969

27 May 1970 46 p refs
(NTSB-AAR-70-10) Avail: CFSTI

About 2035 on January 6, 1969, Allegheny Airlines Flight 737, an Allison Prop Jet Convair 440, N5825, crashed on a golf course about 4.7 nautical miles northwest of the Bradford, Pennsylvania, Regional Airport. The accident occurred while the flight was making an instrument landing approach to the airport. Of the 28 persons aboard the aircraft, 11, including the two pilots, received fatal injuries. At the time of the accident, weather conditions at the Bradford Regional Airport were reported as: partial obscuration, measured 800 feet, overcast; visibility 1-1/2 miles, light snow showers; temperature 20 F, dew point 17 F, wind 170 deg at 10 knots; altimeter setting 29.47 inches. The Safety Board was unable to determine precisely the probable cause of the accident. Of some 13 potential causes examined, three remain after final analysis. They are: (1) misreading of the altimeter by the captain, (2) a malfunction of the captain's altimeter after completion of the instrument approach procedure turn, and (3) a misreading of the instrument approach chart. Of these three, however, no single one can be accepted or rejected. Author

N70-35846*# Northrop Corp., Hawthorne, Calif.

SCALING OF VTOL RECIRCULATION EFFECTS

Gordon R. Hall Washington NASA Aug. 1970 126 p refs
(Contract NAS3-10498)
(NASA-CR-1625) Avail: CFSTI CSCL 21E

Full-scale and small-scale comparisons of VTOL recirculation effects are reported. The full-scale reference data were obtained from an investigation of a lift engine pod with two G.E. YJ-85 engines spaced approximately seven nozzle diameters apart. The small-scale data were obtained using a 1/5 scale geometrically similar model with simulated engine inlet and exhaust flows. Test conditions, instrumentation, and data reduction and analysis techniques were similar for the full-scale and small-scale investigations. The results indicate that the overall flow field and thermal environment including the free jets, ground jets, upwash, and hot gas ingestion are scalable, in terms of both dynamic and time-average characteristics, for the same exhaust pressure/temperature in full scale and small scale. Author

N70-35873# McDonnell-Douglas Co., Long Beach, Calif.

APPLICATION OF OSCILLATORY AERODYNAMIC THEORY TO ESTIMATION OF DYNAMIC STABILITY DERIVATIVES

William P. Rodden and Joseph P. Giesing [1970] 15 p refs
Avail: CFSTI

The use of oscillatory aerodynamic theory for calculating dynamic stability derivatives is discussed with respect to unsteady lifting surface theory and the method is extended to obtain higher order derivatives. The longitudinal derivatives for pitch rate and for rate of change of the angle of attack are considered for illustration. R.B.

N70-35881*# Stanford Research Inst., Menlo Park, Calif. Sensory Sciences Research Div.

JUDGMENT TESTS OF FLYOVER NOISE FROM VARIOUS AIRCRAFT

K. D. Kryter, P. J. Johnson, and J. R. Young Washington NASA Aug. 1970 67 p refs
(Contract NAS1-6855)

(NASA-CR-1635) Avail: CFSTI CSCL 01C

An experiment was conducted in which judgments of the perceived noisiness of the flyover noises made by a variety of fixed-wing and helicopter aircraft were made by subjects seated outdoors and inside two houses. The judgments were related to a variety of physical units measured or calculated from spectral and temporal measures of the noises. Author

N70-35898*# Stanford Research Inst., Menlo Park, Calif. Sensory Sciences Research Div.

POSSIBLE MODIFICATIONS TO THE CALCULATION OF PERCEIVED NOISINESS

K. D. Kryter Washington NASA Aug. 1970 67 p refs

(Contract NAS1-6885)

(NASA-CR-1636) Avail: CFSTI CSCL 20A

Analysis of data from a recent large-scale experiment and reanalysis of similar data from similar or related previous experiments provide a basis for evaluating the accuracy with which various units obtained from physical measurements predict the judged relative perceived noisiness of aircraft. On the basis of the evaluation it is concluded that the best units for estimating judged perceived noisiness are EPNdB-M and E(D2). EPNdB-M and E(D2) are the same as EPNdB and EdB(D) referred to previously except that for EPNdB-M and EdB(D2) the sound energy below about 355 Hz is summed or weighted in ways to better account for the critical bandwidth of the ear of those frequencies. The use of tone corrections with these units appears justified but not unequivocally. Author

N70-35910*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

AN INVESTIGATION OF THE INITIAL CENTURY SERIES RINGSAIL PARACHUTE

Leland C. Norman and Kenneth L. Suit Washington Aug. 1970 60 p

(NASA-TN-D-5968; S-227) Avail: CFSTI CSCL 01C

A program was conducted to develop new methods and techniques for the design, fabrication, packing, and drop testing of parachutes with diameters larger than 100 feet. Three large-parachute configurations were designed and experimentally flight tested. The ringsail parachute was selected for investigation because it opens quickly, it is compatible with staged inflation and cluster operation, and more data were available on fabrication, performance, and scaling of the ringsail parachute than on other types of parachutes. The program concluded with the demonstration of a single-parachute recovery of a 9750-pound payload and with the demonstration of a two-parachute-cluster recovery of a 17,000-pound payload. Author

N70-35926*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A METHOD FOR PREDICTING PRESSURES ON ELLIPTIC CONES AT SUPERSONIC SPEEDS

George E. Kaattari Washington Aug. 1970 27 p refs

(NASA-TN-D-5952; A-3642) Avail: CFSTI CSCL 20D

A method is presented for estimating the pressure distribution over elliptic cones at supersonic Mach numbers and angle of attack. The method is based on an empirical correlation between experimental pressures in the symmetry planes of elliptic cones and the pressures given by two-dimensional shock theory. The method is applicable for Mach numbers greater than 2, for cones whose ellipticity ratios range from 1 to 6, and for cones whose maximum semiapex angle is less than 30°. Results given by the method are shown to agree well with experimental values. Author

N70-35927*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FIXED-BASE VISUAL SIMULATION OF OBSTACLE AVOIDANCE DURING TERMINAL DESCENT OF ADVANCED APOLLO SPACECRAFT WITH AN ALL-FLEXIBLE PARAWING

G. Kimball Miller, Jr. Washington Aug. 1970 51 p refs

(NASA-TN-D-5940; L-7116) Avail: CFSTI CSCL 01C

A fixed-base visual simulation study was conducted to determine the ability of an onboard pilot to control a single-keel all-flexible parawing and advanced Apollo spacecraft combination so as to avoid obstacles located in the desired landing area. The results of the investigation showed that the pilot avoided the obstacles approximately 96 percent of the flights and generally landed within 500 ft (152.4 m) of the center of the desired site regardless of the maximum turn-rate capability of the vehicle. Author

N70-35934+ National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

BRIEFS OF ACCIDENTS: US CIVIL AVIATION, 1969

Apr. 1970 504 p *Its* Issue No. 3

Avail: CFSTI

Brief reports of U.S. civil aircraft accidents are presented. The cause factor, accident type, operational phases, and kinds of flying for each accident are tabulated. F.O.S.

N70-35952*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

DETAILED PRESSURE DISTRIBUTION ON A BLUNTED 60-DEG HALF-ANGLE CONE AT MACH NUMBERS OF 6.08 AND 9.46

Donald W. Kurtz 1 Sep. 1968 10 p refs

(Contract NAS7-100)

(NASA-CR-109982; JPL-TM-33-404) Copyright. Avail: CFSTI CSCL 20D

Hypersonic wind tunnel tests on a specially designed model indicated that the pressure coefficient distribution over the surface seemed to be almost independent of Mach number of 6.08 and 9.46. At both Mach numbers, the nose pressure remained within a band of 3% through angle of attack from 0 to 6 deg. Beyond 2 deg, the displacement of the stagnation point from the longitudinal body axis was not a linear function of angle of attack. Author

N70-36030# Federal Aviation Administration, Washington, D.C.

OPPORTUNITIES FOR DEVELOPMENT OF A NATIONAL AIRPORT SYSTEM

Chester G. Bowers 1969 21 p refs Presented at Am. Soc. of Civil Engr. Natl. Meeting on Transportation Eng., Washington, D.C., 22 Jul. 1969

Avail: Issuing Activity

Problems in planning and financing an adequate civil system of airports are examined in terms of anticipated increases in the aircraft fleet, passenger miles, and mail and freight loads. Topics discussed include: multiple or satellite airport systems for metropolitan regions; payment of development costs by users who benefit the most; federal aid and investment requirements; development of both airfield and terminal facilities; and national planning policies. E.C.

N70-36031# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: JAPAN AIR LINES

COMPANY, LTD., CONVAIR 880, MODEL 22M, JA8028, GRANT COUNTY AIRPORT, MOSES LAKE, WASHINGTON, JUNE 24, 1969
17 Jun. 1970 30 p refs
(NTSB-AAR-70-11) Avail: CFSTI

The investigation of the aircraft accident involving a JAL Convair 880, immediately after takeoff at Moses Lake, Washington is reported. The safety Board determined that the probable cause was the delayed corrective action during a simulated critical-engine-out takeoff maneuver, resulting in an excessive sideslip from which full recovery could not be effected. Recommendations are: (1) re-emphasize to pilots, the characteristics of the aircraft during engine-out maneuvers; (2) assure that all flight personnel are aware of safe and proper engine-out procedures and stall limits of the aircraft; and (3) caution instructor personnel to avoid delay in corrective action during critical maneuvers. F.O.S.

N70-36043# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: JAPAN AIR LINES CO., LTD., DC-8-62, JA 8032, SAN FRANCISCO BAY, SAN FRANCISCO, CALIFORNIA, NOVEMBER 22, 1968
31 Dec. 1969 31 p
(NTSB-AAR-70-2) Avail: CFSTI

Results of investigations conducted concerning the accident of a Japanese airliner which made an unintentional water landing in San Francisco Bay are reported. It was determined that the probable cause of this accident was the improper application of the prescribed procedures to execute an automatic-coupled ILS approach. This deviation from the prescribed procedures was, in part, due to a lack of familiarization and infrequent operation of the installed flight director and autopilot system. There were no injuries to any of the passengers or crew, and the aircraft was recovered from the water about 55 hours after the accident. E.M.C.

N70-36045# Weapons Research Establishment, Salisbury (Australia).
FORCE FLIGHT MEASUREMENT OF AERODYNAMIC LATERAL FORCE AND MOMENT COEFFICIENTS ON BOMBS WITH FREELY SPINNING CRUCIFORM AND MONOPLANE TAILS AND FIXED SPLIT SKIRTS
N. E. Gilbert Nov. 1969 51 p refs
(WRE-TN-HSA-162) Avail: CFSTI

The dependence of aerodynamic lateral force and moment coefficients upon incidence, roll orientation, and angular velocity for bombs with freely spinning cruciform and monoplane tails and fixed split skirts is determined by fitting the flight data to a mathematical model of the force and moment system. Uncertainties in the derived coefficients are shown to arise from errors in the instrument measurements and from truncating the expansions at different points to represent the static and dynamic components. Results are given for Mach numbers near 0.7, and, in general, reasonable agreement is obtained between free flight and wind tunnel measurements of the static forces and moments. However, satisfactory free flight measurements of Magnus coefficients and damping coefficient derivatives were not obtained. Because of inadequate instrumentation, no data were obtained on axial forces and moments. Author

N70-36052*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
AIRCRAFT CONTROL SYSTEM Patent Application
Paul S. Rempfer, Alan J. Robertson, Lloyd E. Stevenson, and Joseph S. Koziol, Jr., inventors (to NASA) Filed 13 Jul. 1970 17 p
(NASA-Case-ERC-10439; US-Patent-Appl-SN-54271) Avail: CFSTI CSCL 01C

This invention relates to an aircraft control system suited to rotary wing aircraft. The control system has four command channels. In the longitudinal channel, the manual control stock provides an acceleration command and has a forward velocity holding capability. In the lateral control channel, the manual control member generates a course rate command and has a course holding capability. In the collective or vertical channel the manual control member provides a rate of descent command and has an altitude hold capability. In the yaw channel, the manual controls provide sideslip commands with coordinated turn coupling from the lateral channel at high airspeeds. At low airspeeds, the manual controls provide a heading rate command with heading hold capability. Each of the control channels incorporates attitude stabilizing gyros with damping inputs from rate gyros. Integral plus proportional compensation networks are used in each of the channels to maintain zero steady-state errors. NASA

N70-36056*# National Aeronautics and Space Administration. Langley Research Center, Langley Station.
HIGH SPEED FLIGHT VEHICLE CONTROL Patent Application
Robert W. Rainey, inventor (to NASA) Filed 30 Jun. 1970 9 p
(NASA-Case-XLA-8697; US-Patent-Appl-SN-837830) Avail: CFSTI CSCL 01C

Control surfaces for a supersonic or hypersonic lifting reentry vehicle are described that produce an aerodynamic control output free of adverse aerodynamic cross coupling. Elevons have hinge lines swept forward to an angle such that the control forces are in a plane that passes through or aft of the vehicle center of gravity, thereby removing any adverse yawing moment of the airdraft during roll control. NASA

N70-36073# Committee on Ways and Means (U.S. House).
PROBLEMS OF AIR TRANSPORTATION IN AMERICA Message from the President of the United States, Jun. 1969
Richard Nixon Washington GPO 16 Jun. 1969 4 p Presented at Comm. on Ways and Means, 91st Cong., 1st Sess., 16 Jun. 1969
(H-Doc-91-130) Avail: US Capitol, House Document Room

The status of air transportation is assessed and proposals are made on methods for planning and financing improvements and expansion of airways and airports. The proposals include a revised tax schedule aimed at funding air transportation improvements mainly through taxation of users and operators of the system. Resulting revenues would be placed in a designated account in the Treasury to be used only for program improvements. E.C.

N70-36078*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
LOCATION IDENTIFICATION SYSTEM Patent Application
Robert L. Trent, inventor (to NASA) Filed 13 Jul. 1970 40 p
(NASA-Case-ERC-10324; US-Patent-Appl-SN-54270) Avail: CFSTI CSCL 17B

A location identification system for identifying a particular ground location from among a plurality of ground locations is described. Each ground location includes a transmitter that transmits a continuous tone signal when the transmitter is activated. Each transmitter also includes a binary encoder for encoding the continuous tone signal at spaced intervals. Each binary code uniquely identifies the particular transmitter with which it is associated. An aircraft flying above ground locations carries a receiver for receiving the continuous tone signal transmitted by an activated transmitter,

and a decoder for decoding the binary encoded portion of the signal. A display device is provided for displaying the identity of the ground location determined as a result of decoding the encoded portion of the signal. NASA

N70-36081*# Techtran Corp., Glen Burnie, Md.
SOME REMARKS ON DYNAMIC SOARING [ZUM DYNAMISCHEN SEGELFLUG]
E. Fritsch Washington NASA Aug. 1970 18 p refs Transl. into ENGLISH of the unpublished manuscript (E. Germany), 1970 20 p
(Contract NASw-2037)
(NASA-TT-F-13217) Avail: CFSTI CSCL 01B

Extensive idealization of dynamic soaring makes it possible to treat the problem completely analytically. The influence of wind shear, air speed, lift-drag ratio and the angle of inclination of the flight path on dE/dh is calculated. A relationship is also derived for the anticipated cruising speed in the jet stream. The most satisfactory air speed and optimum angle of inclination of the flight path are determined for the given values. The cruising speeds and gains of energy to be expected in the jet stream are estimated numerically. Advice for the pilot regarding flight in the jet stream is given. Author

N70-36101# Joint Publications Research Service, Washington, D.C.
LANDING APPROACH USING THE "SVOD' SYSTEM
V. Zakharov 27 Aug. 1970 9 p Transl. into ENGLISH from Aviats. i Kosmonavt. (Moscow), no. 6, 1970 p 14 15
(JPRS-51258) Avail: CFSTI

The radio direction finder of the "Svod" system permits landing approach maneuvering, using the box method, at any airfield within the operating zone of a ground beacon. The approach procedures for each turn of the box pattern are described. R.B.

N70-36114# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: SCANDINAVIAN AIRLINES SYSTEM MC DONNELL-DOUGLAS DC-8-62, LN-MOO (NORWEGIAN REGISTRY) IN SANTA MONICA BAY NEAR LOS ANGELES, CALIFORNIA, JANUARY 13, 1969
1 Jul. 1970 38 p ref
(NTSB-AAR-70-14) Avail: CFSTI

Results of investigations conducted in connection with the accident of a Scandinavian airliner which crashed in Santa Monica Bay, January 13, 1969 are reported. It was determined that the probable cause of this accident was the lack of crew coordination and the inadequate monitoring of the aircraft position in space during a critical phase of an instrument approach which resulted in an unplanned descent into the water. Contributing to this unplanned descent was an apparent unsafe landing gear condition induced by the design of the landing gear indicator lights, and the omission of the minimum crossing altitude at an approach fix depicted on the approach chart. Recommendations were subsequently developed concerning DC-8 failed indicator bulbs, altimeter setting procedures, and approach plate legends. E.M.C.

N70-36116# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: CESSNA 310N, N4111Q NEAR UPLAND, CALIFORNIA, APRIL 12, 1969
25 Jun. 1970 22 p ref
(NTSB-AAR-70-13) Avail: CFSTI

Results of investigations conducted in connection with the accident of a privately owned aircraft which crashed near Upland, California, April 13, 1969, are reported. It was determined that the probable cause of this accident was the radar vectoring of the aircraft below terrain clearance level following target misidentification by the FAA controller. Recommendations were subsequently made for the FAA to conduct a continuing program of analysis to detect and eliminate critical procedures in the air traffic control system. E.M.C.

N70-36152# Joint Economic Committee (U. S. Congress).
AIR FORCE A-7D BRAKE PROBLEM
Washington GPO 1970 322 p refs Hearings before Joint Econ. Comm., 91st Congr., 1st Sess., 13 Aug. 1969
Avail: Subcomm. on Economy in Govt.

Congressional testimony is reported on alleged falsification of data in laboratory tests of brakes for the A-7D aircraft. Statements were presented that laboratory data were changed to make it appear that the tests qualified the brakes. Subsequent flight tests revealed defects in the brake design, and as a result a different brake was developed. R.B.

N70-36155# Congress. Senate. Committee on Commerce.
THE ROLE OF GENERAL AVIATION
Washington GPO 1970 192 p refs Hearings before Comm. on Com., 91st Congr., 1st Sess., 2 May 1969 *Its* Serial 91-46
Avail: Subcomm. on Aviation

Statements on general aviation characteristics, contributions to social and economic systems, and developmental needs are presented. Aircraft safety, airport utilization, aircraft hazards and collisions, air taxi services, navigation aids, air traffic control, and related topics are discussed. N.E.N.

N70-36160# Congress. House. Committee on Science and Astronautics.
ISSUES AND DIRECTIONS FOR AERONAUTICAL RESEARCH AND DEVELOPMENT From Subcommittee on Advanced Research and Technology
Washington GPO 1970 108 p refs Presented by the Comm. on Sci. and Astronaut. to the Comm. of the Whole House on the State of the Union, 91st Congr., 2d Sess., 28 Mar. 1970 *Its* Union Calendar No. 435; *Its* Serial M
(Rept-91-932) Avail: US Capitol, House Document Room

Hearings on establishing national policy in aviation are reported. The responsibilities, roles, and relationships of government and industry are discussed. Primary issues in aviation and aeronautical research and development are reviewed, including research planning, noise abatement, new personnel, and airports. J.A.M.

N70-36161# Congress. House. Committee on Appropriations.
DEPARTMENT OF TRANSPORTATION AND RELATED AGENCIES APPROPRIATIONS FOR 1971. PART 2: CIVIL SUPERSONIC AIRCRAFT DEVELOPMENT, FEDERAL AVIATION ADMINISTRATION
Washington GPO 1970 646 p refs Hearings before Comm. on Appropriations, 91st Congr., 2d Sess., Apr. 1970
Avail: A Subcomm. of the Comm. on Appropriations

Supersonic aircraft and airport planning and development discussions are presented. Among the topics covered are the

following: air traffic control, controller training, airport building and utilization, FAA operations, airport and air traffic control system maintenance, aircraft noise and sonic booms, environmental issues, aircraft testing, and traffic and passenger predictions. N.E.N.

N70-36183# California Univ., Livermore, Lawrence Radiation Lab.
FORCES AND MOMENT ON A PROLATE SPHEROID ACCELERATING WITH A CONSTANT ANGLE OF ATTACK UNDER A FREE SURFACE
William Brace Reuland (Ph.D. Thesis) Apr. 1970 70 p refs
(UCRL-50843) Avail: CFSTI

The forces and moment for a motion history of impulsive acceleration to a constant velocity at time zero plus were calculated as an example: by the superposition principle, the results calculated in the example can be extended to arbitrary motion histories. The steps involved in the determination of the forces and moment on the body include finding a potential function that satisfies all boundary conditions (including the linear free surface conditions) and the application of Landweber's equation for the forces and moment on a submerged body. Landweber's equation gives the forces as functions of the singularity strengths in the potential. The expressions derived are given in integral form. The results are shown to reduce to known expressions for translation parallel to the spheroid's axes as zero angle of attack is approached and to reduce to the steady state results as the depth of the body becomes large. NSA

N70-36198# Document Room (U.S. House).
LAWS RELATING TO COMMERCIAL AIR SERVICE AND MISCELLANEOUS AIR LAWS
Gilman G. Udell, comp. Washington GPO 1968 364 p refs
Avail: SOD $1.50

The full text or extracts of commercial air laws enacted from 1916 to 1968 are presented. Miscellaneous air laws enacted from 1917 to 1968 are also compiled. J.M.

N70-36216 National Lending Library for Science and Technology, Boston Spa (England).
THE CONCORDE SIMULATOR
Gilbert Fretigny 24 Jun. 1970 22 p Transl. into ENGLISH from Automatisme (France), v. 14, no. 9, Sep. 1969 p 468–474 In ENGLISH and FRENCH
(NLL-M-9223-(5828.4F)) Avail: Natl. Lending Library, Boston Spa, Engl.: .2 NLL photocopy coupons

A Concorde research simulator was installed in a Blagnac laboratory; the principle characteristics of the pilot simulator are given. Precision and ease of piloting was tested in various systems, with emphasis on the Concorde system. The aircraft's stability and handling characteristics, flight control quality, instrumental data, usable visual information, control lay-out and general fittings of the cabin, and the infrastructure were examined. Test results are presented using a pilot as supervisor over a servomechanism. It was concluded that the visual reconstruction system was shown to have image inaccuracies, and its reliability has not reached the standards of the rest of the assembly. J.A.M.

N70-36225# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALYTICAL METHOD FOR DETERMINING THE SERVICE LIFE OF OIL IN AN ENGINE
V. N. Sukharnikov et al 20 Feb. 1970 11 p refs Transl. into ENGLISH from Samoletostroenie i Tekhn. Vozdushnogo Flota (USSR), no. 13, 1968 p 132–136
(AD-703999; FTD-HT-23-660-69) Avail: CFSTI CSCL 11/8

A method, based on theoretical considerations and experimental data, is suggested for determining the service time of a lubricant in any aircraft engine. The study includes numerous equations e.g.: formula for determining the processes of oxidation in relation to various operational elements of the engine and properties of lubrication oil; a formula for determining engine wear in relation to its parameters and lube oil properties; a formula for determining the content of inorganic admixtures in the lube oil; and a formula for determining engine wear as affected by the inorganic admixtures in the lube oil. TAB

N70-36237# New York, N.Y. Geophysical Sciences Lab.
ORBIT UNCERTAINTY AND SEA-SURFACE ALTIMETRY
Frederick C. Jackson Mar. 1970 35 p refs
(Contract N62306-68-C-0249; N62306-70-A-0075)
(AD-705268; GSL-TR-70-5) Avail: CFSTI CSCL 8/5

The extent to which unknown disturbances in orbit will affect the accuracy of an altimeter-derived geoid is investigated. A simple perturbation scheme is developed to examine the effects of isolated geopotential anomalies on a 600 km satellite in circular polar orbit. Hypothetical geoid undulations representing two different scales of anomalous geopotential are expanded in zonal harmonics. The resulting perturbations are analyzed and contrasted to the sea-surface (geoid) profiles. It is found that short-period fluctuations caused by mesoscale anomalies will amount to a few percent of the undulation amplitude; orbital-period fluctuations are likely to be ten times as large. Strong microscale anomalies such as those correlative to deep ocean trenches will cause disturbances on the order of 1 to 2 cm. It is concluded that with dense tracking (several fixes per revolution) overall errors in geocentric radius can be kept below 1 m; errors in computed orbit will not prevent the detection of sea-surface features of decimeter height, provided their scales are sufficiently small. Author (TAB)

N70-36250# Environmental Technical Applications Center (Air Force), Washington, D.C.
US NAVAL WEATHER SERVICE WORLD-WIDE AIRFIELD SUMMARIES. VOLUME 8, PART 8: UNITED STATES OF AMERICA (ALASKA AND HAWAII)
Apr. 1970 225 p
(AD-704607) Avail: CFSTI CSCL 4/2

The volume is part of a series of compilations which is world-wide in scope. It consists of climatological summaries for selected airfields in Alaska and Hawaii and for the climatic areas in which they are located. Author (TAB)

N70-36264# Naval Missile Center, Point Mugu, Calif. Systems Integration Div.
IN-FLIGHT COMPARISON OF THE KAISER FP-50 FLIGHT DIRECTOR WITH STANDARD C-131 INSTRUMENTS
K. D. Cross and A. C. Bittner, Jr. 11 Mar. 1970 30 p
(AD-702748; NMC-TP-70-10; JANAIR-690412) Avail: CFSTI CSCL 1/4

Results of a limited and exploratory in-flight comparison of the Kaiser FP-50 Flight Director with standard C-131 instruments are given. The flight director was installed in a modified C-131 airplane that was piloted by two experienced naval aviators. Data were collected and analyzed on errors associated with altitude, heading, pitch, and roll maintenance. Author (TAB)

N70-36265# Naval Ammunition Depot, Crane, Ind. Research and Development Dept.

MK-45 AIRCRAFT PARACHUTE FLARE OPTIMIZATION PROGRAM PRELIMINARY EVALUATION OF EXPERIMENTAL PARACHUTES AND PARACHUTE MATERIALS FLIGHT TEST SERIES NO. 1

Clenneth R. Koch Nov. 1969 28 p

(AD-702752; NAD-CR-RDTR-163) Avail: CFSTI CSCL 1/3

This report depicts the results of MK 45 Aircraft Parachute Flare flight tests (experimental parachutes) conducted at Naval Weapons Center, China Lake, California, on 26 June 1969 through 7 October 1969. This work was performed as authorized by AIRTASK NO. A05-532-057/323-1/W4703-03. Data obtained from these flight tests indicate the cross type parachute possesses the most advantageous characteristics for incorporation into MK 45 Aircraft Parachute Flare. Author (TAB)

N70-36285# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

OSCILLATIONS OF A SLENDER PROFILE IN SUBSONIC FLOW NEAR A SOLID GROUND PLANE

R. E. Gibson 15 Sep. 1969 15 p refs Transl. into ENGLISH from Gidrodinamika Bolshikh Skorostei (USSR), no. 1, 1965 p 74–83

(Contract NOw-62-0604-c)

(AD-703995; APL-CLB-3-T-600) Avail: CFSTI CSCL 1/3

An integral equation is derived for a slender wind oscillating in subsonic flow near a solid ground plane. The analysis is an extension of results obtained by Possio. The equation derived lends itself to solution by the small-parameter method. Author (TAB)

N70-36298# International Business Machines Corp., Poughkeepsie, N.Y. Systems Development Div.

HOLOGRAPHIC HEAD-UP DISPLAY Final Technical Report, 4Jun. 1968 –27 Mar. 1970

Thomas J. Harris, Rodman S. Schools, Glenn T. Sincerbox, David W. Hanna, and Dennis G. Delay 27 Mar. 1970 110 p refs

(Contract N00014-67-C-0453)

(AD-703683; JANAIR-680709) Avail: CFSTI CSCL 1/4

A head-up display system as used by an aircraft commander must provide a simulation of the real-world exterior to his vehicle, and, at the same time, represent any change in his attitude with respect to a predetermined segment of this real world. In the particular case of an aircraft landing approach, one can characterize the pilots view of the aircraft carrier and its subsequent variations into six degrees of freedom. The display must provide the view corresponding to the instantaneous values of these parameters and change as any one or more of the parameters change. This report describes the results of a continuation of the development work initiated in Phase I of the contract on displays of this type using sideband or carrier-frequency Fresnel holographic recorded images. The goals of Phase II were to study the various modes and techniques derived in Phase I and other possibilities, to select the approach that offered the best potential for use in Navy carrier-based aircraft and to build a laboratory model of this selected system. The selected approach uses a GaAs injection laser diode light source to interrogate a hologram of an aircraft carrier model. The real image from the hologram is optically relayed to a special IR vidicon, and the image is then transmitted electrically to a CRT monitor. Author (TAB)

N70-36309# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN ASPECTS OF METHODOLOGY OF ECONOMIC INVESTIGATIONS IN THE APPRAISAL OF AIRCRAFT SYSTEMS

S. A. Sarkisyan 3 Nov. 1969 31 p refs Transl. into ENGLISH from Tr. Aviatsionnyi Inst. (Moscow), v. 168, 1967 p 87–110

(AD-703162; FTD-MT-24-284-69) Avail: CFSTI CSCL 15/5

In view of the diversity of the existing aircraft systems, it is necessary to select optimal variants of these systems for the performance of specific (standard) operations; here optimality is construed as the solution of transport problems at minimum expenditure of labor and equipment. The selection of aircraft systems and the determination of the quantitative ratio between various systems of this kind must be carried out early in the design stage to assure a rational distribution of capital investments as well as to accelerate the production of the necessary types of aircraft. In this connection, certain general indicators of the economic effectiveness of aircraft are considered. These criterions may be divided into three groups: technical, technological and economic. The technical and technological indicators condition the level of transport efficiency of the aircraft systems and, together with the economic indicator, they determine the criterion of the economic effectiveness of the system, namely operating cost. The term operating cost in theory can be applied only with respect to specific aircraft systems, e.g. to agricultural aviation, which takes a direct part in the production process, to transport aviation, which serves production etc. Author (TAB)

N70-36322# West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.

OPTIMUM LOADING ON NONPLANAR WINGS AT MINIMUM INDUCED DRAG

John L. Loth and Robert E. Boyle Aug. 1969 47 p refs

(Contract N00014-68-A-1512)

(AD-704502; TR-19) Avail: CFSTI CSCL 1/3

A numerical technique was developed for computing the optimum spanwise load distribution on nonplanar wings of arbitrary shape. Munks criterion for minimum induced drag was used. The problem is solved in the two-dimensional Trefftz plane. The two-dimensional shed vortex sheet is assumed to have the same shape as the nonplanar wing from which it was shed. The vortex sheet in the Trefftz plane is subdivided into 2N segments. Each vortex sheet segment is assumed to have a linear vorticity distribution. The velocity induced at N-Q stations is determined with the Biot-Savart law. The problem is then reduced to solving a set of linear algebraic equations. The technique was applied to nonplanar wings with various dihedral angles and locations of the nonplanar wing sections. It was concluded that if the span is the limiting factor then it may be advantageous to use nonplanar wings. On the other hand, if the wing total peripheral length is limited, then the planar wing is always the most desirable configuration, with the highest lift over drag ratio. Author (TAB)

N70-36384# Trans-Sonics, Inc., Burlington, Mass.

HELICOPTER LIFT-MARGIN SYSTEM, VOLUME 1 Final Report

Vernon C. Westcott and Sidney B. Williams Feb. 1969 45 p

(Contract N00014-68-C-0300)

(AD-704601; JANAIR-690107) Avail: CFSTI CSCL 1/4

Helicopter power requirements are generally maximum when hovering out of ground effect (at least for speeds less than 100 knots). Thus takeoff and landing maneuvers are the most critical, since the power requirements may not be clear to the pilot at the time he must make the corresponding decisions. Power deficiencies at takeoff or landing are very hazardous. To maximize safety of takeoff and landing operations, a system has been devised which presents to the pilot his lift margin, a figure which represents the excess weight which could be accommodated under locally-existing barometric-pressure and outside-air-temperature conditions. The

system includes two kinds of compensators of which the first corrects available engine torque for ambient conditions and the second makes a similar correction for the ratio of gross weight to required power. Author (TAB)

N70-36395# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SCIENTIFIC AND TECHNICAL SOCIETY OF THE POWER INDUSTRY. CENTRAL BOARD. SECTION ON GASIFICATION: THEORY AND PRACTICE OF GAS COMBUSTION: SELECTED ARTICLES
Sh. A. Ershin et al 23 Oct. 1969 41 p refs Transl. into ENGLISH from Russian reports
(AD-700475; FTD-HT-23-247-69) Avail: CFSTI CSCL 21/2

Contents: Aerodynamics of a turbulent diffusion flame developing in cocurrent coaxial jets; The physical model of flameholding on blunt bodies; Development and stability of a diffusion gas flame in the wake of transverse air jets. TAB

N70-36412* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MULTISTAGE MULTIPLE-REENTRY TURBINE Patent
Warner L. Stewart and David G. Evans, inventors (to NASA) Issued 5 Jan. 1965 (Filed 24 Oct. 1962) 8 p Cl. 253-66
(NASA-Case-XLE-00170; US-Patent-3,164,369; US-Patent-Appl-SN-232914) Avail: US Patent Office CSCL 10A

A multistage axial flow reaction turbine incorporating a reverse flow reentry principle is described, in which the fluid reenters on the same side of the rotor from which it was discharged, the entry being at the upstream side and the exit at the downstream side of each stage. Multistaging is accomplished by passing the fluid flow through a single rotor several times. Reentry ducts direct the fluid flow between successive stages located in segments around the rotor annulus. The latter stages act to cool the rotor, allowing for high turbine inlet temperatures and high inlet enthalpies. P.A.B.

N70-36415# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BASIC TECHNICAL DATA OF THE ENGINE
E. L. Feldman 29 Sep. 1969 12 p Transl. into ENGLISH from Aviats. Turboreaktivnyi Dvigatel (Moscow), 1968 p 25–27
(AD-700477; FTD-MT-24-214-69) Avail: CFSTI CSCL 21/5

The document contains a list of data pertaining to the turbojet engine RD-3M-500. There is also a table giving operating conditions for the engine. TAB

N70-36419# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF THE REYNOLDS NUMBER ON TIP LOSSES
A. S. Maksudyan et al 5 Nov. 1969 13 p refs Transl. into ENGLISH from Ser. Tekhn. Nauk (USSR), v. 20, no. 2, 1967 p 53–59
(AD-700578; FTD-HT-23-247-68) Avail: CFSTI CSCL 21/5

An examination is made of the effect on the Reynolds number on tip losses in foil lattices and under conditions of a rotating turbine stage. The foil lattices were tested on a static stand, while the stages were tested on an experimental turbine. Careful finishing of the blade surfaces excluded the influence of roughness. Author (TAB)

N70-36423# Naval Air Development Center, Johnsville, Pa. Aero-Electronic Technology Dept.
HIGH CURRENT (SHORT-CIRCUIT) FACILITIES FOR AIRCRAFT CONTROL AND PROTECTIVE DEVICES Progress Report
P. F. Ardizzi 17 Jul. 1969 68 p
(AD-705504; NADC-AE-6863) Avail: CFSTI CSCL 14/2

The report describes the NAVAIRDEVCEN updated a-c and d-c high current (short-circuit) facilities for overload and rupture testing of aircraft control and protective devices; also outlined are the procedures and conditions covering the usage of the facilities by other governmental activities and industry. Author (TAB)

N70-36450# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE OPERATION OF AN AIR-FEED JET COMBUSTION CHAMBER UNDER UNSTABLE CONDITIONS
I. P. Goldaev et al Oct. 1969 12 p Transl. into ENGLISH from Samoletostr. Tekh. Vozdush. Flota (USSR), no. 5, 1966 p 59–64
(AD-700801; FTD-HT-23-354-68) Avail: CFSTI CSCL 21/2

An attempt was made to find the reasons for and the conditions under which pressure fluctuations occur in air-feed jet combustion chambers, and to study the effect of certain structural factors on the stabilization of the process. Author (TAB)

N70-36452# National Bureau of Standards, Washington, D.C. Technical Analysis Div.
NATIONAL BUREAU OF STANDARDS MODELING FOR THE NORTHEAST CORRIDOR TRANSPORTATION PROJECT
John Donaldson, Jane Duberg, Richard Ku, Gerald Miller, and William O'Neal Dec. 1969 133 p
(PB-190933; NECTP-213) Avail: CFSTI CSCL 13B

A description of the model and the procedures used are presented. Included is an algorithm for measuring transportation system characteristics, a model for forecasting travel demands, the interface procedure, a common carrier assignment model, and the processing procedure. Experience derived from the application of the model system is used in examining transportation problems, and possibilities for improving them. Author (USGRDR)

N70-36463# Naval Postgraduate School, Monterey, Calif.
AN INVESTIGATION OF OSCILLATIONS IN AN ADAPTIVE AIRCRAFT CONTROL SYSTEM UNDER LARGE INPUT COMMANDS
Larry Smith Wisler (M.S. Thesis) Jun. 1969 82 p refs
(AD-705074) Avail: CFSTI CSCL 1/3

An adaptive control scheme for aircraft was studied to find the cause of limit cycles which occurred under large input commands and to find a method for eliminating the oscillations. The complexity of the system equations dictated that all analytical studies be performed on simplified versions of the adaptive control scheme. After exhaustive analysis of the cause of limit cycles in the simplified systems and an investigation of possible fixes for this problem, it was decided that the oscillations were an inherent feature of the control scheme resulting from the servo and actuator lags. A second adaptive control scheme was thus developed which obtained more feedback information downstream of the aircraft actuator and series servo. A comparison of the two adaptive systems was made under similar flight conditions for the F-4 aircraft and the modified adaptive controller was shown to be practical and free of limit cycle oscillations by analog simulation. Author (TAB)

N70-36479 National Lending Library for Science and Technology, Boston Spa (England).
SOME FINDINGS ON THE FORMATION OF FOG AT L JUBL JANA-BRNIK AIRPORT
Mirko Kovach 2 Apr. 1970 8 p refs Transl. into ENGLISH from Drushtvo Met. Slov., Razprave (Ljubljana), no. 11, 1969 p 47 – 66
(NLL-M-9052-(5828.4F)) Avail: Natl. Lending Library, Boston Spa, Engl.: .1 NLL photocopy coupon

In the first part of the paper the percentage frequencies of visibility less than 1000 m for the 24 hours of the day and 12 months of the year are presented for Ljubljana-Brnik airport for the period 1964 to 1968. Some suggestions for forecasting the formation of radiation fog a few hours ahead are given as well. They are based on measurements of temperature and relative humidity in the thermometer screen (2 m) and on the control tower of the airport (25 m). Formation of fog can be predicted a few hours in advance by using temperature differences and relative humidity differences between the values in the screen and those on the control tower of the airport. Author

N70-36487# Naval Postgraduate School, Monterey, Calif.
AN EXPERIMENTAL INVESTIGATION OF THE SENSITIZATION OF ALIPHATIC HYDROCARBON FUELS
Dennis Raymond Laack Jun. 1969 55 p refs
(AD-704509) Avail: CFSTI CSCL 19/2

Jet aircraft fuels are relatively stable and safe to handle. Therefore they are not readily adaptable to weapons applications. A study of the sensitization of the jet fuel with solid additives was carried out. Comparisons between the mixtures with the different solid additives were made. An investigation of different ignition methods was also made to find a practical means of igniting the mixture. The results indicated that the jet fuel could be sensitized using a strong oxidizer in conjunction with either magnesium or red phosphorous. The fuel can also be ignited with a combination of chemicals. Author (TAB)

N70-36488# Lincoln Lab., Mass. Inst. of Tech., Lexington.
GENERAL RESEARCH Quarterly Technical Summary Report, 1 Nov. 1969 – 31 Jan. 1970
Frederick C. Frick, Herbert G. Weiss, Robert H. Kingston, John F. Hutzenlaub, and Alan L. Mc Whorter 15 Feb. 1970 49 p ref
(Contract AF 19(628)-5167)
(AD-704573; ESD-TR-70-6) Avail: CFSTI CSCL 17/9

Contents: Surveillance techniques; Digital computers; Psychology; Computer systems; Educational technology; Air traffic control; Optics and infrared; Mechanical engineering; Control systems; Microelectronics; and Solid state device research. TAB

N70-36489# Cornell Aeronautical Lab., Inc., Buffalo, N.Y. Aerodynamic Research Dept.
RESEARCH ON NONISENTROPIC GAS DYNAMICS Final Scientific Report, 1 Jan. 1965 – 31 Dec. 1969
Robert J. Vidal, John A. Bartz, and Gordon E. Merritt Jan. 1970 38 p refs
(Contract AF 49(638)-1433)
(AD-705655; CAL-AF-2041-A-6; AFOSR-70-0524TR) Avail: CFSTI CSCL 16/3

The four problems that were investigated are (1) the development of a probe to measure molecular speed ratio and its application in nozzle flows and free-jet expansions, (2) surface measurements (heat transfer, skin friction, and surface pressure) on a sharp flat plate and on wedges in hypersonic flows in the transition from free-molecule to continuum flow, (3) pseudo-transpiration at an orifice and its effect on measured pressures, and (4) studies using speed-ratio probes to determine the structure of the viscous shock layer on a sharp flat plate. The report summarizes the results of those investigations. Author (TAB)

N70-36515# Resource Management Corp., Inc., Bethesda, Md.
EXTERNAL COSTS AND BENEFITS ANALYSES, NECTP
Paul F. Dienemann and Armando M. Lago Dec. 1969 107 p refs
(Contract DOT-7-35297)
(PB-190944; NECTP-224) Avail: CFSTI CSCL 13B

Rational decision-making in the transportation sector requires consideration of externalities or third party effects. The study quantifies the incommensurable and imputed monetary values of costs and benefits of alternative NEC transportation system impacts on: noise, air pollution, aesthetics, safety, air and highway congestion, as well as the employment benefits from system construction. A final tableau of social costs and benefit impacts summarizes the monetary values of incremental impacts of new NECTP transportation modes (highspeed rail, tracked air cushion vehicles, STOL, and VTOL) over the social costs of a 1975 base case composed of auto, bus, conventional air, and the continuation of current NEC demonstration rail projects underway. Author (USGRDR)

N70-36520# Liege Univ. (Belgium).
BIFURCATION OF SPACE FRAMES Technical Report, Jul. – Sep. 1969
B. Fraeijs De Veubeke and A. P. Kabaila (Univ. of Sidney, Australia) Wright-Patterson AFB, Ohio AFFDL Mar. 1970 53 p refs
(Contract F61052-69-C-0004)
(AD-704570; SA-17; AFFDL-TR-70-36) Avail: CFSTI CSCL 13/13

A finite element for a prismatic member subjected to axial loads is derived for the stability analysis of elastic spare frames. The derivation is based on the face that in a stable state of equilibrium the second variation of the total energy is positive definite. A feature of the element developed is that the reduction of torsional rigidity due to the presence of axial stresses is taken into account. Several examples are presented. An excellent agreement with analytical results is obtained, where closed form solutions are available. Author (TAB)

N70-36581# Flying Personnel Research Committee, London (England).
AN ASSESSMENT OF THE AIRCREW EQUIPMENT ASSEMBLIES AND THE TYPE 9 EJECTION SEAT FOR THE HARRIER AIRCRAFT
J. H. Lemon, D. C. Reader, R. Harrison, and A. T. Prescott Nov. 1969 35 p refs
(FPRC/Memo-248) Avail: CFSTI

The type 9 ejection seat for the Harrier aircraft was assessed with various aircrew equipment assemblies and human subjects in a replica of the Harrier cockpit. An assembly using separate parachute and restraint harnesses and two quick release boxes was shown to be unacceptable and was discontinued in favour of an assembly using a parachute torso harness. This latter assembly was shown to be satisfactory. Modifications to incorporate this change are recommended and listed. Author

N70-36590*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPROXIMATION FOR DISTRIBUTION OF FLOW PROPERTIES IN THE ANGLE-OF-ATTACK PLANE OF CONICAL FLOWS

Joseph W. Cleary Washington Aug. 1970 37 p refs
(NASA-TN-D-5951; A-3615) Avail: CFSTI CSCL 20D

A simple approximation is made for the hodographs of stagnation-line streamlines in the angle-of-attack plane of conical flows that yields explicit equations for distributions of velocity and flow angle. It is assumed that shock angle and surface inclination are known and the flow is inviscid and isentropic. Comparisons with exact numerical solutions of the flow over right-circular cones demonstrate agreement over a wide range of cone angles and angles of attack for Mach numbers from one to infinity. Author

N70-36595*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SPACE TRANSPORTATION SYSTEM TECHNOLOGY SYMPOSIUM. VOLUME 2: DYNAMICS AND AEROELASTICITY

Jul. 1970 370 p refs Symp. held at Cleveland, 15-17 Jul. 1970; sponsored by NASA, Washington, D.C.
(NASA-TM-X-52876-Vol-2; E-5866) Avail: CFSTI CSCL 20K

Conference papers pertain to dynamic loads and response, aeroelasticity, and flight dynamics and environment.

N70-36605*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LIFTING AND CONTROL SURFACE FLUTTER

Robert C. Goetz *In its* Space Transportation System Technol. Symp., Vol. 2 Jul. 1970 p 177–198 refs

Avail: CFSTI CSCL 20K

Employing the space shuttle vehicle as a center of discussion, several potential problem areas of lifting and control surface flutter are surveyed. Topics very briefly discussed include flutter of planar lifting surfaces, stall flutter, interference flutter, control surface instabilities, and lifting body - surface flutter. Proposed or needed research in those areas where the state of the art is not presently sufficient to insure a safe and reliable space shuttle mission are delineated. Author

N70-36607*# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

THE RELEVANCE OF RECENT ADVANCES IN UNSTEADY AERODYNAMICS TO THE SPACE SHUTTLE PROGRAM

Walter J. Mykytow and J. J. Olsen *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 2 Jul. 1970 p 223–237 refs
Avail: CFSTI CSCL 20D

In the last ten years, progress in the linearized theory of unsteady aerodynamics has followed two courses, the improvement of the numerical procedures for isolated lifting surfaces, and later the extension of those methods to include the effects of mutual interference between two or more surfaces and bodies. Several examples of recent progress are given to illustrate that the prediction of steady or unsteady airloads on some complicated configurations, such as components of the space shuttle, can now be performed routinely and accurately. However, technological gaps exist and required research from the space shuttle viewpoint is delineated. Author

N70-36608*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

BUFFET AND AERODYNAMIC NOISE

Charles F. Coe *In its* Space Transportation System Technol. Symp., Vol. 2 Jul. 1970 p 238–247 (
Avail: CFSTI CSCL 20D

Buffeting is considered to be the random bending oscillations of overall vehicles and major structural components. Aerodynamic noise (which includes boundary layer noise) is caused by the flow unsteadiness, and is related to the surface pressure fluctuations causing buffeting and local panel response. The main sources of flow unsteadiness causing aerodynamic noise and buffeting are illustrated. The main sources are oscillating shock waves that occur at transonic and supersonic speeds, turbulent wakes, separated flow, attached turbulent boundary layers, vortices and possible flow separation from sharp cornered bodies, interference flows, and transitional flow. The flow over the MSC space shuttle concept in the launch configuration is discussed. However, the same sources of unsteady flow would occur on any configuration for both the launch and reentry phases of flight. Author

N70-36632*# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

OPERATION OF A THREE-FREQUENCY RIOMETER SYSTEM ON THE NASA 711 AIRCRAFT DURING THE 1969 AURORAL EXPEDITION

J. N. Bradbury 25 Jun. 1970 27 p
(Contract NASw-1966)
(NASA-CR-112356; LMSC/N-AP-70-1) Avail: CFSTI CSCL 04A

Riometric measurements are made of ionospheric absorption of cosmic noise in the D region, aboard the NASA 711 aircraft, during an auroral event. The instrumentation, modifications, and data acquisition procedures are described. A discussion of the new noise problems encountered, and the observed absorption events are described and correlated with all-sky camera, photometric, and satellite measurements. E.H.W.

N70-36636# Civil Aeronautics Board, Washington, D.C.

HOW FLYING GETS BETTER

Whitney Gillilland 1969 13 p refs Presented at Ann. Meeting of the Chamber of Com., Shreveport, La., 4 Dec. 1969
Avail: Issuing Activity

Progress in civil aviation is sketched. Incidences involving the Wright brothers are cited as well as comments on costs and benefits of aircraft and aircraft marketing, air transportation development, and community duties. J.M.

N70-36651# National Aviation Facilities Experimental Center, Atlantic City, N.J. Systems Research and Development Service.

INERTIAL NAVIGATION SUPPORT, PHASE 3 Final Report

Robert H. Mayer Mar. 1970 72 p refs
(AD-702090; NA-70-24; FAA-RD-70-3) Avail: CFSTI CSCL 17/7

The report considers several aspects of the use of inertial navigation and guidance in the U. S. Domestic Air Traffic environment. It presents flight test data taken on regular scheduled commercial cargo jet aircraft flights of the Sperry SGN-10 Inertial Navigation system (INS.) It further presents an operational study of inertial guidance as compared with the present VORTAC system of navigation. The results of the data analysis and the study indicate that it is feasible to use inertial navigation during the

enroute portion of the flight and that benefits can thereby be obtained. It also shows that very little use of the system could be realized in the terminal areas under the present standard instrument departures (SIDs) and approach procedures. A cost-benefit study showed that the cost of operation and ownership exceeded the benefits derived unless the cost of operation was prorated with some other service, such as international guidance. Author (TAB)

N70-36652# Boeing Co., Renton, Wash. Commercial Airplane Div.
INITIAL DEVELOPMENT OF AN AIRCRAFT HYDRAULIC SYSTEM FLUIDIC CIRCUIT BREAKER
David H. Smith 24 Feb. 1970 22 p ref
(AD-702172; D6-25522) Avail: CFSTI CSCL 1/3

The report describes the initial development of an aircraft hydraulic system circuit breaker for protection against major system leakage in the event of airplane damage. The circuit breaker compares supply and return flows, and all its functions are controlled by hydraulic fluidics. Successful circuit shutdowns were demonstrated, and recommendations are made to bring the unit to flight status. Author (TAB)

N70-36660*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRITICALITY STUDY OF MELTDOWN CONFIGURATIONS FOR NUCLEAR AIRCRAFT REACTORS
Conrad J. Lennon and Robert E. Hyland Washington Aug. 1970 20 p refs
(NASA-TM-X-2068; E-4973) Avail: CFSTI CSCL 18K

As part of a containment system study for the nuclear aircraft reactors, a description of the meltdown problem is presented along with curves of reactivity for reflected and unreflected slabs, spheres, and cylinders as a function of UO2 fuel loading, composition and size. These are presented to help the early design concepts avoid configurations that would cause excursions in the event of a core meltdown and thereby obtain a feasible containment system. Results are presented which indicate that masses that have melted down from reactors can be kept subcritical provided certain geometrical dimensions for specific dilutions of fuel are not exceeded within the containment system. Author

N70-36782*# National Aeronautics and Space Administration, Washington, D.C.
AMERICA IN SPACE. THE FIRST DECADE, AERONAUTICS
David A. Anderton [1969] 26 p refs
Avail: CFSTI CSCL 01B

Areas of research and development in the NASA program include not only exploration of space but also continued activities in aeronautics and the advancement of military and commercial aviation. Scientific and engineering disciplines provide substantial support for aircraft programs and contribute to the development of the X-15 airplane, the variable-sweep wing fighter, and the supersonic transport. Work is also performed in the low speed flight regime of helicopters and V/STOL aircraft and evolves in a spectrum of flexible wing configurations. G.G.

N70-36804* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PARACHUTE GLIDER Patent
Alan B. Kehlet, inventor (to NASA) Issued 23 Feb. 1965 (Filed 28 Sep. 1962) 7 p Cl. 244-152
(NASA-Case-XLA-00898; US-Patent-3,170,660; US-Patent-Appl-SN-227683) Avail: US Patent Office CSCL 01C

An aerochute capable of being packed and deployed similar to a parachute is described for controlling the landing of Apollo type spacecraft. Three parachutes are hinged together at three points along the edges of their canopies and the shroud lines from each parachute are gathered and connected to three separate control lines which are attached to a servo system carried by the spacecraft. The aerochute is controllable in pitch by deflection of a control parachute and in yaw by changing the relative positions of adjacent parachutes. The parachutes utilized for yaw control are provided with rudders for stabilization purposes. R.B.

N70-36807* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AIRPLANE TAKE-OFF PERFORMANCE INDICATOR Patent
Frederick J. Bailey, Jr., inventor (to NASA) Issued 9 Feb. 1965 (Filed 16 Sep. 1955) 7 p Cl. 73-178
(NASA-Case-XLA-00100; US-Patent-3,168,827; US Patent-Appl-SN-534901) Avail: US Patent Office CSCL 01D

An instrument is described for monitoring possible malfunctions during take-off by providing readings on excess thrust and resistance levels. The instrument is readily adjustable for different take-off weights and may be preset for altitude and temperature variations. An equation of motion for an aircraft during take-off is discussed. E.C.

N70-36809# Douglas Aircraft Co., Inc., Long Beach, Calif.
SONIC BOOM MODELING INVESTIGATION OF TOPOGRAPHICAL AND ATMOSPHERIC EFFECTS Final Report, Jun. 1969 – Jul. 1970
A. B. Bauer and C. J. Bagley Jul. 1970 212 p refs
(Contract FA-69-WA-2114)
(MDC-J0734/01; FAA-NO-70-10) Avail: CFSTI

An experimental program was undertaken to study the effects of: (1) topographical and structural shapes on sonic boom focusing, and (2) atmospheric turbulence on sonic boom signatures. These effects were modeled by firing projectiles and allowing the projectile N waves to interact with model shapes and with turbulent jets. The wave interactions were studied by means of shadowgraph pictures and microphone pressure records. The boom focusing parameters were related to the work of Ting and Pan. A canyon model showed wave amplification factors as large as 14 for a special shape and a particular wave direction of propagation. A large amount of statistical information was obtained from the turbulence interactions. This information was found to be in essential agreement with the theory of Crow, but the mechanisms of the shock front breakup and of certain nonlinear features are not understood. Turbulence scaling parameters are used to relate the model results to full scale. Author

N70-36810# Peat, Marwick, Livingston and Co., Washington, D.C.
NORTHEAST CORRIDOR TRANSPORTATION: PROBLEMS AND PROSPECTS Final Report
Dec. 1969 109 p
(Contract DOT-FR-9-0017)
(PB-190930; NECTP-210) Avail: CFSTI CSCL 13B

The report contains four parts, each based on a region within the Corridor. New York is examined first because of its impact on the remainder of the region. The other three regions covered are: Delaware Valley, Baltimore-Washington and New England. Each region is examined on the basis of four central points.

A preliminary investigation of historic growth patterns is followed by demand for transportation. The level of service in each region now and in the future is examined. Author (USGRDR)

N70-36811# MITRE Corp., Baileys Crossroads, Va.
COST ANALYSES FOR NECTP. VOLUME 2: AIR AND HIGHWAY MODES
William Leathwood and John L. Vialet, Jr. Dec. 1969 74 p refs
(Contract DOT-7-35248)
(PB-190943; MTR-4105-Vol-2; (NECTP-223-Vol-2) Avail: CFSTI CSCL 13B

The document contains a description of the cost analysis of conventional aircraft, vertical and short take-off and landing aircraft, automobile, and intercity bus modes done in support of the Northeast Corridor Transportation Project of the U.S. Department of Transportation. It presents cost characteristics of each mode, relation to other Northeast Corridor models, and appraisal of results. Author (USGRDR)

N70-36814# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
AN EXPERIMENTAL INVESTIGATION OF MACH 2.2, TURBULENT BOUNDARY LAYERS IN NOMINALLY ZERO PRESSURE GRADIENT, OCTOBER 1967 – SEPTEMBER 1968
B. Edwards and S. Sivasegaram Oct. 1968 53 p refs
(BL/TN/3) Avail: CFSTI

A small supersonic wind tunnel with a working section 4 ft. long by 12 inches wide and whose flexible roof is approximately 2 inches above the floor for most of its length, is described. Its associated instrumentation, in particular a floating element balance and a form of surface probe for skin friction measurements, is also described. Velocity profile and skin friction measurements, obtained in the turbulent boundary layer on the floor of the tunnel under nominally zero pressure gradient, Mach 2.2 flow conditions, are recorded. The accuracy and reliability of the results are discussed in detail. It is concluded that the tunnel and its instrumentation may be reliably used in cases of near-zero pressure gradient flows. Author

N70-36824* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC MEASURING DEVICE Patent
Virgil S. Ritchie and Howard F. Ogden, inventors (to NASA) Issued 23 Feb. 1965 (Filed 29 Jun. 1961) 7 p Cl. 73-212
(NASA-Case-XLA-00481; US-Patent-3,170,324; US-Patent-Appl-SN-120797) Avail: US Patent Office CSCL 14B

A cylindrical pressure sampling probe is described for sensing ambient static air pressures on high speed aircraft. Advantages of the probe include: operation over a wide Mach number range, insensitivity to altitude variations over a considerable range of angles of attack, and insensitivity to air stream alignment changes. J.M.

N70-36825* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AIRCRAFT WHEEL SPRAY DRAG ALLEVIATOR Patent
Walter B. Horne, inventor (to NASA) Issued 9 Feb. 1965 (Filed 2 Dec. 1963) 8 p Cl. 244-103
(NASA-Case-XLA-01583; US-Patent-3,169,001; US-Patent-Appl-SN-327565) Avail: US Patent Office CSCL 01C

A device is described for alleviating wheel spray drag on dual tandem landing gear operating on runways covered with slush or water exceeding one-half inch depth. Deflector plates are connected to the dual tandem landing gear so that the front wheel fluid spray is prevented from impinging on the rear wheels, resulting in fluid drag reduction on the gear system. Advantages of the deflector include: increase take-off acceleration and performance, minimum effect on aircraft aerodynamic characteristics, simple design, easy installation and maintenance, reliability under adverse runway conditions, and economical manufacturing. J.M.

N70-36848# National Aviation Facilities Experimental Center, Atlantic City, N.J.
LIVE TESTS OF TOWER CAB RADAR APPROACH CONTROL PROCEDURES Final Report, Apr. 1969 – Apr. 1970
J. Roy Bradley, Jr. and Hugh D. Milligan Aug. 1970 20 p Supported by FAA
(FAA-NA-70-38; FAA-RD-70-31) Avail: CFSTI

This project was conducted primarily to determine the operational feasibility of using bright radar indicator - tower equipment (BRITE-1) as a display to provide all standard radar services from low density control tower cabs and secondarily to delineate BRITE-1 installation and maintenance requirements involved with the tower cab radar approach control operation. Two BRITE-1 displays were installed to the control tower at Wilkes-Barre, Pa. along with appropriate radio and interphone equipment. The approach control operation was then moved from the terminal radar control (TRACON) room to the tower cab where all radar services were provided, on a test basis, for a 60-day period. Results indicate that it is feasible, and desirable, to provide all standard radar services from the tower cab, at low density radar facilities, using the BRITE-1 display. BRITE-1 installation and maintenance requirements involved with the tower cab radar approach control concept were determined and documented. Author

N70-36849# National Aviation Facilities Experimental Center, Atlantic City, N.J.
NAVAID FLIGHT CHECK CONSOLE Final Report
John E. Jensen Aug. 1970 31 p
(FAA-NA-70-57; E70-2) Avail: CFSTI

A portable receiving, conditioning, and recording system to evaluate the performance of common system enroute and terminal aids to navigation is described. The receiving equipment and signal conditioning are conventional, as is the presentation of displayed and recorded information. Features to facilitate recorder trace identification and to normalize and ease the operating specialist's workload were included. Flight tests were conducted with the system installed in DC-6B aircraft N-114. The recorded data compared favorably with equivalent data obtained in the same flight period using T-29 aircraft N-247, configured as a standard flight inspection aircraft. All of these flight tests were conducted in accordance with the applicable portions of the United States Standard Flight Inspection Manual. The Flight Check Console consists of a single channel self-contained airborne navigation system capable of receiving signals from VOR, TACAN, LOCALIZER, GLIDE SLOPE and MARKER BEACON stations in the various assigned frequency bands. It also provides self-contained VHF Communications and such signal conditioning, recording, control, and display features as to allow the analysis of transmitted signals for the purpose of determining performance. Author

N70-36851*# Grumman Aerospace Corp., Bethpage, N.Y.
ANALYSIS OF WING SLIPSTREAM FLOW INTERACTION
Antony Jameson Washington NASA Aug. 1970 150 p refs

(Contract NAS2-4658)
(NASA-CR-1632) Avail: CFSTI CSCL 20D

Theoretical methods are developed for calculating the interaction of a wing with circular and wide slipstreams from a row of propellers. Rectangular and elliptic jets are used as models for wide slipstreams. Standard imaging techniques are used to develop a lifting surface theory for a static wing in a rectangular jet. The effect of forward speed is approximated by multiplying the interference potential by a scalar strength factor, derived with the aid of studies of the interaction of a lifting line with an elliptic jet. A closed form solution is found for an elliptic wing exactly spanning the foci of an elliptic jet. A continuous wide jet is found to provide a substantially greater augmentation of lift than multiple separate jets, because of the elimination of edge effects at the gaps. With aid of the concept of the apparent mass influenced by the wing, simple formulas are developed for the lift and drag of wings in both wide and circular jets. These formulas provide the basis of a method suitable for engineering calculations. Predictions using this method show good correlation with existing experimental data for wings without flaps. Author

N70-36871# National Aviation Facilities Experimental Center, Atlantic City, N.J.
CHARACTERISTICS OF FIRE IN LARGE CARGO AIRCRAFT, PHASE 2 Final Report, 1967 – 1970
Julius J. Gassmann Sep. 1970 18 p refs
(FAA-RD-70-42; FAA-NA-70-16) Avail: CFSTI

The degree to which fire in large cargo compartments may be suppressed by shutoff of ventilation was investigated. Results of the tests indicated that this action alone would not protect the fuselage of large cargo aircraft from severe fire damage. Peak air temperatures occurring during fire increased significantly with increasing compartment size from 1,000 to 2,000 cubic feet and were similar with further increase in size to 5,000 cubic feet. Temperatures in the order of 1,800 F were reached in these larger compartments. An increase in percent loading resulted in a more severe fire condition for compartment volumes of all the sizes. A single cargo fire test indicated the use of bromotrifluoromethane at the time of detection and ventilation shutoff may be an effective means of greatly reducing peak temperatures and pressures and providing a longer control time. Author

N70-36902*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
THEORETICAL CONSIDERATIONS OF SOME NONLINEAR ASPECTS OF HYPERSONIC PANEL FLUTTER Annual Report, 1 Sep. 1968 – 31 Aug. 1969
S. C. Mc Intosh and J. I. Lerner 31 Aug. 1969 54 p refs
(Grant NGR-05-020-102)
(NASA-CR-112668; SU-AR-4) Avail: CFSTI CSCL 01A

Presented is a summary of the fourth year's research activity that has been divided into two more or less independent areas: (1) a study of the effects of aerodynamic nonlinearities on panel flutter at hypersonic speeds; and (2) an attempt to determine theoretically the effects of a turbulent boundary layer on the aerodynamic loading of an oscillating panel. The present study is aimed at improving existing theories to the extent of including all important effects while avoiding unnecessary complication in representing the boundary layer. Author

N70-36909# Hovey-Sores (Ottawa).
AN ANALYSIS OF AIRPORT SNOW REMOVAL AND ICE CONTROL Interim Report
D. J. Tighe, L. A. Garland, and J. C. Cairo Apr. 1970 118 p refs
(Contract FA-68-WAI-149)
(FAA-RD-70-39) Avail: CFSTI

An approach is described using modelling techniques by which airport snow removal and ice control systems may be evaluated on a cost effectiveness basis, taking into account (1) airport type, size, and structure; (2) incidence of snow and/or icing conditions; and (3) volume and type of air traffic. Technical characteristics of the equipment and systems are also discussed. Conclusions and recommendations are enumerated for factors influencing system design, current snow removal and ice control practices, and future research in airport snow removal and ice control. Author

N70-36912# Ohio Univ., Athens. Dept. of Electrical Engineering.
INSTRUMENT LANDING SYSTEM IMPROVEMENT PROGRAM Interim Report, Jan. 1969 – Jan. 1970
R. W. Redlich, R. H. Mc Farland, and J. T. Gorman Jan. 1970 124 p refs
(Contract FA-69-WA-2066)
(EER-5-10; FAA-RD-70-9; SRDS-RD-70-9) Avail: CFSTI

Two analog-type monitors were designed, built and tested to provide a reliable and accurate representation of the ILS localizer signal as seen by an aircraft flying on an approach. One monitor involves detector pickups at the radiating antenna elements and the other uses seven directional elements located 300 feet in front of the localizer array. Both monitors are designed to give quantitative representations of conditions in the far-field which are generated by a wide aperture source. Mathematical models are described which are used for predicting effects on localizer path due to large reflecting surfaces such as hangars and large aircraft. From these models information can be derived for the most critical placement of the reflecting surfaces. Calculations and discussions of the anomalous behavior of the glide paths at San Francisco, and Oakland, California are discussed. Author

N70-36916*# Connecticut Univ., Storrs. School of Engineering.
APPLICATION OF IMPERFECT, REDUCED-STATE RELAY CONTROL TO MODEL-REFERENCE SYSTEMS
T. M. Taylor Washington NASA Aug. 1970 75 p refs
(Grant NGL-07-002-002)
(NASA-CR-1645) Avail: CFSTI CSCL 09D

A design is proposed for model-reference controllers. In contrast to others, it leads to a controlled system in which the effects of several forms of imperfection may be evaluated. Such forms include relay dead-zone and hysteresis, saturation, additive noise in the switching function or filtered noise, error caused by neglecting transducer dynamics, and error caused by using filtered forms of measured states. The development leads to an estimate of the state bound that could result from the imperfections acting individually or together. Simulation results are obtained for an aircraft roll-control loop. Author

N70-36942# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
NOISE EXPOSURE FORECAST CONTOURS FOR AIRCRAFT, NOISE TRADEOFF STUDIES AT THREE MAJOR AIRPORTS Final Report
Dwight E. Bishop and Richard D. Horonjeff Jul. 1970 62 p refs
(Contract FA-68-WA-1900)
(FAA-NO-70-7) Avail: Issuing Activity

The relative effectiveness of three changes in aircraft operating procedures and/or aircraft hardware in reducing noise exposure around three major airports (O'Hare International, John F. Kennedy,

and Los Angeles International Airport) were rated by determining the relative change in land areas falling within Noise Exposure Forecast (NEF) 30 and 40 contours. For projected 1975 operations, sets of NEF contours were calculated for changes which included: power cutbacks after take off and two segment approaches for all aircraft, and retrofit of current four-engine turbofan aircraft with either acoustically-lined nacelles or with a quiet engine under development by NASA. At all three airports, substantial reductions in land areas within NEF 30 and 40 contours occurred with retrofits and operational changes; relative area reductions ranged from 30.5% to 59.5%. For operational changes only sizeable reductions (10.5 to 25%) in land areas occurred at Chicago and Los Angeles, but only minor changes were observed for New York. The differences in effectiveness in reducing NEF contours between lined nacelle and quiet engine retrofits were quite moderate, reflecting the increasing influence of noise from other aircraft on NEF values as four-engine turbofan aircraft noise levels are drastically reduced. Author

N70-36949# National Aviation Facilities Experimental Center, Atlantic City, N.J.
ATS-1 VHF COMMUNICATIONS EXPERIMENTATION Final Report, May 1967 – Dec. 1969
F. W. Jefferson Jun. 1970 87 p
(FAA-RD-70-12; FAA-NA-70-22) Avail: CFSTI

Eight flight tests were conducted utilizing the Applications Technology Satellite-1 (ATS-1) to obtain characteristic data of VHF communications links via satellite relay for use in over-ocean air traffic control subsystem design studies. Measurements of signal level, signal plus noise-to-noise radio, multipath propagation, voice intelligibility, adjacent channel interference, and 75, 1200, and 2400 bits-per-second digital communications performance were obtained. In general, overall communications reliability using the ATS-1 link was considered marginal. Author

N70-36950# National Aviation Facilities Experimental Center, Atlantic City, N.J.
EXECUTIVE SUMMARY OF TECHNICAL AND OPERATIONAL EVALUATION OF THE DIRECT ALTITUDE AND IDENTITY READOUT (DAIR) SYSTEM INTERROGATOR SET AN/TPX-42) Final Report, Sep. 1968 – Jul. 1969
Anthony D. Bradley and Robert L. Tarr Aug. 1970 16 p refs
(FAA-RD-70-29; FAA-NA-70-43) Avail: CFSTI

A summary of both the technical and operational evaluation of the AN/TPX-42 Direct Altitude and Identity Readout (DAIR) equipment is given. It includes a brief description of the system and a statement of the purpose and specific objectives of the effort. Following a statement of the testing and data collection methods employed during the evaluation, the major conclusions are listed concerning the technical suitability, operational capability, controller utility, maintainability, and reliability of the DAIR System. Author

N70-36951# Defence Research Establishment Suffield, Ralston (Alberta).
A REVIEW OF DRES STUDIES ON THE EFFECT OF BLAST ON GAS TURBINE ENGINES
J. C. Muirhead May 1970 40 p refs
(DRES-267) Avail: CFSTI

Experiments in which an Orenda 8 gas turbine engine was subjected to blast waves are described. The inlet of the engine was loaded with blast waves of up to 13 psi overpressure. Only minor effects, such as small transient changes in engine speed and tailpipe temperature, were observed. The exhaust of the engine was loaded with blast waves of up to 20 psi overpressure. At low engine speeds, blast pressures of about 10 psi were sufficient to cause compressor stall and combustion chamber flame-out. The exhaust bullet buckled under similar pressures while the engine was operating at high speeds. Author

N70-36959*+ National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RESEARCH IN AERONAUTICS AND SPACE
Mar. 1969 195 p
(NASA-TM-X-65099) Avail: CFSTI CSCL 05B

The aeronautical research program is aimed at improving the safety, utility, and effectiveness of aircraft over the entire speed range. The classes of aircraft considered in the Langley program are: (1) V/STOL and helicopter; (2) general aviation; (3) subsonic; (4) supersonic, and (5) hypersonic aircraft. The aeronautics research program is largely accomplished in-house with wind tunnels, other ground-based facilities and with the use of full-scale aircraft. Needs of both civil and military aeronautics are considered in the Langley program. The Langley space research program is concerned with the following classes of vehicles: (1) Launch vehicles; (2) manned spacecraft ; (3) unmanned spacecraft; and (4) scientific payloads. This program is accomplished through contract with significant in-house involvement of staff and facilities in supporting research and technology. The technical competence of the Center is also utilized to manage large space flight projects such as Lunar Orbiter and Viking directed toward the achievement of major national goals in space. Author

N70-36963# Lockheed Missiles and Space Co., Palo Alto, Calif.
DETERMINATION OF PARAMETERS OF THE ATMOSPHERE IN THE TRANSITION DOMAIN AT 80-120 km ALTITUDES
E. N. Golubev et al 1970 5 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow) v. 8, no. 3, 1970 p 467-470
Avail: National Translations Center, John Crerar Library, Chicago, Ill. 60616

A method is examined for computing the parameters of an undisturbed atmosphere, used in the case of measurements made on the surface of a blunt body moving at hypersonic velocities in various aerodynamic modes from free-molecule to continuum. Author

N70-36965# Technion - Israel Inst. of Tech., Haifa. Aeronautical Research Center.
THE IIT 40cm x 50cm INTERMITTENT, SINGLE JACK, FLEXIBLE NOZZLE SUPERSONIC WIND TUNNEL-CALIBRATION AT MACH NUMBERS 1.5 TO 3.0
I. Etsion, J. Rom, and M. Salomom Apr. 1970 22 p refs Presented at 33d Semiann. Meeting of the Supersonic Tunnel Assoc., El-Segundo, Calif., 7 – 8 May 1970
(TAE-110) Avail: CFSTI

A test program was conducted to calibrate the test region of the 40cm × 50cm single jack, flexible nozzle supersonic wind tunnel. A general description of the wind tunnel as well as results of the calibration at nominal Mach numbers of 1.5, 2.0, 2.5 and 3.0 are presented. The maximum Mach number variation was + or − 0.01 along the centerline of the sidewall and also + or − 0.01 in the test cross section area for all these Mach numbers. Author

N70-36966# Weapons Research Establishment, Salisbury (Australia).
ANALYTICAL INVESTIGATION OF SPINNING BEHAVIOUR

AND RECOVERY FROM THE DEVELOPED SPIN OF A 60 DEG DELTA-WING AIRCRAFT CONFIGURATION USING A HIGH-SPEED DIGITAL COMPUTER
R. Wilson Sep. 1968 60 p refs
(WRE-TN-HSA-137) Avail: CFSTI

An analytical investigation of the nature of the spin behavior and possible means of recovery from the developed spin for a 60 deg delta-wing aircraft configuration was made using a high-speed digital computer. Details of the computational technique and aerodynamic characteristics of the configuration are described. Author

N70-36967# Federal Aviation Administration, Washington, D.C.
THE NATIONAL AVIATION SYSTEM POLICY SUMMARY
1970 147 p refs
Avail: SOD $1.50

A summary is given for the policies, requirements, goals, and criteria for the development of a national aviation system to be realized over the next 10 years. The plan is oriented toward facilities and functions. These plans are to be incorporated within the limits and constraints of the environment and the resources that are expected to be available. Author

N70-36981*# Syracuse Univ. Research Corp., N.Y.
GENERAL AVIATION WEATHER AVOIDANCE SENSOR STUDY
George M. Kirkpatrick Jun. 1970 227 p refs
(Contract NAS12-2032)
(NASA-CR-112774) Avail: CFSTI CSCL 01D

The report includes: (1) definition of the operational characteristics of on-board weather detection systems, (2) alternative techniques for single and dual in-line engine aircraft, (3) a survey of new system technology, particularly components for electronic scanning, and (4) several proposed system block diagrams with performance specifications and rough estimates on development and quantity production costs. A sketch of a proposed antenna configuration for a low-cost weather radar with an engine-driven scanner is shown. Laboratory measurements on the proposed antenna configuration are recommended for the first phase of a development program. Author

N70-36986*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
A COMPARISON BETWEEN EXPERIMENTAL DATA AND A LIFTING SURFACE THEORY CALCULATION OF VORTEX INDUCED LOADS
Wayne Johnson Aug. 1970 23 p refs
(Grant NGR-22-009-303)
(NASA-CR-112769; ASRL-TR-153-2) Avail: CFSTI CSCL 20D

A comparison is made between experimental data and theoretical calculations using a lifting surface theory solution for the loads induced by a free vortex on a single-bladed rotor operating at high advance ratio. Good correlation between experiment and theory is obtained when the vortex is not close to the rotor hub. Author

N70-37016# Rome Univ. (Italy). Scuola di Ingegneria Aerospaziale.
DESIGN CRITERIA AND CHARACTERISTICS OF THE BLOWDOWN WIND TUNNELS OF THE CENTRO RICERCHE AEROSPAZIALI [CRITERI DI PROGETTO E CARATTERISTICHE DEGLI IMPIANTI AERODINAMICI INTERMITTENTI DEL CENTRO RICERCHE AEROSPAZIALI]
Ugo Ponzi Jun. 1969 46 p refs In ITALIAN; ENGLISH summary *Its* ATTI del Centro Ric. Aerospaziali No. 22
Avail: CFSTI

After general consideration of blowdown wind tunnel operation, the basic criteria and methods for their design and for the calculation of their characteristics are reviewed. The three main elements of these facilities, the air storage, vacuum, and thermal capacity heating systems, are discussed and the blowdown wind tunnels of the Centro Ricerche Aerospaziali (CRA) are described. Author (ESRO)

N70-37021# National Aviation Facilities Experimental Center, Atlantic City, N.J.
SIMULATION OF A CONTINUOUS RUNWAY CENTERLINE MARKING Interim Report
Guy S. Brown and Richard L. Sulzer Aug. 1970 27 p
(FAA-RD-70-40; FAA-NA-70-21) Avail: CFSTI

A simulation study was conducted to compare a continuous runway paint marking with the U.S. standard broken centerline stripe under low-visibility conditions. Overall results showed no strong preference for the guidance value of the continuous centerline. Despite this, the most experienced pilots reported advantages in the continuous mark in that it could be seen farther in reduced visibility and gave slightly better guidance; however, they indicated only a moderate strength of preference. Highlighting one advantage of an interrupted centerline marking, pilots stated the need for speed information. A strong chance was noted that the location of the markings could be confused if the present standard system were revised by exchanging the locations of interrupted and continuous markings. Pilots also reported that VFR as well as instrument runways need to have a common marking. The preferences and comments of the most experienced subject pilots suggest that the present centerline could be improved for low-visibility operations by reducing the length of the gap, without giving up the benefits of speed information, while retaining the broken centerline concept. Author

N70-37026# Federal Aviation Administration, Washington, D.C.
THE NATIONAL AVIATION SYSTEM PLAN. TEN YEAR PLAN, 1971–1980
1970 152 p
Avail: SOD $1.50

The National Aviation System Plan contains estimates of the expenditures needed to develop, establish, maintain, and operate the air traffic control, navigation, and associated systems during the 1971–1980 period, and to develop an adequate system of airports. This involves primarily: a) Research and Development Appropriation (R&D) which provides for necessary research, development and service testing; b) Facilities and Equipment Appropriation (F&E) which provides for the acquisition, establishment, and improvement of air traffic control and experimental facilities; c) Operations Appropriation (O&M) which provides for (1) operations, maintenance, and flight check of the ATC system, including administrative expenses for R&D; (2) establishment of facilities; and (3) carrying out the provisions of the Federal Airport Act; and d) Airport Development Appropriation which provides for grants under the Federal-aid Airport Program, grants to state aviation agencies to assist in airport planning and development, and grants to assist planning agencies in airport system planning. Other programs described in the plan include manpower recruitment and training, noise suppression, and aircraft safety and medical research. E.M.C.

N70-37030*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF VEHICLE BODIES AT CROSSWIND CONDITIONS IN GROUND PROXIMITY
Kalman J. Grunwald Washington Aug. 1970 141 p refs
(NASA-TN-D-5935; L-7088) Avail: CFSTI CSCL 20D

A series of force tests was conducted on unpowered, high-speed ground-vehicle model configurations to provide information on shapes of this type very near the ground. Of particular interest were the crosswind effects on the aerodynamic forces and moments of the six models tested. These tests were conducted

over the moving-belt ground plane in the 17 foot test section of a 300 MPH 7- by 10-foot tunnel at free-stream dynamic pressure values of 10 lb/ft sq. The results indicate that the half-circle configuration is desirable because of the low rolling moments it experienced; however, it did have higher lift values than the other configurations and, from a utility standpoint, could be impractical. The half-circle configurations with extended sides may make good compromise configurations. All the ground-simulation techniques employed; moving ground belt, fixed ground belt, and image model, gave reasonable representations of the overall aerodynamic trends. Author

N70-37033# National Aviation Facilities Experimental Center, Atlantic City, N.J.

A COMPARATIVE ANALYSIS OF INDIVIDUAL AND SYSTEM PERFORMANCE INDICES FOR THE AIR TRAFFIC CONTROL SYSTEM Final Report

Edward P. Buckley, William F. O'Connor, Tom Beebe, William Adams, Gordon MacDonald et al Sep. 1969 343 p refs (NA-69-40; RD-69-50) Avail: Issuing Activity

A simulation study was conducted to examine the relationships of several field facility air traffic controller performance indices with simulation-developed system performance measures. Thirty six air traffic controllers, ranging in age from 31 to 45, from four Air Route Traffic Control Centers served as test subjects. The study encompassed performance criteria developed within two distinct environments; namely, the controller's home facility where he controlled live traffic, and a specifically designed micro-system or one-man ATC system in a dynamic simulation environment at NAFEC. Thus, the experiment represented a comparative examination of several quantitative measures of system functioning derived from air traffic control simulation and, simultaneously, an investigation of these measures as indices for the objective evaluation of the individual air traffic controller. The study presents estimates of the relationship between various performance and evaluation indices. Data from the micro-system model suggested a new system performance criterion which was found sensitive to system load differences. Author

N70-37062# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

PRELIMINARY FLIGHT ASSESSMENT OF THE LOW-SPEED HANDLING OF THE BAC 221 OGEE-WING RESEARCH AIRCRAFT

C. S. Barnes and O. P. Nicholas London Aeron. Res. Council 1970 48 p refs Supersedes RAE-TR-67281; ARC-29913 (ARC-CP-1102; RAE-TR-67281; ARC-29913) Copyright. Avail: CFSTI; HMSO 11s; BIS $2.30

The handling of the BAC 221 slender-ogee-wing research aircraft, at speeds down to 114 knots ias and incidences up to 22 deg, is described. The major problems were of lateral/directional control at high angles of incidence when difficulty was experienced in preventing large sideslip angles from building up. At all angles of incidence in the low-speed range, the response to aileron was oscillatory. Longitudinal control was good, but at alpha = 22 deg a mild pitch-up occurred. Aerodynamic buffet increased at this incidence and vortex bursting is thought to have reached forward to the rear parts of the wing. Although approaches were made well below the minimum drag speed, speed control presented no difficulty. Cross-wind take-offs and landings presented no problems except during the ground run. Side-step maneuvers on the approach were made with no difficulty. Author (ESRO)

N70-37071# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

FREE-FLIGHT MEASUREMENTS OF PRESSURE AND HEAT TRANSFER ON THE LEE SURFACE OF A DELTA WING AT INCIDENCE (M = 1.0 TO 3.6)

G. H. Greenwood London Aeron. Res. Council 1970 46 p refs Supersedes RAE-TR-68246; ARC-31081 (ARC-R/M-3625; RAE-TR-68246; ARC-31081) Copyright. Avail: CFSTI; HMSO £1 3s; BIS $3.78

Pressure and heat-transfer measurements have been made on the lee surface of a delta wing at 14 degrees incidence in free flight over a Mach number range of 1.0 to 3.6 and at free-stream Reynolds numbers between 6 and 24 millions based on centreline chord. A comparison is made with the results from a previous free-flight model test to assess the effect on the lee surface pressure and heat transfer of a change in sweepback angle from 65.9 to 76 degrees. Author (ESRO)

N70-37072# Aeronautical Research Council (Gt. Brit.).

A SHORT STATIC PROBE WITH GOOD INCIDENCE CHARACTERISTICS AT SUPERSONIC SPEED

I. S. Donaldson and D. J. Richardson (Brit. Aircraft Corp.) 1970 20 p refs Supersedes ARC-29558 (ARC-CP-1099; ARC-29558) Copyright. Avail: CFSTI; HMSO 5s; BIS $1.10

Tests carried out on a short static probe at supersonic speeds between Mach numbers of 1.1 and 2.5 are described. The probe consists of a 50 deg included angle cone-cylinder having sensing holes 0.88 calibres aft of the cone-cylinder junction. The tests show that at zero incidence the probe measures a pressure (approximately independent of Mach number) of 0.793 times the local static pressure. They also show that, at up to 18 deg incidence in any pitch plane, the pressure measured is 0.763 + or −0.03 times the local static pressure. For a limited Mach number range near a Mach number of 1.6, this accuracy can be maintained to incidences over 30 deg. Relatively small internal differences between externally identical probes appear to have a significant effect on the incidence characteristics and in some respects can improve the performance. Author (ESRO)

N70-37073# Cambridge Univ. (England). Dept. of Engineering.

AN EXPERIMENTAL INVESTIGATION INTO THE BEHAVIOUR OF THE TURBULENT BOUNDARY LAYER WITH DISTRIBUTED SUCTION IN REGIONS OF ADVERSE PRESSURE GRADIENT

B. G. J. Thompson London Aeron. Res. Council 1970 73 p refs Supersedes ARC-31144 (ARC-R/M-3621; ARC-31144) Copyright. Avail: CFSTI; HMSO £1 17s; BIS $3.78

The developments of seven turbulent boundary layers have been measured on the upper surfaces of three suction aerofoils. Distributed suction was applied, in each case, through a porous plastic suction surface that occupied most of the chord. Good agreement was obtained between the measured development of R sub theta and the predictions of the two-dimensional form of the momentum integral equation when the new skin-friction law taking direct account of the effect of suction was used. The growth of H is predicted very accurately by Head's entrainment approach provided that laminar reversion is absent and that measured H values are used to start the calculations. The simple assumptions for velocity profile shape are found to be inaccurate when the adverse pressure gradients affect the inner region but, before this problem can be tackled satisfactorily, further investigation is required into profile behaviour in the absence of transpiration. Spanwise pitot traverses show that the measured layers are closely two-dimensional. The distribution of suction rate along the chord is also known accurately although surface tube traverses indicate that the supporting structure is partly blocking the suction flow. Author (ESRO)

N70-37079# National Aerospace Lab., Amsterdam (Netherlands).

COMPUTER APPLICATION OF A LINEARISED SUPERSONIC LIFTING SURFACE THEORY ON A CERTAIN

CLASS OF WINGS

T. E. Labrujere Jul. 1969 27 p refs Submitted for publication Sponsored by Neth. Min. of Defence
(NLR-TR-G-50) Avail: CFSTI

A computer program was prepared for the determination of the pressure distribution on a thin wing in supersonic flow. The applicability of the program was restricted to cases with completely supersonic trailing edges in the absence of interacting subsonic regions. This report describes the theory, the numerical evaluation, and the computer program and gives some numerical results. Author (ESRO)

N70-37085# *Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.*

A METHOD OF CORRELATING THE GROUND EFFECTS ON THE LONGITUDINAL CHARACTERISTICS OF SLENDER WINGS

D. L. I. Kirkpatrick 1970 32 p refs Supersedes RAE-TR-69190; ARC-31798
(ARC-CP-1095; RAE-TR-69190; ARC-31798) Copyright. Avail: CFSTI; HMSO 7s; BIS $1.40

A method of calculating the ground effect on the longitudinal characteristics of a slender wing when the span/height ratio is small is described. The results obtained are compared with those obtained from Gersten's method, valid when the span/height ratio is large. From these two sets of results a method of correlating the measured ground effects on the normal force and pitching moment on various slender wings is derived, and hence a means of estimating the ground effect on any slender wing at any height above the ground. Author (ESRO)

N70-37086# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME: SOME CHARACTERISTICS OF SEVERE TURBULENCE

G. E. King London Aeron. Res. Council 1970 53 p refs Supersedes RAE-TR-69150; ARC-31835
(ARC-CP-1098; RAE-TR-69150; ARC-31835) Copyright. Avail: CFSTI; HMSO 12 s; BIS $2.40

Severe turbulence characteristics suggested by an initial study of continuous trace records were tested by examining turbulence encountered over a larger number of flying hours. Records from 23,034 flying hours were searched for patches of severe turbulence and those which produced the highest acceleration increments on the aircraft are presented in detail. The largest acceleration increment in a patch was on average 1.3 times the value that would be predicted from a Rayleigh distribution of peaks. About a half of the patches occurred without warning, and examination of outside air temperature data suggests that little additional warning would be provided by a conventional ram air temperature measuring device. Author (ESRO)

N70-37120# *New York Univ., N.Y. Geophysical Sciences Lab.*

TRANSVERSE JET PLUMES Technical Progress Report, 1 Jan. 1969 – 31 Jan. 1970

James Halitsky and Edward J. Kaplin 31 Jan. 1970 27 p ref
(Contract AT(30-1)-3673)
(GSL-TR-70-4; NYU-3673-4) Avail: CFSTI

Wind tunnel tests were conducted to measure plume concentrations in a low-turbulence, steady air stream. Preparatory work included manufacture of a support rig for holding multiple sample probes, design and construction of a recording ohmmeter for rapid impinger analysis, and development of a new calibration curve for the shorter sampling period. A mathematical model has been written to generate a time mean plume for a turbulent atmospheric wind, using the low turbulence wind tunnel concentrations. NSA

N70-37138# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

LAMINAR BOUNDARY-LAYER CALCULATIONS COMPARED WITH MEASUREMENTS BY HUMMEL

J. C. Cooke London Aeron. Res. Council 1970 33 p refs Supersedes RAE-TR-67227; ARC-28747
(ARC-CP-1096; RAE-TR-29747) Copyright. Avail: CFSTI; HMSO 8s; BIS $1.70

Calculations by an integral method assuming small cross flow, and by a finite-difference method assuming the flow to be quasi-conical, were compared with measurements made available by D. Hummel (Technical University, Brunswick) on a highly swept delta wing at high incidence. It was found that the small cross-flow method gives a rough general picture of the flow but is inaccurate in details, especially velocity profiles. For this problem the quasi-conical method was more accurate over most of the flow field and gave a much better representation of the velocity profiles. Author (ESRO)

N70-37148# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

AEROELASTIC TEST EQUIPMENT FOR THE CONCORDE SST

Gerard Piazzoli 1970 9 p Presented at the 6th Intern. Symp. on Aerospace Instr., Cranfield, Gt. Brit., 23–26 Mar. 1970 Submitted for publication
(ONERA-TP-811) Avail: CFSTI

The harmonic test method was chosen for the fixed parts of the Concorde structure. Nineteen seismic electromagnetic shakers, of four different types, were located in various parts of the aircraft. The appropriation in flight of the vibratory modes was programmed, as was the sequence of test phases. For the control surfaces the impulse excitation method was preferred. Ten impulse generators, of 4000 and 6000 Newton thrust and adapted burning duration, were installed in fairings, in the plane of the control servodynes. The data were processed in the laboratory from magnetic recordings using automatic analogue equipment. Author (ESRO)

N70-37158*# *Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.*

DISPLAY INSTRUMENTATION FOR V/STOL AIRCRAFT IN LANDING

Noel A. J. Van Houtte (Ph.D. Thesis) Jun. 1970 155 p refs
(Grant NGL-22-009-025)
(NASA-CR-112779; MVT-70-2) Avail: CFSTI CSCL 01D

A V/STOL aircraft (of the tilt-engine type) was simulated and flown from cruise altitude to touchdown with severe wind disturbances, descending along glideslopes of 4.47 deg, 8.87 deg, and 17.3 deg. A general display program was written to display a skeleton scenery, consisting of lines connecting the runway boundaries, the glideslope lines, and several distance indicating poles. The piloting task consisted of staying in level flight until intercept of the glideslope, then in tracking the glideslope to hover, and in landing the aircraft with minimum impact velocity and maximum accuracy. The task was quite difficult, because of the lack of stability augmentation. The value of the perspective glideslope is shown in the ease of performing coordinated maneuvers, the consistency of touchdowns, accuracy of tracking the glideslope, the learning curve, and the effectiveness of the representation of the integrated real world outside picture. Author

N70-37161# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

MEASUREMENT OF THE MOMENTS AND PRODUCT OF INERTIA OF THE FAIREY DELTA 2 AIRCRAFT

C. S. Barnes and A. A. Woodfield London Aeron. Res. Council 1970 50 p refs Supersedes RAE-TR-68160; ARC-30973 (ARC-R/M-3620; RAE-TR-68160; ARC-30973) Copyright. Avail: CFSTI; HMSO £1 5s; BIS $4.95

The moments and product of inertia of the Fairey Delta 2 aircraft have been measured using the method of spring restrained oscillations. The moment of inertia results were satisfactory, but difficulty was found in determining the product of inertia due to unsatisfactory design of the single point suspension rig. A dependence of roll period on roll amplitude was discovered and this may be due to some form of ground effect. The damping in roll was found to vary with fuel state. The agreement between the manufacturer's estimates and the measured moments and product of inertia was poor, and there is clearly a continuing need for inertia measurements. Simple estimates of the fuel inertias compared well with the measured values, agreement being within the expected accuracy of the measurements. The fuel load of the Fairey Delta 2 is relatively small, and simple estimates for greater loads might be less satisfactory. Author (ESRO)

N70-37162# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

LOW-SPEED WIND-TUNNEL MEASUREMENTS OF OSCILLATORY ROLLING DERIVATIVES ON A SHARP-EDGED SLENDER WING. EFFECTS OF FREQUENCY PARAMETER AND OF GROUND

T. B. Owen London Aeron. Res. Council 1970 35 p refs Supersedes RAE-TR-68090; ARC-30623 (ARC-R/M-3617; RAE-TR-68090; ARC-30623) Copyright. Avail: CFSTI; HMSO 18s; BIS $3.60

A sharp-edged wing of gothic planform and aspect ratio 0.75 was oscillated in roll about the wing axis of symmetry, and the oscillatory rolling derivatives determined over a very wide range of frequency parameter. If the frequency parameter is increased until the wavelength of the rolling oscillation is comparable with the wing chord, there is a marked increase of roll damping and reduction of roll stiffness at high incidence. Within the practical low-speed flight range of slender-wing aircraft designs, however, although some reduction of the stiffness derivative below its static value is likely at the highest values of incidence and frequency parameter, the damping coefficient is expected to be sensibly independent of frequency parameter at constant incidence. At practical values of frequency parameter the presence of ground leads to an increase of both roll damping and roll stiffness. While, at 10 to 15 deg incidence, there is little effect of ground if the trailing-edge clearance exceeds 0.4 of the wing span, both the damping and stiffness are more than doubled at a practical touch-down clearance of 0.05 to 0.07 of the wing span. Author (ESRO)

N70-37163# Royal Aircraft Establishment, Farnborough (England).

CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME. SPECIAL EVENTS RELATED TO AIRSPEED CONTROL PRACTICES (FEBRUARY 1963 TO FEBRUARY 1966)

A. W. Cardrick and K. D. Mephan, eds. London Aeron. Res. Council 1970 62 p refs Supersedes RAE-TR-69113; ARC-31672 (ARC-CP-1088, RAE-TR-69113; ARC-31672) Copyright. Avail: CFSTI; HMSO 15s; BIS $3.20

Since October 1962 continuous trace records of airworthiness data have been taken from a small number of aircraft in normal airline service. Throughout the recording period the records have been searched for unusual occurrences, and each of these has been studied to determine its nature and, where possible, its cause. This report describes a selection of events related to airspeed control practices which were detected in records taken between February 1963 and February 1966, and a study of exceedences of airspeed limitations. Author (ESRO)

N70-37164# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

LOW SPEED FLIGHT TESTS ON A TAILLESS DELTA WING AIRCRAFT (AVRO 707B). PART 2: LONGITUDINAL STABILITY AND CONTROL

W. G. A. Port and J. C. Morrall London Aeron. Res. Council 1970 53 p refs Supersedes RAE-TR-67198; ARC-30846 (ARC-CP-1105; RAE-TR-67198; ARC-30846) Copyright. Avail: CFSTI; HMSO 8s; BIS $1.70

Flight tests were made to measure the static and dynamic longitudinal stability, the effect of ground on stability, and the elevator power of the Avro 707B which has a delta wing swept back 44.5 deg. The results were compared with those of tunnel tests. There is a loss of static stability, stick fixed and free, above a lift coefficient of 0.5. Stick force/g at low speed is small particularly at the aft cg position, although no great difficulties were encountered due to this or the lack of static stability during the approach and landing. Author (ESRO)

N70-37168*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF HEAT-TRANSFER DISTRIBUTIONS IN DEEP CAVITIES IN HYPERSONIC SEPARATED FLOW

Allan R. Wieting Washington Sep. 1970 29 p refs (NASA-TN-D-5908; L-7059) Avail: CFSTI CSCL 20M

An experimental study was conducted in a 7-inch Mach 7 pilot tunnel to determine the local cold-wall convective heating rates to small rectangular cavities with width-depth ratios varying from 0.063 to 0.524. The tests were conducted at a nominal Mach number of 7.0, zero angle of attack, stagnation temperatures of approximately 3000 deg and 3400 deg R (1700 and 1900 K) stagnation pressures of approximately 1600 and 2000 psia (11 and 14 MN/sq m), and free-stream unit Reynolds numbers between approximately 14 and 23 million per foot (46 and 70 million per meter). The results of the study indicate that the local convective heat flux to the cavity increases with cavity width, is a maximum at the top of the forward-facing wall, and decreases monotonically along the wetted perimeter of the cavity. The experimental heat flux distributions are in good agreement with theory when the flow within the cavity is primarily inviscid. The results also indicate that the average cavity heat flux is, in general, less than the corresponding flat-plate heat flux. Author

N70-37172# Royal Aircraft Establishment, Farnborough (England).

AIRCRAFT BRAKING FRICTION TRIALS ON A COARSE OPEN GRADED MACADAM RUNWAY SURFACE

E. J. Key and E. M. Minter Jun. 1969 62 p refs (RAE-TR-69123) Copyright. Avail: CFSTI

Accelerate-brake trials were made on a coarse open graded macadam runway surface, with a Scimitar Mk.1 aircraft to measure braking friction in wet conditions. For comparison, trials were also made on shallow, transverse grooved and ungrooved asphalt surfaces. Although the aircraft had to be given up before the planned test programme was completed, a tentative assessment of the surfaces was made from seven trials. These indicated that the open graded surface realised somewhat higher wet braking force coefficients than either of the other two surfaces, that the wet

open graded surface was almost as good as the dry grooved asphalt, and that the grooved surface was no better in wet conditions than the ungrooved. Moreover, the trials showed the necessity of using a test vehicle with a high braking performance and the desirability of nosewheel steering. Author (ESRO)

N70-37173# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
A BRIEF ACCOUNT OF SOME UNRECORDED TECHNIQUES FOR FLOW VISUALIZATION IN FLIGHT FOR LOCATING (A) BOUNDARY-LAYER TRANSITION AT ALTITUDE, (B) SHOCK-WAVE POSITION
W. E. Gray London Aeron. Res. Council 1970 13 p refs Supersedes ARE-TR-68188; ARC-30837
(ARC-CP-1090; RAE-TR-68188; ARC-30837) Copyright. Avail: CFSTI; HMSO 3s; BIS $0.70

Flow visualization techniques used in flight tests are described. One indicates boundary-layer transition on a wing with a "china clay coating, that is wetted at high altitude with a liquid of suitable volatility emitted by another aircraft; the result is photographed at altitude. The second shows the shock-wave position by the differential rippling of a viscous oil coating on the wing; at the same time, it also reveals laminar flow areas by unrippled oil. It relies on direct sunlight but is not over-sensitive to its direction. Comparative shock-wave results are given using an earlier direct sun-shadowgraph method which requires precise sun alignment and has been little used. Author (ESRO)

N70-37177# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: MINERAL COUNTY AIRLINES DBA HAWTHORNE NEVADA AIRLINES DC 3, NISS70 NEAR LONE PINE, CALIFORNIA, 18 FEBRUARY 1969
4 Feb. 1970 29 p
(PB-189650; NTSB-AAR-70-5) Avail: CFSTI CSCL 01B

The report contains the analysis, findings, conclusions, and recommendations as determined by the National Transportation Safety Board and Applicable to a DC 3 aircraft which crashed while the crew operated under instrument flight rules in high mountainous terrain, in an area where there was a lack of radio navigation aids. The aircraft crashed on the east slope of Mount Whitney all persons on board perished in the impact. USGRDR

N70-37196# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: ALLEGHENY AIRLINES, INCORPORATED, CONVAIR 580, N5802, NEAR THE BRADFORD REGIONAL AIRPORT, 24 DECEMBER 1968
28 Jan. 1970 49 p
(PB-189649; SA-410 ; NTSB-AAR-70-4) Avail: CFSTI CSCL 01B

The report contains the analysis, findings and conclusions, recommendations and corrective measures as determined by the National Transportation Safety Board and applicable to a Convair 580 aircraft which crashed while the crew attempted an instrument approach to runway 32 at Bradford Regional Airport, Bradford, Penn. USGRDR

N70-37215# National Research Council of Canada, Ottawa (Ontario).
QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 JANUARY–31 MARCH 1970
31 Mar. 1970 87 p refs
(DME/NAE-1970(1)) Avail: CFSTI

Radiation hazards involving supersonic transports are assessed on the basis of environmental and biological dose/effect relationships, and a tidal study of the St. Lawrence River using hydraulic and mathematical models is discussed. Other laboratory projects are mentioned. J.M.

N70-37241# Royal Aircraft Establishment, Bedford (England.) Aerodynamics Dept.
LOW-SPEED WIND-TUNNEL MEASUREMENTS OF THE OSCILLATORY LATERAL STABILITY DERIVATIVES FOR A MODEL OF A SLENDER AIRCRAFT (HP 115) INCLUDING THE EFFECTS OF FREQUENCY PARAMETER
J. S. Thompson, R. A. Fail, and J. V. Inglesby London Aeron. Res. Council 1970 58 p refs Supersedes RAE-TR-69018; ARC-31289
(ARC-CP-1097) Copyright. Avail: CFSTI; HMSO 13s; BIS $2.60

Low-speed tunnel tests on a model of the HP 115 aircraft provided a complete set of lateral derivatives for a range of frequency parameters. Over a range appropriate to full scale flight, the frequency parameter effects were small, but for very high values there was a marked reduction in some derivatives and there was evidence that the virtual inertias were about the same wind-on and wind-off. Some recent improvements in technique are also described. Author (ESRO)

N70-37242# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
ATMOSPHERIC GUSTS: A REVIEW OF THE RESULTS OF SOME RECENT RAE RESEARCH
J. Burnham London Aeron. Res. Council 1970 60 p refs Supersedes RAE-TR-68244; ARC-31113
(ARC-CP-1091) Copyright. Avail: CFSTI; HMSO 13s; BIS $2.60

Recent RAE research has been concerned with severe gusts and the situations in which they occur. In the stratosphere, mountain wave conditions and those in the vicinity of thunderstorm tops have been investigated. At lower altitudes, gusts in and near thunderstorms have also been studied, as have wind and gust effects likely to be significant during take-off and landing. This work has relevance both to aircraft operations and to aircraft design and mathematical models of severe gusts are also described. The effects of pilot control activity during flight through gusts is discussed. Author (ESRO)

N70-37314# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE LIFT AND SIDE FORCE ACTING ON A BODY IN TRANSONIC FLOW
E. D. Terent'ev [1970] 2 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 34, no. 2, 1970 p 324–325
Avail: National Translations Center, John Crerar Library, Chicago, Ill. 60616

A lift and side force distribution between the wake and the exterior transonic flow around a body is found for viscous and perfect gases. Radial and tangential gas components are given for the exterior flow along with velocity components from the wake, and a relationship between the constants associated with lift and side forces is shown. Exterior flow in an ideal gas and a viscous gas is compared and shown to agree. The flux of the transverse momentum components, calculated over the part of the control surface which passes through the wake, is independent of the distance from the body at which the surface passes. It is

concluded that the momentum flux entrained by the exterior flow is independent of the kind of gas in which the flow is analyzed, and should be identical for both perfect and dissipating gases. J.M.

N70-37334# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT. PUERTO RICO INTERNATIONAL AIRLINES, INCORPORATED DE HAVILLAND HERON 114-2, N563PR SIERRA DE LUQUILLO SAN JUAN, PUERTO RICO, 5 MARCH 1969
24 Apr. 1970 32 p
(PB-191991; NTSB-AAR-70-9) Avail: CFSTI CSCL 01B

The report contains the analysis, findings, conclusions and recommendations as determined by the National Transportation Safety Board and applicable to a De Havilland Heron 114-2. The aircraft crashed in the Sierra de Luquillo mountains while being vectored for an ILS approach to runway 7 at the San Juan International Airport, March 5, 1969. USGRDR

N70-37337# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
AIRCRAFT NOISE AND AIRPORT NEIGHBORS: A STUDY OF LOGAN INTERNATIONAL AIRPORT
Peter A. Franken and David Standley Mar. 1970 178 p refs
(Contract DOT-OS-A9-009)
(PB-190118; DOT/HUD-IANAP-70-1) Avail: CFSTI CSCL 01E

The report describes a study of means for providing relief from aircraft noise annoyance to residents of the vicinity of Logan International Airport, Boston, Massachusetts. The noise exposure situations in 1967 and 1975 are described in terms of such measures as land area, populations, schools, and hospitals affected. Operational noise abatement procedures considered include flight track changes, preferential runway systems, runway threshold shifts, aircraft type restrictions, power cutbacks, and schedule restrictions. Nonoperational abatement procedures considered include land use management and redevelopment, and acoustic insulation. The report also describes the utilization of abatement procedures at other major airports, and presents a generalization of the approaches developed in a form suitable for use by other airport authorities. Author (USGRDR)

N70-37342# Dartmouth Coll., Hanover, N.H. Thayer School of Engineering.
THE SEPARATED FLOW REGIME OF TWO-PHASE FLOW
Graham B. Wallis Sep. 1969 65 p refs
(Grant NSF GK-1841)
(PB-189804) Avail: CFSTI CSCL 20D

Contents: General theory; Gravity balanced by drag; Drag balanced by particle pressure; The sum of buoyancy and drag forces balanced by inertia; Interactions between buoyancy, drag, inertia and particle pressure; The Mach number; Interaction between buoyancy, drag and particle pressure; Apparent mass effects in one-dimensional two-phase flow. USGRDR

N70-37395*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF A POINTED NOSE ON SPIN CHARACTERISTICS OF A FIGHTER AIRPLANE MODEL INCLUDING CORRELATION WITH THEORETICAL CALCULATIONS
Joseph R. Chambers, Ernie L. Anglin, and James S. Bowman, Jr. Washington Sep. 1970 59 p refs
(NASA-TN-D-5291; L-7325) Avail: CFSTI CSCL 01A

An investigation was conducted to correlate the results of theoretical spin calculations with the results of free flight model tests for a contemporary fighter configuration. The study was designed to substantiate the theoretical methods before these methods are applied to studies of the spin and recovery characteristics of the airplane. In order to explain some of the results obtained, however, a series of wind tunnel tests which produced significant information on the effects of a long pointed fuselage nose on spin characteristics was conducted. Various techniques employed in the study included static and forced oscillation wind tunnel tests theoretical calculations, flow visualization tests, autorotation tests, and free spinning tests of dynamically scaled models. Author

N70-37453# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT. NORTHEAST AIRLINES, INCORPORATED, FAIRCHILD HILLER FH 227C, N380NE NEAR HANOVER, NEW HAMPSHIRE 25 OCTOBER 1968
1 Apr. 1970 63 p refs
(PB-191201; NTSB-AAR-70-7; SA-408) Avail: CFSTI CSCL 01B

The report contains the analysis, findings, conclusions and recommendations by the National Transportation Safety Board and applicable to a Fairchild Hiller FH-227C's crash. The aircraft had been cleared for an approach to the Lebanon Regional Airport, West Lebanon, New Hampshire. Included are the investigation and hearings. USGRDR

N70-37466*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
STUDY OF CONVECTIVE HEAT TRANSFER TO CONES AND CYLINDERS AT ANGLE OF ATTACK Final Report
W. G. Dean, C. J. Wojciechowski, and A. G. Bhadsavle May 1970 106 p refs
(Contract NAS8-24535)
(NASA-CR-102824; LMSC/HREC-D162315; HREC-4535-1) Avail: CFSTI CSCL 20M

A study effort directed toward developing handbook-type methods for predicting, without undue conservatism, aerodynamic heating rates to cones and cylinders at angle of attack is summarized. Applicability of these isolated body methods to composite body geometries consisting of cones and cylinders is discussed. Approximate methods for compression and expansion corner regions are given. In general, the test data trends were predicted well by several theories. Using the heat transfer theories that correlated best with the test data, extrapolations to typical boost trajectory flight conditions were made, and the results are presented in the form of graphs that can be used for rapid estimates of aerodynamic heating rates. To aid in the calculation, the local flow field properties for cones and cylinders are presented. Finally, two example calculations are made to illustrate the use of the graphs presented. Author

N70-37486# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: TRANS WORLD AIRLINES, INC., BOEING 707-331, N787TW, NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER, ATLANTIC CITY AIRPORT, POMONA, NEW JERSEY, JULY 26, 1969
25 Mar. 1970 59 p
(PB-191318; NTSB-AAR-70-8; FILE-1-0017) Avail: CFSTI CSCL 01B

Presented are the analysis, findings and recommendations

applicable to a Boeing 707's crash during a simulated three-engine, missed approach. One of the required proficiency check maneuvers included a simulated instrument approach and the execution of the missed-approach procedure, with a critical engine reduced to training idle in order to also simulate engine failure. While this simulated approach was in process, and after the landing gear and full flaps had been extended, fatigue failure of the left outboard spoiler actuator downline caused the loss of hydraulic fluid from the aircraft's utility hydraulic system. Author (USGRDR)

N70-37498# East Central Florida Regional Planning Council, Titusville.
A PLAN FOR THE FUTURE. REPORT 7: GENERAL AVIATION AIRPORT SYSTEM
Feb. 1970 8 p Sponsored by HUD Prepared in cooperation with Orange-Seminole-Osceola Planning Comm., Orlando, Fla.
(PB-191235) Avail: CFSTI CSCL 05A

The report summarizes the planning study of general aviation in Orange, Seminole and Osceola Counties. A detailed technical report is available which presents the entire study including rationale supporting the major recommendations. Author (USGRDR)

N70-37524*# Translation Consultants, Ltd., Arlington, Va.
INFLUENCE OF FLOW TURBULENCE ON THE EFFICIENCY OF HEAT TURBINE BLADE SYSTEMS
J. Elsner and J. Porochnicki Washington NASA Sep. 1970 17 p refs Transl. into ENGLISH from Zeszyty Nauk. Politech. Czestochow. Tech.-Mech. (Czestochowa), no. 3, 1969 p 95–113
(Contract NASw-2038)
(NASA-TT-F-13180) Avail: CFSTI CSCL 20D

The influence of turbulence on the flow through efficiency of turbines is analyzed using experimental data for the energy losses in blade cascades. Subsonic tests show that losses increase for both rotor and stator blades with increasing distance from blade trailing edge. The data demonstrate a sharp influence of initial flow turbulence on the results of wind tunnel tests. Author

N70-37529*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AERODYNAMIC DESIGN AND CALIBRATION OF THE MSFC THERMAL-ACOUSTIC JET FACILITY: COLD FLOW DUCT
K. D. Johnston and W. C. Tidmore 12 Sep. 1969 51 p refs
(NASA-TM-X-53907; MSFC-IN-AERO-69-1) Avail: CFSTI CSCL 14B

The aerodynamic design of the cold flow duct is reviewed, and some of the data obtained in the calibration test of the facility are presented. The calibration test showed that good control of the settling chamber pressure could be maintained from 689,000 N/sq m to 17 million N/sq m, well within the + or − 1 percent design limits and that the facility was generally suitable for a variety of tests requiring a cold jet exhausting into the atmosphere. Author

N70-37535*# Scientific Translation Service, Santa Barbara, Calif.
THE EFFECT OF THE LAW OF MOLECULAR REFLECTION ON THE AERODYNAMIC CHARACTERISTICS OF BODIES IN A RAREFIED GAS FLOW [O VLIYANII ZAKONA OTRAZHENIYA MOLEKUL NA AERODINAMICHESKIYE KHARAKTERISTIKI TEL V POTOKE RAZREZHENNOGO GAZA]
M. L. Kagan Washington NASA Sep. 1970 10 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. 1: Mat. i Mekhan. (Moscow), v. 25, no. 1, 1970 p 70–75
(Contract NASw-2035)
(NASA-TT-F-13250) Avail: CFSTI CSCL 01A

A model problem of a rarefied gas flow past a plate is solved for the case when the law governing the reflection of molecules varies continuously from diffusive to one in a direction normal to the surface. Author

N70-37542*# Translation Consultants, Ltd., Arlington, Va.
COMPARISON OF THE TAKEOFF AND LANDING PERFORMANCES OF JET- AND FAN- VTOL-AIRCRAFT [VERGLEICH VON START-UND LANDELEISTUNGEN STRAHLGESTUETZTER SENKRECHTSTARTER]
H. Herb Washington NASA Sep. 1970 54 p refs Transl. into ENGLISH of DFVLR, Brunswick report DLR-FB-69-61 p 1–42
(Contract NASw-2038)
(NASA-TT-F-13181; DLR-FB-69-61) Avail: CFSTI CSCL 01C

The demand for fast aircraft which could take off and land vertically led to a variety of types of aircraft. The advantages and disadvantages of the individual models are discussed with respect to the arrangement of the engines and the values attained by computing wind tunnel measurements and flight tests are compared. The investigations dealing with the performance of the different models during take-off and landing are presented. Author

N70-37551# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS BY MAKE AND MODEL OF AIRCRAFT. US GENERAL AVIATION, 1967. VOLUME 1: BEECH 23 AND 25, PIPER 3/PA-11, PA-12, PA-16, PA-18, PA-20, PA-22, PA-24, PA-25, PA-28 AND PA-32
Dec. 1969 719 p
(PB-192067) Avail: CFSTI HC$10.00/MF$0.65 CSCL 01C

The report contains the briefs of accidents involving Beechcraft and Piper aircraft occurring in 1967. Author (USGRDR)

N70-37552# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS BY MAKE AND MODEL OF AIRCRAFT. US GENERAL AVIATION: 1967. VOLUME 2: CESSNA 120/140, 140-A, 150, 170, 172, 175, 180, 182, 185, 190/195, 205/210
Jul. 1969 686 p
(PB-192068) Avail: CFSTI CSCL 01B

The report contains the briefs of accidents involving Cessna aircraft occurring in 1967. Author (USGRDR)

N70-37553# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS BY MAKE AND MODEL OF AIRCRAFT. US GENERAL AVIATION: 1967 VOLUME 3: TWIN ENGINE AIRCRAFT: AERO COMMANDER, BEECHCRAFT, CESSNA 310, PIPER PA-23 AND PA-30
Jul. 1969 244 p
(PB-192069) Avail: CFSTI CSCL 01B

The report contains briefs of accidents involvng the following aircraft: Aero Commander twin engine; Beechcraft twin engine; Cessna 310; and Piper PA-23 and PA-30. USGRDR

N70-37554# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
BRIEFS OF ACCIDENTS BY MAKE AND MODEL OF

AIRCRAFT. US GENERAL AVIATION: 1967. VOLUME 4: AERONCA 7 AND 11, ERCOUPE, GLOBE GC-1A, NAVION, LUSCOMBE 8, MOONEY MK 20/21, STINSON 108 AND TAYLORCRAFT
Jul. 1969 365 p
(PB-192070) Avail: CFSTI CSCL 01B

The report contains the briefs of accidents involving the following aircraft: Aeronca, Ercoupe, Globe, Luscombe, Mooney, Navion, Stinson and Taylorcraft. USGRDR

N70-37570*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A STUDY ON THE USE OF FIGHTER AIRCRAFT TO PROVIDE A ZERO g ENVIRONMENT IN SUPPORT OF SPACE MANUFACTURING EXPERIMENTS
12 Sep. 1969 39 p refs
(NASA-TM-X-53896; MSFC-R-ME-IN-68-19) Avail: CFSTI CSCL 01C

Systems development in support of space manufacturing and construction require a locally available, low cost, zero g testing method with time/cost variables between the present drop tower and orbital flight. Studies indicate that such a facility can best be provided by minimal conversion of a fighter-type aircraft. The T-38 should be considered the optimal aircraft for conversion; it can produce continuous zero gravity parabolas lasting 1 minute and 20 seconds. For initial conversion, the T-33 aircraft represents the best choice since it is more available and can be modified at a lower cost than the T-38; it is capable of a maximum single parabola time of 35.8 seconds. Removable pods equipped with instrumentation for monitoring of tests under zero g flight are recommended. These pods would be designed to fit available space within the aircraft or fasten to existing attach points external to the aircraft. Costs involved in modifying and operating the T-33 aircraft for zero g experimentation were estimated. Author

N70-37606# National Transportation Safety Board, Washington, D.C.
BRIEFS OF ACCIDENTS, 1969, NO. 1: US CIVIL AVIATION
Oct. 1969 332 p
(PB-188859) Avail: CFSTI CSCL 01B

The publication contains reports of U.S. Civil aircraft accidents, in brief format. The reports are reproduced directly from the coded record on magnetic tape by electronic data processing equipment. The cause factor, accident types, operational phases, and kinds of flying, contained in the report are tabulated. Author (USGRDR)

N70-37607# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT. DOUGLAS DC-3, N142D: NEW ORLEANS INTERNATIONAL AIRPORT (MOISANT FIELD), NEW ORLEANS, LOUISIANA, 20 MARCH 1969
1969 45 p
(PB-189376) Avail: CFSTI CSCL 01B

The report gives the analysis, findings, conclusions and recommendations as determined by the National Transportation Safety Board and applicable to a Douglas DC-3's crash while the crew attempted to land, the conditions being an ILS approach, RVR of less than 600 ft because of fog and smoke. USGRDR

N70-37608# National Transportation Safety Board, Washington, D.C.
A PRELIMINARY ANALYSIS OF AIRCRAFT ACCIDENT DATA, US CIVIL AVIATION, 1969
1969 30 p
(PB-189247) Avail: CFSTI CSCL 01B

The report provides a preliminary compilation and a statistical analysis of aircraft accidents in U.S. Civil Aviation that occurred during calendar year 1969. The compilation is in the form of several tables of statistical data which are attached as appendices. Author (USGRDR)

N70-37640# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
JET ENGINES AND FUELS
V. N. Zrelov et al 20 Feb. 1970 318 p refs Transl. into ENGLISH from the Russian
(AD-706167; FTD-HT-23-244-69) Avail: CFSTI CSCL 21/5

The report covers the effect of jet fuels on service properties of modern jet aircraft engines. Reasons for poor engine performance due to fuel are given and problems discussed on improvement of technical characteristics of engines and aircraft and extension of service life by using new and improved high quality fuels. A new method for improving jet fuel purity by coagulant additives is given. A reliable means of improving operation of fuel regulating devices is mentioned and an effective means for decreasing wear of plunger type fuel pumps and regulators by use of antiwear additives is given. Antifreeze additives which prevent fuel filter obstruction at high altitudes is discussed. Relationship of engine operation to fractional composition and volatility of fuels is described. Author (TAB)

N70-37666# Minnesota Univ., Minneapolis. Inst. of Technology.
MATHEMATICAL THEORY OF CONTROL OF NONLINEAR PROCESSES Yearly Report, 1 Jan. - 31 Dec. 1969
E. B. Lee May 1970 10 p
(Grant AF-AFOSR-1502-68)
(AD-706908; AFOSR-70-1500TR) Avail: CFSTI CSCL 12/1

Primary emphasis during the year has been on the development of controller design techniques for systems with distributed parameters, and time delays. Necessary, and in some cases sufficient conditions, were found for the determination of the control policy to use when there are delays in the control action as well as the state. These results could be used in the synthesis of controllers for vehicles which are in space and the control decisions are made by equipment or men on the earth. Various approximations to be used in the modeling of systems with distributed parameters have been investigated. Approximate models for systems with distributed parameters have been achieved using a lumped parameter approach with time delays in the interaction between the lumps. Such models retain essential features, such as controllability, of the distributed parameter system and should prove useful in the design of boundary controllers for flexible plates or membranes (which occurs in the control of certain large flexible aircraft structures). Significant results have been achieved in the theory of feedback control for linear systems with time delays and the quadratic performance criterion. Author (TAB)

N70-37667# Boeing Scientific Research Labs., Seattle, Wash.
INSTABILITY OF A TWO-DIMENSIONAL COMPRESSIBLE JET
C. H. Berman and J. E. Ffowcs Williams Jan. 1970 21 p refs
(AD-707257; D1-82-0952) Avail: CFSTI CSCL 20/1

A linearized analysis of the two-dimensional double vortex sheet model of a jet shows that inviscid jet instabilities occur over a wide range of frequencies at all jet Mach numbers. No particular frequency for maximum growth rate exists unless finite shear layer thickness effects are considered. It is suggested that the model describes the essential characteristics of a real jet disturbed by long

wavelength perturbations. The idea is advanced that the jet flow constitutes a broad band amplifier of high gain. Disturbances can grow rapidly to a size when non-linear effects bring about significant interaction with the mean flow. By seeding the jet with disturbances of a type that are highly amplified it is argued that gross features of the flow may be affected and that the jet may be rendered less noisy at high Mach number. It is argued that some of these ideas are supported by the observation that a supersonic jet diffuses at an unusually rapid rate when subject to the oscillatory condition known as screech. Author (TAB)

N70-37672# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE ENERGY SOURCES OF AVIATION ENGINES

Pin-Chuan Chang 15 May 1970 8 p Transl. into ENGLISH from Hang K'ung Chih Shih (Communist China), no. 7, 1960 p 16

(AD-707178; FTD-HT-23-213-70) Avail: CFSTI CSCL 21/4

After reviewing the properties and limitations of chemical fuels such as gasoline, solid fuel and hydrogen fuel, the report discusses the possibilities of ionic fuel and nuclear fuel, and their existing problems of application to aviation. It is stressed that due to the fast scientific progress and requirements, these pending problems may soon be solved. Author (TAB)

N70-37673# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

AXIAL COMPRESSOR AIRFOILS FOR SUPERSONIC MACH NUMBERS Final Report

Richard M. Hearsey and Arthur J. Wennerstrom Mar. 1970 109 p refs

(AD-707144; ARL-70-0046) Avail: CFSTI CSCL 21/5

The report concerns axial compressor airfoils suitable for operation at supersonic Mach numbers. Two, relatively versatile camber-line shapes and a common thickness distribution are mathematically derived. One camber line is particularly appropriate for blades of continuously positive camber. The other is capable of defining J-blades, S-blades or a smooth transition between the two. A method is presented whereby the airfoils are specified on arbitrary axisymmetric streamsurfaces and then are accurately redetermined' in Cartesian coordinates on planes normal to the stacking axis. A computer program implementing these calculations is presented and described in detail. This program determines the coordinates, calculates section properties, and provides direct plots for both coordinate systems. Author (TAB)

N70-37696# Bell Helicopter Co., Fort Worth, Tex.

A STABILITY AND CONTROL PREDICTION METHOD FOR HELICOPTERS AND STOPPABLE ROTOR AIRCRAFT. VOLUME 2: USER'S MANUAL Final Report, Dec. 1968–Feb. 1970

Billy J. Bird and Tyce T. McLarty Feb. 1970 164 p refs

(Contract F33615-69-C-1121)

(AD-706918; AFFDL-TR-69-123-Vol-2) Avail: CFSTI CSCL 1/3

The volume presents all documentation available to aid the user of the computer program developed in this work. The input format section provides an explanation of all of the quantities input to the computer program. Many of the inputs are defined by equations showing how they function in the program. This makes the use of the inputs as clear as possible. Four typical sets of input data are included as working examples. The output guide gives a thorough discussion of all of the forms of computer output obtained by the user. Author (TAB)

N70-37703# Weather Wing (3rd), Offutt AFB, Nebr. Aerospace Sciences Div.

AEROSPACE SCIENCES: TERMINAL FORECAST VERIFICATION

Ray J. Telfer, Randall C. Webb, and Limon E. Fortner, Jr., ed. Feb. 1970 36 p refs

(AD-707498; Rept-3; WW-TN-70-2) Avail: CFSTI CSCL 4/2

The paper presents philosophical and operational concepts of the 3d Weather Wing TAF Verification System. Discusses the concept of measuring forecasting performance relative to previous performance and the use of the automated forecast verification diagnostic material as a management tool. Author (TAB)

N70-37708# Weather Wing (1st), San Francisco, Calif. 96553.

CEILING AND VISIBILITY ATLAS FOR SOUTHEAST ASIA (1000/2 1/2) Final Report

May 1970 104 p Supersedes Rept-1WW-SS-105-12/1, May 1966

(AD-707496; Rept-1WW-SS-105-12/1) Avail: CFSTI CSCL 4/2

Consists of isoline maps (scale 1:9,000,000) of Southeast Asia showing the distribution of percent frequency of occurrence of ceilings > 1000 ft and visibility > 2 1/2 miles at 0100, 0400, 0700, 1000, 1300, 1600, 1900, and 2200 LST. This publication supersedes the Ceiling/Visibility Atlas for Southeast Asia (1000 and 2 1/2), published by 20th Weather Squadron in April 1966. Author (TAB)

N70-37709# Weather Wing (1st), San Francisco, Calif. 96553.

CEILING AND VISIBILITY ATLAS FOR SOUTHEAST ASIA (5000 AND 5) Final Report

May 1970 104 p Supersedes Rept-1WW-SS-105-12/2, May 1966

(AD-707494; Rept-1WW-SS-105-12/2) Avail: CFSTI CSCL 4/2

Consists of isoline maps (scale 1:9,000,000) of Southeast Asia showing the distribution of percent frequency of occurrence of ceilings = or > 5000 ft and visibility = or > 5 miles at 0100, 0400, 0700, 1000, 1300, 1600, 1900, and 2200 LST. This publication supersedes the Ceiling/Visibility Atlas for Southeast Asia (5000 and 5), published by 20th Weather Squadron in May 1966. Author (TAB)

N70-37723# RAND Corp., Santa Monica, Calif.

MEASURING PRICE AND PRODUCTIVITY CHANGE IN THE AIRCRAFT INDUSTRY

J. A. Dei Rossi Apr. 1970 38 p refs

(Contract F44620-67-C-0045)

(AD-706885; RM-5805-PR) Avail: CFSTI CSCL 5/3

The study examines the problems and issues involved in estimating price and productivity change in the aircraft industry. Price indexes are derived by using pounds of airframe weight as the measure of output for aircraft and parts and pounds of thrust for the engines. These indexes are combined to provide a single aircraft industry price index. Estimates of productivity change are made using a constant elasticity of substitution production function. Constant returns to scale are assumed, and the estimate of the production function scaling factor is taken as the measure of productivity. Assuming various positive annual rates of quality change flattens out the trend line for both the price index and the productivity index. An assumed rate of about 12 percent per year would eliminate the trend in both the price index and the productivity index. Changes in output price are seemingly the result of changes in quality and productivity more than of changes in input price. Author (TAB)

N70-37730# RAND Corp., Santa Monica, Calif.
SOME DESIGN POSSIBILITIES FOR TACTICAL AIRCRAFT IN THE DECADE AHEAD
Terrell E. Greene Apr. 1970 13 p refs
(AD-707042; P-4362) Avail: CFSTI CSCL 1/3

A brief overview is given of some design options for tactical combat and support aircraft during the next decade. Although continuing advances in vehicle technology are expected, it appears that exploitation of new technology for avionics and ordnance systems can produce the most significant improvements in over-all system capability. Selected design approaches are discussed to improve aircraft control and utilization and to aid in defense penetration and weapon delivery. The potential for using existing technology to develop remotely manned systems for tactical air applications is discussed. Author (TAB)

N70-37740# Naval Postgraduate School, Monterey, Calif.
A MULTI-CHANNEL INTERIOR COMMUNICATION SYSTEM UTILIZING TIME MULTIPLEXING
Carl William Kellem (M.S. Thesis) Dec. 1969 36 p refs
(AD-706723) Avail: CFSTI CSCL 17/2

The development of a multi-channel interior communication system utilizing a single wire as a transmission line was undertaken. The principle of time multiplexing was used incorporating the Pulse Amplitude scheme of modulation. Synchronization was accomplished by continuously transmitting a synchronization pulse from one 'Master' station to all other 'Slave' stations. This system permits mutually exclusive conversations between any stations concurrently. A master station and one slave station were built and tested. Using a 10-k Hz sampling frequency, a frequency response of from 100 Hz to 4.8 k Hz was obtained. By using solid-state devices throughout, the size and weight of each station are minimized. This, in conjunction with the need for only one connecting wire, makes this system ideal for modern aircraft. Author (TAB)

N70-37753# Advisory Group for Aerospace Research and Development, Paris (France).
HIGH REYNOLDS NUMBER SUBSONIC AERODYNAMICS
Jun. 1970 291 p refs Lectures Held at Rhode-Saint-Genese, Belgium, 21-25 Apr. 1969; Sponsored jointly by AGARD and Von Karman Inst.
(AGARD-LS-37-70) Avail: CFSTI

CONTENTS:

1. ADVANTAGES AND PROBLEMS OF LARGE SUBSONIC AIRCRAFT B. H. Little, Jr. (Lockheed-Georgia Co., Marietta) 13 p refs

2. AEROMECHANICS B. H. Little, Jr. (Lockheed-Georgia Co., Marietta) 31 p refs

3. SCALING EFFECTS ON SHOCK-INDUCED SEPARATION B. H. Little, Jr. (Lockheed-Georgia Co., Marietta) 13 p refs

4. SCALING EFFECTS ON DRAG PREDICTION J. H. Paterson (Lockheed-Georgia Co., Marietta) 13 p

5. HIGH REYNOLDS NUMBER SUBSONIC AERODYNAMICS D. M. Ryle, Jr. (Lockheed-Georgia Co., Marietta) 116 p

6. ADVANCED COMPUTER TECHNOLOGY IN AERODYNAMICS. LECTURE 1: COMPUTER-AIDED AIRCRAFT DESIGN B. H. Little, Jr. (Lockheed-Georgia Co., Marietta) 12 p refs

7. ADVANCED COMPUTER TECHNOLOGY IN AERODYNAMICS: A PROGRAM FOR AIRFOIL SECTION DESIGN UTILIZING COMPUTER GRAPHICS J. L. van Ingen (Tech. Hogeschool, Delft, Neth.) 34 p refs

8. ENGINE PERFORMANCE CONSIDERATINGS FOR THE LARGE SUBSONIC TRANSPORT B. Wrigley (Rolls-Royce, Ltd., Derby, Engl.) 15 p

9. THE AERODYNAMICS OF ENGINE COMPONENT DESIGN PROBLEMS ASSOCIATED WITH LARGE SUBSONIC AIRCRAFT R. Hetherington (Rolls-Royce, Ltd., Derby, Engl.) 37 p refs

N70-37754# Lockheed-Georgia Co., Marietta.
ADVANTAGES AND PROBLEMS OF LARGE SUBSONIC AIRCRAFT
B. H. Little, Jr. *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 13 p refs
Avail: CFSTI

The advantages of large aircraft are considered to be basically economy, which includes skin friction drag reduction, and secondarily passenger comfort and less air traffic congestion. Important problems are wing design for high subsonic speeds and good low speed performance, stability and aeroelastic effects, total configuration design and optimization, propulsion system integration requirements, and fluid flow scaling effects due to large vehicle size. The demands for large passenger and cargo aircraft is expected to be great. N.E.N.

N70-37755# Lockheed-Georgia Co., Marietta.
AEROMECHANICS
B. H. Little, Jr. *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 31 p refs
Avail: CFSTI

Fundamental concepts of unsteady aeromechanics and a few problems of greatest significance for large high speed subsonic aircraft are discussed. Aeromechanics is defined as the area of dynamic, low frequency interactions between aircraft and flight environment, such as flutter, buffet, and buzz. The status of unsteady aerodynamic theory is described, limited to attached flow and neglecting viscosity and heat conduction. Unsteady interference flow, subsonic and transonic flutter and buffet, transonic control surface buzz, and turbulence penetration buffet are considered. The specific aeromechanic problems discussed are auto and transonic buffet, whirl and wing flutter, aeroelastic optimization, and control surface buzz. N.E.N.

N70-37756# Lockheed-Georgia Co., Marietta.
SCALING EFFECTS ON SHOCK-INDUCED SEPARATION
B. H. Little, Jr. *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 13 p refs
Avail: CFSTI

Experiments with models in high speed subsonic flows are reviewed. It was found that good results were obtained when the following conditions are provided: a turbulent boundary layer upstream of the shock wave, shock strengths of sufficient magnitude to produce local separation, a flow adjacent to the boundary layer containing mixed subsonic and supersonic flows, and strong adverse pressure gradients downstream of the shock region. The state-of-the-art in wind tunnel testing is described, and it is felt that the significance of the interaction of separated flow regions found in experiments is confirmed by flight tests. The necessary conditions for transonic flight simulation and trailing edge criteria are mentioned. N.E.N.

N70-37757# Lockheed-Georgia Co., Marietta.
SCALING EFFECTS ON DRAG PREDICTION
J. H. Paterson *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 13 p
Avail: CFSTI

The problems in predicting the Reynolds number effect on drag during wind tunnel tests are discussed. Techniques in using wind tunnels to establish absolute drag level and to predict full scale drag levels are described, based mainly on skin friction drag increment are given. Determinations of the form factor, for finding the skin friction drag of a particular component, are outlined. Attempts at correlating profile drag with Reynolds number are evaluated, and wind tunnel drag testing techniques are discussed. N.E.N.

N70-37758# Lockheed-Georgia Co., Marietta.
HIGH REYNOLDS NUMBER SUBSONIC AERODYNAMICS
D. M. Ryle, Jr. *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 116 p
Avail: CFSTI

The phases in high speed subsonic aircraft design and development are discussed. Parametric design studies for evaluation aircraft systems and limited to trend indication and effects are outlined. Problems associated with wing shaping and contouring for high speed cruise conditions are discussed in detail, and those associated with body design are considered. The necessity for effective high lift design, approaches in design, high lift system effects, some C-5 high lift system development experience, and a design approach which may alleviate some of the problems are presented. Experience gained in developing stability and control, and flying qualities with the C-5 are described. N.E.N.

N70-37759# Lockheed-Georgia Co., Marietta.
ADVANCED COMPUTER TECHNOLOGY IN AERODYNAMICS. LECTURE 1: COMPUTER-AIDED AIRCRAFT DESIGN
B. H. Little, Jr. *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 12 p refs
Avail: CFSTI

Applications of computer graphics in aircraft design are described. Details are given on the design program, pressure reduction, program structural analysis programs, and a numerical control program for milling operations. N.E.N.

N70-37760# Technische Hogeschool, Delft (Netherlands).
ADVANCED COMPUTER TECHNOLOGY IN AERODYNAMICS: A PROGRAM FOR AIRFOIL SECTION DESIGN UTILIZING COMPUTER GRAPHICS
J. L. van Ingen *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 refs 34 p
Avail: CFSTI

Details are presented on the program for airfoil design and the aerodynamic analysis methods used. The complete program, including the application of computer graphics, is described, and applications of the aerodynamics subroutines are given. It is concluded that the use of computer graphics greatly facilitates the design process. N.E.N.

N70-37761# Rolls-Royce, Ltd., Derby (England).
ENGINE PERFORMANCE CONSIDERATIONS FOR THE LARGE SUBSONIC TRANSPORT
B. Wrigley *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 15 p
Avail: CFSTI

The relative importance of the design point parameters and factors influencing off-design performance are discussed. The parameters of importance are identified as the overall compressor total pressure ratio, turbine entry total temperature, component efficiency level, by-pass ratio, and fan total pressure. The limitations on the choice of thermodynamic cycle are outlined, and the interaction between by-pass ratio and fan total pressure ratio is described. Engine matching and off-design performance of a high by-pass engine are discussed with respect to turbine entry total temperature and mixed exhausts, and transient performance, windmilling, and sensitivity to offtakes and losses are considered. N.E.N.

N70-37762# Rolls-Royce, Ltd., Derby (England).
THE AERODYNAMICS OF ENGINE COMPONENT DESIGN PROBLEMS ASSOCIATED WITH LARGE SUBSONIC AIRCRAFT
R. Hetherington *In* AGARD High Reynolds Number Subsonic Aerodynamics Jun. 1970 37 p refs
Avail: CFSTI

Design considerations are discussed for the individual components of fan, gas generator multistage compressors, the LP turbine, and the HP turbine. Engine geometry, aspect ratio, intercompressor and inter-turbine ducts, air intake, inlet maldistribution, noise and model testing and ascale effects are included. Design techniques and computational procedures are described in general, and in particular for through flow analysis, blading techniques in turbines, and compressor blading at high incident Mach numbers. N.E.N.

N70-37787# Joint Publications Research Service, Washington, D.C.
AERONAUTIC NAVIGATION EQUIPMENT
26 Aug. 1970 81 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Priborostr. (Moscow), no. 2, 1967 p 85–87 no. 4, 1967 p 87–104 no. 5, 1967 p 85–90 no. 7, 1967 p 92–95 no. 4, 1968 p 93–103 no. 8, 1968 p 67–72 no. 1, 1969 p 84–87 no. 6 (year not given) p 91–96 (no. and year not given) p 114–118
Avail: CFSTI

CONTENTS:

1. SOME INSTRUMENTAL ERRORS OF GYROSCOPES M. A. Pavlovskiy p 1 - 4 refs

2. ON THE THEORY OF THE COMPENSATING GYROAZIMUTH V. P. Demidenko et al p 5 - 10 refs

3. DYNAMIC BALANCING OF ROTORS V. Ye. Myachin p 11 - 17 refs

4. ERROR INFLUENCE OF A REAL ACCELEROMETER ON THE MEASURING ACCURACY OF ANGULAR VELOCITY V. I. Lopatin p 18 - 23 refs

5. CALCULATION OF THE AERODYNAMIC DRAG MOMENT FOR A GYROMOTOR OPERATING IN AIR B. A. Delektorskiy et al p 24 - 30

6. THE EFFECT OF THE ELECTROMECHANICAL MOMENT OF A GYROMOTOR ON THE SYSTEMATIC DRIFT OF A TRIAXIAL GYROSTABILIZER V. S. Slepkov p 31 - 37 refs

7. DETERMINATION OF MAGNETIC MOMENT OF MAGNETIZED GYROSCOPE I. A. Ushakov p 38 - 44 refs

8. INVESTIGATION OF THE PROBABILITY DISTRIBUTION FUNCTION OF RADIAL ERRORS IN A PLANE D. N. Davydov p 45 - 52 refs

9. DRIFTS OF A GYROSCOPE ON A ROTATING BASE V. P. Vedenin p 53 - 60 refs

10. ON THE APPLICATION OF SELF-ADJUSTING SYSTEMS IN DIRECTIONAL GYROSCOPES V. P. Demidenko et al p 61 66 refs

11. CERTAIN ERRORS IN INERTIAL NAVIGATION SYSTEMS E. I. Sliv et al p 67 - 72

12. INERTIAL NAVIGATION SYSTEM ERRORS DUE TO INTERGRATION INACCURACY Ye. I. Sliv et al p 73 78

N70-37788# Joint Publications Research Service, Washington, D.C.
SOME INSTRUMENTAL ERRORS OF GYROSCOPES
M. A. Pavlovskiy *In its* Aeron. Navigation Equipment 26 Aug. 1970 p 1-4 refs
Avail: CFSTI

Estimates are made of specific examples of increases of axial and centrifugal moments of inertia of the frame of a Cardan suspension arising from static balance of the instrument, and also the centrifugal moment of inertia of the rotor arising from inaccurate dynamic balancing of it. Author

N70-37790# Joint Publications Research Service, Washington, D.C.
DYNAMIC BALANCING OF ROTORS
V. Ye. Myachin *In its* AERON. Navigation Equipment 26 Aug. 1970 p 11-17 refs
Avail: CFSTI

The problem of combined determination and correction of unbalanced rotors is considered. The processes of locating and eliminating the unbalance and the establishment of prerequisites for the effective automation of all processes of dynamic balancing are included. Author

N70-37791# Joint Publications Research Service, Washington, D.C.
ERROR INFLUENCE OF A REAL ACCELEROMETER ON THE MEASURING ACCURACY OF ANGULAR VELOCITY
V. I. Lopatin *In its* Aeron. Navigation Equipment 26 Aug. 1970 p 18-23 refs
Avail: CFSTI

Consideration is given to errors in the measurement of components of the angular velocity of a moving object with the aid of an existing accelerometer mounted on the rotor, when its sensitive axis is parallel to the rotation axis and the angular rotation velocity is not stable. Curves are presented for the dependence of measurement errors on the measured values of angular velocity. Author

N70-37802# Advisory Group for Aerospace Research and Development, Paris (France).
MANUAL ON FATIGUE OF STRUCTURES. VOLUME 1: FUNDAMENTAL AND PHYSICAL ASPECTS
William G. Barrois Jun. 1970 295 p refs
(AGARD-MAN-8-70-Vol-1) Avail: CFSTI

CONTENTS:

1. STRENGTH OF STRUCTURES AND FATIGUE: GENERAL p 3-33 refs
2. PLASTIC STRAIN IN METALS p 37-70 refs
3. STATIC TESTS OF SPECIMENS: CREEP p 73-126 refs
4. STATIC STRENGTH OF NOTCHED OR CRACKED COMPONENTS p 129 200 refs
5. PHYSICAL CHANGES AND DAMAGE DURING FATIGUE p 203-278 refs

N70-37803# Advisory Group for Aerospace Research and Development, Paris (France).
STRENGTH OF STRUCTURES AND FATIGUE: GENERAL
In its Manual on Fatigue of Struct., Vol. 1 Jun. 1970 p 3-33 refs
Avail: CFSTI

A study intended for design and production engineers in the aircraft industry is presented. The representativeness of fatigue testing, strength of structures concept, and airframe fatigue are reviewed. Further discussion includes the following concepts: fatigue notations; fractures; Wohler S-N curve; stress concentrations, including scale effect and stress gradient, and test results on notched specimens; and the effect of static mean stress and residual stresses. P.A.B.

N70-37804# Advisory Group for Aerospace Research and Development, Paris (France).
PLASTIC STRAIN IN METALS
In its Manual on Fatigue of Struct., Vol. 1 Jun. 1970 p 37-70 refs
Avail: CFSTI

The way in which external loads and heating can change the atomic or molecular arrangement and affect its stability is examined. It is assumed that plastic development in metals before cracking causes a change in the relative plastic stiffnesses of neighboring small regions, even though the average stiffness increases, which results in the transfer of a portion of the external loads to smaller areas likely to break. Topics discussed are: work hardening and recovery, including slip, dislocations, and structural defects, slip planes, lamellae, and slip bands, and the Bauschinger effect; stability of atomic lattice distortions, including energy barriers and deformation bands, diversification of plastic stiffness on slip planes, the Cottrell effect, and residual stresses and strains; hot recovery and recrystallization; deformation and metallurgical transformations, including precipitation, aging, structural hardening, and martensitic transformation; and common features and differences in static and fatigue failures. P.A.B.

N70-37805# Advisory Group for Aerospace Research and Development, Paris (France).
STATIC TESTS OF SPECIMENS: CREEP
In its Manual on Fatigue of Struct., Vol. 1 Jun. 1970 p 73-126 refs
Avail: CFSTI

Tensile tests are discussed with relation to the effect of the test rate on the stress-strain curve, the effect of temperature, the pre-straining effect, hardness, notch impact strength, and notch effect. The aspects of plastic deformation common to both static testing and creep are examined, and the apparent differences due to the time and temperature ranges are considered. Straining in crystals, a description of creep, graphic representations and mathematical approximations of creep, creep life, the effect of pre-strain, and intermittent creep are discussed. Simultaneous stresses and yielding are considered, including simplified assumptions of plastic yielding theories and invariants of the states of stress and strain. Buckling during or after fatigue and creep is examined, with reference to eccentric buckling in the plastic range, changes in compressive stress-strain curves under the effect of hot soaking, creep, or fatigue, and hot static and creep properties. P.A.B.

N70-37806# Advisory Group for Aerospace Research and Development, Paris (France).
STATIC STRENGTH OF NOTCHED OR CRACKED COMPONENTS
In its Manual on Fatigue of Struct., Vol. 1 Jun. 1970 p 129-200 refs
Avail: CFSTI

The static strength of components containing various machined notches is examined, and a general survey of the problem associated with the static strength of cracked specimens is presented. Stress distribution in an infinite thin sheet having a transverse elliptic hole is considered with relation to the limiting case of the slot; a thin sheet of finite width having a transverse central slot is also discussed, along with plasticity correction. The initiation and growth of cracks are considered, including fracture modes on a submicroscopic scale, the stability concept, experimental measurement of the elastic energy released under deflection for a unit increase of the fractured area, the behavior of cracked plates in fatigue and static failure, and the effect of the sheet thickness. Solutions suggested by the theory of elasticity are examined for such problems as crack-tip stress field, crack at the edge of a circular hole, edge cracks in plates, and internal and surface cracks. Methods of prediction of the residual static strength of cracked components are discussed; physical methods applicable to thin sheet material are analyzed. Test data are included. P.A.B.

N70-37807# Advisory Group for Aerospace Research and Development, Paris (France).
PHYSICAL CHANGES AND DAMAGE DURING FATIGUE
In its Manual on Fatigue of Struct., Vol. 1 Jun. 1970 p 203-278 refs
Avail: CFSTI

The plastic process prior to the appearance of visible cracks is discussed with relation to adjustments and creep during fatigue; fatigue curves under constant amplitude strain loading; changes in stiffness and in damping during fatigue; changes in the magnetic quantities; electrical resistivity changes with plastic strain, annealing, and fatigue; fatigue gauges, and fatigue monitors. Fatigue crack propagation is considered, including the physical process; relative duration of crack initiation and crack propagation stages; crack growth rate; mean stress effect; frequency, temperature, and humidity effects; heat treatment effect; variations with the batch, the manufacturer, and the rolling direction; effect of load sequences; and the measurement and evaluation of the stress intensity factor in thin sheet structures. Facts concerning the average qualitative laws governing the behavior of materials and structures in fatigue are reviewed. The effect of stress gradient, damaging and improving changes during the fatigue process, and the improving effect of overloads on crack propagation are included in the survey. P.A.B.

N70-37817 Arizona Univ., Tucson.
GENERATION OF SUPOPTIMAL, CLOSED LOOP GUIDANCE FOR MINIMUM TIME AIRCRAFT TRAJECTORIES
Teruo Ishihara (Ph.D. Thesis) 1969 177 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 69-18336

An approximate optimal guidance scheme to achieve miniminim time flight of a simulated F-4C Phantom aircraft flying in a vertical plane between two specified points in range-altitude space was investigated. The technique involved determining the guidance program from a greatly simplified version or idealized model of the simulated aircraft. The minimum time flight equations of the idealized model were obtained from the calculus of variations. An idealized version of the aircraft was first selected and analyzed. This was based on constant values of thrust, weight, drag coefficient, and uniform atmospheric condition. By means of the calculus of variations the optimizing equations in comparatively convenient analytic form were obtained. These equations, governing minimum time flight for the idealized model, were numerically solved on a digital computer to yield an optimum trajectory between two specified points. Dissert. Abstr.

N70-37824# RAND Corp., Santa Monica, Calif.
MARKOV CHAIN ANALYSIS OF A SITUATION WHERE CANNIBALIZATION IS THE ONLY REPAIR ACTIVITY
Alan J. Rolfe May 1970 28 p refs
(AD-707041; P-4326) Avail: CFSTI CSCL 15/5

The paper considers a group of S identical aircraft, each of which is partitioned into K parts which fail exponentially. The only way in which a failed aircraft can be repaired is by cannibalizing its out-of-commission parts from other failed aircraft. The evolution of the number of good aircraft over time is governed by the transient behavior of an absorbing Markov chain. One can therefore study this behavior by matrix multiplication although the computational problem grows large when K equals or exceeds 3. Some numerical results and some approximations are also provided. Author (TAB)

N70-37826*# National Aeronautics and Space Administration, Washington, D.C.
SPACE TRANSPORTATION SYSTEM TECHNOLOGY SYMPOSIUM. VOLUME 1: AEROTHERMODYNAMICS AND CONFIGURATIONS
Jul. 1970 575 p refs Symp. held at Cleveland, Ohio, 15-17 Jul. 1970
(NASA-TM-X-52876) Avail: CFSTI CSCL 22B

Selected articles are presented on the aerodynamics and configurations for space shuttle systems, including dynamic stability and control, abort separation procedures, hypervelocity wind tunnel tests of models, flight performance of the booster and orbiter vehicles in the atmosphere, aerodynamic heating, and heat transfer correlations at hypersonic speeds.

N70-37832*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
THE ONERA HOT SHOT WIND TUNNELS CAPABILITIES IN THE SPACE SHUTTLE STUDIES
Jean-Pierre Chevallier *In* NASA, Washington Space Transportation System Technol. Symp., Vol. 1 Jul. 1970 p 119 126 refs

Avail: CFSTI CSCL 14B

The ARC1 and ARC2 wind tunnels of ONERA, designed for hypersonic studies at Mach numbers from 15 to 20 with large variations of the Reynolds number, are described. The main features of the tunnels, their simulation range, and equipment, with examples of studies on electromagnetic wave transmission in the plasma, are given in tabular form. R.B.

N70-37843*# McDonnell-Douglas Co., St. Louis, Mo.
BOUNDARY LAYER TRANSITION ON LIFTING ENTRY VEHICLE CONFIGURATIONS AT HIGH ANGLE-OF-ATTACK
R. V. Masek *In* NASA, Washington Space Transportation System Technol. Symp., Vol. 1 Jul. 1970 p 445-462

Avail: CFSTI CSCL 22C

Methods of correlating boundary layer transition on the centerline of highly swept configurations at angles of attack between 15 deg and 60 deg were investigated. The correlating parameters included local Reynolds number at transition onset, angle of attack, local Mach number, local Reynolds number per foot, and local Reynolds number based on momentum thickness. It was found necessary to account for streamline divergence in formulating the momentum thickness for the high angle of attack data in order to achieve reasonable correlation of the data. The resulting scatter of data around a mean curve fit corresponds to an uncertainty in

transition distance of a factor of 4. The scatter of the same data using local Reynolds number at transition as the correlating parameter corresponds to an uncertainty of a factor of 20 in the transition distance. Author

N70-37861# Weather Wing (1st), San Francisco, Calif.
OCCURRENCE OF TYPHOONS/TROPICAL STORMS (1949-1969) AT SELECTED LOCATIONS
27 Apr. 1970 52 p *Its* Spec. Study No. 105-55
(AD-706408) Avail: CFSTI CSCL 4/2

WWg Special Study 105-55, Occurrence of Typhoons/Tropical Storms 1949-1969 at Selected Locations, presents the number of typhoons and tropical storms passing within 60, 120, and 240 nautical miles of selected locations in Asia and the Western Pacific. Author (TAB)

N70-37871# Army Electronics Command, Fort Monmouth, N.J.
COMPUTER PROGRAM FOR SYSTEM RELIABILITY
John R. Niemela, David Mandelbaum, and Harold Zell Mar. 1970 22 p
(AD-706827; ECOM-3267) Avail: CFSTI CSCL 14/4

A computer program for calculating the reliability of a system is presented with a brief discussion of the basic redundancy concepts and several examples with their appropriate data format and answer. In this respect, the discussion follows closely that presented in Army Materiel Command Pamphlet AMCP 703-3, Quality Assurance, Reliability Handbook, dated 28 October 1968. Author (TAB)

N70-37875# Naval Postgraduate School, Monterey, Calif.
WARM FOG DISPERSAL METHODS AND FOG CHARACTERISTICS AT MONTEREY, CALIFORNIA
Thomas Owens (M.S. Thesis) Oct. 1969 129 p refs
(AD-706738) Avail: CFSTI CSCL 4/2

As a prerequsite to a study of fog dispersal, the literature is surveyed and the various methods of warm fog dispersal are summarized. From an analysis of weather observations during June 1968 - May 1969 at the Naval Auxiliary Landing Field, Monterey, California, it is concluded that the early morning hours of September through November present the highest frequency of fog occurrence and would, therefore, be well suited to fog dispersal field tests. A hand-held, gelatin-coated glassslide method of obtainingfog samples is evaluated in the process of determining the fog droplet distribution in fog and stratus occurring on the Monterey Peninsula. It is found that the distribution is centered about a radius size of 10 microns and in good agreement with current fog models. A series of laboratory experiments using various household detergents as seeding agents are discussed. Author (TAB)

N70-37882# Joint Publications Research Service, Washington, D.C.
METEOROLOGY
In its Soviet Bloc Res. in Geophys., Astronomy, and Space, No. 232 15 Jul. 1970 p 6 31 refs
Avail: CFSTI

News items include reports on a method for measuring precipitation quantity from aircraft, an instrument for measuring circulation in a turbulent atmosphere ways to increase radiosonde altitude on ships, the effect of Arctic air on Soviet climate, and the transactions of a on aviation meteorology. Abstracts of 43 scientific articles are presented, including the following: the role of coronal discharge in thunderstorm development, meteorological problems of supersonic aircraft, aerological sounding in and synoptic processes over the southeastern part of the Atlantic, heat content of the Southern Hemisphere oceans, analysis of the cloud cover field over the tropical zone, the correlation between air humidities at different levels, a method for estimating horizontal turbulent diffusion, atmospheric density determination using sodium clouds, rocket measurements of the neutral composition of the upper atmosphere, an urban atmospheric contamination study, determination of sea surface temperature and earth characteristics using satellite measurements, the use of lasers in studying atmospheric diffusion, and the climatology of the earth's radiation balance. P.A.B.

N70-37916# Bell Helicopter Co., Fort Worth, Tex.
A STABILITY AND CONTROL PREDICTION METHOD FOR HELICOPTERS AND STOPPABLE ROTOR AIRCRAFT. VOLUME 4: APPENDICES Final Report, Dec. 1968 - Feb. 1970
Billy J. Bird Mar. 1970 313 p
(Contract F33615-69-C-1121)
(AD-706919; AFFDL-TR-69-123-Vol-4)

Contents: Variable definitions; Subroutines and commons containing each common and variable; Commons and variables in each subroutine and common; Subroutines containing each variable, by common; Program sections containing each variable, by common; and FORTRAN listing. TAB

N70-37975# Army Electronics Command, Fort Monmouth, N.J.
RAPID INITIALIZATION OF INERTIAL NAVIGATION SYSTEMS THROUGH PARAMETER ESTIMATION
Joseph A. Dasaro Mar. 1970 104 p refs
(AD-706219; ECOM-3243) Avail: CFSTI CSCL 17/7

The accuracy of an aircraft inertial navigation system depends upon the accuracy with which the system is initially aligned. One procedure for initial alignment involves the use of an external reference. This method utilizes equipment which is much too elaborate for normal operational use. An alternate procedure uses the systems inertial sensors in a self-contained method. If sufficient time were available, the self-contained method could achieve accuracies commensurate with the sensor accuracies; however, in an operational environment it is usually necessary to sacrifice some accuracy in the interest of achieving a more rapid initiation. This dissertation investigates the methods presently available for initialization of an inertial platform in an azimuth wander or free azimuth instrumentation and presents a new method for rapid initialization. The paramount problem is the determination of the initial azimuth angle in minimum time in the presence of random gyro drifts, random accelerometer drifts, and measurement noise. Author (TAB)

N70-37993# IIT Research Inst., Annapolis, Md.
COMPATIBILITY FACTORS AFFECTING CONCEPT DEVELOPMENT OF APPROACH AND LANDING GUIDANCE SYSTEM
M. Maiuzzo Electromagnetic Compatibility Analysis Center May 1970 110 p refs
(Contract F19628-69-C-0073)
(AD-707129; ESD-TR-70-134) Avail: CFSTI CSCL 17/7

Results presented in the report issue from four tasks undertaken for the FAA. These results contribute to the specification of a concept for a guidance system for approach and landing. The electromagnetic emitter environment is established for the 1975 time frame for the frequency bands, 5.0 to 5.25 GHz, 9.0 to 9.2 GHz, and 15.4 to 15.7 GHz. Possible interactions between a proposed guidance system located at John F. Kennedy International Airport and the 9.0 to 9.2 GHz band emitter/receiver environment

are established. Estimates are made of the minimum number of separate channels required of a guidance system. Channel frequency separation requirements for a specific signal format/system deployment are also established. Author (TAB)

N70-38011* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VARIABLE SWEEP AIRCRAFT WING Patent
Edward C. Polhamus, inventor (to NASA) Issued 17 Sep. 1963 (Filed 16 Nov. 1961) 8 p Cl. 244-46
(NASA-Case-XLA-00350; US-Patent-3,104,082; US-Patent-Appl-SN-153266) Avail: US Patent Office

A variable sweep wing planform for supersonic aircraft is described which is operable to vary aspect ratio without adversely affecting the control and stability characteristics of the aircraft. It is intended to maximize aspect ratio for subsonic takeoff, climb, cruise, descent, and landing, and to minimize it during supersonic cruise. In a powered aircraft having a conventional fuselage, a wing projecting from each side of the fuselage is provided. Each wing includes a main wing panel pivotally connected to the fuselage near the outboard edge, for rotation in the wing areal plane to vary the leading edge sweep, and a forward wing panel pivotally connected near its forward extremity to the fuselage and pivotally linked near its rear extremity to the main wing panel. When the main wing panel is positioned in its lowest sweep attitude, the forward wing panel is completely retracted into the fuselage. When the main wing panel is swept back toward its highest sweep attitide, however, the forward wing panel rotatably extends about its forward fuselage pivotal connection from the side of the fuselage to form a forward extension of the main wing panel. P.A.B.

N70-38036# Naval Postgraduate School, Monterey, Calif.
AN ANALYSIS OF OIL SAMPLE DATA OBTAINED FROM AIRCRAFT ENGINES BY SPECTROMETRY
John Joseph Carty (M.S. Thesis) Oct. 1969 71 p refs
(AD-706697) Avail: CFSTI CSCL 11/8

The spectrometric oil analysis program as applied to naval aviation was developed as a portion of the overall aviation safety program of the U. S. Navy. The equipment and techniques have been refined, and the program has been steadily expanded since its inception in 1955. The value of this system in determining densities of microscopic particles of certain oil-wetted wear metals in samples of oil extracted from aircraft engines has proved to be helpful in predicting incipient engine failure. In this study data relating to both reciprocating and jet engine models was analyzed in an attempt to determine which of the following elements provided significant information regarding the internal condition of the engine: aluminum, iron, chromium, silver, magnesium, nickel, copper, and silicon. Multiple and simple linear regression analyses and correlation techniques were applied in order to determine the mathematical model which corresponded most closely to the data compiled. Author (TAB)

N70-38116# Toronto Univ. (Ontario). Inst. for Aerospace Research.
[INSTITUTE FOR AEROSPACE RESEARCH] Annual Progress Report, 1969
Nov. 1969 175 p refs
(Grants DRB-G-9501-02; DRB-G-9511-92; DRB-G-9550-40; DRB-G-9551-16; DRB-G-9551-17 et al)
Avail: CFSTI

CONTENTS:

1. MECHANICS OF RAREFIED GASES p 5-9 ref

2. PLASMA DYNAMICS p 10-15

3. COMBUSTION, EXPLOSIONS AND HYPERVELOCITY p 14-25 refs

4. A COLLISIONAL TREATMENT OF THE REFLECTION OF AN IMPLODING HEMISPHERICAL SHOCK WAVE, USAF/ARL, NRC A. K. Machpherson p 25

5. A PRELIMINARY INVESTIGATION OF SONIC BOOM PROBLEMS - NRC I. I. Glass and I. Wada p 26-27 refs

6. CALIBRATION OF CONDENSER MICROPHONE COSMIC DUST SENSOR - NRC R. L. Evans p 27-28

7. AN EXPERIMENTAL DETERMINATION OF THE POLARIZABILITY FOR SINGLY IONIZED ARGON USAF/AFOSR, NRC M. Bristow p 28-29 ref

8. AN EXPERIMENTAL INVESTIGATION OF NONEQUILIBRIUM CORNER EXPANSION FLOW OF IONIZED ARGON - NRC, USAF/AFOSR O. Igra p 29-30 refs

9. SOME ASPECTS OF NONEQUILBRIUM EXPANSION OF AN IONIZED GAS - USAF/AFOSR, NRC O. Igra p 30

10. THE DIFFRACTION OF STRONG SHOCK WAVES BY A COMPRESSION CORNER - USAF/AFOSR, NRC C. K. Law p 30-32 refs

11. A NORMAL SHOCK WAVE COMPUTER PROGRAM - USAF/AFOSR, NRC C. K. Law p 32

12. NORMAL SHOCK WAVE PROPERTIES IN CHLORINE - NRC, USAF/AFOSR Y. Kondo p 32-40

13. AERODYNAMIC NOISE p 41-48 refs

14. SUBSONIC AERODYNAMICS p 49-56 refs

15. AEROSPACE FLIGHT DYNAMICS p 58-63 refs

16. MATERIALS SCIENCE AND STRUCTURES p 64-79 refs

17. ROCKET RESEARCH p 80-86

18. GAS SURFACE INTERACTIONS p 87-96

19. HIGH TEMPERATURE GAS DYNAMICS AND GAS PHYSICS p 97-105 refs

20. LASER EXCITATION AND DIAGNOSTICS p 106-112

21. FLIGHT TRANSPORTATION p 113-115

22. INDUSTRIAL AND ARCHITECTURAL AERODYNAMICS p 116-117 ref

N70-38119# Toronto Univ. (Ontario). Inst. for Aerospace Research.
COMBUSTION, EXPLOSIONS AND HYPERVELOCITY
In its [Inst. for Aerospace Res.] Nov. 1969 p 14-25 refs

Avail: CFSTI

During the past year theoretical and experimental investigations were conducted in the two major developed areas associated with the UTIAS Implosion-Driven Hypervelocity Launcher and the 4 in × 7 in Hypervelocity Shock Tube, as well as the developing areas of micrometeroid impact and sonic boom. The launcher program has been especially fruitful in providing research and development investigations in combustion and explosions in a spherical geometry at high pressures. Some major items in the launcher program that were considered this year are as follows: The completion of the design of the 24 in dia Mk II Launcher, which is theoretically capable of accelerating a 13 g, 1 in dia, right circular cylinder to 50 k ft/sec by using about 50 lb of PETN, marks an important step. A third-scale model of this novel launcher is now in operation and undergoing calibration tests. Spectroscopic temperature measurements have also been made of gas-driven implosions and

their agreement with improved numerical calculations are very satisfactory. Microwave measurements of the projectile velocities within the launcher barrel agree quite well with numerical predictions for early times. Author

N70-38121# Toronto Univ. (Ontario). Inst. for Aerospace Research.
AERODYNAMIC NOISE
In its [Inst. for Aerospace Res.] Nov. 1969 p 41-48 refs

Avail: CFSTI

The quantitative connection between jet turbulence and jet noise was studied. The noise was related to the fourth derivative of experimental hot-wire correlation curves in Chu's 1966 investigation. A re-examination has confirmed the fear that the computational technique carries a large uncertainty. Modifications to the experimental procedure are being explored in a current investigation. A complementary investigation of the properties of the turbulence in the transition region of a round jet was also studied. The results, consisting of spectra, space-time correlations, and convection speeds are reported. The sensitivity of yawed hot-wires to the tangential component of flow has been explored further. The proportionality factor k of Champagne and Webster has been found to depend somewhat on flow speed. A computer-oriented method has been developed for predicting the refracted sound field of a sinusoidal point source immersed in a jet flow. Author

N70-38122# Toronto Univ. (Ontario). Inst. for Aerospace Research.
SUBSONIC AERODYNAMICS
In its [Inst. for Aerospace Res.] Nov. 1969 p 49-56 refs

Avail: CFSTI

The Institute's activities in subsonic aerodynamics are reported with the development of air cushion vehicles (ACV) and V/STOL airplanes and their potential importance in Canada's transportation complex. The program at UTIAS during the current year included 11 separate projects, some theoretical, and some experimental. Some projects are directly related to our continuing research on the aerodynamic problems associated with the wind-generated turbulence that exists near the ground. The problems relate both to flight, especially V/STOL aircraft, and to structures such as buildings, towers, bridges, etc. It is shown that the basic assumption concerning aerodynamic forces made in earlier theoretical work on the subject is quite erroneous. The aerodynamics of an airfoil in unsteady flow, e.g., turbulence, has been studied theoretically, in an extension of Sears' classic work to oblique disturbances. Author

N70-38124# Toronto Univ. (Ontario). Inst. for Aerospace Research.
MATERIALS SCIENCE AND STRUCTURES
In its [Inst. for Aerospace Res.] Nov. 1969 p 64-79 refs

Avail: CFSTI

The structural mechanics program was expanded to include a study of bonded honeycomb curved panels and thermal flutter of long flexible booms used in satellite applications, and efforts to determine the effect of shape imperfections on the buckling behavior of cylinders has continued. The shell research concerned with uniform axisymmetric distributions of imperfections was completed. Work has been directed towards analyzing random axisymmetric imperfection profiles using power spectral density techniques. The scope has been broadened to include buckling studies of perfect and imperfect oval impact cylinders, and dynamic impact testing of thin walled cylinders. Author

N70-38140# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PARACHUTE PACKING
Yu. Shtennikov 2 Feb. 1970 17 p Transl. into ENGLISH from Krylya Rodiny (USSR), v. 20, no. 2, Feb. 1969 p 26-29
(AD-706159; FTD-HT-23-586-69) Avail: CFSTI CSCL 1/3

The article is a sequence to study No. 11 dated 1968, which described a parachute, interaction of parts, sequence and reliability. The author now discusses, in detail, parachute packing for safety purposes. Some hints are given to skydiving instructors for conducting parachute packing classes. Author (TAB)

N70-38146# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SYSTEMS OF ORIENTATION AND GUIDANCE OF AIRCRAFT: SELECTED ARTICLES
L. A. Dmitrochenko et al 5 Sep. 1969 30 p refs Transl. into ENGLISH from Tr. Aviats. Inst. (USSR), no. 179, 1968 p 20 29; 110 142
(AD-696052; FTD-MT-24-148-69) Avail: CFSTI CSCL 17/7

Contents: Correcting inertial systems by using astronomical instruments; Hydrodynamic suspension-forces and centering; Calculation of the force characteristics of the external spherical suspension device of a cryogenic cyroscope. TAB

N70-38155# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THE EFFECT OF HIGH INTENSITY TURBULENCE ON THE AERODYNAMICS OF A RIGID CIRCULAR CYLINDER AT SUBCRITICAL REYNOLDS NUMBER Final Report, May 1965-May 1968
David Surry Mar. 1970 211 p refs
(Contract AF 33(615)-2305)
(AD-704121; AFFDL-TR-69-98) Avail: CFSTI CSCL 1/3

The interaction of high intensity turbulence with the flow past a rigid circular cylinder was studied experimentally at subcritical Reynolds numbers. Grids were used to produce homogeneous turbulence fields with longitudinal scales ranging from 0.36D to 4.40D, and with longitudinal intensities greater than 10%. Power and cross-spectra of the turbulence components (the system input) were measured in order to carefully define the turbulence characterists. In particular, lateral coherences of the longitudinal component were found to collapse well when plotted versus zeta/lambda (lateral separation/wavelength) as suggested by Davenport. A model with which measurement of arbitrary two-point pressure correlations could be made was used in the response experiments. Subsequent integrations yielded the spectral properties of the unsteady drag and lift. Measurement of mean drag and Strouhal frequency indicate that to some extent even severe large-scale turbulence can be considered equivalent to an increase in the effective Reynolds Number. Vortex shedding is not disrupted drastically by severe turbulence, but is affected more by that at low frequency than at high. The unsteady lift response is still dominated by the vortex shedding, whereas the unsteady drag is primarily a response to turbulence. The cross-spectra of the drag collapse well when plotted versus zeta/lambda, and were used, for one grid, to derive a describing function for the drag response to turbulence. This describing function is the central element needed for the calculation of structural response in the drag direction. Author (TAB)

N70-38173# Georgia Inst., of Tech., Atlanta. School of Aerospace Engineering.
COMPRESSIBILITY EFFECTS IN HELICOPTER ROTOR BLADE FLUTTER
Charles Eugene Hammond (Ph.D. Thesis) Dec. 1969 218 p

refs Sponsored in part by Naval Weapons Lab.
(Contract DAHC04-68-C-0004; Proj. Themis)
(AD-706243; GIT-AER-69-4; AROD-T-2.13-E) Avail: CFSTI CSCL 1/3

An analytical investigation of the effect of compressibility on the flutter condition of rotary wings is presented. A two-dimensional model for the helicopter rotor flow field is postulated and used to develop a two-dimensional, unsteady, compressible aerodynamic theory. A kernel function technique is used and the resulting downwash integral equation is solved numerically by collocation using a pressure mode assumption. The resulting aerodynamic coefficients are compared with the results of two other existing theories (one incompressible and one compressible) and found to agree with these theories when the different flow models used are brought into close agreement. The compressible aerodynamic theory is used in a classical two degree of freedom flutter analysis and a variation of the flutter parameters made to establish their influence under compressible flow conditions. The results indicate that the general trend is for decreasing flutter speed with increasing Mach number. The flutter results obtained using the compressible aerodynamic theory with zero Mach number are also shown to be in excellent agreement with the results obtained using an existing incompressible aerodynamic theory. Author (TAB)

N70-38206# Air Weather Service, Scott AFB, Ill.
INTRODUCTION TO JET-ENGINE EXHAUST AND TRAILING VORTEX WAKES
Dale N. Jones Apr. 1970 35 p refs
(AD-707118; AWS-TR-226) Avail: CFSTI CSCL 1/3

The report is a result of a survey of the immediately available literature on aircraft wakes. While it should not be considered the final word on the subject, it is a good general representation of techniques and problems involved. The simple, approximate relations used are chosen for their simplicity and should result in an accuracy useful to define areas dangerous to fight. Author (TAB)

N70-38207# Environmental Technical Applications Center (Air Force), Washington, D.C.
US NAVAL WEATHER SERVICE WORLD-WIDE AIRFIELD SUMMARIES. VOLUME 1, REVISED: SOUTHEAST ASIA
May 1970 486 p revised Supersedes AD-656092; See N68-10045
(AD-705355; AD-656092) Avail: CFSTI CSCL 4/2

The volume is part of a series of compilations which is world-wide in scope. It consists of climatological summaries for selected airfields and for the climatic areas in Southeast Asia. Author (TAB)

N70-38226# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: LOS ANGELES AIRWAYS, INCORPORATED SIKORSKY S-61L, N303Y, PARAMOUNT, CALIFORNIA, 22 MAY 1968
18 Dec. 1969 37 p refs
(PB-189143; SA-404) Avail: CFSTI CSCL 01B

About 1751 P.d.t., May 22, 1968, Los Angeles Airways Flight 841, A Sikorsky S-61L, N303Y, crashed and burned at Paramount, California. All 23 persons aboard the aircraft were fatally injured and the aircraft was destroyed by impact and fire after impact. The Safety Board determines that the probable cause of this accident was the loss of main rotor blade damper integrity due to either a failure of the black blade damper or a loss of effective damping action by the white blade damper. This resulted in uncontrolled excursions of the main rotor blades in their lead/lag axis, an overload detachment of the yellow main rotor blade pitch change control rod and destruction of the structural integrity of the aircraft by blade strikes. The precise reason for either of the possibilities for the loss of damper integrity is undertermined. Author (USGRDR)

N70-38243# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: ALLEGHENY AIRLINES, INCORPORATED, DC-9, N988VJ AND A FORTH CORPORATION, PIPER PA-28: N7374J 4 MILES NORTHWEST OF FAIRLAND, INDIANA 9 SEPTEMBER 1969
15 Jul. 1970 20 p
(NTSB-AAR-70-15; SA-417) Avail: CFSTI

An Allegheny Airlines, Inc., DC-9, N988VJ, and a Forth Corporation, Piper PA-28, N7374J, collided in flight approximately 4 miles northwest of Fairland, Indiana, at approximately 15:29 edt, September 9, 1969. All 83 occupants, 78 passengers and four crewmembers, aboard the DC-9 and the pilot of the PA-28 were fatally injured. Both aircraft were destroyed by the collision and ground impact. Allegheny 853 was under positive radar control of the Federal Aviation Administration's Indianapolis Approach Control, descending from 6,000 feet to an assigned altitude of 2,500 feet at the time of the collision. N7374J was being flown by a student pilot on a solo cross-country in accordance with a Visual Flight Rules flight plan. The collision occurred at an altitude of approximately 3,550 feet. The visibility in the area was at least 15 miles, but there was an intervening cloud condition which precluded the crew of either aircraft from sighting the other until a few seconds prior to collision. Based in part upon this investigation, the Board has submitted recommendations to the FAA concerning establishment of minimum standards for radar reflectivity of small aircraft, and mandatory aircrew training programs on effective scanning patterns and procedures. Author

N70-38299# France. Direction de la Meteorologie Nationale, Paris.
CLIMATOLOGY OF THE TONTOUTA AIRFIELD [CLIMATOLOGIE DE L'AERODROME DE LA TONTOUTA]
D. Rignot and M. T. Tanguy May 1970 63 p In FRENCH
Its Monographie No. 74
Avail: CFSTI

Following a general summary of the geographical and atmospheric conditions of the Tontouta Airfield, New Caledonia, some typical meteorological charts are given. Climatological statistics are then presented for the period 1952 to 1966, in the form of tables with isopleth and isofrequency curves. These tables include information on temperature, insolation, precipitation, evaporation, relative humidity, water vapor pressure, mean pressure distribution, solar wind velocity and direction, wind velocity, visibility, and ceiling. The percentages of temperature measurements in the shade are tabulated at two degree intervals for different local times. Monthly statistics are presented on visibility and ceiling for 1951 to 1960; it is pointed out that very poor visibilities and very low cloud covers are rare. Transl. by P.A.B.

N70-38357# Bell Helicopter Co., Fort Worth, Tex.
A STABILITY AND CONTROL PREDICTION METHOD FOR HELICOPTERS AND STOPPABLE ROTOR AIRCRAFT. VOLUME 3: PROGRAMMER'S MANUAL Final Report, Dec. 1968 - Feb. 1970
Billy J. Bird Wright-Patterson AFB, Ohio AFFDL Mar. 1970 37 p
(Contract F33615-69-C-1121)
(AD-706374; AFFDL-TR-69-123-Vol-3) Avail: CFSTI CSCL 1/3

The report describes a mathematical model of rotorcraft that may be used to determine characteristics of performance, stability, response, and rotor blade loads. The complexity of the equations used requires the use of a digital computer for efficient solution. This volume contains aids for the computer programmer. The programming aids are divided into two groups: Background material for the programmer just starting to work on this computer program and the detailed explanation of the computer generated documentation which is necessary for any programmer to work effectively on this program. Author (TAB)

N70-38374# Naval Research Lab., Washington, D.C.
NAVAL RESEARCH LABORATORY, WASHINGTON Annual Report, 1969
1969 157 p refs
(AD-706718) Avail: CFSTI CSCL 5/2
Contents: Electronics; Materials; General sciences; Oceanology. TAB

N70-38390# Stevens Inst. of Tech., Hoboken, N.J. Davidson Lab.
ENGINEERING APPROXIMATION OF MAXIMUM ACCELERATIONS EXPERIENCED BY PLANNING CRAFT IN ROUGH WATER Final Report
John K. Roper Dec. 1969 35 p refs
(Contract N00014-67-A-0202-0014)
(AD-706098; SIT-DL-69-1437) Avail: CFSTI CSCL 1/3
An engineering procedure is presented for estimating the maximum impact accelerations experienced by planing craft in irregular head seas. General agreement between calculated and model test results indicates that the proposed method is realistic. The procedure should be particularly useful during preliminary design. Author (TAB)

N70-38435*# Sage Action, Inc., Ithaca, N.Y.
NONLINEAR ACTUATOR DISK THEORY AND FLOW FIELD CALCULATIONS, INCLUDING NONUNIFORM LOADING
Michael D. Greenberg and Stephen R. Powers Washington NASA Sep. 1970 83 p refs
(Contract NAS1-8173)
(NASA-CR-1672) Avail: CFSTI CSCL 20D
The axisymmetric flow induced by an actuator disk with prescribed nonuniform circulation distribution is considered. Coupled, nonlinear, singular integral equations governing the wake geometry and vortex density are developed from the force-free condition and discussed from physical and mathematical points of view. An iterative solution based partly on the method of successive approximations and partly on the Newton – Raphson method is put forward, together with convergent numerical results for illustrative cases, both static and nonstatic. Corresponding detailed flow field calculations are included. Author

N70-38458# Bureau of Mines, Bartlesville, Okla. Petroleum Research Center.
STORAGE STABILITY OF HIGH TEMPERATURE FUELS. PART 3: THE EFFECT OF STORAGE UPON THERMALLY INDUCED DEPOSITION OF SELECTED FUEL COMPONENTS AND ADDITIVES Technical Report, Mar. 1969 – Mar. 1970
Marvin L. Whisman, John W. Goetzinger, and Cecil C. Ward Jun. 1970 96 p refs
(Contract F33615-67-M-5003)
(AD-707524; AFAPL-TR-68-32-Pt-3) Avail: CFSTI CSCL 21/4
The investigation was concerned with the contribution of selected components and additives of high-temperature aircraft fuels to thermally induced deposits before and after 52 weeks storage at 130F. Of particular concern is the influence of these fuel constituents on thermal stability quality of these jet fuels during storage. The study utilizes a microfuel coker test apparatus to measure the thermal stability of test fuels and blends. The contribution of selected fuel components, labeled with carbon-14, to deposit-forming mechanisms is determined by radioactive counting techniques. Twenty-eight blends of the five test fuels with carbon-14-labeled fuel additives or components reached the final stage of storage at 130F and received final analyses for deposit forming tendency. These additives included an amine-type antioxidant, a metal deactivator, and a corrosion inhibitor. Also included in this study group were oleic acid and 1,5-hexadiene. All three additives showed a great tendency to degrade and react during storage and thermal stress. It was found that oleic acid interacts with cadmium present in aircraft fuel systems to produce deleterious effects upon the thermal stability quality of the fuel. Results showed changes in thermal stability quality of many of these blends containing sulfur compounds. Four additional special studies were conducted as preliminary investigations to continued research of jet fuel stability characteristics. Author (TAB)

N70-38484# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Muelheim (West Germany).
THEORETICAL INVESTIGATION OF THE THREE-DIMENSIONAL STRESS DISTRIBUTION IN RADIAL FLOW COMPRESSOR WHEELS [THEORETISCHE ERMITTLUNG DER DREIDIMENSIONALEN SPANNUNGSVERTEILUNG IN RADIALVERDICHTERRAEDERN]
Ralf Cuntze May 1970 75 p refs In GERMAN; ENGLISH summary Sponsored by Deut. Forschungsgemeinschaft
(DLR-FB-70-16) Avail: CFSTI; ZLDI Munich: 19,90 DM
The stress-distribution in a rotating, thermally loaded anisotropic disc with radial blades was examined. The problem was divided into three parts: (a) inplane loading of the blade, (b) symmetrical rotational loading of the disc, and (c) circumferential harmonic loading of the disc due to the blades. The method of finite elements was used and an iterative solution of the combined problem was carried out in which the displacements of the disc were used as boundary conditions for the blade, and the nodal point forces at the junction of the blade and the disc were used as boundary conditions for the disc. The results are compared with closed form solutions where possible. Author (ESRO)

N70-38493# Advisory Group for Aerospace Research and Development, Paris (France).
AGARD BULLETIN: MEETINGS. PUBLICATIONS. MEMBERSHIP, JANUARY 1970
Jan. 1970 48 p refs
(AGARD-Bull-70-1) Avail: CFSTI
An outline is given of the 1970 panel meeting topics and their calendar dates for each of the following panels: aerospace medicine, avionics, electromagnetic wave propagation, flight mechanics, fluid dynamics, guidance and control, propulsion and energetics, structures and materials, technical information, research and development, and consultant and exchange program. A list of the 1969 publications issued in each field is presented, with accompanying abstracts. Panel membership lists are included. P.A.B.

N70-38534# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MOSCOW. INSTITUTE OF AUTOMATION AND

TELEMECHANICS (TECHNICAL CYBERNETICS). SYSTEMS WITH A VARIABLE STRUCTURE AND THEIR APPLICATION TO PROBLEMS DEALING WITH THE AUTOMATION OF FLIGHT: SELECTED ARTICLES

E. N. Dubrovskii et al 18 Mar. 1970 117 p refs Transl. into ENGLISH from Sistemy s Peremen. Strukt. i Ikh Primeneniye v Zadachakh Avtomatiz. Poleta (Moscow), 1968 p 34 50, 54 71
(AD-706798; FTD-MT-24-432-69) Avail: CFSTI CSCL 12/1

Contents: Adaptive system of automatic control with variable by structure with limited controlling influence; Means of reducing of the volume of information, necessary for the construction of a composite variable-structure automatic control system; Synthesis of variable-structure system without the use of undistorted derivaties from error signal in the control law; Systems with variable-structure along with a delay in switching elements; Stability conditions of forced motion in variable-structure systems; On one approach to the problems of the synthesis of variable-structure systems; On the problem of the stability of motion of variable-structure systems for control objects with variable parameters; and Variable-structure control system for a flexible object. TAB

N70-38574# Naval Air Propulsion Test Center, Philadelphia, Pa.

INVESTIGATION OF NEW METHODS OF FLUID FILTRATION, PHASE A REPORT

Rudolph E. Harrer Jun. 1970 57 p refs
(AD-707058; NAPTC-AED-1933) Avail: CFSTI CSCL 13/11

The document is concerned with new methods of filtration for aircraft fuel systems, presenting a study of the vortex separator principle. The report discusses its basic principles of operation and the calculated performance of the separator in specific engine fuel systems. Author (TAB)

N70-38625*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

FLIGHT INVESTIGATION OF THE ROLL REQUIREMENTS FOR TRANSPORT AIRPLANES IN CRUISING FLIGHT

Euclid C. Holleman Washington Sep. 1970 107 p refs
(NASA-TN-D-5957; H-616) Avail: CFSTI CSCL 01C

An airborne simulator provided a wide range of maximum roll control power and time constants for pilot evaluation and rating. Roll criteria were developed and compared favorably with previously reported criteria. Maximum roll angular acceleration, maximum roll rate, roll time constant, time to bank, and bank-angle change in a given time all appear to be effective roll-criteria parameters. Steady-state roll rates of about 20 deg/sec and roll time constants of 1.8 seconds or less were required for satisfactory pilot ratings. With experienced test pilots, valid evaluation of single-degree-of-freedom roll response can be obtained with a fixed-base simulator. Author

N70-38629# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FLIGHT DYNAMICS: TRAJECTORIES OF FLIGHT VEHICLES

I. V. Ostoslavskii et al 2 Feb. 1970 34 p Transl. into ENGLISH from the Russian
(AD-706663; FTD-HT-23-37-70) Avail: CFSTI CSCL 1/2

In addition to the Annotation of the forewords to the first and second edition, the translation encompasses sections of the monograph dealing with the theoretical flight dynamics of three dimensional maneuvers and the calculation of the trajectory of a winged rocket aircraft. Calculation equations are given for the cchandelle; only brief descriptions are given of the half roll, Immelmann, and roll. Extensive mathematical treatment of the behavior of a rocket powered winged vehicle in the atmosphere is presented from the point of view of the variational problem of the optimum flight program. Author (TAB)

N70-38635# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FUNDAMENTALS OF GAS FLAME THEORY

L. A. Vulis et al 27 Mar. 1970 235 p refs Transl. into ENGLISH from the Russian
(AD-706646; FTD-HT-23-401-69) Avail: CFSTI CSCL 21/2

Principles of aerodynamic theory and methods of calculating gas jets are covered in this monograph. Problems of the flow structure, turbulent combustion of nonmixed gases, and thermal regimes of flames are discussed. Some special problems are reviewed dealing with high velocity combustion and flame interaction with an electromagnetic field. The monograph is intended for engineers dealing with thermal physics, power engineering, and mechanical engineering. It may also be of use to postgraduate students and students specializing in thermal physics and heat engineering. Author (TAB)

N70-38644# National Transportation Safety Board, Washington, D.C.

MOHAWK AIRLINES, INC., FAIRCHILD HILLER FH-227B, N7811M, NEAR GLEN FALLS, NEW YORK, NOVEMBER 19, 1969

25 Jun. 1970 29 p refs
(NTSB-AAR-70-12) Avail: CFSTI

The flight had been cleared for a VOR approach with a ceiling of 2100 feet overcast, and visibility of 7 miles in light rain. The flight overflew Glen Falls at 3000 feet and proceeded north for about 1 minute and 15 seconds at which time a left turn was initiated preparatory to return to the airport to land on runway 19. During the last portion of this turn, the aircraft contacted trees on the northwest slope of Pilot Knob Mountain on a heading of about 180 deg, approximately 1 nautical mile east of Kattskill Bay, New York. It then impacted the face of a rock cliff, after which it dropped approximately 38 feet, became lodged between trees and the side of the mountain, and burned. It was determined that the probable cause of the accident was that the pilot, while conducting an approach, exceeded the clearance limits and flew the aircraft into a severe lee of the mountain downdraft at an altitude insufficient for recovery. No evidence was found to explain why this particular approach was attempted. Author

N70-38655# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPROXIMATE METHODS OF CALCULATING THE DISTRIBUTION OF VELOCITY WITH ALTITUDE DURING THE BRAKING OF BODIES IN THE ATMOSPHERE

O. A. Privarnikov 29 Jan. 1970 12 p refs Transl. into ENGLISH from Samoletostr. Tekh. Vozdush. Flota (USSR), no. 13, 1968 p 10–15
(AD-706171; FTD-HT-23-602-69) Avail: CFSTI CSCL 20/4

The problem of determining the velocity distribution with respect to the altitude of a body falling free in the atmosphere from an altitude is considered. Expressions are derived for the velocity distribution and braking coefficient. Approximate methods for calculating velocity distribution are outlined for two cases when: (1) the wave drag coefficient is constant; and (2) the wave drag coefficient varies as a function of M and flight altitude. The cases of vertical and ballistic trajectories are considered. It is shown that beginning with the value of the braking coefficient the landing velocity depends weakly upon the initial conditions and is determined by the braking coefficient. TAB

N70-38666# Civil Aeronautics Board, Washington, D.C.

CIVIL AERONAUTICS BOARD Annual Report, Fiscal Year 1969

1969 131 p refs
Avail: SOD $1.25

The activities of the Civil Aeronautics Board are reported. Major problems are considered airport and airways congestion, and surface traffic between airports and city centers. Hearings were completed on the Northeast Corridor VTOL feasibility investigation. Other topics discussed include: domestic air commerce, international aviation, rate regulation, planning, programming and research activities. F.O.S.

N70-38709# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AIR TRAFFIC CONTROL Quarterly Technical Summary Report, 1 Feb. - 30 Apr. 1970
Herbert G. Weiss 15 May 1970 11 p refs
(Contract AF 19(628)-5167)
(AD-707137; ESD-TR-70-95) Avail: CFSTI CSCL 17/7

Because the allowable effort on ATC is comparatively small, it has been focused on only one facet of the problem; namely, on the data acquisition and communications task. The new group has started to make significant progress in several study aspects of the problem and has also obtained experimental L-band multipath data from an experimental air-ground test system. When additional support is received, the program will be expanded to include over-all system design studies and the investigation of radar improvements and multilateration systems, both ground- and satellite-based. Author (TAB)

N70-38782# Advisory Group for Aerospace Research and Development, Paris (France). Propulsion and Energetics Panel.
AIRCRAFT ENGINE NOISE AND SONIC BOOM Technical Evaluation Report on Agard Specialists' Meeting
John O. Powers (FAA, Washington, D.C.) and M. Pianko (Serv. Tech. Aeron., Paris) Jun. 1970 8 p refs
(AGARD-AR-26-70) Avail: CFSTI

A brief evaluation of aircraft noise generation and reduction techniques is given. Jet, fan, and compressor noise sources, noise prediction, designs for noise source control and reduction, acoustic path control, and acoustic impact on receivers are included. J.M.

N70-38711* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PENSHAPE EXHAUST NOZZLE FOR SUPERSONIC ENGINE Patent
James F. Connors, inventor (to NASA) Issued 12 Mar. 1963 (filed 6 Jan. 1960) 8 p Cl. 60-35.55
(NASA-Case-XLE-00057; US-Patent-3,080,711;
US-Patent-Appl-SN-914) Avail: US Patent Office CSCL 21E

An exhaust nozzle with circular end projections and easily controllable throat area modulation is described. The throat area modulation is caused by either a movable single or double ramp structure in the nozzle exit or a movable clamshell element at the lip of the nozzle exit. The design provides high nozzle efficiencies, high thrust coefficients over a wide range of nozzle pressure ratios and flight conditions, the favorable external expansion features of a plug nozzle, low afterbody drag, and an exit particularly suited for supersonic turbojet and rocket-type jet engines. N.E.N.

N70-39001*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AERODYNAMICS OF THE MODEL AIRPLANE. PART 1: AIRFOIL MEASUREMENTS
F. W. Schmitz Nov. 1967 201 p refs Transl. into ENGLISH from German report Sponsored in part by Redstone Scientific Information Center
(NASA-TM-X-60976; RSIC-721-Pt-1) Avail: NTIS CSCL 20D

Measurements are discussed that show the behavior of wing sections in the low-turbulence stream (turbulence factor = 1.06) in a Reynolds number range from 20,000 to 170,000 in which the profiles pass through a critical region. This measuring region corresponds approximately to the Reynolds number range of model airplane wings. Author

N70-39012# Aeronautical Research Labs., Melbourne (Australia).
ON THE MECHANISM OF SUPERSONIC INTAKE INSTABILITY, WITH SOME THOUGHTS FOR FURTHER WORK
S. A. Fisher Mar. 1970 15 p refs
(ARL/ME-313) Avail: NTIS

A possible mechanism is described for avoiding Ferri instability in external compression supersonic air intakes. The technique employed prevents a vortex sheet or shear layer from entering the intake within the desired range of mass flow. However, this margin of stable subcritical flow is secured at the expense of preentry drag at the critical condition. Possible approaches to the problem of controlling this instability without the currently encountered drag are discussed. E.M.C.

N70-39023# Aeronautical Research Labs., Melbourne (Australia).
PERFORMANCE AT TRANSONIC SPEEDS OF AN ATTITUDE SENSING HEAD USING SHORT PROTRUDING TUBES
D. A. Secomb Mar. 1970 34 p refs
(ARL/A-321) Avail: NTIS

The performance of an attitude sensing head using short protruding tubes was determined in a transonic wind tunnel for Mach numbers 0.5-1.1 and pitch angles up to 25 deg. The differential pressure coefficient sensitivity is 0.10-0.11 per deg, and the useful operating range of pitch angle is + or − 10 deg. At higher angles the sensitivity drops, because the leeward tube is then enveloped in a region of separated flow. No large effect of Reynolds number was found within the range covered. A comparison of the sensitivity with that of commonly used yawmeter configurations is included. For the head, the sensitivity is 30 per cent higher than that of a comparable head using flush pressure holes. The greater operating range, and lesser susceptibility to manufacturing error or damage in service for the flush hole head would be overriding advantages. Author

N70-39031# Aeronautical Research Labs., Melbourne (Australia).
PERFORMANCE OF AN 0.81 INCH DIAMETER HEMISPHERE-CYLINDER YAWMETER AT TRANSONIC SPEEDS AND VARYING REYNOLDS NUMBER
D. A. Secomb Feb. 1970 23 p refs
(ARL/A-320) Avail: NTIS

Wind tunnel measurements of the sensitivity of a hemisphere-cylinder yawmeter of 0.81 in. (2.06 cm.) diameter having pressure holes at the location of 45.0 deg. surface slope were made for Mach numbers from 0.5 to 1.3 angles of attack from −5 deg. to +15 deg. and for Reynolds numbers based on hemisphere diameter in the range 30 thousand to 300 thousand. At comparable Reynolds numbers the results agree with earlier measurements on a similar yawmeter of 0.156 in. (0.40 cm.) diameter. At Mach numbers of 0.8 or higher the sensitivity is independent of Reynolds number, but at lower Mach numbers the sensitivity increases with increase of Reynolds number through the test range. The increase at Mach number 0.5 is approximately 15 per cent. The results provide some evidence that the relatively

large pressure holes (subtending 7.8 deg. at the hemisphere centre) indicate too high a pressure. However, the principal cause of the variation of sensitivity with Reynolds number appears to be a change of flow regime of the type well known to occur on spheres. Author

N70-39091# Advisory Group for Aerospace Research and Development, Paris (France).
ADVANCED COMPRESSORS
Aug. 1969 282 p refs Held in Brussels and Bolkesjoe, Norway, Jun. 1970
(AGARD-LS-39-70) Avail: NTIS

CONTENTS:
1. THE THROUGH-FLOW ANALYSIS OF AXIAL FLOW COMPRESSORS H. Marsh (Cambridge Univ.) 17 p refs

2. MASS FLOW LIMITATION IN SUPERSONIC COMPRESSORS J. Fabri (Office Natl. d'Etudes et de Recherches Aerospatiales, Paris, France) 25 p refs
3. TRANSONIC COMPRESSOR CASCADES H. Griepentrog 41 p refs
4. SECONDARY FLOW LOSSES IN AXIAL COMPRESSORS H. Griepentrog 16 p refs
5. BASIC ELEMENTS FOR ADVANCED DESIGNS OF RADIAL-FLOW COMPRESSORS M. H. Vavra (Naval Postgraduate School) 43 p refs
6. SUPERSONIC RADIAL DIFFUSERS D. P. Kenny (United Aircraft of Can., Ltd.) 34 p refs
7. SUPERSONIC CASCADE PERFORMANCE H. Starken and H. J. Lichtfuss (Deut. Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, W. Ger.) 65 p refs

8. APPLICATION OF THROUGH-FLOW THEORIES TO RADIAL WHEEL DESIGN M. H. Vavra (Naval Postgraduate School) 12 p refs

N70-39092# Cambridge Univ. (England). Dept. of Engineering.
THE THROUGH-FLOW ANALYSIS OF AXIAL FLOW COMPRESSORS
H. Marsh *In* AGARD Advanced Compressors Aug. 1969 17 p refs
Avail: NTIS

Methods for predicting the performance of axial flow compressors are described in detail and it is shown that the methods of streamline curvature and matrix through-flow analysis are based on the same mathematical model for flow on the mean stream surface. The need for an accurate loss model is emphasised and the Mach number limitations of these two methods of analysis are defined. Methods for predicting the development of the wall boundary layers are discussed and shown to be in agreement with experimental results obtained for flows with low angles of swirl. If an accurate estimate of the wall boundary layer can be obtained, then it is possible to predict the flow pattern across the entire annulus. Author

N70-39093# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
MASS FLOW LIMITATION IN SUPERSONIC COMPRESSORS
Jean Fabri *In* AGARD Advanced Compressors Aug. 1969 25 p refs
Avail: NTIS

Accurate prediction of supersonic compressor mass flows is the main condition of progress for these machines. As in the case of supersonic aircraft air-inlets, different types of flow patterns may appear. The choked (or unstarted) regime corresponds to high subsonic or low supersonic rotor speeds. The sonic choking of the blade channel throats limits the mass flow. The supersonic (or started) regime appears for higher supersonic rotor Mach numbers. The periodicity of the shock and expansion wave pattern, that extends upstream of the rotor inlet, imposes the mass flow. The corresponding unique incidence, function of rotor speed, can be calculated. For even higher supersonic rotor speeds, the shock waves are swallowed by the rotor, the inlet velocity in absolute reference frames becomes sonic, and mass flow is independent of rotor speed. The range of validity of these regimes is given; values of limit mass flows are calculated, and experimental results are compared to theoretical evaluations. Author

N70-39094# Advisory Group for Aerospace Research and Development, Paris (France).
TRANSONIC COMPRESSOR CASCADES
H. Griepentrog *In its* Advanced Compressors Aug. 1969 41 p refs
Avail: NTIS

The necessity for investigating bladings with inlet and outlet subsonic flows, but presenting a local supersonic region, used in all of the advanced axial compressors is affirmed. The general features of the compressible flow effects in cascade are discussed, together with the influence of compressibility on the performance of compressor cascade. The notions of critical and choking Mach number are introduced, together with a physical description of the flow in the blade passage, where four distinct regions can be distinguished (subsonic inlet and outlet flow field, supersonic flow field, sonic line region and shock-boundary layer interaction region). The evaluation of the critical and choking Mach number is treated, as well as the effects of compressibility on losses, turning and static pressure rise, and the design of transonic cascades. The four regions of flow detailed above are dealt with independently. A review is made of the existing theories and experimental correlations, and their limit of application for cascade flows is defined. A semi-empirical model, valid for cascade flows, is presented for the shock-boundary layer interaction region. Author

N70-39095# Advisory Group for Aerospace Research and Development, Paris (France).
SECONDARY FLOW LOSSES IN AXIAL COMPRESSORS
H. Griepentrog *In its* Advanced Compressors Aug. 1969 16 p refs
Avail: NTIS

The importance of secondary flows and losses in highly loaded compressor is stressed. The various types of possible secondary flows are described, and the three most usual models representing those flows are presented with their limitations. The sources of the losses induced by the secondary flows are then identified with the relevant cascade parameters, and the classical semi-empirical formula of loss evaluation with actual data on highly loaded compressor blading, it is concluded that they fail in predicting correctly the losses for high camber and/or low aspect ratio bladings. A new model for secondary flow is introduced, based on boundary layer growth on the hub or casing and a horse-shoe vortex model, and a formula is derived which appears to be valid for a larger range of blading configuration. Effects of secondary flow on outlet flow direction, and the methods available to reduce secondary flow losses are also discussed. Author

N70-39096# Naval Postgraduate School, Monterey, Calif.
BASIC ELEMENTS FOR ADVANCED DESIGNS OF RADIAL-FLOW COMPRESSORS
M. H. Vavra *In* AGARD Advanced Compressors Aug. 1969

43 p refs
Avail: NTIS

High speed centrifugal compressors with rotors that have radial blades at the discharge, and where the absolute inlet velocities are in axial direction are considered. With a straight annular inlet duct these inlet velocities will be uniform between the radii R sub 1i and R sub 1o of the impeller eye. For a particular relative flow angle beta sub 1o and the relative velocity W sub 1o at R sub 1o, there is then known the peripheral speed U sub 1o, which, for chosen radius ratios R sub 2/R sub 1o, establishes the peripheral rotor speed U sub 2 at R sub 2. The average relative velocity W sub 2 at the discharge of a rotor with radial blades is not radial, but has an average angle beta sub 2. Author

N70-39097# United Aircraft of Canada, Ltd., Jacques Cartier (Quebec).
SUPERSONIC RADIAL DIFFUSERS
D. P. Kenny *In* AGARD Advanced Compressors Aug. 1969 34 p refs
Avail: NTIS

Various diffuser concepts for centrifugal compressors are discussed with regard to overall performance in the chronological order: vaneless, vaned, passage, multiple cascade and pipe. Then each type is discussed individually with regard to its basic mechanism, design technique, performance evaluation, and possible improvements. Finally, general conclusions are drawn with regard to the capability of the various types and possible ultimate performance. Author

N70-39099# Naval Postgraduate School, Monterey, Calif.
APPLICATION OF THROUGH-FLOW THEORIES TO RADIAL WHEEL DESIGN
M. H. Vavra *In* AGARD Advanced Compressors Aug. 1969 12 p refs
Avail: NTIS

A review is presented of the basic flow equations for the analysis of flows in rotors, together with a discussion of the effects of simplifying assumptions that are necessary to obtain solutions. Particular flows in radial compressor rotors are treated, and the approach necessary to calculate arbitrary flow patterns for given blade shapes is described. The necessity of using a correct description of the blade surface is demonstrated, and the applicability of the results to the design of compressor rotors is discussed. Author

N70-39164# Sandia Corp., Albuquerque, N.Mex. Experimental Aerodynamics Div.
PROGRAM WTDPLT: A COMPUTER CODE FOR PLOTTING AERODYNAMIC DATA
D. E. Berg Jun. 1970 150 p
(SC-DR-69-690) Avail: NTIS

Program WTDPLT, a computer code designed to machine-plot aerodynamic data acquired in 12 inch trisonic and 18 inch hypersonic wind tunnels, is described. This program is operational on CDC 6600 and UNIVAC 1108 computers and utilizes the Stromberg-Carlson 4020 plotter. The input required by the program is discussed in detail and the various plot formats available are illustrated. Author

N70-39251 Michigan Univ., Ann Arbor.
QUASICONFORMAL MAPPINGS IN SPACE
Mavina Krishna Vamanamurthy (Ph.D. Thesis) 1969 84 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 69-18125

Three types of problems in the study of quasiconformal mappings in space are discussed. A pair of quasiconformal mappings in space, obtained by rotating two plane quasiconformal mappings which have an axial symmetry are presented. In general, mappings so obtained need not be quasiconformal in space. The Schwarz lemma enables the proof that space mappings are again quasiconformal. Some results of Gehring and Vaisala are extended on coefficients of quasiconformality of domains in space. The inner coefficient of a nonconvex cone is calculated and bounds for the outer coefficient of a nonconvex dihedral wedge se obtained. A local characterization of a quasiconformal disk is given by following a method similar to that of Gehring in characterization of a quasiconformal sphere. Dissert. Abstr.

N70-39253# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
THE STABILITY DERIVATIVES OF THE NAVION AIRCRAFT ESTIMATED BY VARIOUS METHODS AND DERIVED FROM FLIGHT TEST DATA
E. Seckel and J. J. Morris Jul. 1970 31 p refs *Its* Princeton Univ. Rept. No. 923
Avail: NTIS

For application to a new technique of predicting aerodynamic loads, to determine the accuracy of dynamic stability derivatives as predicted for the North American Navion by several different sources. Using the results of spring 1970 flight tests as the norm, estimates from 1969 wind tunnel tests and several texts were compared and found to be accurate to within the order of 20% with a few exceptions. It is believed that the results can be extended to all single engine light aircraft with straight wing and tail, propeller propulsion, and low power effects. Author

N70-39271# Royal Aircraft Establishment, Farnborough (England).
MEMORANDUM ON TEST FACILITIES REQUIRED IN PARACHUTE TECHNOLOGY [DENKSCHRIFT UEBER NOTWENDIGE VERSUCHSEINRICHTUNGEN AUF DEM GEBIET DER FALLSCHIRMTECHNIK
H.-D. Melzig Mar. 1970 51 p Transl. into ENGLISH from Deut. Forschungsanstalt Luftfahrt e.V., no. 0460, Jan. 1968
(RAE-LIB-Trans-1447) Avail: NTIS

The present state of parachute technology in Western Europe and the United States is evaluated. Various outstanding problems and possible methods of solution are discussed. A vertical tower is described, the interior of which can be depressurized and in which model tests of aerodynamic deceleration systems can be made. The proposed instrumentation for the tower is described in detail. Author

N70-39296*# Scientific Translation Service, Santa Barbara, Calif.
GROUND EFFECT VISUALIZATION AT LOW SPEEDS AROUND AIRCRAFT MODELS [VISUALISATION DE L'EFFET DE SOL A BASSE VITESSE AUTOUR D'UNE MAQUETTE D'AVION]
Henri Werle Washington NASA Sep. 1970 27 p refs Transl. into ENGLISH from Rech. Aerospatiale (Chatillon-sous-Bagneux), no. 2, Mar.–Apr. 1970 p 79–93
(Contract NASw-2035)
(NASA-TT-F-13254) Avail: NTIS CSCL 20D

The ground effect on the water flow around models is analyzed using a visualization method in a water tunnel. Ground simulation methods used previously for basic research have been adapted to applied aerodynamics studies. Some examples of models which have been tested are the airbus-type air intake, vertical jet VTOL aircract, and Concorde with or without simulation of the downward movement. Author

N70-39330# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
FLUTTER OF CIRCULAR CYLINDRICAL SHELLS, A REVIEW
S. Parthan and D. J. Johns Nov. 1969 98 p refs
(TT-6917) Avail: NTIS

A comprehensive review is given of the aerodynamic and structural assumptions made in existing cylindrical shell flutter analyses. A review is also given of such analyses for shells of infinite and finite lengths, and a critical discussion of the results is included. Recommendations are made for future work, and a comprehensive chronological bibliography is appended. Author

N70-39350# Department of Civil Aviation, Melbourne (Australia).
WAKE TURBULENCE IS DANGEROUS Aviation Safety Digest Publication
[1970] 10 p
Avail: NTIS

The hazards posed by wing tip vortices of large aircraft to light aircraft taking off or landing are discussed. Examples and illustrations of the phenomena are given. Flight rules are suggested for light aircraft to prevent accidents. These rules include: avoidance of flight below and behind large aircraft in the circuit area, assuming a flight path above the settling vortices of large aircraft on takeoff, starting the takeoff run from the end of the runway so as to be airborne before the point where heavy aircraft have lifted off, and maintaining an above and beyond position during final landing approach. Air traffic control procedures are also discussed. E.H.W.

N70-39376*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DESCRIPTION OF A DIGITAL COMPUTER PROGRAM FOR AIRPLANE CONFIGURATION PLOTS
Charlotte B. Craidon Washington Sep. 1970 85 p
(NASA-TM-X-2074; L-7149) Avail: NTIS CSCL 01C

A computer program (D2290) is presented which generates the necessary instructions for automatic plotting of the numerical model of an airplane configuration. Program options may be used to draw three-view and oblique orthographic projections, as well as perspective projections of an airplane. These plots are useful in checking the accuracy of the numerical model data. Magnetic tape output from this program was used to drive a CalComp plotter and a Gerber plotter. The program was also used for online display of a configuration on a cathode ray tube device. Author

N70-39377*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ELECTRONIC STRAIN-LEVEL COUNTER FOR AIRCRAFT STRUCTURAL MEMBERS
Felix L. Pitts and J. Larry Spencer Washington Sep. 1970 19 p refs
(NASA-TN-D-5944; L-7190) Avail: NTIS CSLC 14B

The description and test results of an electronic strain level counter designed for obtaining structural strain data on in-flight aircraft are presented. The device counts the number of times the strain at a point in a structural member exceeds each of four preset levels. A dead band is provided at each level to prohibit the counting of small strain variations around a given preset level. A resistance strain gage is used as the sensor; microelectronic and discrete solid state circuits are used for signal processing, and electromechanical counters are used for data storage. Author

N70-39388*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REVIEW OF THE BRAYTON ENGINE ELECTRICAL SUBSYSTEM DESIGN AND COMPUTERIZED TECHNIQUE USED TO DOCUMENT WIRING
James Nestor and Pierre A. Thollot Washington Sep. 1970 42 p refs
(NASA-TM-X-2079; E-5621) Avail: NTIS CSCL 10B

A general description of the Brayton-B engine space power system is presented, with special emphasis on the electrical subsystem. The interval between delivery of individual components and the initiation of systems testing is covered in detail, with particular attention to the computer-oriented approach used to document all the many interconnections of the electrical components. Applications of the documentation technique are recommended for development of other complex electrical - electronic systems. Author

N70-39419*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYTICAL INVESTIGATION OF BLADE EFFICIENCY FOR TWO-DIMENSIONAL SUPERSONIC TURBINE ROTOR BLADE SECTIONS
Louis J. Goldman Washington Sep. 1970 21 p refs
(NASA-TM-X-2095; E-5532) Avail: NTIS CSCL 20D

An analysis was conducted to determine the blade efficiency for two-dimensional, supersonic rotor blade sections designed to produce vortex flow within the blade passage. Boundary layer characteristics were calculated and used to obtain the conditions downstream of the rotor blades after the flow had mixed to a uniform state. Subsonic and supersonic aftermixing axial Mach number solutions were obtained for this loss model. The effect of the surface Mach number levels on both blade efficiency and boundary layer separation were investigated. In addition, the effects of inlet flow angle and inlet Mach number on blade efficiencies were obtained. Author

N70-39421*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF DYNAMIC VARIATIONS IN ENGINE-INLET PRESSURE ON THE COMPRESSOR SYSTEM OF A TWIN-SPOOL TURBOFAN ENGINE
John E. McAulay Washington Sep. 1970 33 p refs
(NASA-TM-X-2081; E-5618) Avail: NTIS CSCL 21E

The effects of spatially uniform and distorted dynamic engine-inlet pressure variations between 1 and 80 Hz on the compressor system of a twin-spool turbofan engine are presented. The inlet pressure variations were produced by rapid changes in secondary airflow injected as many small contrastream jets ahead of the engine. Compressor system stall was encountered with both spatially uniform and distorted dynamic variations in inlet pressure. The factors which induced compressor stall were found to be the magnitude of instantaneous distortion, rate and magnitude of change of inlet pressure, and dwell-time of the fan-compressor rotor blading in the low-pressure region of an engine-inlet distortion. Author

N70-39449# Technische Hochschule Hannover (West Germany).
THE EFFECTS OF UNIFORM PROFILE CHANGES ON THE DEGREE OF EFFICIENCY, THE INCLINE, AND THE MASS FLOW IN MULTIPLE STEP AXIAL TURBINES [DER EINFLUSS GLEICHMAESSIGER PROFILAENDERUNGEN AUF DEN WIRKUNGSGRAD, DAS GEFAELLE UND DEN MASSENDURCHSATZ MEHRSTUFIGER AXIALTURBINEN]
Helmut Stobbe (Ph.D. Thesis) 1969 219 p refs In GERMAN
Avail: NTIS

Corrosion related profile changes on turbine blades affect pressure and efficiency curves of turbines markedly. Thinned profiles of the primary stage dominate pressure curve characteristics and the suction capacity of the turbine; thickened profiles of the later

stages decrease turbine efficiency but do not affect pressure and suction capacities as much. Pressure drop and mass flow decreases are three times higher when profile thickening in the last two stages is present in comparison with profile thickening on only one later stage. Thus, the fouling of later stages in a turbine affects its capacity much more than corrosion of primary stages. Transl. by G.G.

N70-39489 Advisory Group for Aerospace Research and Development, Paris (France).
AIR AND SPACEBORNE COMPUTERS
Edward Keonjian, ed. (Grumman Aerospace Corp.) Apr. 1970 191 p refs Lecture Ser. Held at Amsterdam, Farnborough, Engl. and Bologna, Jun. 1968
(AGARDograph-127) Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks., Engl. US Distributor: Circa Publications, Inc., 415 Fifth Ave., Pelham, N.Y. 10803 (attn. Mr. A. L. Candido)

CONTENTS:

1. THE IMPACT OF COMPUTERS ON THE OVERALL DESIGN OF AEROSPACE SYSTEMS P. B. Rayner (Elliott Bros., Ltd., London, Engl.) p 15 - 20

2. SPECIAL COMPROMISES AND CONSIDERATIONS J.-J. Mayer and J. Chinal (Ecole Natl. Superieure de l'Aeronautique, Paris, France) p-21 - 37

3. STRUCTURE OF AN AEROSPACE COMPUTER FAMILY W. J. Patzer (IBM, Corp., Oswego, N.Y.) p 39 - 56 refs

4. TECHNIQUES FOR DEVELOPING OPTIMUM MAN/COMPUTER RELATIONSHIPS IN AEROSPACE AVIONICS SYSTEMS W. M. Gaddes (IBM, Corp. Owsego, N.Y.) p 57-72 refs

5. NEW COMPUTING DEVICES AND SPECIAL AIDS P. B. Rayner (Elliott Bros., Ltd., London, Engl.) p 73 - 86

6. AEROSPACE SYSTEMS IMPLICATIONS OF MICROPROGRAMMING W. J. Patzer and G. C. Vandling (IBM, Corp., Oswega, N.Y.) p 87 - 97 refs

7. MODULAR COMPUTER SYSTEM ARCHITECTURE J. Weissman (N. Am. Rockwell Corp., Anaheim, Calif.) p 99 - 112

8. LARGE SCALE INTEGRATION L. M. Spandorfer (Sperry Rand Corp., Philadelphia, Pa.) p 113 - 126 refs

9. NEW MEMORY AND STORAGE TECHNIQUES L. M. Spandorfer (Sperry Rand Corp., Philadelphia, Pa.) p 127 - 140 refs

10. OPTIMAL PACKAGING APPROACHES R. F. Redemske (Teledyne Sys. Corp., Hawthorne, Calif.) p 141 - 150

11. SYSTEM AND HARDWARE DESIGN CONCEPTS FOR ULTRA SURVIVABLE AND MAINTAINABLE COMPUTERS E. Kanter (Teledyne Sys. Corp., Hawthorne, Calif.) p 151 - 163

12. THE DILEMMA OF COMPUTER CHOICE PANEL DISCUSSION p 165 - 190

13. CLOSING REMARKS E. Koejian p 191

N70-39496 North American Rockwell Corp., Anaheim, Calif.
MODULAR COMPUTER SYSTEM ARCHITECTURE
J. Weissman *In* AGARD Air and Spaceborne Computers Apr. 1970 p 99 - 112
Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks., Engl. US Distributor: Circa Publications, Inc., 415 Fifth Ave., Pelham, N.Y. 10803 (attn. Mr. A. L. Candido)

The modular computer system presented consists of a set of off-the-shelf, widely applicable modules and design practices that enable quick realization of avionic computing systems. Off-the-shelf items are defined. Each consists of basic computer elements such as memories, registers, arithmetic units, and control units. The basic ingredients of a modular computer system and the practices and techniques of configuring a system for a given application are discussed. It is shown that such a system, even when utilizing a maximum of off-the-shelf components, enjoys computational abilities equal to specially designed computing systems. The multi-processing capabilities of the modular computer system, which are the reasons for its computing advantages, are stressed. Author

N70-39604*# Pan American World Airways, Inc., Patrick AFB, Fla.
COMMERCIAL AIRCRAFT TECHNOLOGY APPLICABLE TO THE SPACE SHUTTLE
Charles L. Carroll *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 5 Jul. 1970 p 1 - 32 refs
Avail: NTIS CSCL 22B

Certain topics in commercial aircraft technology with potential application to the space shuttle have been briefly reviewed. It can be concluded that much commercial aircraft technology available in 1975 will be directly applicable. This includes maintainability, maintenance, avionics, management techniques, and operations. Strongly recommended is: (1) that airline management, engineering, maintenance and operations techniques be used in the procurement, design, test and operation of the space shuttle; and (2) insofar as possible only technology available in the 1975 time frame - so called - off the shelf technology be used in the space shuttle. Author

N70-39605*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
SPACE SHUTTLE RELATED MAINTENANCE EXPERIENCE WITH THE X-15 AIRCRAFT
Vincent N. Capasso, Jr. *In its* Space Transportation System Technol. Symp., Vol. 5 Jul. 1970 p 33 - 44

Avail: NTIS CSCL 01C

Discussed is the maintenance activity between X-15 flights and the number and types of repair items which would be related to space shuttle requirements. The increased size and complexity of the shuttle systems will magnify the number of repair items, making the required turnaround time difficult or impossible to achieve unless careful consideration is given to problem prevention and access for system repair and maintainability. Author

N70-39607*# International Business Machines Corp., Gaithersburg, Md.
INSTRUMENT LANDING SYSTEMS FOR THE SPACE SHUTTLE
Herbert P. Raabe *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 5 Jul. 1970 p 73 - 90

Avail: NTIS CSCL 17G

The terminal flight characteristics of the returning space shuttle are described and the requirements for an instrument landing system ILS derived. The presently available systems are reviewed and their deficiencies to serve the shuttle are pointed out. The effort of the special committee of the Radio Technical Commission for Aeronautics is reported. This effort consists of defining future requirements for aircraft ILS's, screening proposed techniques for their potential in meeting these requirements and establishing a common waveform. The requirements for space shuttle and aircraft landing operations are compared. An ILS concept potentially capable of meeting shuttle and aircraft requirements is described. Author

N70-39637*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ENGINE DESIGN AND TECHNOLOGY REQUIREMENTS (PANEL DISCUSSION)
In its Space Transportation System Technol. Symp., Vol. 4 Jul. 1970 p 291–378
Avail: NTIS CSCL 21H

Reviewed are some of the mission and environmental requirements facing the airbreathing engines for the space shuttle. Many of these requirements are new for gas turbine engines. These include the hydrogen fuel system and exposure to launch, reentry, and space environments. Engine design studies being conducted have the primary purpose of determining engine features and modifications required for the shuttle mission. Engines typical of those being considered for the shuttle vehicles will be selected for these design studies. The steady-state and transient operation of a hydrogen fuel system will be studied by analyzing, fabricating and testing such a system using an existing engine as a test bed. The purpose of the technology studies is to provide a sound basis for the development of the airbreathing propulsion system for the shuttle. Author

N70-39638# Advisory Group for Aerospace Research and Development, Paris (France.)
FUELS, LUBRICANTS, AND AUXILIARY FLUIDS FOR SUPERSONIC AND HYPERSONIC AVIATION [COMBUSTIBLES, LUBRIFIANTS ET FLUIDES AUXILIARES POUR AVIATION SUPERSONIQUE ET HYPERSONIQUE]
Jun. 1970 334 p refs In FRENCH; ENGLISH summary
(AGARDograph-108; AGARD-AG-108-70) Avail: NTIS

CONTENTS:

1. FUELS POSED BY HIGH SPEED FLIGHTS J. Ducarme (Liege Univ., Belgium) p 1–28 refs
2. FUELS FOR SUPERSONIC AIRCRAFT T. de Menten de Horne (Labofina Soc. Anonyme, Brussels) p 29–50 refs
3. LUBRICANTS AND HYDRAULIC FLUIDS G. J. Souillard (Labofina Soc. Anonyme, Brussels) p 51–71 refs

N70-39639# Liege Univ. (Belgium).
REQUIREMENTS POSED BY HIGH SPEED FLIGHTS [EXIGENCES POSEES PAR LES VOLS A GRANDE VITESSE]
Jacques Ducarme *In* AGARD Fuels, Lubricants, and Auxiliary Fluids for Supersonic and Hypersonic Aviation Jun. 1970 p 1–28 refs In FRENCH
Avail: NTIS

The usefulness of a standard atmosphere is discussed. Elements of fluid flow are considered, including boundary layer flow, the forces of friction, supersonic flows, and hypersonic flows. Thermal aspects examined include thermal equilibrium of an engine in flight, ways to limit kinetic heating effects on the engine, the conditions imposed by kinetic heating, and thermal stability of the fuel. Problems in very high speed propulsion are discussed, such as the choice of system to use, the influence of high speed flight on propulsion system functioning, and ways to organize and maintain combustion in very high speed flow. Transl. by P.A.B.

N70-39640# Labofina Societe Anonyme, Brussels (Belgium).
FUELS FOR SUPERSONIC AIRCRAFT [LES COMBUSTIBLES POUR AVIONS SUPERSONIQUE]
Thierry de Menten de Horne *In* AGARD Fuels, Lubricants, and Auxiliary Fluids for Supersonic and Hypersonic Aviation Jun. 1970 p 29–50 refs In FRENCH
Avail: NTIS

Estimates of fuel consumption in commercial aviation are considered for the years 1960 to 1985. The technical requirements of a fuel are examined, including caloric power provided, weak volatility, thermal stability, combustion characteristics, and behavior at low temperature. The use of additives to correct fuel faults is discussed with relation to the formation of static electricity, fuel stability during storage, microorganism activity in turbine fuels and resulting corrosion, and additives modifying the flow properties of kerosenes. Other solutions proposed for supersonic and hypersonic flights are mentioned, including cryogenic fuels and fuels derived from boron. Transl. by P.A.B.

N70-39641# Labofina Societe Anonyme, Brussels (Belgium).
LUBRICANTS AND HYDRAULIC FLUIDS [LUBRIFIANTS ET FLUIDES HYDRAULIQUES]
Georges J. Souillard *In* AGARD Fuels, Lubricants, and Auxiliary Fluids for Supersonic and Hypersonic Aviation Jun. 1970 p 51–71 refs In FRENCH
Avail: NTIS

Lubrication oils and systems for supersonic and hypersonic turbine engines are discussed, along with hydraulic fluids and systems, with relation to function and classification. Principal factors of influence are related, including density, viscosity, thermal degradation and oxidation of the oils and fluids, hydrolysis effects, lubricating properties, hydraulic fluid compressibility, fire resistance, and tendency to foam. Possible choices of oils and fluids are suggested for both present and future applications. Base products for lubricant oils and hydraulic fluids are then considered. The influence of the chemical structure on physiochemical properties is examined. The properties and preparation of hydrocarbons, esters and polyesters in general, phosphoric esters, organic halogen derivatives, organic derivatives of silicon, polyphenyl eithers, and other chemical derivatives are discussed. Antioxidation additives for oils operating at elevated temperatures are described, along with additives to protect against rust, corrosion, wear and extreme pressure. Lubricating greases, solid lubricants, and lubrication by molten metals and salts and by gas are also considered. Bibliographies are included. Transl. by P.A.B.

N70-39664# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
AIR FORCE AIRCRAFT STRUCTURAL INTEGRITY PROGRAM: AIRPLANE REQUIREMENTS
Harold M. Wells, Jr. and Troy T. King May 1970 51 p
(AD-707884; ASD-TR-66-57) Avail: CFSTI CSCL 1/3

The report summarizes requirements for the airplane portion of the Aircraft Structural Integrity Program based upon the results of experience and events since the inception of the program in 1958. It supplements the detailed structural specifications for Air Force airplanes and updates Aeronautical Systems Division Technical Report 66-57, dated January 1968. Applicable military specifications are referenced throughout. Author (TAB)

N70 39716* National Aeronautics and Space Administration. Washington, D.C.
NASA SAFETY MANUAL. VOLUME 1: BASIC SAFETY REQUIREMENTS
Jul. 1969 92 p refs Supersedes NHB-1700.1
(NASA-TM-X-66319; NHB-1700.1(V1); NHB-1700.1) Avail: NASA Scientific and Technical Information Div., Washington, D.C. CSCL 13L

The basic requirements are presented for system, industrial, aviation, and public safety. System safety concerns itself primarily with safety aspects of aerospace flight hardware, whether for manned or automated space systems. Astronaut safety is an important aspect of system safety. System safety is to be emphasized

throughout the life cycle of these systems, from inception through end use. Industrial safety involves the safety of personnel and property in day-by-day operations, not only within facilities, but in the transportation of people and things. There exists a strong relationship with industrial hygiene activities, and with the system safety aspects of many fabrication, transport, and test activities. Aviation safety is intended to assure adequacy of safety in the NASA aviation activities of R and D, proficiency, program support, and administrative flying. Public safety activities are aimed at protection of the general public and public property from the harmful effects of NASA operations. Author

N70-39729# Bell Helicopter Co., Fort Worth, Tex.
A STABILITY AND CONTROL PREDICTION METHOD FOR HELICOPTERS AND STOPPABLE ROTOR AIRCRAFT. VOLUME 1: ENGINEER'S MANUAL Final Report
Charles L. Livingston Feb. 1970 89 p refs
(Contract F33615-69-C-1121)
(AD-707881; AFFDL-TR-69-123-Vol-1) Avail: NTIS CSCL 1/3

This report describes a mathematical model of rotorcraft that may be used to determine characteristics of performance, stability, response, and rotor blade loads. The complexity of the equations used requires the use of a digital computer for efficient solution. This four volume report describes the computer program in detail and illustrates the method of computing rotorcraft characteristics by specific example. Author (TAB)

N70-39737# Office of Naval Research, London (England).
ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS (12th)
I. Estermann 11 May 1970 11 p
(AD-703726; ONRL-C-15-70) Avail: NTIS CSCL 1/2

Topics discussed in 26 papers were centered around aircraft development, aerodynamics and fluid dynamics, propulsion, structures, and flight mechanics and control. An exhibition showed models of two locally produced aircraft types and accessories, as well as exhibits by foreign firms. Author (TAB)

N70-39778# Louisiana State Univ., Baton Rouge. Dept. of Electrical Engineering.
A MINMAX STUDY OF AIM ANGLE FOR PROPORTIONAL NAVIGATION MISSILE (THE PLANAR CASE)
Glenn Paul Orgeron (M.S. Thesis) May 1970 186 p refs
(Contract F44620-68-C-0021)
(AD-708167; AFOSR-70-1808TR) Avail: NTIS CSCL 16/4

The problem of minimizing the maximum terminal miss of a planar case, proportional navigation missile attacking a high performance aircraft by optimally selecting missile launch angle is studied. System models are developed for both the aircraft and the missile; constraints are introduced to preserve physical realism. An algorithm based upon a worst-case error analysis is applied to find the optimum missile launch angle. Recurring patterns have been found for target and missile control over the area of interest. Effects of variations in missile velocity, missile time constant, and proportional navigation constant have been observed. Author (TAB)

N70-39844# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Hypersonic Research Lab.
SOME DESIGN ASPECTS OF HYPERSONIC VEHICLES Final Report
Wilbur L. Hankey Mar. 1970 71 p refs
(AD-708133; ARL-70-0049) Avail: NTIS CSCL 1/3

Some design concepts of hypersonic vehicles are present including fundamental high velocity flight mechanics, prediction of hypersonic aerodynamic characteristics, and the optimization of hypersonic lifting bodies and hypersonic cruise vehicles. The material represents that which was given in lecture form at the von Karman Institute for Fluid Dynamics, Brussels, Belgium as part of a short course on Hypersonic Aircraft to engineers of the NATO countries on 19-23 Jan 70. Author (TAB)

N70-39849*# Translation Consultants, Ltd., Arlington, Va.
INTAKE AND JET EFFECTS OF TWO LIFT FAN CONFIGURATIONS ON FLOW PAST A WING [ZULAUF- UND STRAHLEINFLUESSE ZWEIER HUBGEBLAESEKONFIGURATIONEN AUF DIE FLUEGELSTROEMUNG]
H. Neppert Washington NASA Oct. 1970 55 p refs Transl. into ENGLISH of DGLR Symp. Paper No. 70-008 Presented at Symp. on the Future of Com. Air Transport Technol., Hamburg, 29 Jan. 1970
(Contract NASw-2038)
(NASA-TT-F-13277) Avail: NTIS CSCL 20D

Pressure measurements conducted on two lift fan configurations on a semimodel in a 3-m wind tunnel at a constant incident flow velocity are described. Based on these pressure measurements, normal force and pitching moment distributions of the wing of a VTOL aircraft were determined for different ground distances. The results obtained for both lift fan configurations are compared and discussed. Author

N70-39885# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
THE RESPONSE AND AIRLOADING OF HELICOPTER ROTOR BLADES DUE TO DYNAMIC STALL
Wayne Johnson May 1970 48 p refs
(Contract DA-31-124-ARO(D)-247)
(AD-707939; ASRL-TR-130-1; AROD-4846-11-E) Avail: NTIS CSCL 1/3

An aerodynamic model is constructed for the application of the properties of dynamic stall of airfoils to the calculation of the airloads and blade motion of helicopter rotor blades. Dynamic stall occurs on an airfoil undergoing pitching motion at high angle of attack, and is characterized by peak section lift and moment much larger than the corresponding static stall loads. A method is developed for the solution of the equations of motion of a rotor blade by means of harmonic analysis. The effect of dynamic stall on the blade torsional motion at high advance ratio is examined, and comparison is made with the limited experimental data available. An increase in the dynamic stall angle is shown to significantly decrease the amplitude of the pitch motions. Author (TAB)

N70-39895* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MULTISTAGE MULTIPLE-REENTRY TURBINE Patent
Warner L. Stewart and David G. Evans, inventors (to NASA) Issued 25 Dec. 1962 (Filed 27 Apr. 1960) 7 p Cl. 253-66
(NASA-Case-XLE-00085; US-Patent-3,070,349;
US-Patent-Appl-SN-25175) Avail: US Patent Office CSCL 21E

A multistage axial flow turbine is described as being relatively small in size and low in weight, and as having a low rotating mass, comparatively low rotor blade operating temperatures for a given turbine-inlet temperature, high rotor blade heights and high rotative acceleration. The turbine consists of a single rotor having a plurality of blades circumferentially placed around the periphery of the rotor. An inlet duct is provided which directs the incoming fluid to one side of the rotor blades and serves to keep a supply of fluid within the turbine. A reentry duct is also provided to receive the outlet

stream after the fluid passes across the rotor blades and to conduct the fluid back to the opposite side of the rotor blades. A plurality of reentry ducts may be utilized; the process of reentry is repeated continually until all of the work of the incoming fluid is expended. The particular application described is a three stage turbine, with two reentry ducts comprising the second stage and three ducts comprising the third stage. P.A.B.

N70-39899* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TELESCOPING-SPIKE SUPERSONIC INLET FOR AIRCRAFT ENGINES Patent
James F. Connors, inventor (to NASA) Issued 11 Dec. 1962 (Filed 27 Feb. 1958) 4 p Cl. 60-35.6
(NASA-Case-XLE-00005; US-Patent-3,067,573; US-Patent-Appl-SN-718095) Avail: US Patent Office CSCL 21E

An aircraft engine inlet with high diffuser efficiencies over a large range of Mach numbers and essentially zero cowl drag is described. The nozzle approximates the theoretical contour required for isentropic compression and provides a subsonic dump or abrupt area of discontinuity downstream of the throat. The inlet has an axially movable cowl, and a compression spike mounted concentrically and with tapered sections which telescope into a conical contoured surface. N.E.N.

N70-39902# Weather Wing (2nd), APO 332, New York.
FORECASTING REDUCED VISIBILITIES DUE TO ATMOSPHERIC AEROSOLS
Richard L. Walterscheid 1 Jun. 1970 7 p refs
(AD-708141; Rept-2WW-TN-70-2) Avail: NTIS CSCL 4/2

The problem of forecasting low visibilities has become less a problem of forecasting restrictions owing to condensed water droplets but rather has become more a problem of forecasting low visibilities owing to suspended particles. This paper discusses a formula and graph to calculate forecast visibility given initial conditions of visibility and relative humidity. Author (TAB)

N70-39907*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER STUDIES TO DETERMINE NACELLE AERODYNAMIC EFFECTS ON A FAN-JET TRANSPORT MODEL FOR TWO MOUNT SYSTEMS AND TWO WIND TUNNELS
Moses G. Farmer Washington Sep. 1970 37 p refs
(NASA-TN-D-6003; L-7120) Avail: NTIS SCL 20K

Low-speed flutter studies of a dynamically and elastically scaled model of a large multijet transport airplane have been conducted primarily to determine the nacelle aerodynamic effects for high-bypass-ratio fan-jet engines. Data were obtained on a vertical rod mount in two wind tunnels and on a two-cable mount in one of the tunnels. The flutter response of the model was found to be dependent on nacelle aerodynamics, engine-pylon stiffness, mount-system–wind-tunnel configuration, and mass ratio. Author

N70-39926# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATIONS OF KEROSENE FUELS IN SMALL LABORATORY COMBUSTION CHAMBERS
Bogdan Wislicki 8 May 1970 20 p refs Transl. into ENGLISH from Tech. Lotnicza i Astronautyczna (Poland), v. 23, no. 4, 1968 p 12–68
(AD-708352; FTD-HT-23-156-70) Avail: NTIS CSCL 21/4

A number of small laboratory-type combustion chambers used to evaluate the properties of the kerosene-based fuels employed in jet aircraft engines are reviewed with respect to the effect of the physical and chemical characteristics of the fuels on the combustion process, as well as observations of secondary factors of that process - the interreaction of exhaust gases and engine components. Such observations are concerned with: the completeness of combustion; the stability of combustion; starting properties; ignition delay; combustion rate; tendency to deposit carbon scale; corrosion-erosion properties of combustion gases; effect of fuel additives on combustion process characteristics; effect of fuel additives on the corrosion and erosion caused by exhaust gases; resonance and vibrational combustion. Among the specific combustion chamber models described in the article are several developed and used in the US (Starkman, Evans, Phillips Petroleum Company, and Shell Oil Company), a Soviet-designed combustion chamber for studying the tendency of fuels to leave deposits (Chertkov, Ya. B., Zrelov V. N.: Novosti Neftyanoy Tekhniki, Nefteperabotka, No. 2, 1956, p. 12), another combustion chamber type Soviet burner, a West German Model described by G. Spengler, H. Gemperlein, and others. The principal characteristics of these laboratory combustion chambers are given. TAB

N70-39937# West Virginia Univ., Morgantown. Dept. of Aerospace Engineering.
NONSTEADY FLOW THROUGH A HEAVILY LOADED ACTUATOR DISK
Jia J. Hu and Yu. K. Hsu Aug. 1969 127 p refs
(Contract N00014-68-A-0512; Proj. Themis)
(AD-708396; TR-16) Avail: NTIS CSCL 1/3

The present investigation is concerned with the non-steady axisymmetric flow of an inviscid, incompressible fluid through a heavily loaded actuator disk. Since the steady state problem is essentially non-linear, a closed form solution is not possible. The small perturbation theory is applied, and the first-order solution is obtained. The resulting perturbation equations which contain the steady state solution as coefficients are solved numerically by using the method of finite differences. The non-steady solutions are compared with the zeroth-order basic solutions. Author (TAB)

N70-39939*# Scientific Translation Service, Santa Barbara, Calif.
QUASI-TWO-DIMENSIONAL FLOW THROUGH A SUPERSONIC CASCADE [ECOULEMENT SUPERESONIQUE QUASI-BIDIMENSIONNEL DANS UNE GRILLE D'AUBES SUPERSONIQUE]
J. Jehl Washington NASA Sep. 1970 16 p refs Transl. into ENGLISH from Rech. Aerosp. (France), no. 3, May–Jun. 1970 p 137–143
(Contract NASw-2035)
(NASA-TT-F-13260) Avail: NTIS CSCL 20D

A theoretical scheme is considered in which the influence of the transverse stream contraction in a compressor or turbine cascade on the supersonic flow crossing the cascade is taken into account. The numerical method developed in the theoretical scheme may also be adapted to the case of a flow variation in the stream. Author

N70-40002# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Section.
A FLIGHT INVESTIGATION OF LATERAL-DIRECTIONAL HANDLING QUALITIES FOR V/STOL AIRCRAFT IN LOW SPEED MANEUVERING FLIGHT Final Report, Aug. 1968–Aug. 1969
K-H. Doetsch, Jr., D. G. Gould, and D. M. McGregor Wright-Patterson AFB, Ohio AFFDL Mar. 1970 62 p refs Prepared for Cornell Aeron. Lab., Inc.
(Contract AF 33(615)-)3736)
(AD-707831; LTR-FR-12; AFFDL-TR-69-41) Avail: NTIS CSCL 1/3

An investigation to determine the ranges of various lateral

directional characteristics required to provide adequate flying qualities for turning maneuvers at low speed was undertaken using an airborne V/STOL aircraft simulator. Five parameters were varied in a systematic manner: the damping ratio, the frequency, and the ratio and the frequency of the numerator of the roll-angle to aileron-control-input transfer function. The pilots performed a low speed, visual maneuvering task and documented their assessment of the characteristics through extensive comments and a numerical rating. The report presents all the data categorized with respect to the test parameters. Author (TAB)

N70-40019*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
DISPLAY SYSTEM Patent Application
Anne W. Story, inventor (to NASA) Filed 16 Jul. 1970 21 p
(NASA-Case-ERC-10350; US-Patent-Appl-SN-55535) Avail: NTIS CSLC 09E

A situational display and a means for creating the display are disclosed. The display comprises a moving line or raster, on a cathode ray tube, which is disposed intermediate of two columns of lamps or intensifications on the cathode ray tube, the raster and lights to either side thereof being controlled in such a manner that pairs of lights define a line which is either tracked or chased by the raster in accordance with the relationship between the optimum and actual values of a monitored parameter. NASA

N70-40023# Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.
COMPUTER OPTIMIZATION OF WATER-AUGMENTED TURBOFAN CONCEPT AND DEVELOPMENT OF A TEST FACILITY FOR TWO-PHASE FLOW
Randolph Grant Watson Jun. 1969 110 p refs
(AD-708044) Avail: NTIS CSCL 13/10

A turbofan engine propulsion system in which large amounts of water are injected into the fan discharge duct is investigated with the goal of increasing both the thrust and propulsive efficiency while retaining the light-weight qualities of a standard turbofan engine. A parametric computer analysis is used to examine the effect of several variables, including water-to-gas generator air ratio, water injection velocity, fan duct pressure loss, and fan duct thermal and dynamic nonequilibrium, upon thrust and propulsive efficiency. In addition, the design parameters of fan pressure ratio and fan bypass ratio are examined for their optimum values, and optimum operating combinations of water-to-gas ratio and water injection velocity are determined. A test apparatus is developed for the direct measurement of wall friction force in two-phase flows. A computer program is presented to reduce experimental data and compare with pressure drop predicted by two empirical correlations. Author (TAB)

N70-40024# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN INVESTIGATION OF PERFORATION MECHANICS IN THIN ALUMINUM PLATES
Richard David Gabbert (M.S. Thesis) Jun. 1970 78 p refs
(AD-707837; GAW/MC/70-2) Avail: NTIS CSCL 11/6

The Nishiwaki theory of penetration was investigated for seven projectile shapes against three thicknesses of 6061-T6 aluminum target material. The projectiles were fired from a 50 caliber gun at impact velocities near 500 m/sec. Initial velocities and projectile velocity losses were measured by flash x-rays and chronographs. The same projectile shapes were also used to perforate identical targets quasi-statically with a laboratory universal testing machine. This provided the empirical information necessary to the application of the Nishiwaki theory. The basic Nishiwaki equations were found to be inaccurate for most projectile shapes. A modification of this theory was investigated and found to be accurate in predicting projectile velocity losses to within 8 m/sec at impact velocities near 500 m/sec. Additional proposed penetration models are presented but not investigated. Author (TAB)

N70-40026# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
PORTABLE INSTRUMENT PACKAGE (PORTAPAK) FOR THE MEASUREMENT OF NOISE AND VIBRATION
Harald K. Hille, J. F. Rose, Jr., and L. Keith Kettler (Dayton Univ. Res. Inst.) Mar. 1970 27 p
(AD-707826; AMRL-TR-69-75) Avail: NTIS CSCL 14/3

A portable, self-contained, instrument package (PORTAPAK) for recording noise and vibration environmental data in and around aircraft was developed. It was especially designed for use in field surveys where conditions limit the use of large and heavier recording equipment. The battery-operated recording system consists of a tape recorder and associated circuitry, a condenser microphone and a linear servo accelerometer as the vibration transducer. It weighs only 30 pounds and the overall dimensions are 17 inches wide, 14 1/2 inches deep and 5 1/2 inches high. Noise levels from 54 to 150 db SPL in the frequency range from 20 to 16,000 Hz and acceleration levels from 0.3 to 5 G in the frequency range from dc to 30 Hz can be measured. A complete description of the system is included and its performance characteristics for both the acoustical and vibration recording section are given. Author (TAB)

N70-40037# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.
SYNTHESIS OF AERODYNAMIC FORCE CHARACTERISTICS OF BISYMMETRIC LIFTING VEHICLES
Reinald G. Finke Apr. 1970 31 p refs
(Contract DAHC15-67-C-0011)
(AD-708022; N-595(R); IDA/HQ-68-9485) Avail: NTIS CSCL 22/2

The dependences of lift and drag coefficients on angle of attack for bisymmetric lifting vehicles are synthesized using two simplifying assumptions: (1) the axial force coefficient is independent of the angle of attack, and (2) the normal force coefficient increases linearly with the angle of attack. Good agreement with experimental data is found for the value of the the angle of attack at which the maximum L/D occurs and the angle of attack for maximum C sub L in the hypersonic regime; applicability for subsonic flight is limited to those angles of attack below the inception of flow separation. Conditions for terminal equilibrium glide and landing for aircraft are derived from the simplified aerodynamic characteristics. With the linearized normal force, the following useful rules of thumb are obtained for super and hypersonic vehicles with maximum L/D greater than 1.0: (1) the drag at maximum L/D is very closely twice the zero-lift drag, (2) the L/D at maximum C sub L is about 0.8, (3) the angle of attack for maximum C sub L is about 48 deg, (4) the ratio of the maximum C sub L to the C sub L at L/D max is approximated by 0.5 + L/D(max), and (5) the ratio of the normal force slope to the maximum lift is closely 2.0 per radian. Author (TAB)

N70-40069# National Aerospace Lab., Amsterdam (Netherlands).
FATIGUE LOAD MONITORING OF MILITARY AIRCRAFT
Paris AGARD Aug. 1970 9 p ref
(AGARD-AR-28) Avail: NTIS

The results of a study on fatigue level control are summarized, and include current monitoring, measurement, and analysis techniques along with major problems and needs. The following conclusions were reached: For present-day aircraft the monitoring

of fatigue loads appears to be mandatory. The monitoring systems used at present measure and record movement parameters. The conversion of these parameters to structural loads or stresses may be difficult for more complex aircraft. The monitoring of strains instead of c.g. acceleration should be preferred with complex aircraft where no consistent relation between acceleration and structural load can be taken to exist. It is recommended that efforts to develop a simple strain recording system should be encouraged. Within the the NATO countries with relatively large air forces, well-established techniques for fatigue life monitoring exist, which are adapted to their specific demands and problems. It is recommended that the smaller NATO countries coordinate their efforts to arrive at a solution which suits their joint requirements. Author

N70-40071*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
HONEYCOMB CORE STRUCTURES OF MINIMAL SURFACE TUBULE SECTIONS Patent Application
Alan H. Schoen, inventor (to NASA) Filed 22 Jul. 1970 45 p
(NASA-Case-ERC-10363; US-Patent-Appl-SN-57253) Avail: NTIS CSCL 13M

Honeycomb cores formed of tubule sections bounded orthogonally by plane facings are described. The tubule sections are defined as being formed of minimal surface elements that orthogonally intersect all of the surfaces of a kaleidoscopic cell at least once. In other words, the tubule sections are broken into elements for definition purposes. The elements are defined as minimal surface elements, i.e., elements that have a mean curvature that is equal to zero at all points on their surface. These elements are further defined inside of an imaginary kaleidoscopic cell in that they orthogonally intersect all surfaces of an imaginary kaleidoscopic cell at least once. Moreover, the tubule sections are smoothly interconnected to form honeycomb core structures that have no internal discontinuities. NASA

N70-40109# Institute for Defense Analyses, Arlington, Va.
A BIBLIOGRAPHY ON AIR TRAVEL AND ASSOCIATED GROUND TRANSPORTATION: URBAN MASS TRANSPORTATION PROJECT
Janet D. Kiernan Jun. 1970 48 p refs
(Contract DAHC15-67-C-0011; DOT-UT-43(IAA))
(AD-708023; N-731(R); IDA/HQ-70-11522) Avail: NTIS CSCL 1/2

A survey of documents and articles was made to help identify current data and studies relating to air travel demand projections, alternative airport configurations, flow patterns and rates, and available or potential ground transportation concepts, systems, and components. The bibliography covers the subject areas up to August 1969. Author (TAB)

N70-40129# Naval Research Lab., Washington, D.C.
PRECIPITATION EFFECTS ON OMEGA AIRCRAFT RECEIVERS Final Report
R. L. Eisenberg 18 May 1970 29 p refs
(AD-707710; NRL-7055) Avail: NTIS CSCL 17/7

Omega is a very-low-frequency (vlf) radio navigation system characterized by very long range and an accuracy on the order of 1 to 2 mi with respect to earth coordinates. Early flight tests of Omega aircraft receivers using vertical electric-field antennas achieved excellent results in good weather but experienced almost constant signal loss in precipitation conditions. Signal losses appeared to be caused by precipitation static and shorting of the insulation at the bases of the antennas. Modifications of vertical antennas, including shielding of the leading edge and improved base insulators, reduced but did not solve the problem. An experimental NRL-designed-and-constructed crossed-loop antenna system improved reception characteristics with respect to both wetting and static pickup. NRL has evaluated the performance of modified vertical antennas and crossed-loop antennas in the laboratory and on Omega test flights. These flight tests have revealed that the crossed-loop antenna offers adequate sensitivity and a significant reduction of precipitation effects and thus provides all-weather operation of Omega aircraft receivers. Author (TAB)

N70-40157* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AIRCRAFT INSTRUMENT Patent
Joseph W. Wetmore, inventor (to NASA) Issued 7 Dec. 1965 (Filed 9 Nov. 1962) 15 p Cl. 73-178
(NASA-Case-XLA-00487; US-Patent-3,221,549;
US-Patent-Appl-SN-236748) Avail: US Patent Office CSCL 01D

An aircraft instrument is described which permits pilot control of aircraft rotation in takeoff attitude at the proper speed, near optimum climbout path control, and vertical plane flight path control in poor visibility conditions. The instrument combines angle-of-attack indications for controlling takeoff rotation with total-pressure rate of change indications and eliminates low-frequency, poorly damped, large amplitude, phugoid oscillation of the flight path. The instrument is composed of pneumatic and mechanical components with an electrical servomotor drive for positioning an angle-of-attack sensing head, and self-synchronizing motors for indicating the angle-of-attack head position. The linkage system, operation, instrument adjustment, modifications, mathematical models, and figures are presented. J.M.

N70-40162# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
HYPERSONIC WAKE STUDIES Final Report, 15 Jan. 1962–15 Jan. 1970
Seymour M. Bogdonoff 10 Jul. 1970 21 p refs
(Contract Nonr-1858(37); ARPA Order 322)
(AD-708757) Avail: NTIS CSCL 20/4

Contents: Two-dimensional wakes; Magnetic suspension system - hypersonic tunnel development; Sphere wakes; Transition studies; Sharp and blunt cone wakes; Low density studies; Surface and base geometry effects on the wake; Wire support effects; Effects of Mach number, Reynolds number and surface temperature; Two-dimensional wakes; Magnetic suspension system; Hypersonic tunnel development; Study of sphere wakes; Study of sharp cone wakes; Study of blunt cone wakes; Other cone studies; Preliminary results of high Reynolds number; Other incompleted studies. TAB

N70-40188# Franklin Inst., Philadelphia, Pa. Research Labs.
EXPERIMENTAL SYSTEMS FOR IMPACT PROTECTION Final Report, Sep. 1969–Mar. 1970
F. W. Cooke, B. L. Rosenberg, and M. G. Kelley 16 Apr. 1970 40 p refs
(Contract N00156-70-C-1192)
(AD-708017; FIRL-F-C2636; NADC-AC-7003) Avail: NTIS CSCL 1/3

The impact absorbing properties of starch/brine dilatant suspensions were characterized with an instrumented, pendulum-type impact tester. The starch concentrations were varied between 47.5 and 52.5% and sealed in heavy rubber bags of varying thickness. The temperature of the filled rubber bags was varied between 45 and 110F. Impacting energies ranged between 30 and 141 ft-lbs with velocities of 11 and 17 ft/sec. The dilatant suspensions were found to be highly efficient and reusable energy absorbers under all test conditions. Impactor penetration, peak deceleration, and jerk varied depending on the impact energy input,

impact velocity, bag wall thickness, and, to a lesser extent, starch concentration and temperature. The filled bags readily conform to the shape of a 1 cm radius impactor and yield relatively low peak deceleration and jerk. There was no noticeable deterioration of the dilatant properties as a result of temperature cycling and repeated impacts. Author (TAB)

N70-40214# Mechanical Technology, Inc., Latham, N.Y.
A TWO PHASE FLOW ROTOR BEARING SYSTEM: EXECUTION OF AN EXTENDED (500 HOUR) TEST Progress Report, 1 Jan. 1969 – 31 Mar. 1970
E. F. Finkin and S. Malanoski Apr. 1970 20 p refs
(Contract AT(30-1)-3839)
(MTI-70-TR-33; NYO-3839-9) Avail: NTIS

Activities in a program to develop design data and guidelines for the introduction of two-phase flow steam-lubricated bearings in turbomachines are summarized. Information is included on steam supply system development and instrumentation design. Information is also included on compressed air tests and 500 hour endurance tests. NSA

N70-40252# North American Rockwell Corp., Downey, Calif. Space Div.
HYDROELASTIC ANALYSIS OF A CIRCULAR CYLINDER/LIFT ON BODIES OF REVOLUTION Final Report
Howard D. McLaughlin and Ben H. Ujihara Dec. 1969 350 p refs
(Contract N00014-68-C-0223)
(AD-708434; SD-69-558) Avail: NTIS CSCL 20/4

Potential theory is applied to numerical solution of non-steady, separated flows about cylindrical bodies. The particular configurations studied are (1) an elastically supported circular cylinder in uniform onset flow and (2) a growing elliptical cylinder representing, in the cross flow plane, a slender body at angle of attack. Solution of non-steady, separated flows by potential theory is made possible by a generalization of the Kutta-Joukowski Condition to govern the rate of vorticity transport from the attached boundary layer into the near wake. This vorticity is represented by incremental, discrete particle vortices. Both theory and numerical results are presented. For the elastically supported circular cylinder, the natural frequency is taken to be the Strouhal frequency. Instantaneous pressure distributions, and force time histories are shown. For slender bodies at angle of attack, lift distributions, force and moment coefficients are presented for a body of revolution with length-diameter ratios of 10 at various angles of attack. Detailed separated flow stream lines are also shown. Author (TAB)

N70-40257# All American Engineering Co., Wilmington, Del.
CAPSTAN DESIGN. LOW INERTIA TRANSMISSION STUDY Final Report
Linwood C. Robinson 25 May 1970 36 p
(Contract N00156-69-C-1897)
(AD-708759; AAE-N-585) Avail: NTIS CSCL 13/9

A capstan suitable for driving an energy absorber for aircraft recovery systems was designed. Performance analysis of various contours were obtained using a capstan analysis computer program. The design is for a 1-1/8 inch diameter steel cable and a cable tension ration of 12 to 1. Author (TAB)

N70-40276# MITRE Corp., Bedford, Mass.
TACTICAL AIRLIFT AUTOMATION DEVELOPMENT/TESTED EXPERIMENTATION
Duncan A. MacQueen, Jr. 2 Jun. 1970 7 p Presented at the Tactical Airlift Command and Control Panel Armed Forced Commun. and Electron. Assoc. Conv., Washington, D.C., 2 Jun. 1970
(Contract F19628-68-C-0365)
(AD-708722; ESD-TR-70-199) Avail: NTIS CSCL 9/2

The Air Force Electronic Systems Division and the MITRE Corporation have established a Tactical Data Systems Development Testbed at ESD to evaluate automation concepts for the control of tactical air operations. The testbed has been used to implement and evaluate a current operations tactical airlift capability. Author (TAB)

N70-40297# Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
SOME RECENT EXPERIMENTAL STUDIES ON THE AEROELASTIC STABILITY OF THIN CYLINDRICAL SHELLS. PART 1: AN EXPERIMENTAL STUDY OF THE SUPERSONIC FLOW FIELD OVER AN AEROELASTIC OGIVE CYLINDER MODEL WITH BOUNDARY LAYER CONTROL
Philip L. Dailey, James P. Williams, and Ronald O. Stearman Jan. 1970 151 p refs
(Grant AF-AFOSR-1234-67)
(AD-708485; AFOSR-70-1177TR-Pt-1) Avail: NTIS CSCL 1/3

An experimental study was conducted as the first phase in a program to determine the influence of a compressible viscous boundary layer on cylindrical shell panel flutter. In the first part of the experiment, a study was conducted to provide data on the uniformity of the surface pressure distribution over the region of the flutter model where the thin cylindrical shells were mounted for the flutter experiments. The measured data confirmed that for all flow conditions above Mach Number 1.2, no significant pressure gradient existed over the region of the model where the flutter shells were mounted for testing. A study was then conducted to determine the effectiveness of the boundary layer control system for increasing the boundary layer thickness over the region of the model where the flutter shells were mounted. The boundary layer control system proved to be quite effective and under optimum conditions could increase the displacement and momentum thicknesses by a factor of 10. In general, the displacement and momentum thicknesses could be increased by at least 50% for most of the operating conditions of the wind tunnels by maximum activation of the boundary layer control systems. Finally boundary layer transition and profile similarity studies were conducted to determine the range of free stream flow conditions and boundary layer control activation rates where boundary layer profile similarity could be achieved over the test shell area of the model. The results indicate that similar laminar or turbulent boundary layer profiles can be maintained over the test region of the model for flow conditions where panel flutter can be expected to occur. Author (TAB)

N70-40298# All American Engineering Co., Wilmington, Del.
LOW INERTIA TRANSMISSION STUDY, PHASE 2 Final Report
Linwood C. Robinson 25 May 1970 67 p
(Contract N00156-69-C-1897)
(AD-708760; AAE-N-586) Avail: NTIS CSCL 13/9

The feasibility of the use of the Low Inertia Transmission System (LITS) as an aircraft arresting gear was determined by performance analysis and testing of a small scale model of the system. The configuration of a capstan to be driven by steel cable, with reversing capability, was determined and a capsian model tested to prove the feasibility of the design. The design of a full scale capstan was made and the performance of a full scale system was determined using energy absorbers with torque as a function of angular velocity squared and with a constant torque function. Initial cable dynamic characteristics determined analytically are shown graphically for each torque characteristic. A scale model, using 3/8 inch diameter steel cable, of the complete low inertia transmission system, was tested as an arresting system. The results of this test give the time history from engagement to end of runout. Author (TAB)

N70-40339# Naval Research Lab., Washington, D.C. Solid State Technology Branch.
AN ASSESSMENT OF HIGH-VOLTAGE DC ELECTRICAL POWER IN AIRCRAFT ELECTRICAL SYSTEMS Interim Report
B. J. Wilson and J. P. O'Connor 1 Jul. 1970 14 p refs
(AD-709079; NRL-7126) Avail: NTIS CSCL 10/2

If the presently installed three-phase ac transmission system on aircraft were replaced by a higher voltage dc (HVDC) transmission using a ground return (the aircraft frame), a reduction in weight of wiring, number of wires, and total power losses equal to one-third their present value could be achieved at a dc system voltage of 345 V. A plot of system wire weight vs values of dc system voltage shows an increase in wiring weight with decreasing values of dc system voltage. The weight reduction with increasing values of voltage is significant because the distribution wiring weight is about from one- to two-thirds of the total electrical system weight. HVDC may have some disadvantages such as higher short-circuit currents, some increase in personnel hazard, and at present a limitation on the use of transistors. The compromise between the weight advantages to be gained at 345 V and the disadvantages that were anticipated at this value leads to the choice of a standard value of 230 V. At this voltage, a saving of approximately 50% in wire weight and 50% in power losses results when compared to the ac systems on WF-2 and F4J aircraft. Author (TAB)

N70-40359# Shock and Vibration Information Center (Defense), Washington, D.C.
THE SHOCK AND VIBRATION DIGEST, VOLUME 2, NO. 2
Feb. 1970 21 p refs
(AD-700811) Avail: NTIS CSCL 20/11

Contents: Analytical methods; Design information; Modeling and simulation; Numerical techniques; Excitation; Phenomenology; Testing techniques; Mechanical elements; Metal working; Vibration isolation, and Shock isolation. TAB

N70-40380# Colorado State Univ., Fort Collins. Engineering Research Center.
GASEOUS PLUME DIFFUSION ABOUT ISOLATED STRUCTURES OF SIMPLE GEOMETRY Annual Progress Report, 14 Jun. 1969 – 14 Jun. 1970
Robert N. Meroney Mar. 1970 18 p
(Contract AT(11-1)-2053)
(COO-2053-1) Avail: NTIS

A model was constructed to perform geometrically and dynamically similar experiments for diffusion of gases in building wakes in the atmosphere and in the meteorological wind tunnel. Kr-85 was used as a tracer gas for obtaining concentration distributions. Dispersion of the gas was affected by the aerodynamic structure of the flow and the temperature stratification condition. Photographs showed a strong mixing in the cavity region and a turbulent mixing motion was dominant in the wake region. The apparatus allowed different places for release of the smoke, and similar contours of concentration distribution showed no effect of the release location. The stable stratified flow suppressed the turbulent motion and resulted in higher concentrations at a given down wind distance. NSA

N70-40442# National Aerospace Lab., Tokyo (Japan).
DRAG MEASUREMENT IN NEARLY-FREE-MOLECULE-FLOW REGIME
Akira Onji and Kiyoshi Yamamoto 1970 8 p refs In JAPANESE; ENGLISH summary
(NAL-TR-191) Avail: NTIS

The measurements of sphere drag in a nearly free molecule flow regime are presented. The measurements were made using a rotating arm apparatus. The circulating speed of the models mounted on the arm tip decreases due to the drag force and other effects such as mechanical friction and the arm drag. From the measurement of this deceleration rate and by subtracting the outside effects, the drag coefficients of the model were determined. The results are compared with existing theories and experimental data. Author

N70-40470# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
A METHOD FOR GUIDING EFFLUX AIR FROM A FAN-IN-WING MODEL INTO A DISCHARGE DUCT
U. W. Schaub and R. J. Rimmer Feb. 1970 15 p ref
(NRC-11446; MET-508) Avail: NTIS

A scheme is described by means of which the 12-inch fan-in-wing model in the Engine Laboratory was separated from a mechanically connected efflux-removing duct. The modifications that were introduced included a slotted bellmouth inlet, which served as a catch-flow entrance below the air gap, and a diffuser at the exit of the ducting system, which corrected the static pressure level in the duct for transmission of the full efflux flow. The modifications were intended to facilitate mechanical isolation of the model so that direct lift measurements could be made while the efflux air was removed with essentially zero ground effect. Author

N70-40472# Waterloo Univ. (Ontario).
FLOW DEVELOPMENT IN CONICAL DIFFUSERS WITH ANNULAR INJECTION AT INLET
W. B. Nicoll and B. R. Ramaprian Feb. 1969 29 p refs
(RR-14) Avail: NTIS

The occurrence of stall in widely divergent conical diffusers can be delayed by injecting high velocity air through an annular slot at the diffuser inlet. Results of theoretical and experimental investigation of the flow development in such cases are presented. A finite difference method suggested by Patankar and Spalding is applied to predict the flow development. Prandtl's mixing length hypothesis is assumed with a simple mixing length model. The experimental data have been obtained from three conical diffusers of cone angles 10 deg, 20 deg and 30 deg at different injection rates. The predictions are found to compare well with experiments if a first order correction is applied for the asymmetry present in the experimental flow. Experimental data on the effect of injection on pressure recovery and diffuser efficiency are reported in a companion paper. Author

N70-40514# Army Aviation Test Activity, Edwards AFB, Calif.
WIND TUNNEL AND FLIGHT EVALUATION ROSEMOUNT SHIELDED PITOT-STATIC TUBE MODEL 850N Final Study, Jul. 1967 – Feb. 1970
Kenneth R. Ferrell, John J. Shapely, Jr., and Jervis Mishlof Apr. 1970 43 p
(AD-708859; USAASTA-68-12) Avail: NTIS CSCL 14/2

Test airspeed probes are generally of a fixed or swiveling pitot-static type. Fixed probes are inaccurate at the low speeds and large inflow angles common to helicopter flight regimes. Swivel head probes provide more accurate information, but are often limited by the dynamic pressure they can withstand. A fixed probe which was reportedly not sensitive to angles of attack or sideslip was tested in the wind tunnel and on a helicopter to evaluate suitability for use as a test instrument. Author (TAB)

N70-40542# Analytic Services, Inc., Falls Church, Va.
THE WASHINGTON-BALTIMORE REGIONAL AIR FREIGHT TRANSPORT SYSTEM
D. H. Reeher and James W. Dwyer Mar. 1970 140 p refs
(AD-708623) Avail: NTIS CSCL 1/5

The report examines the structure and operation of, and the air freight flows within, the domestic air freight transport system that centers on the airport complex composed of Washington National, Dulles International, and Friendship International airports. It discusses the regional role of each of the three airports, their interactions, and important operational and service activities of associated air and ground links. The report also examines prominent factors that either constrain or facilitate operation of the system. Author (TAB)

N70-40556 Oklahoma Univ., Norman.
TURBULENT BOUNDARY LAYER CHARACTERISTICS OF FLOW OVER A COMPLIANT SURFACE
Robert Raymond Walters (Ph.D. Thesis) 1969 129 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 69-18468

A detailed hot-wire anemometer study was made to determine the basic characteristics of the turbulent boundary layer flow with a zero pressure gradient over a compliant surface. The compliant surface was constructed from a 0.001 inch polyvinyl-chloride membrane backed by a 3/16 inch damping layer of polyurethane foam. The tests were run at a constant velocity of 50 feet per second. The hot-wire anemometer study over the compliant surface revealed little change in the velocity profile, however a reduction of turbulence intensities was recorded as well as a 25 percent decrease in the Reynolds stresses when compared with hard plate data. The spectra of turbulence measurements indicated a decrease in energy at the higher frequencies throughout the boundary layer. Production, dissipation, and convection of turbulent energy were found to decrease over the compliant surface when compared with the hard plate measurements. Dissert. Abstr.

N70-40562# National Aerospace Lab., Tokyo (Japan). V/STO Div.
WIND TUNNEL INVESTIGATIONS OF THE STOL AIRPLANE, WITH ATTENTION TO THE RELATIONS BETWEEN THE AERODYNAMIC CHARACTERISTICS AND THE WAKE STRUCTURE
Norio Inumaru, Kiyomi Kitamura, Nagakatsu Kawahata, Hitoshi Takahashi, and Tomoaki Suzuki May 1970 32 p refs
(NAL-TR-197T) Avail: NTIS

Wind tunnel measurements were carried out extensively on the flow field behind a powered model of the twin-propeller deflected slipstream STOL airplane. By the use of new equipments in the measurement, spacial distributions of the flow velocity, down wash angle and side wash angle were obtained. Consequently the extraordinary deformation of the slipstream boundaries, and also the complicated movements of wake vortex systems have been recognized in the flow field. Furthermore by changing the direction of the propeller rotation, marked influences of the rotating flow on the flow field have been exhibited. These observed experimental facts seem to have some connection with the nonlinear aerodynamic characteristics of such a type of STOL airplane. The aerodynamic forces and moments of the model have also been obtained by the use of a sting type balance. The probable relations among the relevant facts are discussed. Author

N70-40566# Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
FLUCTUATING TURBULENT STRESSES IN THE NOISE-PRODUCING REGION OF A JET, PART 2
Ian S. F. Jones Mar. 1968 36 p refs
(RR-10-Pt-2) Avail: NTIS

Measurements are presented of the wave-number frequency spectrum of a fluctuating Reynolds stress in the mixing layer of a jet. From these measurements the influence of retarded time in acoustic radiation from a jet can be assessed. Static pressure fluctuations have also been measured and are included for comparison with the Reynolds stresses. Author

N70-40594# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
PROPELLER STATIC PERFORMANCE TESTS FOR V/STOL AIRCRAFT. PART 2: TEST DATA, APPENDIX 3, REPORT FOR JULY 1965–NOVEMBER 1967
Matthew H. Chopin Jan. 1970 366 p
(AD-708742; ASD-TR-69-15-Pt-2-App-3) Avail: NTIS CSCL 1/3

The report presents the reduced data obtained during an extensive series of propeller static performance tests which were run because of a static performance thrust deficiency encountered during flight tests of the XC-142A V/STOL Cargo Aircraft. Thirteen different propellers were used; 28 different configurations were obtained by changing parameters of some of the 13 blades. The reduced data for the 28 versions of propellers tested are presented. Parameters studied during the tests included blade cuff (on or off), tip shape, twist, activity factor, camber, and airfoil section. Data on several other static thrust propellers tested on Rigs Nos. 1 and 4, which were not a part of this test series, are also presented for additional information. The information obtained from the tests, in effect, represents a state-of-the-art study for improving propeller static performance for V/STOL aircraft applications. The information obtained during these tests can be used to more accurately predict static thrust for future propeller driven V/STOL aircraft. Author (TAB)

N70-40624*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A SWIRL-CAN PRIMARY COMBUSTOR TO OUTLET TEMPERATURES OF 3600 F (2256 K)
Richard W. Niedzwiecki, Albert J. Juhasz, and David M. Anderson Sep. 1970 10 p refs
(NASA-TM-X-52902) Avail: NTIS CSCL 21E

A swirl-can full-annulus combustor was operated at an average outlet temperature of 3616 F (2264 K) which is 377 R (187 K) below the stoichiometric temperature. The combustion efficiency, pattern factor, smoke emission, and pressure loss were all quite favorable. Author

N70-40628# School of Aerospace Medicine, Brooks AFB, Tex.
NOISE ENVIRONMENTS WITHIN MULTIPLACE FIXED WING AIRCRAFT Final Report, Jul. 1965–Dec. 1969
Donald C. Gasaway May 1970 23 p refs
(AD-708430; SAM-TR-70-26) Avail: NTIS CSCL 20/1

Noise environments within various multiplace fixed-wing aircraft demonstrate differences related to the proximity of the occupant to primary and secondary noise-generating mechanisms. The report defines acoustic environments sampled at different locations within eight groups of fixed-wing aircraft during conditions of normal cruise. A total of 51 aircraft, representative of vehicles powered by reciprocating, turbopropeller, and turbojet or turbofan engines, provided the data from which 28 noise envelopes were plotted. Author (TAB)

N70-40655# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.

CONDENSATION IN A CONTOURED-NOZZLE SHOCK TUNNEL, REPORT FOR JANUARY–APRIL 1970

Robert L. Varwig and Stephen B. Mason 1 Jul. 1970 29 p refs

(Contract F04701-69-C-0066)

(AD-708475; TR-0066(5240-10)-11; SAMSO-TR-70-228) Avail: NTIS CSCL 20/4

The onset of condensation in a hypersonic shock tunnel was investigated to determine the limiting temperature to which the gas may be expanded. Previous research indicated some supercooling could be obtained; however, a confident assessment could not be made because of scatter in available experimental results. Static wall pressure and pitot pressure, which vary with condensation, were measured, while reservoir temperature was reduced for constant reservoir pressure. Under these conditions, measurements were made of condensation and supercooling. Author (TAB)

N70-40657*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SPIN-TUNNEL INVESTIGATION OF A 1/20 SCALE MODEL OF A MODIFIED STRAIGHT-WING, TWIN-BOOM, COUNTER-INSURGENCY AIRPLANE

Henry A. Lee Washington Oct. 1970 23 p refs

(NASA-TM-X-2053; L-7142) Avail: NTIS CSCL 01C

The test results indicate that the airplane will spin in the erect attitude for all loading conditions and will spin inverted only for ailerons-with control settings. The optimum control technique for recovery from all spins is movement of the rudder to against the spin followed about one-half turn later by neutralization of the longitudinal and lateral controls. Satisfactory emergency recoveries from spins can be obtained by the use of rockets that produce an antispin yawing moment (about the Z body axis) of at least 27,600 ft-lb for at least 4.5 seconds. Author

N70-40659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

AN ANALYSIS OF THE CAPABILITIES AND LIMITATIONS OF TURBINE AIR COOLING METHODS

Jack B. Esgar, Raymond S. Colladay, and Albert Kaufman Washington Sep. 1970 51 p refs

(NASA-TN-D-5992; E-5669) Avail: NTIS CSCL 21E

The relative merits of convection, transpiration, and full coverage film air cooling methods were investigated for local turbine inlet temperatures from 2000 to 3500 F, gas pressures from 5 to 40 atmospheres, and cooling air temperatures from 600 to 1200 F. Effects of blade and vane wall thickness, leading edge radius, and material temperature were also investigated. The results indicate the design trends required for the cooled turbines of future engines, the superiority of transpiration and full coverage film cooling over convection cooling, and approaches that can be used to improve convection cooling. Author

N70-40667*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MODEL WIND-TUNNEL AND FLIGHT INVESTIGATION OF A PARAWING LIFTING BODY LANDING SYSTEM

Rodger L. Naeseth Washington Oct. 1970 91 p refs

(NASA-TN-D-5893; L-6995) Avail: NTIS CSCL 01C

A parawing has been used with a model hypersonic lifting body, and landing and maneuvering capability which would be needed for the landing phase of the reentry trajectory was demonstrated. Small-scale wind tunnel and flight test results were used in designing the rigging and controls for an instrumented flight test model (70 in. long). The wind tunnel tests were made in the 17-foot test section of the Langley 300-MPH 7- by 10-foot tunnel and the flight tests were made at the NASA Wallops Station. Results of the tests showed that the rigging tightly coupled the body to the parawing so that little or no relative motion between wing and body occurred even in sharp turns. Lateral control by means of the parawing tip lines could produce turn rates of 25 deg per second and longitudinal control by means of the aft keel line could modulate the model in pitch from nose tuck (low angle of attack) to stall. The model was tested in a fully developed stall and was found to recover satisfactorily. Landing on the rounded bottom of the body was not satisfactory, at least in model size. Operations and safety procedures developed during the flight tests are described. Author

N70-40679# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Fluid Dynamics Facilities Research Lab.

TURBULENT MIXING OF SUPERSONIC JETS Final Report

Ronald L. Haugen May 1970 102 p refs

(AD-708735; ARL-70-0078) Avail: NTIS CSCL 21/2

The mixing of compressible turbulent jets is investigated theoretically. Two solution techniques are presented. A FORTRAN IV computer coding is included for each technique. In the first method, the problem is solved by first writing the momentum and energy equations in Crocco variables. The resulting coupled pair of integral equations are solved numerically using a method of successive approximation. In the second method, the problem is solved, assuming self-similar solutions, by applying a coordinate transformation. The resulting coupled pair of nonlinear ordinary differential equations are solved numerically. Author (TAB)

N70-40688*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED WIND-TUNNEL INVESTIGATION OF ALL-FLEXIBLE TWIN-KEEL TENSION-STRUCTURE PARAWINGS

Paul G. Fournier Washington Oct. 1970 85 p refs

(NASA-TN-D-5965; L-7035) Avail: NTIS CSCL 01C

Low-speed wind-tunnel tests were made to determine the static aerodynamic characteristics of several tension-structure all-flexible twin-keel parawings having keel cant angles from 0 deg to 20 deg. Of the configurations tested, those having 5 deg to 15 deg canted keels showed higher values of lift-drag ratio throughout most of the resultant-force range, especially at the higher values of resultant-force coefficient. The overall performance of the basic model was not improved by the addition of either a lower surface scoop or keel mounted upper surface ram-air-inflated tubes. Narrowing the center panel of the basic model did not change the overall performance, whereas widening the center panel resulted in somewhat lower performance. Limited increase in keel-to-payload separation distance resulted in improved performance. Author

N70-40689*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A TWIN-TURBOFAN SUBSONIC TRANSPORT WITH NACELLES MOUNTED UNDER THE WINGS

Francis J. Capone Washington Oct. 1970 94 p refs

(NASA-TN-D-5971; L-7141) Avail: NTIS CSCL 01C

An investigation has been conducted in the Langley 16-foot transonic tunnel to determine the longitudinal aerodynamic characteristics of a 0.062-scale, twin-turbofan subsonic transport at

Mach numbers from 0.55 to 0.85 and angles of attack from about −2 deg to 6 deg. The Reynolds number based on wing mean aerodynamic chord varied from 0.00000225 to 0.00000270. The effects of model-component buildup, horizontal-tail effectiveness, boundary-layer transition, and wing and nacelle modifications were measured. The model was mounted by using a sting-strut arrangement with the strut entering the model through the underside of the fuselage approximately 65 percent of the fuselage length rearward of the model nose. Strut-interference effects were measured and applied as a correction to the data. Author

N70-40690*# National Aeronautics and Space Administration. *Langley Research Center, Langley Station, Va.*

GROUND-EFFECTS INVESTIGATION OF A STOL AIR-SEA TRANSPORT MODEL WITH BLOWING OVER THE CANARD AND WING FLAPS

Raymond D. Vogler Washington Oct. 1970 44 p refs
(NASA-TN-D-5988; L-7193) Avail: NTIS CSCL 01C

Compressed air was used for blowing over the flaps of the canard and wing. The total mass flow over the flaps was varied as well as the distribution of the flow between the canard and wing. Data were obtained through an angle-of-attack range and an angle-of-sideslip range with the model at various heights above a moving ground plane. Interference effects between canard and wing were obtained by comparing complete model data with data for the wing alone and canard alone. Author

N70-40701# Advisory Group for Aerospace Research and Development, Paris (France).

PRELIMINARY DESIGN ASPECTS OF MILITARY AIRCRAFT

Mar. 1970 303 p refs Presented at 35th Meeting of the Flight Mech. Panel of AGARD, The Hague, 2–5 Sep. 1969
(AGARD-CP-62) Avail: NTIS

The aspects discussed included project design, aerodynamics, power plants, structures, airframe systems, and operational systems and requirements.

N70-40702# Advisory Group for Aerospace Research and Development, Paris (France).

INTRODUCTORY REMARKS ON PRELIMINARY AIRPLANE DESIGN

Clem C. Weissman *In its* Prelim. Design Aspects of Mil. Aircraft Mar. 1970 5 p
Avail: NTIS

Following a brief discussion of the mission of AGARD, it is stated that the object of the symposium is to highlight the methods and techniques of preliminary airplane design and to explore those compromises involved in the early design stage. The stages usually found in a development program are outlined. Feasibility studies concerning a generalized requirement are undertaken to investigate the various possible technical solutions, together with indications of timescale and cost. An initial study of the relative cost effectiveness of alternative proposals may be determined. A firm requirement may then be produced, which is the technical solution chosen from the feasibility study. Project studies are subsequently carried out against the full requirement; from these, a complete aircraft specification with detailed performance, development, and production time scales and costs is drawn up. Thus, the major compromises and decisions are made prior to the design go-ahead. P.A.B.

N70-40703# British Aircraft Corp., Preston (England).

PROJECT DESIGN OF COMBAT AIRCRAFT

B. O. Heath *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 25 p
Avail: NTIS

The traditional role of establishing a datum aircraft configuration is covered as one part of a project design process which as a whole must ensure margins and tolerances acceptable to both contractor and procurement agency. Organizational aspects, parametric studies, layout considerations, overall design synthesis examples, systems, and structure are discussed. It is stated that project design is a process which draws upon past experience and upon the advice of specialists in order to obtain the best balance of performance in all its aspects, costs, and timescale. P.A.B.

N70-40704# Dassault (Marcel) Aeronautique-Electronique, Vaucresson (France).

ARMY AIRCRAFT: PROGRAMS AND REALIZATIONS [AVIONS D'ARME: PROGRAMMES ET REALISATIONS]

H. Deplante *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 7 p In FRENCH
Avail: NTIS

The selection and development of aircraft apparatus (engines, airframes, equipment, or armament) over the last twenty years is discussed, including the cooperation between the official services and the constructors, the responsibilities of each, and development programs generated. Interactions between the state and the constructors are examined, and the influence of competition and the challenge for survival noted. The creation of Dassault prototypes is reviewed in this context. Transl. by P.A.B.

N70-40705# Messerschmitt-Boelkow G.m.b.H., Munich (West Germany).

THE USE OF TRADE-OFF STUDIES IN PRELIMINARY DESIGN

Helmut Langfelder *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 12 p
Avail: NTIS

The technique of balanced effectiveness studies is illustrated by a discussion of such questions as wing and thrust loading choices, sizing, speed capability, number of engines, aerodynamic configuration, aircraft subsystems, automatic checkout, and electronic system complexity, as seen in relation to weight and cost penalties. It is concluded that tradeoff studies on a wide range of parameters are the only means of rationalizing basic design decisions. Author

N70-40706# Boeing Co., Seattle, Wash.

AEROELASTIC CONSTRAINTS FOR LARGE AIRPLANES WITH A CANARD CONTROL

William T. Hamilton *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 11 p
Avail: NTIS

Preliminary design studies were made of a large, supersonic, transport, variable sweep airplane with a canard pitch control. The combined effects of the rigid aircraft aerodynamics and aeroelasticity; the size, location, planform, and elastic characteristics of the canard control; and the interacting effects of wing, fuselage, and mass distribution are among the design considerations. P.A.B.

N70-40707# Royal Aircraft Establishment, Farnborough (England).
SOME FLUID-DYNAMICS CONSIDERATIONS RELATING TO THE PRELIMINARY DESIGN OF COMBAT AIRCRAFT
John Williams and Robert K. Page *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 14 p refs

Avail: NTIS

Some of the fluid dynamics considerations which arise in the early design stages of advanced combat aircraft are examined. After some performance considerations of this type of aircraft, including comparisons between fixed wing and variable sweep layouts, reference is made to aerodynamic problems in the design of variable sweep aircraft. A brief outline is given of some of the outstanding problems of wing design, wing-body interference, and the estimation of wave drag. Some questions arising in the choice of engine intakes are mentioned, along with the many jet and afterbody problems, including the possible effects of jet temperature on the base drag. Author

N70-40708# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
FUTURE ADVANCES IN THE AERODYNAMICS OF MILITARY STRIKE AIRCRAFT
Richard H. Klepinger, John W. Carlson, and William M. Stout *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 18 p refs
Avail: NTIS

The primary mission requirements of an air superiority fighter are reviewed, and the factors which affect performance and maneuverability are discussed. The aerodynamic features which have a strong influence on fighter capability are indicated. The effect of the rapid development of numerical solution techniques, using the digital computer, on aerodynamic design methods is noted. The current trend toward configurations with minimum basic aerodynamic stability and extensive stability augmentation is discussed. The need for improved aerodynamic stability is emphasized, and some of the current flight problems of supersonic fighter aircraft are described. It is shown that stability augmentation can cause adverse effects in some flight regimes. The analyses and test programs that are essential before an aerodynamic design is committed to production are summarized. Author

N70-40709# Hawker Siddeley Aviation, Ltd., London (England).
DESIGNER'S VIEW OF POWERPLANT PROBLEMS
R. S. Hopper *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 18 p
Avail: NTIS

The problems of installing the powerplant in the airframe are examined, including the overall problem of layout along with the detailed problems arising at the engine/airframe interface, and limited to the jet engine as installed in fighter type aircraft. The development of the jet fighter is briefly traced from the end of the piston engined era, with Hawker Siddeley aircraft used as examples. Engine starting, gyroscopic coupling, foreign object damage, fuel systems, intake design, exhaust design, and powerplant cost are considered, with recommendations for both the airframe and engine designers. P.A.B.

N70-40710# General Electric Co., Cincinnati, Ohio.
THE DESIGN PROCESS
James E. Worsham *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 8 p
Avail: NTIS

The development of a modern multi-mission fighter engine requires a weapon system design approach, with close integration of the engine and aircraft manufacturers, to assure a successful program. Some of the key decision points that are vital to such a program, including the conceptual approach, technology improvement programs, compatibility requirements, final selection of technology, and engine size selection are discussed. The criteria for full program initiation is a total system defined by firm specifications, definitive interface agreements, verified technical approach, and firm schedule and cost. These criteria can be satisfied by the proper system design process. Author

N70-40711# Dassault (Marcel) Aeronautique-Electronique, Vaucresson (France).
THE INTEGRATION OF THE PROPELLER AND THE AIRFRAME ON A SUPERSONIC COMBAT AIRCRAFT [L'INTEGRATION DU PROPULSEUR ET DE LA CELLULE SUR UN AVION DE COMBAT SUPERSONIQUE]
G. de Richemont *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 13 p In FRENCH
Avail: NTIS

The compromises between diverse requirements are studied. Leading ideas and the development process are shown and illustrated by analysis of the conception and evolution of air intakes and afterbodies of Dassault aircraft. Design constraints are also illustrated by examples. In-flight and wind tunnel test methods are presented, as well as tentative principles of correlation with the aid of mathematical models. Transl. by P.A.B.

N70-40712# Advisory Group for Aerospace Research and Development, Paris (France).
DESIGNER'S VIEW ON STRUCTURAL PROBLEMS
Rolf Riccius *In its* Prelim. Design Aspects of Mil. Aircraft Mar. 1970 20 p refs
Avail: NTIS

The aircraft designer has the obligation to analyze carefully the specific requirements and then to present an optimum approach to a weapon system within a reasonable number of iterations. Accurate data are imperative for optimizing the structure, especially in the fields of weight prediction, materials, design research, and production methods. These problems are discussed by means of a number of examples, and development trends are demonstrated. Recommendations are issued concerning in which way and by what means preliminary design, with special attention to structural design, should be improved. Author

N70-40713# British Aircraft Corp., Preston (England).
LOAD ESTIMATION AND AEROELASTICITY IN THE INITIAL STAGES OF ADVANCED COMBAT AIRCRAFT DESIGN
B. J. Beele *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 16 p refs
Avail: NTIS

Within the areas of load estimation and aeroelasticity, the essential needs during the initial design stages of an aircraft are the rapid provision of realistic loading information and the exertion of a favorable aeroelastic influence on the design. These needs are examined in terms of three basic steps, namely, data acquisition, aircraft stability assessment, and response calculations, with special reference to the problems posed by typical advanced combat aircraft configurations and requirements. The design of such aircraft highlights the need for an approach which integrates the various aerodynamic and structural disciplines, with the major problem being the acquisition of aerodynamic data, particularly for loading purposes. Author

N70-40714# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

THE INFLUENCE OF NEW MATERIALS ON AIRCRAFT DESIGN

Richard F. Hoener *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 17 p refs

Avail: NTIS

Currently available materials are reviewed, and their limitations and future potentials discussed. New materials and their application and development programs, which were initiated to validate their design potentials as well as to establish confidence in their structural impact on future military aircraft, are highlighted. It is found that significant potential savings are possible if new metals are utilized to the fullest extent and that revolutionary advances in aircraft design and performance can be made by the utilization of the new advanced filament composite materials. It is also noted that many potential advances have not been made because of low cost effectiveness potential, lack of confidence in the new material, extensive data requirements, the requirement for large capital investment in new machine tools, and the presence of a highly skilled labor force. Finally, the requirements for a better mutual understanding between the technical specialists, which is necessary if these new materials are to be integrated into new military aircraft, are outlined. Author

N70-40715# North American Rockwell Corp., El Segundo, Calif.

AIRFRAME SYSTEMS DESIGN EVALUATION

Lawrence P. Greene *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 13 p

Avail: NTIS

A general view of the compromises a designer must make in aircraft subsystems to achieve the correct and optimum effectiveness of the total aircraft system is presented. The emphasis is directed at resolution of problems relating to flight mechanics functions. It is intended to identify the contribution an imaginative systems designer can make to an effective flying machine, which in turn is recognized to be one of the necessary assets of military aircraft. The essence of any successful design is the understanding the proponents of each associated discipline exercises when dealing with others of the design team. Examples of design ingenuity are shown to illustrate some of the areas where innovation provided reasonable answers to otherwise troublesome problems. General observations of the requirements imposed on supporting airframe systems are developed, with particular attention to control system options, power sources, environmental problems , and total system dependability. Author

N70-40716# Service Technique de l'Air, Paris (France).

ADVANCED STUDIES IN THE FIELD OF FLIGHT CONTROLS [ETUDES AVANCEES DANS LE DOMAINE DES COMMANDES DE VOL]

In AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 35 p In FRENCH Prepared in cooperation with sud-Aviation, Paris

Avail: NTIS

Problems met in the design of modern combat aircraft are discussed, including the increase of the power necessary for activating the control surfaces, variations of stability and controllability characteristics; the introduction of severe perturbations linked, for example, to the Mach number, structural deformations, and safety problems. Some possible solutions to the problems are examined. The system of flight control of the civil supersonic transport aircraft Concorde is then investigated, with reference to performance objectives and objectives of reliability, in the sense of navigability and operational utilization. Application of these objectives to the general design of the system and to its technology is discussed. An electrical system of transmitting the piloting orders, which integrates a plurality of automatic navigation aids, is utilized, which is derived from advanced military aircraft development. Transl. by P.A.B.

N70-40717# Royal Aircraft Establishment, Farnborough (England). Avionics Dept.

ADVANCES IN AIRCRAFT CONTROL SYSTEMS WITH PARTICULAR REFERENCE TO COMBAT AIRCRAFT

G. C. Howell *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 15 p refs

Avail: NTIS

A review of current flight control system design for combat aircraft is given, highlighting the reliance placed on forms of electrical signalling of the flying control surfaces and the increasing use of feedback control techniques to achieve satisfactory handling qualities. In all current systems, however, a mechanical backup system is retained. A description of a possible electrical signalling system design is given, including maneuver demand control characteristics, and some of its advantages are discussed. The conclusion is reached that, although some experience is being gained in service of forms of electrical signaling, aircraft designers have not yet the confidence to eliminate mechanical reversion systems; these often compromise the primary electrical signalling system performance. Recent system developments should lead to the abandoning of these mechanical reversion systems in future project designs and the full benefits of feedback control can then be obtained. These include the optimization of the overall airframe, taking advantage of feedback control, and new cockpit layouts, taking advantage of the use of small side controllers. Author

N70-40718# LTV Aerospace Corp., Dallas, Tex. Vought Aeronautics Div.

THE INTERFACE OF MAINTAINABILITY, RELIABILITY, AND ASSOCIATED DISCIPLINES IN AIRCRAFT DESIGN

S. Love *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 7 p

Avail: NTIS

Techniques for assuring proper reliability, maintainability, human factors, and system safety considerations in the initial design phase are considered. The definition of the problem, development of a prediction capability, and the formulation of these disciplines in such a manner that they are useful in the overall design process are discussed. In each of the four areas, a formal program plan is required; the techniques used to accomplish the program include the translation of general requirements into specifics, design definition inputs, design surveillance, and participation in design reviews and trade studies, as well as the use of mockups and simulator studies. P.A.B.

N70-40719# Aeronautical Systems Div., Wright-Patterson AFB, Ohio. Avionics Div.

AVIONICS DESIGNER'S VIEW OF THE SYSTEMS INTEGRATION PROBLEM

Saul Weissman *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 12 p refs

Avail: NTIS

An example is given of the electronic designer's problem in providing an avionics subsystems design which can be suitably integrated into an aeronautical system to satisfy a critical operational requirement, i.e., low level, high speed penetration at a minimum altitude of 300 feet over or around any terrain profile. The required sensors and their capabilities are examined, and the necessary interfaces for accommodation of the aircraft responses and control restraints are considered. The man-machine relationships

are described, and air safety required features are delineated. The basic sensor, a forward looking radar with a phased interferometer array and associated receiver, is examined. Flight station display and instrumentation is described. Data of simulated low level flights over a selected terrain profile are shown under various conditions of environment (rain) and radar measurement error parameters. Author

N70-40720# Air Force Systems Command, Wright-Patterson AFB, Ohio.
DEVELOPMENT PLANNING AND OPERATIONAL CAPABILITIES
F. M. Rogers *In* AGARD Prelim. Design Aspects of Mil. Aircraft Mar. 1970 11 p
Avail: NTIS

The development planning process as a method for identifying, advocating, and obtaining approval for military system and equipment programs needed for new and improved operational capabilities is discussed. The experience of the U.S. Air Force in development planning is used as the example. The changes within the development planning process, the activities, and the tools used in the process are examined. A specific review of the technology plot tool is presented as a means of improving communications among the user (the operational command), the design engineer, and the planner. Development planning evolved as the disciplined process which directs the talents and techniques of operational planners, system analysts, engineers, designers, and technologists toward the goal of providing effective and valid proposals for new systems and equipment for meeting the operational capability needs of the future. Author

N70-40736# Advisory Group for Aerospace Research and Development, Paris (France).
AGARD SPECIALISTS' MEETING ON THE AERODYNAMICS OF ATMOSPHERIC SHEAR FLOWS Technical Evaluation Report
J. E. Cermak and B. W. Marschner May 1970 9 p refs Conf. held at Munich, 15-17 Sep. 1970
(AGARD-AR-24-70) Avail: NTIS

The purpose of this meeting was to coordinate the efforts of atmospheric scientists and aeronautical engineers. The common language of fluid dynamics was used in attacking the basic and applied problems of atmospheric motion near the earth's surface. One of the main recommendations is for a coordinated field and laboratory study to verify similarity between wind tunnel generated flow and the corresponding atmospheric shear flow. A list of the papers presented is included, with brief comments on their content and value. Author

N70-40743*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN APPROACH GUIDANCE METHOD USING A SINGLE ONBOARD OPTICAL MEASUREMENT
Harold A. Hamer and Katherine G. Johnson Washington Oct. 1970 82 p refs
(NASA-TN-D-5963; L-7053) Avail: NTIS CSCL 17G

An empirical method was developed for onboard guidance within the sphere of influence of a celestial body. For guidance maneuvers made at a relatively large distance from the body, only one preselected measurement from a star to the body is required. Although the method is designed to control the magnitude of the periapsis radius (or entry angle), the periapsis position and velocity automatically remain close to the nominal values. For lunar approach, error analysis with an assumed one-sigma error of 10 seconds of arc in the optical angular measurements and a one-sigma velocity-cutoff error of 0.2 m/sec has shown that perilune radius can be controlled to a one-sigma accuracy of from 7 to 13 km, depending on the time the approach guidance is performed. Author

N70-40748# Federal Aviation Administration, Washington D.C. Office of the Associate Administrator for Engineering and Development.
RESEARCH AND DEVELOPMENT PLAN TO INCREASE AIRPORT AND AIRWAY SYSTEM CAPACITY: PROGRAM DESCRIPTION
May 1970 62 p
(AD-707186) Avail: NTIS

The research and development activity described is to achieve the national goal of providing an air transportation system for all categories of aviation commensurate with projected growth of the air transportation industry. This objective requires an accelerated effort to substantially upgrade the existing airport and airway systems by developing and introducing new concepts and technologies which are adpated to the needs while tempered by evolutionary, sociological, and economic factors. Prior studies and experience provide a substantial foundation of understanding requirements and technical opportunities from which this program evolves. The urgency to proceed expeditiously stems from the basic fact that aviation growth is rapidly outpacing the capacity of the existing system. Accordingly, the philosophy of this program is to proceed simultaneously from the outset with hardware development for early implementation based on current knowledge and assumptions, and, concurrently, with system engineering analyses which will refine performance requirements, detail system integration and interface specifications for both the present and next generation systems. Author

N70-40751*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND TUNNEL STUDIES OF EFFECTS OF CONSTRUCTION METHODS, DESIGN DETAILS, AND CANOPY SLOTS ON THE AERODYNAMIC CHARACTERISTICS OF SMALL-SCALE ALL-FLEXIBLE PARAWINGS
Paul G. Fournier and William C. Sleeman, Jr. Washington Oct. 1970 92 p
(NASA-TN-D-5974; L-7013) Avail: NTIS CSCL 01C

A low-speed wind-tunnel investigation was conducted to determine the effects of canopy construction methods, design details, and canopy slots on the static longitudinal aerodynamic characteristics of all-flexible parawings. Construction details such as type of nonporous canopy fabric, glued or sewed seams, tape reinforcement, or cloth-weave orientation had little effect on maximum lift-drag ratios and resultant-force coefficients. The maximum lift-drag ratios varied from 2.2 to 2.5 for the various single-keel unslotted parawings, and from 2.2 to 2.4 for the slotted canopy parawings. Incremental reductions in the lengths of all the suspension lines caused corresponding reductions in the resultant-force coefficients and maximum lift-drag ratios. The available range for modulation of resultant-force coefficient and lift-drag ratio by shortening the control lines was very limited. Author

N70-40756# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
AN INVESTIGATION OF ROTATING STALL PHENOMENA IN TURBINE ENGINE COMPRESSORS Final Report, Mar. 1967 - Mar. 1970
Gary R. Ludwig, Joseph P. Nenni, and Roy S. Rice, Jr. Wright-Patterson AFB, Ohio AFAPL May 1970 212 p refs
(Contract F33615-67-C-1552)

(AD-708484; CAL-DE-2422-S-12; AFAPL-TR-70-26) Avail: NTIS CSCL 21/5

The work encompasses both theoretical and experimental studies of rotating stall and an investigation of the requirements for a stall control system. The theoretical studies approached the problem primarily from the point of view that rotating stall is the consequence of an instability of the mean flow to small disturbances. Both two-dimensional flows and a certain class of three-dimensional flows with wheel-type swirl were studied. In addition, numerical experiments were performed with a computer program for a two-dimensional cascade of discrete flat plate blades. Of the theoretical models, only the two-dimensional small disturbance approach exhibited an instability which might lead to rotating stall. The experimental program was performed to provide fundamental data prior to and during rotating stall for comparison with theory and for use as a guide in improving the theoretical model. Extensive investigations of the conditions for inception and the properties of rotating stall were performed on a row of stator blades in an annular cascade. The effects of blade profile shape, blade stagger angle and blade row spacing were studied in the cascade. In addition, several methods for detecting unsteady pressures were studied to determine their suitability as a generator of a rotating stall signature which could be used in a closed loop control system. It was found that a pressure tap located on the suction surface of a stator blade near the quarter-chord showed promise of providing a satisfactory signal. Author (TAB)

N70-40765# Federal Aviation Administration, Washington, D.C. Office of Management Services.

ENROUTE IFR AIR TRAFFIC SURVEY, PEAK DAY, FY 1969

1969 213 p refs

(AD-710762) Avail: NTIS CSCL 17/7

Statistical data on peak day instrument flight rules (IFR) departures from the enroute air traffic facilities operated by the Federal Aviation Administration (FAA) are presented in tabular and graphic form. The peak day for a facility is the day during the fiscal year when the largest number of IFR departures is recorded at the facility. It is not the same date for all facilities. Therefore, national totals, which summarize all individual facility peak day figures, represent IFR departures on a theoretical, rather than on an actual peak day. Author

N70-40766*# Center for the Environment and Man, Inc., Hartford, Conn.

CLOUD AND SYNOPTIC PARAMETERS ASSOCIATED WITH CLEAR AIR TURBULENCE Final Report

John T. Ball Aug. 1970 72 p refs

(*Contract* NAS12-699)

(NASA-111778; CEM-7496-413) Avail: NTIS CSCL 04B

Research was initiated to determine relationships between clear air turbulence (CAT) in the stratosphere and upper troposphere, and meteorological variables, circulation features and cloud characteristics. For this purpose, a total of 372 cases of CAT occurrence and nonoccurrence were analyzed using aircraft instrumented reports of CAT in the 45,000-70,000 ft layer as obtained by the U.S. Air Force in Project HICAT from 1966 through 1968. Light to moderate or more intense CAT occurs frequently when the vertical temperature profile about the level of interest is irregular and includes both strong inversions and layers in which the temperature decreases rapidly with height. Consistent numerical relationships were determined for a number of meteorological variables describing this condition. Implementation of these results for the development of CAT detection instrumentation is discussed. The analysis of circulation features showed that significant stratospheric CAT was associated with large horizontal temperature gradients at upper-level surfaces. Cloud characteristics associated with significant turbulence were cirrus bands and streaks, a well-defined frontal cloud band, transverse wave clouds, and cumulonimbus clouds. Author

N70-40776# Federal Aviation Administration, Washington, D.C.

RESEARCH AND DEVELOPMENT REPORT TO INDUSTRY

Jun. 1969 161 p refs

Avail: NTIS

CONTENTS:

1. OPERATIONAL EVALUATION OF STOL AIRCRAFT AND RELATED STOL DEVELOPMENTS J. C. Staples 6 p

2. RUNWAY TRACTION R. C. McGuire 5 p

3. PROPULSION FUEL SYSTEM FIRE SAFETY T. G. Horeff 10 p

4. FLIGHT TESTS OF SPIRAL DIVERGENCE AND BANK ANGLE CONTROL OF EXECUTIVE JETS J. Teplitz 9 p

5. VFR-IFR EXPERIMENTAL TRAINING PROGRAM AND DEVELOPMENT OF IMPROVED METHOD OF ICE PREVENTION AND REMOVAL FOR LIGHT AIRCRAFT G. C. Hay 13 p

6. AEROMEDICAL RESEARCH: THE NEW GENERATION AIRCRAFT S. R. Mohler 18 p refs

7. EXPANSION OF AUTOMATION IN TERMINAL ATC FACILITIES J. C. Mercer 25 p

8. ALL WEATHER LANDING DEVELOPMENT TESTS J. R. Nelson 13 p

9. VISIBILITY MEASUREMENT FOR AVIATION USE E. Bromley, Jr. 15 p refs

10. APPLICATION OF TIME ORDERED TECHNOLOGY TO THE FUTURE NAS P. J. LaRochelle 29 p

11. AIRCRAFT NOISE AND SONIC BOOM RESEARCH AND DEVELOPMENT I. H. Hoover 6 p refs

N70-40777# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.

OPERATIONAL EVALUATION OF STOL AIRCRAFT AND RELATED STOL DEVELOPMENTS

J. Clay Staples *In its* Res. and Develop. Rept. to Ind. Jun. 1969 6 p

Avail: NTIS

The status of several FAA STOL activities are reviewed. Briefly discussed are: (1) STOL operational evaluation at the test facility, Atlantic City; (2) FAA participation in the McDonnell Douglas/Eastern Airlines and the McDonnell Douglas/American Airlines STOL demonstrations; (3) FAA procurement of a steep gradient approach navigation aid; and (4) investigation of STOL handling characteristics. A.L.

N70-40778# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.

RUNWAY TRACTION

R. C. McGuire *In its* Res. and Develop. Rept. to Ind. Jun. 1969 5 p

Avail: NTIS

The status of the FAA research and development work on runway friction is presented. The need for an early solution to the improvement of aircraft safety of operations on wet and slippery runways is reiterated. Brief summaries are given of research

progress on: (1) runway grooving; (2) friction measurement correlation with aircraft performance; (3) analog computer correlation study of an airplane and its brake and anti-skid systems; and (4) correlation of runway friction measurements with airplane performance by use of decelerometers. A.L.

N70-40779# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.
PROPULSION FUEL SYSTEM FIRE SAFETY
Thomas G. Horeff *In its* Res. and Develop. Rept. to Ind. Jun. 1969 10 p
Avail: NTIS

Research and development progress on aircraft propulsion fuel system fire safety and prevention is presented. Specifically discussed are: (1) tests of liquid nitrogen as a fire extinguishing agent; (2) flame propagation through aircraft vent systems; and (3) thickened safety fuels and fuel system compatibility. Also discussed is the amount of air pollution caused by aircraft and the limitations it may have on the growth of air transportation if precautions are not taken. A.L.

N70-40780# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.
FLIGHT TESTS OF SPIRAL DIVERGENCE AND BANK ANGLE CONTROL OF EXECUTIVE JETS
Jerome Teplitz *In its* Res. and Develop. Rept. to Ind. Jun. 1969 9 p
Avail: NTIS

Results of an FAA sponsored investigation into the spiral divergence and bank angle control parameters of high performance executive jet aircraft are presented. For this investigation, the three axis variable stability T-33 airplane developed for the Air Force Flight Dynamics Laboratory was used. The test program was established following a comprehensive review and analysis of available data on modern subsonic executive jets. Test variables included: (1) spiral mode time constant; (2) roll-to-sideslip ratio; (3) roll mode time constant; and (4) lateral hysteresis and breakout force. Analysis of the flight test data demonstrates the benefits in handling qualities available from close attention to the aerodynamic and control system design of high speed aircraft. It is also possible for the executive jet or high performance personal aircraft designer to make a realistic estimate of the acceptability of the lateral-directional handling qualities, cruise flight, and the upset/divergence characteristics of a new design, based on relatively simple calculations, other research data, and comparisons with the results of these flight tests. A.L.

N70-40781# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.
VFR-IFR EXPERIMENTAL TRAINING PROGRAM AND DEVELOPMENT OF IMPROVED METHOD OF ICE PREVENTION AND REMOVAL FOR LIGHT AIRCRAFT
George C. Hay *In its* Res. and Develop. Rept. to Ind. Jun. 1969 13 p
Avail: NTIS

The increased utility of general aviation requires continual consideration of newer and better ways of training pilots and more effective ways of coping with the operating environment. A VFR-IFR experimental training program and development of improved methods of ice prevention and removal for light aircraft were investigated. Results indicate that: (1) Certification of private pilots with instrument ratings requires approximately 120 hours flight time; greater utilization of the current procedure trainers; and structuring of a curriculum into three distinct phases of about 40 hours each. (2) Tests of ice accretion characteristics and release properties of newly developed passive materials did not reveal any test material which permitted the air stream to blow the ice from the wing, however, marked reductions were noted in forces required to release the ice from certain of the treated aluminum surfaces. A.L.

N70-40782# Federal Aviation Administration, Washington, D.C. Aeromedical Applications Div.
AEROMEDICAL RESEARCH: THE NEW GENERATION AIRCRAFT
Stanley R. Mohler *In its* Res. and Develop. Rept. to Ind. Jun. 1969 18 p refs
Avail: NTIS

Aeromedical personnel are providing human tolerance data to design engineers for incorporation in tomorrow's aircraft. Tentative airworthiness standards for SST aircraft continue to be refined as new aeromedical research data is translated into engineering terms. These include cabin decompression, heat, and ozone limits. Studies are also continuing in other areas, including air crew workload considerations, cosmic radiation aspects, and crashworthiness. Author

N70-40783# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
EXPANSION OF AUTOMATION IN TERMINAL ATC FACILITIES
John C. Mercer *In its* Res. and Develop. Rept. to Ind. Jun. 1969 25 p
Avail: NTIS

A brief picture of some of the more interesting and challenging expansion items of the FAA's Terminal Automation System is presented. Included in the discussion are: (1) installation of the ARTS-3 Beacon Tracking Level of automation at 64 towers; (2) automation of the ARTCCs and TRACONs; (3) addition of alphanumeric data to the BRITE tower display; (4) terminal flight data distribution system; (5) surface control of aircraft in areas not visible from the control tower; and (6) use of computers in metering, sequencing, and spacing of aircraft in the terminal area. A.L.

N70-40784# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
ALL WEATHER LANDING DEVELOPMENT TESTS
James R. Nelson *In its* Res. and Develop. Rept. to Ind. Jun. 1969 13 p
Avail: NTIS

FAA conducted tests of an airborne system designed for use in landings where the runway visual range is 150 feet are described. The tests were successful and demonstrated that, with certain limitations, initial flight operations in Category 3B weather should be feasible. The tests were conducted in a C-141 and were part of a joint program with the Air Force to develop an all weather landing system in the C-141. The Category 3 system was designed so that the approach and landing would be made fully automatic, and that the automatic system would flare, decrab, and steer along the runway until rudder effectiveness diminished. The pilot's flight director system was specially designed to compute and display flare, decrab, and runway steering commands for him. Results of the program illustrated that the automatic system was sufficiently accurate to land the aircraft safely on a 150-foot wide runway under any environmental conditions suitable for landing. A.L.

N70-40785# Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
VISIBILITY MEASUREMENT FOR AVIATION USE
Edmund Bromley, Jr. *In its* Res. and Develop. Rept. to Ind. Jun. 1969 15 p refs
Avail: NTIS

The development of all weather landing systems requires a reassessment of the credibility of the present system for providing visibility information to the pilot. Results of recent efforts in determining the credibility of the present Runway Visual Range (RVR) System and in analyzing the limitations and capabilities of this system indicate that for values of RVR below 600 feet, development of new techniques is essential. The need for standardization on an international basis of the characteristics of Runway Visual Range systems influences the direction of these development efforts. The technical feasibility of a laser to measure transmissivity has been demonstrated and an approach to providing visibility data in terms of visual range is outlined. Author

N70-40787# Federal Aviation Administration, Washington, D.C. Office of Noise Abatement.
AIRCRAFT NOISE AND SONIC BOOM RESEARCH AND DEVELOPMENT
I. H. Hoover *In its* Res. and Develop. Rept. to Ind. Jun. 1969 6 p refs
Avail: NTIS

The Federal Aviation Administration's research and development programs related to sonic booms and abatement of aircraft noise are briefly described by means of several slides. Also included are lists of reports issued on FAA sponsored research on sonic booms and noise abatement. A. L.

N70-40796# ARO, Inc., Arnold Air Force Station, Tenn.
VELOCITY MEASUREMENTS IN THE AEDC LOW SPEED WIND TUNNEL (V/STOL) USING A LASER DOPPLER VELOCIMETER Final Report
F. H. Smith and J. A. Parsons AEDC Jul. 1970 36 p refs
(Contract F40600-71-C-0002)
(AD-708717; AEDC-TR-70-119) Avail: NTIS CSCL 14/2

An in-house developed laser Doppler velocimeter (LDV) was used to make velocity measurements in a low speed wind tunnel. The installation and instrumentation are discussed, and velocity profiles obtained with the LDV are compared with those obtained using conventional techniques. A discussion on the factors which affect the accuracy of the LDV and improvements that would be desirable are also included. Author (TAB)

N70-40800# Federal Aviation Administration, Washington, D.C. Information and Statistics Div.
THE 1970 STUDY OF GENERAL AVIATION FLYING OCCUPANT LOAD FACTORS. BASED UPON ACCIDENT RECORDS FOR GENERAL AVIATION FLYING 1964–1968
Jay L. Zebooker May 1970 50 p
(Rept-70-9) Avail: NTIS

Content of the general aviation accident data system was analyzed to derive occupant load factors. Their applicability to all general aviation flying is substantiated. It is estimated that there were 2.5 persons on the average general aviation flight. Author

N70-40807*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
USE OF THE COMPUTER IN DESIGN OF GAS TURBINE MAINSHAFT SEALS FOR OPERATION TO 500 FT/SEC (122 M/SEC)
L. P. Ludwig, J. Zuk, and R. L. Johnson 1970 37 p refs
Presented at 26th Ann. Meeting of the Natl. Conf. on Fluid Power and the 10th Ann. Meeting of the Fluid Power Soc., Chicago, 13–15 Oct. 1970
(NASA-TM-X-52886; E-5917) Avail: NTIS CSCL 11A

Computer programmed analyses of the seal temperature field, elastic displacements, and seal force balance were used in an iterative design procedure to arrive at a final mainshaft seal design. For high speeds, temperatures and pressures in advanced engines, the sealing surfaces must not operate with rubbing contact. Hence, self-acting lift pads were incorporated to achieve positive separation of the sealing surfaces. A small gas film separating the sealing surfaces is achieved and the associated high gas-film-stiffness forces the seal nosepiece to dynamically track the runout motion of the seal face. Analysis revealed that the pressure profile across the sealing dam was significantly affected by sealing face deformation and that choked flows occur at a pressure ratio of greater than 4 to 1. The effect of this face deformation and choked flow was considered in establishing the seal force balance. To mitigate the effects of thermal deformation, it was necessary to structurally isolate the seat from the shaft. The role of the computer in the seal design is discussed. Tests confirm operation as predicted by the design analysis. Author

N70-40808*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANALYSIS OF BENDING LOADS OF HYPERSONIC AIRCRAFT
Mark D. Ardema Washington Oct. 1970 29 p
(NASA-TM-X-2092; A-3625) Avail: NTIS CSCL 20K

The longitudinal bending moments on all-body configurations and wing-body configurations of a hypersonic aircraft are determined and compared. Bending-moment distributions are determined from idealized vehicle loadings due to a static maneuver, a dynamic gust condition, and a dynamic landing impact. Characteristics of selected nominal configurations are discussed, and parametric data are given that relate bending-moment magnitude to design load criteria and configuration parameters. The results indicate that for the nominal design load criteria there is no appreciable difference in the magnitude of the bending moments on the two nominal configurations. The maneuver and landing loads are found to be dominant for both the all-body and the wind-body configurations. Author

N70-40911# Federal Aviation Administration, Washington, D.C.
COMPILATION OF WORK PAPERS CONCERNING WAKE TURBULENCE TESTS, 12 FEBRUARY–30 APRIL 1970
30 Apr. 1970 405 p refs
Avail: NTIS

CONTENTS:

1. FLIGHT-TEST EVALUATION OF THE WING VORTEX WAKE GENERATED BY LARGE JET-TRANSPORT AIRCRAFT W. H. Andrews, G. H. Robinson, G. E.Krier (NASA. Flight Res. Center), and F. J. Drinkwater (NASA. Ames Res. Center) 35 p ref
2. RESULTS OF THE BOEING COMPANY WAKE TURBULENCE TEST PROGRAM P. M. Condit (Boeing Co., Renton, Wash.) 70 p refs
3. MEASUREMENTS OF THE VORTEX WAKE CHARACTERISTICS OF THE BOEING 747, LOCKHEED C-5A, AND OTHER AIRCRAFT Data Report, 18–21 Feb. 1970 L. J. Garodz (Dept. of Transportation) 279 p ref
4. VORTEX HAZARD INDEX 3 p

N70-40912*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
FLIGHT-TEST EVALUATION OF THE WING VORTEX WAKE GENERATED BY LARGE JET-TRANSPORT AIRCRAFT
William H. Andrews, Glenn H. Robinson, Gary E. Krier, and Fred J. Drinkwater, III (NASA. Ames Res. Center) *In* FAA Comp. of Work Papers Concerning Wake Turbulence Tests 30 Apr. 1970 35 p ref
Avail: NTIS CSCL 01A

An evaluation of the behavior of the wing vortex wake of large, jet transport airplanes is presented. The primary objectives of the test program were to provide preliminary information to establish a logical terminal-area airspace separation criterion for all types of aircraft operating in the proximity of large transports. The flight tests were conducted to obtain data for the determination of the wing vortex wake location, persistence, and intensity behind the generating airplanes. In addition, a portion of the testing was directed toward evaluating the effects of the wing vortex wake on several different classes of aircraft. Author

N70-40913# Boeing Co., Renton, Wash. Commercial Airplane Div.
RESULTS OF THE BOEING COMPANY WAKE TURBULENCE TEST PROGRAM
P. M. Condit *In* FAA Comp. of Work Papers Concerning Wake Turbulence Tests 30 Apr. 1970 70 p refs

Avail: NTIS

The results of a flight test investigation of vortex wake turbulence generated by large jet transport aircraft are presented. Test results, showing the dynamic response of aircraft which were flown in the wakes of large jet transports, are discussed. Experimental results are compared to theoretical predictions. Test program results are applied to the problem of air traffic control and specific recommendations are presented for air traffic separations. Author

N70-40914# Department of Transportation, Washington, D.C. Test and Evaluation Div.
MEASUREMENTS OF THE VORTEX WAKE CHARACTERISTICS OF THE BOEING 747, LOCKHEED C-5A, AND OTHER AIRCRAFT Data Report, 18-21 Feb. 1970
Leo J. Garodz *In* FAA Comp. of Work Papers Concerning Wake Turbulence Tests 30 Apr. 1970 279 p ref

Avail: NTIS

A preliminary analysis of the flight test data is presented for the vortex wake characteristics of large, medium and small transport aircraft by low altitude tower fly-by techniques. The instrumentation, tower, and fly-by techniques are described. Some of the conclusions reached are: (1) More persistent, clearly defined tubular-type vortex systems are generated as the flap setting is decreased on aircraft. (2) Tubular-type vortex systems are very persistent, up to approximately two minutes in age, as sighted visually and recorded photographically. (3) An airborne airflow measurement system is mandatory for longer time-history data out of the ground effect and out of the atmospheric boundary layer. F.O.S.

N70-40915# Federal Aviation Administration, Washington, D.C.
VORTEX HAZARD INDEX
In its Comp. of Work Papers Concerning Wake Turbulence Tests 30 Apr. 1970 3 p
Avail: NTIS

Equations are proposed for determining the vortex hazard index for the encountering aircraft. Equations are developed for calculating the vortex strength when the aerodynamic and inertia characteristics of the probe aircraft are known. It is concluded that further data is required to clarify the effect of the span of the encountering aircraft. F.O.S.

N70-40927# Federal Aviation Administration, Washington, D.C.
THE THIRTY-THIRD COLLISION PREVENTION ADVISORY GROUP (COPAG) MEETING
28 May 1969 67 p refs Conf. held at Middle River, Md., 28 May 1969
Avail: NTIS

CONTENTS:

1. SIMULATION STUDY OF NASA/ERC OPTICAL PILOT WARNING INDICATOR IN TERMINAL AREA TRAFFIC J. R. Ruetenik, J. H. Thompson (Kaman AviDyne), C. H. Leigh, and A. S. Richardson, Jr. (NASA. ERC) p 1-47

2. LANGLEY PWI PROGRESS REPORT J. Schrader p 48-53

3. COLLISION AVOIDANCE SYSTEM STUDY B. N. MacDonald (Instr. Systems. Corp.) p 54-56

4. PROJECT SUMMARY FOR INTER-SERVICE COORDINATING/WORKING GROUP. SIMULATION AND ANALYSIS OF ATC/CAS SYSTEM DESIGN p 57-64 refs

5. ANALYSIS OF VISUAL SEPARATION TECHNIQUES AND TEST OF PWI EQUIPMENT STATUS REPORT p 65-67

N70-40928*# Kaman AviDyne, Burlington, Mass.
SIMULATION STUDY OF NASA/ERC OPTICAL PILOT WARNING INDICATOR IN TERMINAL AREA TRAFFIC
J. Ray Ruetenik, John H. Thompson, Charles H. Leigh (NASA. ERC), and Albert S. Richardson, Jr. (NASA. ERC) *In* FAA 33d Collision Prevent. Advisory Group (COPAG) Meeting 28 May 1969 p 1-47
(Contract NAS12-698)
Avail: NTIS CSCL 17G

Results of a digital simulation study of terminal area traffic and a pilot warning indicator (PWI) system, based upon the detection of infrared energy emitted by a light source placed on each aircraft, are presented. The CASTE (collision avoidance system technical evaluation) computer program is described; hazard criteria are used to evaluate the alarm system. The four hazard criteria employed are range-altitude guard, acceleration criterion, tau criterion, and modified tau criterion. The sequence of alarm events are studied during many encounters, and the statistics of valid alarms, false alarms, and missed alarms are compiled and examined. Methods for reducing the false alarm ratio are reported. P.A.B.

N70-40930# Instrument Systems Corp., Huntington, N.Y.
COLLISION AVOIDANCE SYSTEM STUDY
Bruce N. MacDonald *In* FAA 33d Collision Prevent. Advisory Group (COPAG) Meeting 28 May 1969 p 54-56

(Contract N00019-68-C-0196)
Avail: NTIS

The study, intended to define and demonstrate the feasibility of a non-time frequency aircraft collision avoidance system, includes an analysis of required measurement resolution, traffic handling capability, and avoidance maneuver determination information. The analysis is followed by the definition and building of a system to make the required measurements, determine the degree of hazard,

and predict the required avoidance maneuver. The system designed consists of two units, an interrogator and a transponder. The interrogator is composed of a bearing encoder device, a pulse correlator, a range encoder, a computer, and a display, all of which are built excepting the bearing encoder, which is reported under construction. Preliminary tests and their results are reported, and two problem areas associated with the system are mentioned. P.A.B.

N70-40931# Federal Aviation Administration, Washington, D.C.
PROJECT SUMMARY FOR INTER-SERVICE COORDINATING/WORKING GROUP. SIMULATION AND ANALYSIS OF ATC/CAS SYSTEM DESIGN
In its 33d Collision Prevent. Advisory Group (COPAG) Meeting 28 May 1969 p 57 64 refs
Avail: NTIS

In an effort to find the order of magnitude of expected interaction between the collision avoidance system (CAS) and the air traffic control (ATC) system, a small sample of real world track history data was gathered and analyzed. Eleven sample hours of positional data were recorded using the advanced radar tracking system. Counts of CAS-detected events and threat duration data were provided. Two sets of CAS parameters were exposed to the sample data; representative results are given. The reduction of the number of threat events found by the proposed terminal area parameters as compared to the enroute parameters was in the order of 20 to 1. Plans for real time digital simulation of the overall project are described. P.A.B.

N70-40932# Federal Aviation Administration, Washington, D.C.
ANALYSIS OF VISUAL SEPARATION TECHNIQUES AND TEST OF PWI EQUIPMENT Status Report
In its 33d Collision Prevent. Advisory Group (COPAG) Meeting 28 May 1969 p 65-67
Avail: NTIS

The project deals with the visual collision avoidance problem as related to general aviation aircraft and is intended to seek a solution to this type of problem by implementing a low cost pilot warning instrument. The objectives of the project are outlined, along with the schedule of planned reports. P.A.B.

N70-40939# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
PROPELLER STATIC PERFORMANCE TESTS FOR V/STOL AIRCRAFT, PART 1 Summary Report, Jul. 1965-Nov. 1967
Matthew H. Chopin Jan. 1969 186 p refs
(AD-708501; ASD-TR-69-15-Pt-1) Avail: NTIS CSCL 1/3

The tests were made because of a static performance thrust deficiency encountered during flight tests of the XC-142A V/STOL cargo aircraft. Twenty-eight versions of propellers were tested. Parameters studied during the tests included blade cuff (on or off), tip shape, twist, activity factor, camber, and airfoil section. Reduced data are presented in the form of performance coefficients and various tip Mach numbers for each configuration tested. Data on several other VTOL static thrust propellers are presented for additional information although they were not a part of this test series. Complete blade characteristic charts describing the physical characteristics of each blade tested provide a means of comparing the distribution of twist, thickness, chord, and camber against blade redial location for any given blade. Author (TAB)

N70-40954*# General Dynamics/Convair, San Diego, Calif.
SOFTWARE INTEGRATION FOR INTEGRATED ELECTRONICS
R. F. Klawa *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 51-66

Avail: NTIS CSCL 09B

An approach is discussed for minimizing cost and schedule problems of software integration of the avionics system. The decisions affecting software are the degrees of centralization, autonomy, crew participation versus automation, redundancy, and commonality, which are targeted at low cost integrated avionics. The objectives of the various development phases are discussed. R.B.

N70-40957*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MULTIPLEX DATA BUS TECHNIQUES
Walter O. Frost *In its* Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 91-94
Avail: NTIS CSCL 17B

The application of data bus techniques in the space shuttle provides potential improvements in size and weight, flexibility, and reliability. The general requirements for a space shuttle data bus are described, and critical technology considerations are discussed. Some design alternatives for transmission media, signal design, synchronization and control, input/output interfaces, and operational reliability are described. Author

N70-40960*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
EXPERIENCE WITH UNPOWERED TERMINAL AREA INSTRUMENT APPROACHES
B. Lyle Schofield, Harold G. Gaidsick, and Shu W. Gee *In its* Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 133-147
Avail: NTIS CSCL 17G

A terminal area guidance technique developed around the F-111A inertial navigation system is discussed for application to the return of a manned space shuttle vehicle to a predetermined runway. The results of flying under instrument flight rules using the guidance technique and the results of ground controlled approaches using an NB-52B aircraft in an unpowered, low lift-to-drag configuration are reported. A circular approach guidance scheme under development for the space shuttle vehicle is considered. Author

N70-40961*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AUTOMATIC AND MANUAL TERMINAL GUIDANCE AND CONTROL STUDIES IN SUPPORT OF THE SPACE SHUTTLE PROGRAM
D. W. Smith *In its* Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 149-154
Avail: NTIS CSCL 17G

The technology requirements for designing a terminal area navigation, guidance, and control system suitable for automatic or piloted landings of space shuttle vehicles under Category 2 conditions are discussed. The problems associated with the high cross-range orbiter are emphasized, although the low cross-range vehicle is also examined. The research program is divided into three phases of analysis, simulation, and flight testing. The technical objectives of each phase and the status of each of the separate research investigations are described. Author

N70-40962*# Sperry Phoenix Co., Ariz.
TERMINAL CONTROL AND AUTOMATIC LANDING OF UNPOWERED SPACE SHUTTLE VEHICLES
Stephen S. Osder *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 155-176
Avail: NTIS CSCL 17G

Guidance and control techniques used to accomplish terminal energy management and automatic horizontal landings of unpowered vehicles are described. The concepts discussed were previously used in the X-20 Dynasoar remote recovery system. This system was to acquire the Dynasoar glider at an altitude of about 120,000 feet and provide the guidance and energy management for an automatic landing of an unmanned, single orbit, test flight. The final approach and landing concepts are also similar to the manual techniques used in landing lifting body vehicles in VFR conditions. Author

N70-40963*# North American Rockwell Corp., Downey, Calif.
STABILIZATION AND CONTROL OF THE SPACE SHUTTLE ORBITER DURING ENTRY/PITCHDOWN MANEUVERS
D. Engels, E. Estrine, and P. Shipley *In* NASA. Lewis Res. Center Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 176-192
Avail: NTIS CSCL 17G

Results of recent shuttle entry flight control studies are discussed with respect to both high and low L/D orbiter vehicles. A pitchdown control system for the low L/D orbiter is synthesized, and typical time histories are shown. Effects of variations and uncertainties in aerodynamic parameters on the entry control problem are discussed. Author

N70-40992# Ball Bros. Research Corp., Boulder, Colo.
INSTRUMENTATION AND FLIGHT OF SOLAR POINTING CONTROL SPC 204 AND TELEMETRY SYSTEM TEL 335 WITH NRL AEROBEE NF 3.193 Final Technical Report
Ralph W. Shook 23 Jun. 1970 15 p
(Contract Nonr-5032(00))
(AD-709102) Avail: NTIS CSCL 9/6

The report contains information concerning the integration and field testing, the flight and subsequent data evaluation, and the performance analysis of Solar Pointing Control SPC 204 and Telemetry System TEL 335 with the NRL flight experiment aboard NRL Aerobee Sounding Rocket. Author (TAB)

N70-40993# Aeronautical Research Council (Gt. Brit.)
THE DESIGN OF COMPRESSION SURFACES FOR HIGH SUPERSONIC SPEEDS USING CONICAL FLOW FIELDS
J. G. Jones and B. A. Woods 1968 25 p refs
(ARC-R/M-3539) Avail: HMSO 11s 6d; BIS $2.30

A method is presented for designing the lower surface of a lifting configuration for high supersonic speeds using the known flow field behind an axisymmetrical conical shock wave. The leading edge can be prescribed on the conical shock wave and the lower surface is obtained by replacing the stream surface through this leading edge by a solid surface. Provided that the upper surface is so designed as not to cause shock detachment, the resulting configuration supports a conical shock wave attached at its swept leading edge, with a known flow field between the shock and the lower surface. Formulas for the calculation of the forces on such surfaces are also given. Author

N70-41001# Massachusetts Univ., Amherst. School of Engineering.
DEFINING THE FLOW FIELD OF AN OPEN-JET WIND TUNNEL
Donald B. Poole and Duane E. Cromack Jun. 1970 81 p refs
(Contract N00014-68-A-0146-12; Proj. Themis)
(AD-709158; THEMIS-UM-70-3) Avail: NTIS CSCL 14/2

This investigation deals with mapping the velocities at successive cross-sectional planes in the test section of an open-jet wind tunnel. The instrumentation was chosen so that the total uncertainty on the calculated velocity would be less than 1% with a 95% confidence level. The jet was studied using photography and a grid-and-tuft scheme, and it was determined that the same flow characteristics appear at both high and low flow rates. The best probable location for model testing was determined to be 1-1/4 ft. to 2-1/2 ft. away from the exit plane of the tunnel as indicated by the combined pressure measurements and the photographic studies. It was also noted that turbulent mixing occurred between the jet and the still air in the room. The turbulence had a tendency to move in toward the center of the jet at successive planes from the exit plane of the tunnel. The most drastic change in turbulent mixing occurred at a cross-section 3 ft. away from the exist plane. Recommendations for alterations to the facility are made for testing at or near the 3 ft. location. Author (TAB)

N70-41014# Naval Postgraduate School, Monterey, Calif.
AN INVESTIGATION OF GROUND EFFECT ON VERTICAL TAKEOFF AIRCRAFT
Charles Douglas Thompson (M.S. Thesis) Jun. 1970 74 p refs
(AD-709096) Avail: NTIS CSCL 1/3

The theoretical solution for the flow beneath V/STOL aircraft was extended to include tilted jet configurations. A laboratory model was constructed to test the effect of variation of the parameters governing the flow. Free streamline plots, pressure coefficients on the ground and fuselage and velocity profiles in the nozzles were determined from hot-wire anemometer traverses and micromanometer readings. Experimetal data compared favorably with the theoretical determinations. Author (TAB)

N70-41029*# Boeing Scientific Research Labs., Seattle, Wash.
RESPONSE OF AN ACOUSTICALLY LOADED PANEL EXCITED BY SUPERSONICALLY CONVECTED TURBULENCE
L. Maestrello and T. L. J. Linden May 1970 57 p refs
Sponsored jointly by NASA
(NASA-CR-113879; AD-707258; D1-82-0971) Avail: NTIS CSCL 01C

Measurements were made of the wall pressure fluctuation and the response of the panel structure. The deg angle the flow downstream of the shock is separated. The wall pressure fluctuations and panel displacement are notably greater than the case without the shock present. The response of a plate clamped in a baffle is determined. The plate is coupled acoustically to a uniformly moving fluid. The boundary-layer exciting the plate does not interact with the acoustic field and is furthermore taken to be spatially uncorrelated. Finally, the radiation is determined over the solid angle of the Mach cone. The response is derived using finite Fourier transforms and then solving the resulting algebraic equation by expressing the solution expanded in a complete set of functions, a process which leads to an infinite set of linear equations. The right-hand side of this system of equations is a stochastic variable so that performing an ensenble average the resulting equation is solved for the covariance matrix which is subsequently diagonalized to yield the power spectral density in the statistically independent states (degrees of freedom). Author (TAB)

N70-41032# Civil Aeronautics Board, Washington, D.C.
STOL-VTOL AIR TRANSPORTATION SYSTEMS. CIVIL

AERONAUTICS BOARD PLANNING STUDY
Carl Hintze, Jr. [1970] 37 p refs
Avail: NTIS

A consolidation of available information concerning the current status of STOL and VTOL aircraft, terminals, and allied facilities is arranged to indicate the consensus of opinion of the various authorities in the field. A brief description of the changing socio-economic aspects of the major metropolitan areas of the nation and their anticipated effects on urban transportation requirements is included. The probable course of events in the evolution of STOL and VTOL air transportation systems is summarized. Author

N70-41040*# Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Lab.
DETERMINATION OF THE OPTIMUM RESOLUTION ELEMENT FOR A PILOT WARNING INDICATOR
Thomas Basil Smith, III (M.S. Thesis) Jun. 1970 112 p refs
(Grant NGR-22-009-444)
(NASA-CR-113808; MVT-70-4) Avail: NTIS CSCL 17G

Experiments were performed in order to determine how accurately the PWI device need establish the direction of an incoming threatening aircraft. A PWI resolution was sought such that near optimum pilot performance could be expected and such that no excessive resolution need be purhcased. Examination of the data revealed that a resolution element of about 11 deg by 11 deg is optimal for a low cost device. Resolution of about 6 deg by 6 deg gives somewhat better pilot performance, but the increased cost of instrumenting this reduced sector size was not justified by the slight increases in pilot performance. Author

N70-41043# Federal Aviation Administration, Washington, D.C.
USE OF COMPUTERS IN AIR TRAFFIC CONTROL
Jun. 1970 35 p
Avail: NTIS

In an effort to meet growing demands for air traffic, an automatic air traffic control program is being developed. When completed, the combined system will provide automation at each of the 20 air route traffic control centers, and those terminals where automation is warranted. All of these facilities will be interconnected with data transmission links, and the entire system will function as a nationwide, realtime automated system. This automation program is intended to provide increased safety to the existing air traffic control system. The enroute portions of the automation program and terminal are discussed. Author

N70-41055# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MECHANICAL AND POWER EQUIPMENT OF AIRPORTS
A. A. Bromberg et al 27 May 1970 432 p refs Transl. into ENGLISH of the book "Mekhanicheskoe i Energeticheskoe Oboru, Oborudovanie Aeroportov" Moscow, 1968 p 1–336
(AD-709693; FTD-MT-24-55-70) Avail: NTIS CSCL 1/5

Methods of selecting, constructing, and operating airport mechanical and power supply equipment are discussed. TAB

N70-41156# Federal Aviation Administration, Washington, D.C. Flight Standards Service.
EVALUATION OF LOWER ILS MINIMUMS FOR LIGHT AIRCRAFT
Raymond W. Skinner and Frank Parr Jun. 1970 54 p
(AD-708294) Avail: NTIS CSCL 1/2

The evaluation included 120 ILS approaches flown under simulated IFR (hooded) conditions by 17 pilots in 6 types of light twin aircraft, to test the ability of pilots to align for landing or to execute a missed approach at minimums lower than 200 feet height and 1/2 mile visibility. A decision height of 100 feet was used during the entire project. Although only 80 percent of the scheduled landings were completed, pilots indicated that with normal runway lengths (5000 feet) most runs scheduled for landing could have been completed. The altimeter errors at the 100 foot decision height ranged from −80 to +45 feet, and seemed to cause the major problem. Missed approach data indicate that the missed approach obstacle clearance must be revised if minimums below 200 feet are to be approved for this pilot group. Author

N70-41058*# Rocketdyne, Canoga Park, Calif. Advanced Turbomachinery.
LOW SPEED INDUCERS FOR A ROCKET ENGINE FEED SYSTEM Final Report
J. A. King Jun. 1970 111 p refs
(Contract NAS3-10280)
(NASA-CR-72716; R-8272) Avail: NTIS CSCL 21E

Analytical performance data for optimum lowspeed inducers were developed, and analog and digital system simulation were used to evaluate the potential of using a low-speed inducer to simplify propellant tank pressurization and avoid resonant interaction of oscillations in the feed system and vehicle structure. Transient study results defined low-speed fuel inducer requirements for starting with zero suction pressure. Results of a study of LOX feed apparatus of the type having an ion emitter and a separated ion accelerator. An electrical potential gradient is established between the emitter and the accelerator so that ions flow from the emitter towards the accelerator to form an ion beam. An electron source mounted between the ion emitter and the accelerator increases the density of the ion beam. The fast-moving electrons from the source travel within the ion beam in a direction opposite to that of the ion movement, increasing the beam density and thus increasing the available power per unit area. R.B.

N70-41076# Federal Aviation Administration, Washington, D.C.
PAPERS PRESENTED AT STOL PORT PLANNING AND DESIGN CONFERENCE
26 May 1970 100 p refs Conf. held 20 Apr. 1970, Washington, D.C.
(N-5390.3) Avail: NTIS

CONTENTS:

1. STOL CONFERENCE OBJECTIVES C. G. Bowers p 1–6
2. FORMULATION OF DESIGN CRITERIA R. J. Endres p 7–12
3. OPERATIONAL EXPERIENCE WITH STOL AIRCRAFT P. Baker and A. Betti p 13–20
4. STOL RUNWAY LENGTH DETERMINATION G. Buley p 21–30
5. TERMINAL NAVAIDS AND IFR OPERATIONS G. E. Gibson p 31–40
6. OBSTRUCTION CLEARANCE SURFACE G. L. Crosby p 41–50
7. STOL MARKING AND LIGHTING T. J. Williams p 51–56
8. STOL PORT SAFETY C. Shulten and H. W. Eakins p 57–74
9. OPERATIONAL RESEARCH RELATED TO STOL PORTS J. C. Staples p 75–80
10. PLANNING THE STOL AIR TRANSPORT SYSTEM T. McNamara p 81–92 ref

11. FEDERAL ASSISTANCE IN FUNDING STOL PORT DEVELOPMENT L. E. Gutherie p 93-97

N70-41077# Federal Aviation Administration, Washington, D.C.
STOL CONFERENCE OBJECTIVES
Chester G. Bowers *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 1-6

Avail: NTIS

Introductory remarks on the objectives of the conference are presented. It is pointed out that the common goal is the improvement of the national air transportation system by the establishment of a STOL air transportation system which supplements and complements the conventional aircraft system. To achieve this goal will require the concurrent development of both the vehicles and the landing facilities. One port design characteristic specifically discussed is that of the FAA suggested runway length of 1500 feet which is considered within the current state of the art. A.L.

N70-41078# Federal Aviation Administration, Washington, D.C.
FORMULATION OF DESIGN CRITERIA
Robert J. Endres *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 7-12

Avail: NTIS

Rationale being considered by the FAA in the formulation of design and construction standards for the development of STOL ports are discussed. In the establishment of these standards it is necessary to ferret out and determine a balance of the needs between all of the related areas of the air transportation industry, the user, the supplier, and the vehicle with equal emphasis on the effects on the community, environment, and the general public. The optimum criteria developed must be compatible with the already existing complex system. A.L.

N70-41079# Federal Aviation Administration, Washington, D.C.
OPERATIONAL EXPERIENCE WITH STOL AIRCRAFT
Paul Baker and Alder Betti *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 13-20

Avail: NTIS

Operational tests conducted on aircraft which were candidates for STOL operations indicated that crosswinds, tailwinds, turbulence, and wind shear may be limiting factors on STOL operations, particularly where bi-directional elevated STOLports are concerned. Operational requirements considered necessary for the conduct of safe operations from elevated STOLports are: (1) approach guidance and departure system; (2) containment on elevated port; and (3) aircraft performance. Also being investigated are passenger acceptance, pilot reaction and performance when landing on elevated sites, and wind considerations as they apply to building design and operations. A.L.

N70-41080# Federal Aviation Administration, Washington, D.C.
STOL RUNWAY LENGTH DETERMINATION
George Buley *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 21-30
Avail: NTIS

Parameters which affect runway length determination for STOL ports are discussed. It is intended that the procedure discussed will establish a common understanding of STOL runway length and how it is derived, particularly for an elevated port. Author

N70-41081# Federal Aviation Administration, Washington, D.C.
TERMINAL NAVAIDS AND IFR OPERATIONS
Gerald E. Gibson *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 31-40

Avail: NTIS

The policies and philosophies of the FAA concerning the type of navigation aids necessary to permit safe, viable, and economic IFR operations of STOL aircraft in metropolitan and terminal areas are discussed. A specially designed microwave ILS guidance system for STOL operations is described. Acceptance tests are being conducted on the airborne version of the system. A.L.

N70-41082# Federal Aviation Administration, Washington, D.C.
OBSTRUCTION CLEARANCE SURFACE
Gerald L. Crosby *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 41-50

Avail: NTIS

Prevention of encroachment of construction on the airspace needed for a STOL port is discussed. It is pointed out that local zoning ordinances and Federal regulations that require screening of construction proposals are two means of controlling it. However, both require some kind of standard guide to determine when an obstacle is an obstruction and when an obstruction is a hazard. Methods of determining imaginary surfaces of airspace through which no obstacle shall be permitted to penetrate are discussed. Federal regulation FAR Part 77 already provides protection of airspace, within definite limits, and will be revised as additional operational experience is gained regarding STOL aircraft. A.L.

N70-41083# Federal Aviation Administration, Washington, D.C.
STOL MARKING AND LIGHTING
Thomas J. Williams *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 51-56

Avail: NTIS

Rapid development of STOL lighting and marking systems has resulted in a configuration having safeguards believed necessary to prevent conventional aircraft from inadvertantly landing on STOL runways. Application of existing hardware to the problem has resulted in adequate performance for STOL aircraft operations but a need exists to improve VASIS for the lower zone near the surface. Further development is also needed for IFR operations as to approach light configuration and hardware characteristics for approach lighting as well as other fixtures used in the threshold, edge, centerline, and end lighting components. Author

N70-41084# Federal Aviation Administration, Washington, D.C.
STOL PORT SAFETY
Carl Shulten and Howard W. Eakins *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 57-74

Avail: NTIS

The history of the evolution of aircraft arresting systems is briefly reviewed along with some of the energy absorbing systems in use by the military that might be used for STOL port

uses. It has been determined that no existing system can be taken off the shelf and used on a STOL port that will meet all the tentative requirements. It is proposed that action be taken with industry to define the future application of arresting systems at STOL ports and develop specifications for the production of a system that will contain STOL aircraft on elevated STOL ports. The degree of fire and rescue protection needed at STOL ports will be determined by applying the critical area criteria expressed in AC 150/5210-6A. Modification of this criteria might be necessary for certain elevated STOL ports where the size of the port may limit the type of equipment which can be used. A.L.

N70-41085# Federal Aviation Administration, Washington, D.C. Aircraft Div.

OPERATIONAL RESEARCH RELATED TO STOL PORTS

J. Clay Staples *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 75-80 :

Avail: NTIS

Activities undertaken by the FAA to gain the necessary knowledge and experience to assist in the establishment of realistic STOL port criteria, related airworthiness and operational criteria, and flight test procedures are briefly reviewed. Several programs being conducted for the FAA by NASA are discussed. In the absence of an elevated STOL port, tentative plans have been made to conduct tests on an airport which provides some of the characteristics of an elevated port. A.L.

N70-41086# Federal Aviation Administration, Washington, D.C.

PLANNING THE STOL AIR TRANSPORT SYSTEM

Thomas McNamara *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 81-92 ref

23 :)

Avail: NTIS

Air traveler convenience is considered the most important factor in the planning of the STOL air transportation system. With STOL operations geared to the short haul market, less than 500 miles, locations of STOL ports will in all probability be widely dispersed and will serve the needs of many different groups of people. Some of the constraining factors effecting the planning for STOL ports include: (1) airspace limitations; (2) land limitations; (3) airport ground access; (4) environmental impact; (5) noise; and (6) financial considerations. A.L.

N70-41087# Federal Aviation Administration, Washington, D.C. Airports Service.

FEDERAL ASSISTANCE IN FUNDING STOL PORT DEVELOPMENT

Lamar E. Gutherie *In its* Papers presented at STOL Port Planning and Design Conf. 26 May 1970 p 93-97

Avail: NTIS

Statutory definitions establishing guidance for identifying airports that can qualify for Federal assistance are reviewed. Three basic requirements are involved in obtaining Federal aid for airport development: eligibility of airport, sponsor, and development itself. Legislative definitions clearly include airports for STOL aircraft use. Legislation under consideration will increase the capability of the FAA to afford aid to public agencies for airport development by more than threefold. A.L.

N70-41131# Kaman Nuclear, Colorado Springs, Colo.

THE THEORY AND CAPABILITIES OF MAGNETICALLY DRIVEN FLYERS

Thomas F. V. Meagher and David C. Williams Jun. 1970 69 p refs

(Contract DASA-01-68-C-0084)

(AD-708449; KN-770-70-35; DASA-2440) Avail: NTIS CSCL 14/2

The basic theory governing the behavior of magnetically driven flyer plates is derived and discussed. Analytical tools capable of predicting the non-linear response of flyer plate systems are described and one such tool is utilized to predict the behavior of a typical capacitor bank-magnetically driven flyer plate facility. Practical applications and achievements, including instrumentation and bank diagnostics, of operating systems are described. Consideration is given to uncertainties arising from a lack of definition of the cushioning (air or magnetic) between the sample and flyer, the thermodynamic condition of the flyer at impact, and the degree of buckling of a curved flyer at impact with a curved test specimen. Particular attention is given to the high impulse capability of magnetically driven flyer plates. Theoretical predictions of the temperature rise in various materials due to I2R heating are presented along with hydrodynamic calculations of the pressure-time history resulting from magnetically driven flyer plate impacts on tape wound nylon phenolic. Included in the summary is a discussion of the need for magnetically driven flyer plate loadings of structural items. Author (TAB)

N70-41142# Civil Aeronautics Board, Washington, D.C.

IMPACT OF NEW LARGE JETS ON THE AIR TRANSPORT SYSTEM, 1970-1973

Nov. 1969 255 p refs

Avail: NTIS

An attempt to define the significant problem areas possibly emerging with the advent of wide bodied jet aircraft, including the Boeing 747, DC-10, and L-1011, and to estimate the economic impact resulting from the introduction of large numbers of these aircraft is discussed. Conclusions are presented concerning passenger capacity increases, domestic and international fares, routes and service patterns, economic viability, aircraft acquisition problems, airway and airport congestion problems, the future for air cargo, the impact on supplemental operations such as inclusive tour charters, the impact on cooperative arrangements, the impact on international operations, and an agreement relating to support equipment purchases. P.A.B.

N70-41143# Aeronautical Center, Oklahoma City, Okla.

AVIATION TECHNICAL ASSISTANCE TO PANAMA, MARCH/OCTOBER 1969

[1970] 44 p ref

(AC-70-3188) Avail: NTIS

The observations and recommendations of the advisory team arranged by the USAID Mission to Panama to aid in refining Panama's Directorate of Civil Aeronautics are presented. The statutory and budgetary background of the Directorate is investigated, including the basic Panamanian aviation law, air travel tax versus airport service charge, and airport fees. The organization of the Directorate is discussed with reference to its advisory board, statistical services, and office procedures and practices. Aviation safety responsibility recommendations relate to licensing procedures, the flight crew, ground crew, the aircraft, air traffic services, airways improvements, facilities maintenance, and airports. Suggestions are also made regarding programs for increasing tourism, travel statistics amplification, and measures to assist economic regulation of air routes and services. P.A.B.

N70-41152# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

RESEARCH ON ADVANCED GASDYNAMIC FACILITIES

Quarterly Progress Report, 11 Sep. – 10 Dec. 1969
Wright-Patterson AFB; Ohio ARL Feb. 1970 34 p refs
(Contract AF 33(615)-5389)
(AD-709210; ARL-70-0027; QPR-14) Avail: NTIS CSCL 14/2

Progress is reported on a research program which has the objective of investigating new techniques for producing hypervelocity flows in aerodynamic test facilities. One phase is a study utilizing high peak-power lasers and another phase is a study of the isentropic-compression tube. Both of these approaches are being considered as possible means of heating and accelerating test gases. Author (TAB)

N70-41156# Federal Aviation Administration, Washington, D.C. Flight Standards Service.
EVALUATION OF LOWER ILS MINIMUMS FOR LIGHT AIRCRAFT
Raymond W. Skinner and Frank Parr Jun. 1970 54 p
(AD-708294) Avail: NTIS CSCL 1/2

The evaluation included 120 ILS approaches flown under simulated IFR (hooded) conditions by 17 pilots in 6 types of light twin aircraft, to test the ability of pilots to align for landing or to execute a missed approach at minimums lower than 200 feet height and 1/2 mile visibility. A decision height of 100 feet was used during the entire project. Although only 80 percent of the scheduled landings were completed, pilots indicated that with normal runway lengths (5000 feet) most runs scheduled for landing could have been completed. The altimeter errors at the 100 foot decision height ranged from −80 to +45 feet, and seemed to cause the major problem. Missed approach data indicate that the missed approach obstacle clearance must be revised if minimums below 200 feet are to be approved for this pilot group. Author

N70-41172# Federal Aviation Administration, Washington, D.C. Information and Statistics Div.
COMMUTER AIR CARRIER OPERATORS AS OF SEPTEMBER 1969
[1970] 80 p
Avail: NTIS

Statistical operations and facilities data are tabulated for 153 commuter carriers of which 8 are designated as mail only carriers. The information is compared with other data on commuter carrier systems. E.H.W.

N70-41183*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EVALUATION OF A MOVING-GRAPH INSTRUMENT DISPLAY FOR LANDING APPROACHES WITH A HELICOPTER
R. Earl Dunham, Jr. and Robert W. Sommer Washington Oct. 1970 24 p refs
(NASA-TN-D-6025; L-7241) Avail: NTIS CSCL 01D

A flight test evaluation was conducted of an instrument display for VTOL all-weather landing which included a moving graph pictorial presentation for slope guidance. The instrument display included a moving map presentation for course guidance, a large (4.5-inch-diameter (11.43-cm)) attitude indicator, and moving pointer airspeed and vertical-speed indicators. The tests were conducted under simulated instrument flight rules conditions in landing approaches with a helicopter along a 6 deg glide slope at an airspeed of 30 knots. Author

N70-41191# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
A DISCUSSION OF THE USE OF XENON FLASH LAMPS FOR ANTICOLLISION PURPOSES Final Report, Nov. 1969 – Apr. 1970
Peter L. Land May 1970 47 p refs
(AD-709191; ARL-70-0083) Avail: NTIS CSCL 1/2

The report points out a number of advantages which flash lamps have when used for anticollision light systems. A renewal of interest in the use of flash lamps for collision avoidance is noted, and this includes the related problem of avoiding bird strikes. Some of the important factors relevant to the effectiveness of anticollision lights, such as background illumination, intensity distribution and phase relations for a system of flashing lights are discussed. It is noted that the intensity distribution for a rotating beacon has cylindrical geometry, which is a limitation, and that phase relations for rotating or oscillating lamp systems are not and could not be easily maintained constant. It is noted that the advantages which flash lamps have in these respects are not always utilized; for example, at night the intensity distribution for a flash lamp anticollision light system should have the same form as that which applies to navigation lights. It is noted that during turns, the intensity patterns for most focused anticollision light systems are tilted out of the desired plane and it is suggested that for some aircraft it would be practical to sense and compensate for a banked condition. It is noted that flight test results show that flash lamp systems have been rejected mainly because the reflected light which may occur during various conditions caused pilot discomfort and may cause loss of dark adaptation and disorientation. Author (TAB)

N70-41193*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SIMULATION STUDY OF THREE INSTRUMENT DISPLAYS TO ASSIST IN AIRPLANE THRUST MANAGEMENT
Milton D. McLaughlin Washington Oct. 1970 44 p refs
(NASA-TN-D-5982; L-7200) Avail: NTIS CSCL 01D

Three displays were evaluated on a piloted simulator, each of which provided information which could be used in thrust management. The three displays were (1) rate of change of speed, (2) potential flight path angle, and (3) potential rate of climb. Results are presented in the form of time histories, histograms, and pilot comments. The results include comparisons of flight path and speed control and throttle activity with and without each display and pilot comments. Author

N70-41195# Federal Aviation Administration, Washington, D.C. Airports Service.
THE 1980 METROPOLITAN AREA AIRPORT CAPACITY ANALYSIS. LOCATION: ATLANTA, GEORGIA Staff Study
Louis N. Million 19 Jun. 1969 24 p
Avail: NTIS

An example of the use of airport airfield capacity techniques in analyzing long range (ten or more years) airport needs for a metropolitan area is presented. The Atlanta Standard Metropolitan Statistical Area (SMSA) was selected as a representative location for preparation of this example. Several related factors were reviewed including population trends, economic development, highway, rail and waterway transportation systems, zoning plans, topography, and airspace. Airfield capacity is defined as that movement rate of aircraft using the runway-taxiway system which results in a reasonably acceptable average delay to operations. The analytical approach and procedures described are adaptable to any SMSA. Author

N70-41197# National Aviation Facilities Experimental Center, Atlantic City, N.J.

ALTIMETRY: A LITERATURE REVIEW AND BIBLIOGRAPHY, PHASE 1 Final Report
Jack J. Shrager Sep. 1970 104 p refs
(FAA-RD-70-52; FAA-NA-70-19) Avail: NTIS

The design, maintainability, and reliability of altimeter systems are presented in this review in an effort to promote safety and economy by the aviation community. The bibliography is annotated and has 259 items, an author's index is also provided. E.M.C.

N70-41198# National Aviation Facilities Experimental Center, Atlantic City, N.J.
GRAPHIC SIMULATION STUDY OF TWO SITES FOR A SECOND MAJOR AIRPORT IN THE ATLANTA AREA Final Report, Feb.–Apr. 1970
Sidney B. Rossiter Oct. 1970 51 p ref
(FAA-RD-70-63) Avail: NTIS

A graphic simulation study was made of the Atlanta terminal area to provide comparisons between two proposed sites for a second major airport based on air traffic control considerations. Terminal area air traffic control procedural plans were developed incorporating each new site. Through the use of a questionnaire, developed around factors that comprise an air traffic control subsystem, each site was evaluated by a panel of 12 air traffic control specialists for each of four different wind directions. The results of this evaluation indicated that Site D was significantly preferred for the west, northwest, and east landing directions with Site A being significantly preferred for a southeast direction of operation. Considering all wind directions, Site D was preferred over Site A when the wind directions were weighted based on percentage of occurrence, or when considered equal in weight. The primary reasons for this choice were the lesser interaction with satellite airports, more available airspace, fewer areas requiring critical vectoring, less interaction between Site D and the Atlanta airport for north/south departures, less coordination because of less compression of airspace, and no added effect on the satellite airports operations. Author

N70-41207# National Aviation Facilities Experimental Center, Atlantic City, N.J.
ENGINEERING SURVEY AND ANALYSIS OF ENROUTE ATC RADAR/DISPLAY SYSTEM ERRORS Final Report, Jul. 1968–Jun. 1969
Reuben H. Holliday Oct. 1970 43 p refs
(FAA-NA-70-14; FAA-RD-70-46) Avail: NTIS

En route radar (primary and secondary) range and azimuth accuracy data were collected from other projects and analyzed, along with theoretical considerations, to determine if the available accuracy data were adequate for assessing the position measuring performance of en route, air traffic control radar display systems. Author

N70-41227# National Transportation Safety Board, Washington, D.C.
NATIONAL TRANSPORTATION SAFETY BOARD: ANNUAL REPORT TO CONGRESS, 1969
15 Apr. 1970 99 p
Avail: SOD $0.50

The annual report to congress on the activities of the National Transportation Safety Board is presented. Investigations, public hearings, and safety recommendations for both air and surface transportation are included. F.O.S.

N70-41229# Naval Postgraduate School, Monterey, Calif.
THE EFFECTS OF TINTED PLEXIGLASS ON VISIBILITY IN THE AH-1G COBRA AIRCRAFT
Jac Darrell Lind Watson (M.S. Thesis) Apr. 1970 29 p refs
(AD-709405) Avail: NTIS CSCL 5/5

The problem of heat reduction in the AH-1G helicopter presented several options for solution. To alleviate the problem until permanent means could be devised for airconditioning the aircraft, tinted glass was installed. This immediately caused a series of objections to the glass because of the loss of vision by pilots at night. The problem of vision loss was studied using three independent variables; color, angle of the test glass to the line of sight, and target contrast. Author (TAB)

N70-41242*# Alabama Univ., Huntsville.
HUNTSVILLE AIR TRAFFIC FORECAST
David G. Mishkin [May 1970] 39 p
(Grant NGL-01-002-001)
(NASA-CR-113917) Avail: NTIS CSCL 05C

The results are presented of a survey of Huntsville commercial air traffic based on published reports of the Civil Aeronautics Board, the Federal Aviation Agency, and the Air Transport Association of America. Contained in the report is a sample of Huntsville air traffic that was obtained in May, 1970, in order to generate additional data. The study was undertaken to better understand the characteristics of Huntsville's pattern of commercial air traffic in order that future passenger requirements and service improvements may be better evaluated. This report is limited to passenger traffic and ancillary market characteristics. Author

N70-41266# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
AIRFOILS IN TWO-DIMENSIONAL NONUNIFORMLY SHEARED SLIPSTREAMS Final Report, Jun. 1967–Jun. 1970
Gary R. Ludwig and John C. Erickson, Jr. Jul. 1970 21 p refs
(Contract DAHC04-67-C0071)
(AD-709696; CAL-AC-2489-S-1; AROD-7082-1-E) Avail: NTIS CSCL 1/3

A theoretical and experimental program was conducted to investigate the aerodynamics of an airfoil in a two-dimensional nonuniformly sheared slipstream. A mathematical model was developed to predict airfoil pressure distributions in such a slipstream and was used successfully for slipstreams with moderate shear. Pressure distributions over a wide angle of attack range were measured experimentally on an airfoil at each of seven different locations in a highly sheared two-dimensional slipstream. Study of the pressure distributions obtained on the airfoil at a location slightly above the flow centerline and also at a location slightly below the flow centerline indicates that the large effects on stalling characteristics are due to differences in the upper surface pressure distributions. These pressure distributions are affected by the freestream shear. Moreover, in the data obtained for airfoils located near the flow centerline, the differences in the lift appear to be caused primarily by differences in the stagnation pressure of the streamline which intersects the airfoil. This stagnation pressure is a function not only of airfoil location relative to the slipstream, but also of the angle of attack of the airfoil. Author (TAB)

N70-41268# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero-Acoustics Branch.
MEASUREMENTS OF THE RADIATED NOISE FROM SAILPLANES Technical Memo, Aug. 1969–Feb. 1970
D. L. Smith, R. P. Paxson, R. D. Talmadge, and E. R. Hotz Jul. 1970 116 p refs
(AD-709689; AFFDL-TM-70-3-FDDA) Avail: NTIS CSCL 20/1

The noise associated with a flight vehicle is generated by two distinct type sources: (1) the propulsion system and (2) the aerodynamic noise associated with movement of the vehicle through the atmosphere. The minimum noise will be radiated when the propulsion noise is eliminated. Measurements were taken of the noise radiated from three sailplanes in order to define the aerodynamic noise and to determine its relation to aircraft size and velocity. The report presents the results obtained from one microphone and relates the overall sound pressure level (SPL) to aircraft parameters. Author (TAB)

N70-41271# National Aviation Facilities Experimental Center, Atlantic City, N.J.
TEST AND EVALUATION OF AN ADVANCED INTEGRATED LANDING SYSTEM FOR ALL-WEATHER LANDING Final Report, Aug. 1965 – Feb. 1970
Vincent L. Bencivenga Aug. 1970 148 p
(FAA-RD-70-28; FAA-NA-70-26) Avail: NTIS

Test and evaluation of an Advanced Integrated Landing System (AILS) is reported. The system incorporates a distance measuring equipment function, as well as a radar function for providing precision approach radar type monitoring of an approach. During the test program, AILS approaches were made in fixed-wing aircraft, both prop and jet, including short take-off and landing aircraft. Based on evaluation of the data collected, it was determined that the AISL is capable of providing air-derived space position information to the following accuracies, DME data to + or − 100 feet or 1 percent of distance, whichever is greater, azimuth angle data to + or − 0.05 deg 1 sigma, and elevation angle data to + or −. 0.03 deg 1 sigma. The system is not adversely affected by overflying aircraft, and taxiing aircraft and/or other vehicles only affect performance when stopped so that they effectively shadow a transmitting antenna. Some minor system deficiencies exist for which proposed corrective measures are discussed. Author

N70-41273# Civil Aeronautics Board, Washington, D.C.
PROBLEMS OF AIRPORT CONGESTION BY 1975
Myron S. Heffter, Evans Wiley, and James Craun Sep. 1969 173 p refs
Avail: NTIS

Traffic handling characteristics are described for fourteen high density airports in the United States and Puerto Rico (Los Angeles, Atlanta, Miami, Boston, San Francisco, Philadelphia, Cleveland, Minneapolis, St. Louis, Memphis, Oakland, Denver, Las Vegas, and San Juan). Five airports already at saturation levels of operation are excluded from the discussion (JFK, LaGuardia, Newark, Washington National, and O'Hare). The major causes of airport congestion are identified as: (1) saturation of runways, (2) noise restrictions, (3) insufficient runway turnoffs, (4) lack of aprons and holding areas, (5) insufficient parking gates, and (6) inadequate highway approaches to airports and parking facilities. E.C.

N70-41283*# Illinois Univ., Urbana.
A STUDY OF THE LOCAL PRESSURE FIELD IN TURBULENT SHEAR FLOW AND ITS RELATION TO AERODYNAMIC NOISE GENERATION Semiannual Status Report, 1 Feb. – 31 Jul. 1970
Barclay G. Jones and Bruce W. Spencer 31 Jul. 1970 32 p refs
(Grant NGR-14-005-149)
(NASA-CR-113881; SASR-1) Avail: NTIS CSCL 20D

Noise generation by turbulent aerodynamic shear flow was studied in the context suggested by Ribner's dilatation formulation for jet noise. The fluctuating fluid field is comprised of a pseudosound pressure field, responsible for generating sound, and a true acoustic pressure field, responsible for its propagation. The pseudosound pressure is a fluid mechanics phenomenon resulting from fluctuating inertial forces within the turbulent flow. Its behavior encompasses the mechanism by which the sound is produced, and the study of this phenomenon is thereby fundamental in understanding and subsequently controlling noise emission from jets. The fluctuating pressure was studied by means of a miniature bleed-type pressure transducer for turbulence measurements. This unique device permits pursuance of the dilatation concept on a laboratory scale basis. Initial phases of the investigation include detailed measurements of the Eulerian and Lagrangian frame velocity and pressure characteristics in a turbulent shear flow. Author

N70-41290# Federal Aviation Administration, Washington, D.C.
NEAR MIDAIR COLLISION REPORT OF 1968
15 Jul. 1969 207 p refs
Avail: NTIS

The classification and analysis of 2,230 near midair collision (NMAC) reports received during 1968 resulted in 1,128 of these reports being classified as hazardous to flight. Of these hazardous NMACs, 719 occurred in the terminal airspace—98 occurred at airports without control towers and 621 occurred within a 30 nautical mile radius of airports with control towers. The remaining 409 hazardous NMACs occurred within the enroute airspace. The data showed large clusters of reported NMACs occurring around large air transportation hubs and along published airways. The large metropolitan area reflected the heavy concentration of air traffic. Here, the number of near misses was directly related to the density of air traffic. All NMAC reports were considered for data collection. Each occurrence was classified as hazardous (critical or potential) or no hazard, based on a thorough analysis of the operational situation and on specific guidelines. Factors influencing the number of reported near misses in these hubs involved airport proximity, terrain, traffic flow, air traffic control services, and types of aircraft and operations. Author

N70-41291# Federal Aviation Administration, Washington, D.C. Office of Aviation Economics.
AIR TRAFFIC FORECASTS: LARGE AND MEDIUM HUBS, AIR CARRIER AIRPORTS
Feb. 1970 14 p refs
Avail: NTIS

The study includes forecasts for 26 large hub airports and 36 medium hub airports. Their significance in the total national traffic pattern is revealed by the fact that in FY 1968 these 62 airports accounted for 72.4 percent of the air carrier aircraft operations; 39.0 percent of total itinerant operations, 29.3 percent of total aircraft operations, and 59.7 percent of instrument operations reported by the 318 FAA air traffic control towers in the United States. The data on air carrier passengers enplaned cover all passengers enplaned at these airports by U.S. as well as foreign flag air carriers. Base data on U.S. certificated route air carriers were obtained from joint FAA/CAB reports. In the absence of reported data, it was necessary to develop estimates of passenger enplanements for foreign flag, supplemental, and intra-state air carriers from other sources such as airport managers, state aviation commissions, and published flight schedules. Author

N70-41302# Federal Aviation Administration, Washington, D.C. Office of Aviation Economics.
WASHINGTON NATIONAL AND DULLES INTERNATIONAL AIRPORT FORECASTS, FISCAL YEARS 1970 – 1981
Nov. 1969 39 p
(AD-705087) Avail: NTIS

Forecasts for eight major traffic categories at both Washington National Airport and Dulles International Airport for fiscal years 1970 through 1981 are presented. These categories are air carrier passengers, all other passengers, express, freight, mail and aircraft movements for air carrier, general aviation and military. These forecasts indicate probable aviation demand for the Washington metropolitan area. They are not intended to imply that the physical capacity to fully meet this demand is available and in being today. These projections provide a foundation on which airport engineers and regional airport planning officials can make specialized studies and recommendations on how best to meet this demand. The report focuses on the period through fiscal 1976 and gives specific projections for each year, 1970 through 1976. Forecasts for fiscal years 1980 and 1981 are also included to meet longer-range planning needs. Author

N70-41307# Federal Aviation Administration, Washington, D.C. Library Services Div.
HIJACKING: SELECTED REFERENCES, 1961-1969
Ann O'Brien, comp. Jun. 1969 23 p refs *Its* Bibliog. List No. 18
(AD-688766) Avail: NTIS

This selected annotated bibliography was compiled to assist individuals working on the problem of aircraft hijackings. Author

N70-41325# Litton Systems Inc., Canoga Park, Calif. Aero Products Div.
FLIGHT EVALUATION OF INERTIAL/DME/DME SYSTEM Final Report
R. J. Holm May 1970 179 p
(Contract FAA-69-WA-2122)
(FAA-RD-70-24; FR-10) Avail: NTIS

A LTN-51 inertial navigation system augmented by two ARINC 568 digital DME's was flown in an FAA flight inspection aircraft for evaluation of updated inertial performance in the domestic area. The LTN-51 inertial computer received range inputs for two separate DME stations. The geographic fix of the two DME ranges was used to update the inertial system. Data were recorded automatically every four seconds and performance validated by comparison with flight inspection position calibration. The 150 successful flight hours covering the Western United Satates were achieved in 2-1/2 months. Data show deviation was 1,102 feet, 50%; 1,233 feet, 68%, 2,530 feet, 95%; and 3,499 feet, 100% (mean percentile points). Terminal approaches were also demonstrated. Author

N70-41339# Bunker-Ramo Corp., Canoga Park, Calif. Defense Systems Div.
FLIGHT EVALUATION OF A PILOT-ASSIST STABILITY AUGMENTATION SYSTEM FOR A LIGHT AIRCRAFT Final Report
R. Walchi and D. Eldredge May 1970 125 p refs Sponsored jointly with FAA
(Contract F33615-69-C-1142)
(FAA-DS-70-14; H0191-0U10) Avail: NTIS

The utility of a light aircraft Pilot-Assist stability augmentation system in extracting the noninstrument qualified pilot from accidentally encountered instrument flight conditions is evaluated. Ten noninstrument rated pilots flew a predetermined course consisting of visual flight and instrument flight conditions. The aircraft was equipped with the Pilot-Assist system and a conventional stability augmentation system. The utility of the Pilot-Assist system was established through comparisons of continuous photographic data recordings of the airspeed, heading, bank angle, altitude, and altitude rate indicators on the aircraft's instrument panel, and through comparisons of pilot opinionnaire and detailed questionnaire data obtained for flights with both systems. The analysis of these data for both the Pilot-Assist system and the conventional stability augmentation system demonstrated that the utility of the Pilot-Assist system exceeded that of the conventional system. This relative utility was demonstrated both in terms of improvements in pilot performance and potential pilot acceptance. Author

N70-41375*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
GAS-SURFACE INTERACTIONS AND ORBITAL AERODYNAMIC CALCULATIONS Final Report
Chien Fan and J. W. Warr Apr. 1970 167 p refs
(Contract NAS8-24401)
(NASA-CR-102827; LMSC/HREC-D162228; HREC-4401-2) Avail: NTIS

The findings of a literature survey of experimental and theoretical studies on gas-surface interactions are presented. The experimental studies include the following: (1) laboratory techniques used in producing molecular beams for gas-surface studies; (2) observed molecular scattering phenomena; and (3) determination of momentum and energy accommodation coefficients. The theoretical studies include both analytical and numerical calculations of molecular scattering and accommodation coefficients. Particular attention and emphasis have been paid to those gas-surface interaction studies which have beam energies corresponding to earth orbital flight speeds. A computer program is presented that was developed to calculate force, moment, and heat transfer coefficients for simple and complex vehicle configurations in a variety of orbital environments. Details of the inputs and outputs of the program are described and sample problems are given to illustrate the handling procedure of the program. Author

N70-41394# Civil Aeronautics Board, Washington, D.C.
REMARKS BY THE HONORABLE SECOR D. BROWNE, CHAIRMAN, CIVIL AERONAUTICS BOARD, BEFORE THE SOCIETY OF AUTOMOTIVE ENGINEERS' AIR TRANSPORTATION LUNCHEON
Secor D. Browne 22 Apr. 1970 4 p Conf. held in New York, 22 Apr. 1970
Avail: NTIS

Problems that must be resolved for the air transport industry to meet the challenges and opportunities from 1970 to 1975 are discussed. Some of the problems and questions are: (1) air pollution and the economic impact of environmental programs, (2) air traffic control, and (3) airport capacity. F.O.S.

N70-41400# Department of Transportation, Washington, D.C.
A PRELIMINARY REPORT ON THE CLEVELAND BEFORE AND AFTER STUDY Interim Technical Report
George F. Wiggers May 1969 108 p refs
(PB-184060) Avail: NTIS

The Cleveland Before and After Study is an analysis of the rapid rail extension to Cleveland Hopkins Airport. A survey of airport users and employees at Hopkins Airport was conducted before the start of rail service to the airport, and an after survey will be conducted one year later. The data from these surveys will be compared to determine trip time and cost factors influencing choice of the rapid rail to the airport over alternative modes of transportation. Progress of the study to date, and preliminary estimates of ridership and impact on the rapid rail by air passengers, indicate only marginal reduced congestion of highway facilities at the airport. Charts, tables, and maps are included to verify these estimates. Author

N70-41437# Civil Aeronautics Board, Washington, D.C.
REMARKS OF JOHN G. ADAMS, MEMBER, CIVIL AERONAUTICS BOARD BEFORE THE ASSOCIATION OF LOCAL TRANSPORT AIRLINES SPRING QUARTERLY REGIONAL MEETING
John G. Adams 1 May 1970 9 p Conf. held at New Orleans, 1 May 1970
Avail: NTIS

Changing patterns of commercial air service in the near future and their impact on airline economics are outlined. Air services to a large number of towns are uneconomical and require a federal subsidy program. Subcontracting of small aircraft for massive substitution of services over traffic loss segments provides a suitable feeder service to small towns and relieves the burden on large airline companies. G.G.

N70-41438# Civil Aeronautics Board, Washington, D.C.
REMARKS BY THE HONORABLE SECOR D. BROWNE, CHAIRMAN, CIVIL AERONAUTICS BOARD, TO METROPOLITAN BOARD OF TRADE AVIATION COMMITTEE
Secor D. Browne 9 Apr. 1970 3 p Conf. held at Washington, D.C., 9 Apr. 1970
Avail: NTIS

The chairman of the Civil Aeronautics Board discussed the air transport problem in the Washington, D.C. area. The need for helicopter inter-airport services is outlined and the critical issue of the air traffic controller strike with its economic losses is discussed briefly. G.G.

N70-41439# Civil Aeronautics Board, Washington, D.C.
REMARKS BY THE HONORABLE SECOUR D. BROWNE, CHAIRMAN, CIVIL AERONAUTICS BOARD AT THE UNIVERSITY OF SOUTH FLORIDA'S SYMPOSIUM, 'AIR 70'
Secor D. Browne 1 May 1970 10 p Conf. held at Tampa, Fla., 1 May 1970
Avail: NTIS

The chairman of the Civil Aeronautics Board discusses the effects of pollution, air traffic control systems, airport locations, and advanced aircraft on the airline industry. Increasing movement of people in the foreseeable future requires stolports, an adequate traffic control system, and short-haul as well as supersonic transport aircrafts. G.G.

N70-41450# Shock and Vibration Information Center (Defense), Washington, D.C.
THE SHOCK AND VIBRATION DIGEST. VOLUME 2, NUMBER 8, AUGUST 1970
Aug. 1970 35 p refs
(AD-709734) Avail: NTIS CSCL 20/11

Contents: News briefs; Reviews of meetings; Previews of mettings; Short courses; Abstracts from the current literature; (Analysis and design methods, Excitation, Phenomenology, Experimentation, Components, Systems); Book reviews; Publications of SVIC. TAB

N70-41476# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium). Turbomachinery Lab.
BLUNT TRADING EDGE BLADING STUDIES IN LOW AND HIGH SPEED FLOWS Interim Scientific Report, 1 Apr. 1969 –31 Mar. 1970
J. Chauvin, F. Breugelmans, H. Griepentrog, and H. Rottiers 31 Mar. 1970 55 p refs
(Contract F61052-69-C-0025)
(AD-709472; VKI-TN-35; ARL-70-0134) Avail: NTIS CSCL 13/7

The report covers first cascade calculations and testing on blunt trailing edge blades in the subsonic range. First, improvement on a potential flow method is described, and the results of calculations are compared with cascade tunnel data. Fair agreement is obtained. A boundary layer correction was also applied with moderate success. Exploratory studies of the dump diffusion region are reported. Application of the blunt trailing edge blade concept to the low Re number range is then discussed, and the first experimental data bearing on pitch chord ratio optimization are reported. Finally, the essential features of two supersonic compressor stages are discussed. Author (TAB)

N70-41477# Honeywell, Inc., Minneapolis, Minn. Manned Systems Technology Group.
AIRCRAFT DISPLAYS FOR STEEP-ANGLE APPROACHES
James D. Wolf and Richard B. Hoppe Jul. 1970 379 p refs Sponsored in part by ONR and Army Electron. Command
(Contract N00014-68-C-0191)
(AD-709475; Rept-12571-FR1; JANAIR-681215) Avail: NTIS CSCL 1/4

The primary objective of the program was to investigate aircraft display requirements for steep-angle approaches and landings with 1975-1980 era tactical rotary-wing and V/STOL aircraft. The study was conducted with variable-velocity simulations of Bell UH-1 and Ryan XV-5 aircraft. Alternative display formats were developed and empirically evaluated by means of real-time man-in-the-loop simulation techniques. In addition, approach angle and profile characteristics were systematically varied to ascertain their effects on task performance. Interpreted within the constraints imposed upon and by the simulations, results of the study indicated that manually controlled IFR steep-angle approaches and landings are possible with all display formats evaluated. Generally, horizontal situation display formats were found to yield more accurate and precise piloting performance with both vehicles. Effects of approach-profile variations were minor, while effects of approach angle did vary as a function of the vehicle flown and the axis of error or performance measurement. Author (TAB)

N70-41479*# *National Aeronautics and Space Administration.* Washington, D.C.
ADVENTURES IN RESEARCH: A HISTORY OF AMES RESEARCH CENTER, 1940–1965
Edwin P. Hartman 1970 673 p refs
(NASA-SP-4302) Avail: SOD $4.75; NTIS CSCL 14B

A historical survey of the Ames Research Center is presented, beginning with its founding in 1936 and continuing through 1965. The survey discusses early developments in aviation and concludes with the emphasis on space research from 1959 to 1965. The development of physical facilities for research are described in detail. R.B.

N70-41493*# Massachusets Inst. of Tech., Cambridge. Man-Vehicle Lab.
DISPLAY RESEARCH, COLLISION WARNING SYSTEMS Final Report
Renwick E. Curry Jul. 1970 65 p refs
(Grant NGR-22-009-444)
(NASA-CR-113886) Avail: NTIS CSCL 17G

Display studies were conducted on an infrared Pilot Warning Indicator (PWI) system. The display is important not only from the point of view of the workload, but primarily because the pilot must

quickly detect the target and evaluate the situation for the PWI system to work effectively. The feasibility of creating a stereophonic alarm to be used in the cockpit as an audio display was considered. The use of such a display would allow the pilot to turn his head immediately toward the target and start searching without having to refer to any visual instruments. Two experiments were performed with visual displays. The effect of the fields of view covered by the individual silicon detectors on a person's ability to locate targets was investigated. A moving-base simulator was constructed, and the time to detect targets using a head-up display, a panel mounted display, and a warning-only (buzzer) display tabulated. E.M.C.

N70-41516# Joint Economic Committee (U.S. Congress).
FEDERAL TRANSPORTATION EXPENDITURE FROM THE SUBCOMMITTEE ON ECONOMY IN GOVERNMENT TOGETHER WITH SEPARATE VIEWS
Washington GPO 1970 31 p *refs* *Presented by the Joint* Econ. Comm., 91st Congr., 2d Sess., 17 Aug. 1970
Avail: SOD $0.20

The ability of congress and the executive branch to conduct an effective evaluation of transportation programs is examined, as well as the application of general principles of economic analysis to the Federal aid highway program and the supersonic transport development program. Conclusions are: (1) expenditure decisions by both branches should be more unified; (2) laws for investment analysis should be amended; (3) the executive branch should provide congress with more comprehensive analysis of the social costs and benefits of Federal transportation programs; and (4) Congress should improve its capability for evaluating such information. E.H.W.

N70-41517# California Univ., Berkeley. Inst. of Transportation and Traffic Engineering.
RUNWAY MARKING STUDIES Final Report
Don O. Horning and Karl Mellander Washington FAA Aug. 1970 43 p
(Contract FAA-ARDS-434)
(FAA-RD-70-27) Avail: NTIS

To help evaluate the effectiveness of several different runway marking patterns under limited visibility conditions, a set of special composite photographs was prepared simulating a pilot's-eye view of the patterns from various points along the glide path. The set includes three marking patterns, the U.S. Standard (TSO-N10b) and two modified versions thereof, on both asphalt and concrete surfaces, as viewed under daytime visual-range conditions from 2400 ft down to 700 ft. Each of the composite photos consisted of two visual components combined through appropriate processing techniques. One component was made by photographing a 30:1 scale model runway layout in the UC-FAA Fog Chamber under a given set of conditions. The other component was taken from motion picture film showing the inside of a Boeing 707 flight simulator cockpit as viewed from the pilot's-eye position. The contrasts in the original scenes were matched in the photographs by means of suitable photometric controls. Author

N70-41526# Federal Aviation Administration, Washington, D.C.
NATIONAL AVIATION SYSTEM PLANNING REVIEW CONFERENCE Summary Report
Apr. 1970 178 p Conf. held Washington, D.C., 14-17 Apr. 1970
Avail: NTIS

CONTENTS:

1. SATELLITE COMMUNICATIONS, NAVIGATION AND SURVEILLANCE p 1-13

2. FACILITY ESTABLISHMENT CRITERIA p 15-19

3. IMPLEMENTATION OF 50 kHz/Y CHANNELS FOR ILS/VOR/DME p 21-26

4. FAA SERVICES AT NON-PUBLICLY OWNED AIRPORTS p 27-36

5. FLIGHT INSPECTION SYSTEM p 37-39

6. REDUCED TERMINAL IFR SEPARATION p 41-47

7. CONTROL ZONES FOR INSTRUMENT APPROACHES p 49-52

8. GENERAL AVIATION DATA SYSTEMS p 53-55

9. COLLISION AVOIDANCE p 57-67

10. INCREASED ENROUTE CAPACITY THROUGH INCREASED SECTORIZATION p 69-72

11. AIRPORT/AIRWAY COST ALLOCATION STUDY p 73-77

12. ATC DATA ACQUISITION CONCEPT p 79-95

13. THE EVOLUTION OF STOL/VTOL SYSTEMS p 97-113

14. AIRPORT CLASSIFICATION AND CERTIFICATION p 115-132

15. NEW GENERATION ILS p 133-139

16. ENVIRONMENTAL QUALITY p 141-150

17. RESEARCH AND DEVELOPMENT PLANNING REVIEW p 151-153

18. NATIONAL AVIATION SYSTEM POLICY AND PLAN p 155-158

N70-41527# Federal Aviation Administration, Washington, D.C.
SATELLITE COMMUNICATIONS, NAVIGATION AND SURVEILLANCE
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 1-13
Avail: NTIS

Aeronautical services via satellites are discussed as to ways in which the feasibility, method, and cost of providing such services affect short and long term objectives, to what extent the FAA should pursue this area and what relative priority should be assigned, the operational need, and the cost/benefit factors. Development of both VHF and L-band technology is considered, along with the possibilities of a hybrid configuration. The proposed development program for the aeronautical satellite system and the near term requirement plan are included. P.A.B.

N70-41528# Federal Aviation Administration, Washington, D.C.
FACILITY ESTABLISHMENT CRITERIA
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 15-19
Avail: NTIS

The extent to which establishment criteria should incorporate number of people served, number of operations, type of mission, or type of use is investigated, along with the programs the FAA should follow to develop criteria changes. Specific recommendations include the use of seat capacity as the basis of the criteria, the revision of VORTAC airway structure to a modified grid plan founded on area navigation use, criteria proposals for the air traffic control tower, federal funding uses, joint military/civil use of airport facilities, and the establishment of a permanent joint

Government/industry advisory council for long range planning purposes. A specific example concerning instrument landing system criteria development is presented. P.A.B.

N70-41529# Federal Aviation Administration, Washington, D.C.
IMPLEMENTATION OF 50 kHz/Y CHANNELS FOR ILS/VOR/DME
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 21-26
Avail: NTIS

The implementation of a 50 kHz frequency separation standard is considered with regard to the following questions: the extent to which the operations of general aviation and the air carriers might be adversely affected, the ability of the avionics industry to provide reasonably priced equipment in sufficient quantities, and whether or not compatible modes of operation will exist so as not to obsolete present equipment. The need for such channel splitting, as a result of a growing demand for navigational aids, is discussed. Specific recommendations concerning the manner of implementation and long range coordinate planning are presented. A proposed schedule of events up to 1973 is included. P.A.B.

N70-41530# Federal Aviation Administration, Washington, D.C.
FAA SERVICES AT NON-PUBLICLY OWNED AIRPORTS
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 27-36
Avail: NTIS

Federal policy relative to facility establishment and operation at privately owned, public use airports is examined. Eligible FAA services, current policy for implementing the servies, and the scope of the four related federal programs are presented in graphical form. Considerations in airport development, the non-federal Navaid program, state airports, and the use of part-time facilities to support high peaks of activity are discussed. The need for a policy review is recognized; a chart showing anticipated timing and steps involved in developing a policy change is included. P.A.B.

N70-41531# Federal Aviation Administration, Washington, D.C.
FLIGHT INSPECTION SYSTEM
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 37-39
Avail: NTIS

The current status of the flight inspection program and its effectiveness are considered. Inspection and monitoring of the performance of navigation systems and of air traffic control facilities, through ground based facilities or through a combination of air and ground methods, are discussed. The need for facility accuracy and reliability is stressed. The establishment of a FAA-industry study group is noted. P.A.B.

N70-41532# Federal Aviation Administration, Washington, D.C.
REDUCED TERMINAL IFR SEPARATION
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 41-47
Avail: NTIS

Reduction of the present three mile IFR separation standards and/or the spacing between parallel runways, as a means of increasing capacity, is considered. The necessity for increased precision in establishing the desired flight paths and desired performance profiles, in adhering to these specifications, and in monitoring and taking corrective actions is noted. Plans and programs translating these objectives to subsystem functions are mentioned, along with program relating to system capacity and demand, multiple runway configurations, sequencing and spacing, and wake turbulence. Estimations of risk associated with the procedural changes, possible differences between theory and practice, the use of an airborne cockpit display to aid the pilot, segregation of traffic flow, and the need for guidance concerning the types of equipment needed to reduce runway separation are discussed. P.A.B.

N70-41533# Federal Aviation Administration, Washington, D.C.
CONTROL ZONES FOR INSTRUMENT APPROACHES
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 49-52
Avail: NTIS

The practicality and economic feasibility of establishing control zones at all locations with approved instrument approach procedures are considered. Possible safety benefits involved, the effect on users, and the possibility of other alternatives are discussed. Comments concerning weather reporting and communications requirements and costs, possible solutions to collision potential in terminal airspace, the need for education programs to increase safety, and a recommended restructuring of airspace categories are included. P.A.B.

N70-41534# Federal Aviation Administration, Washington, D.C.
GENERAL AVIATION DATA SYSTEMS
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 53-55
Avail: NTIS

The adequacy of current programs to provide meaningful general aviation data, their use as a base for future systems planning, and the willingness of the community to support the necessary expanded data programs are discussed. Policy and objectives in data system development are considered, in the areas of airports, airmen, aircraft, air traffic, and safety information. The need for a nationwide FAA-state aviation data collection program is suggested. P.A.B.

N70-41535# Federal Aviation Administration, Washington, D.C.
COLLISION AVOIDANCE
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 57-67
Avail: NTIS

Systems available for collision prevention are considered as to the development and function of each, the user needs they satisfy, the impact they have on the air traffic control system, the implementation and operational problems they create, and the role the FAA should play regarding funding priority, standards, and regulatory action. The four areas discussed are: (1) conspicuity enhancement (CE); (2) pilot warning instrument (PWI); (3) collision avoidance system (CAS); and (4) intermittent positive control (IPC). P.A.B.

N70-41536# Federal Aviation Administration, Washington, D.C.
INCREASED ENROUTE CAPACITY THROUGH INCREASED SECTORIZATION
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 69-72
Avail: NTIS

The agency's plan to increase the number of control sectors is presented and discussed with regard to its viability, and possible alternative solutions for accommodating the growth in air traffic are considered. Basic deficiencies in enroute communications systems are mentioned, along with a possible new and improved system.

Intermediate and long-range actions are suggested for increasing the controller's ability to handle increased traffic loads without decreasing sector size, with the ultimate aim of increasing the sector size as the controller's productivity increases. The determination of sectorization by mathematical analysis and the application of automation to the solution of air traffic problems are also discussed. P.A.B.

N70-41537# Federal Aviation Administration, Washington, D.C.
AIRPORT/AIRWAY COST ALLOCATION STUDY
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 73-77
Avail: NTIS

The cost allocation study, as specified in the Bill H.R. 14465, is discussed with reference to the language of the legislative provisions, current estimates of airport and airway expenditures, procedures for government/industry consultation in conducting the study, and the study scope and content. The ten-year funding requirement and the trust fund provisions contained in the legislation are considered. Coordination of the work statement with other interested government agencies and immediate establishment of a government/industry working group are recommended. P.A.B.

N70-41538# Federal Aviation Administration, Washington, D.C.
ATC DATA ACQUISITION CONCEPT
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 79-95
Avail: NTIS

Policy and plans for developing data acquisition capabilities are investigated in the areas of (1) the upgraded beacon system, (2) application of time frequency (TIF), and (3) the use of satellite based air traffic control systems. The current R and D program is divided into a mainstream development activity for upgrading the beacon system and into system analysis studies and feasibility experiments for the possible other system candidates. The time frame into which a satellite based system could be put into operation, the issues associated with T/F systems, DOD suggestions, airline requirements, and pilot opinions are discussed. Studies of the recommendations made by the Air Traffic Control Advisory Committee are considered with reference to the assumptions made in the systems model, the environments postulated, and the conclusions reached. A digital system of position determination, consisting of a receiver, a clock driven by a fairly precise oscillator, and an airborne pulse transmitter, is described, and its advantages noted. P.A.B.

N70-41539# Federal Aviation Administration, Washington, D.C.
THE EVOLUTION OF STOL/VTOL SYSTEMS
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 97-113
Avail: NTIS

Federal government policies, plans, and priorities for the evolutionary development of a STOL/VTOL city-center transportation system, as part of a balanced national air transportation system, are considered. Specific actions are suggested, such as the establishment of a V/STOL national goal, the use of the Northeast Corridor Project study to reevaluate current policies, the need for a fully coordinated STOL system definition, and provision of V/STOL services and facilities at all hub airports. Support of at least a 12 month STOL demonstration program is proposed. Time schedule charts concerning economic studies, R and D activities, certification, and STOLport design requirements and criteria are included. P.A.B.

N70-41540# Federal Aviation Administration, Washington, D.C.
AIRPORT CLASSIFICATION AND CERTIFICATION
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 115-132
Avail: NTIS

The imposition of minimum airport safety standards is considered; the pros and cons of airport certification and inspection are discussed. It is stated that, since certification is incorporated in the Airport/Airways Development and Revenue Act, it will be enacted. With respect to the proposed airport classification system, several alternate suggestions are presented. Charts concerning these suggested systems, a regional classification category with a validation matrix, and estimated travel times with respect to regional airport development are included. A more aggressive federal role in airport planning and siting is recommended. P.A.B.

N70-41541# Federal Aviation Administration, Washington, D.C.
NEW GENERATION ILS
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 133 139
Avail: NTIS

The urgency of a replacement for the current instrument landing system and the best method of an evolutionary transition are investigated. The FAA's future development and implementation plans are described, following the conclusion that a microwave system with different modulation techniques will be required. Comments are presented concerning the development of a precision guidance system concept for approach and landing and of an associated signal structure, airline requirements for a replacement ILS, military developments in microwave ILS, development needs in cockpit instrumentation, and management of the transition phase. Implementation and use of conventional ILS facilities are discussed, including delays in implementation of VHF Category 3A ground facilities, the uses to be made of Category 3A ILS when available, and the compatibility of microwave scanning beam ILS accuracy with 2500 ft runway separation. Specific recommendations include immediate provision of Category 3A capability at an operational airport, work toward agreement on a single microwave ILS signal format applicable for all classes of service, and development of operational procedures to be used with the scanning beam ILS. P.A.B.

N70-41542# Federal Aviation Administration, Washington, D.C.
ENVIRONMENTAL QUALITY
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 141-150
Avail: NTIS

Aircraft noise and exhaust emission are discussed with reference to means to increase public acceptance of the problem and the extent to which the problem can be resolved with minimum regulation action. Federal efforts in the area of environmental quality are reviewed, along with the associated laws and executive orders. Opinions regarding the cause, effect, and steps necessary to resolve the noise and emission problems are presented, including work on airport regulations, airport planning, takeoff standardization, an engine retrofit program, and other engine design activities. P.A.B.

N70-41543# Federal Aviation Administration, Washington, D.C.
RESEARCH AND DEVELOPMENT PLANNING REVIEW
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 151-153
Avail: NTIS

Research and development efforts are reviewed in the areas of increased airport/airway capacity, improvements in the national

airspace system, the aircraft aspects of aviation safety, and civil aeromedical programs. P.A.B.

N70-41544# Federal Aviation Administration, Washington, D.C.
NATIONAL AVIATION SYSTEM POLICY AND PLAN
In its Natl. Aviation System Planning Rev. Conf. Apr. 1970 p 155–158
Avail: NTIS

Long range planning is reviewed with reference to the national aviation system policy and plan documents. Issues involving flight services, airspace allocation and rules, and airport classification are discussed. Remarks are included on the consultative planning process, specific issue consultative sessions, research and development, and conference planning. Anticipated federal action is described for each issue discussed. P.A.B.

N70-41579* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FOLDABLE CONDUIT Patent
Laurence W. Gertsma and James H. Dunn, inventors (to NASA) Issued 3 Jan. 1967 (Filed 26 Aug. 1963) 4 p Cl. 138-119
(NASA-Case-XLE-00620; US-Patent-3,295,556;
US-Patent-Appl-SN-304698) Avail: US Patent Office CSCL 13M

A description is given of a nonpermanent deforming, foldable conduit capable of spring back into a rigid position as a self-erecting structural member. The conduit has a cross sectional contour defined by opposing arcs with substantially equal radii so that when flattened the contour will provide a fairly uniform stress. Each arc has three changes of curvilinear shape with approximately equal radii, and the two elements are fastened at the ends so that the curvilinear ends are in juxtaposition tangentially at the point of fastening. Some of the suggested applications of the conduit include radiators for space power systems, rigid legs for landing vehicles which are coiled up within the vehicle itself before being deployed prior to landing, and for connecting a nuclear reactor propulsion system to a space vehicle but at a distance from the vehicle. N.E.N.

N70-41586# Princeton Univ., N.J. Gas Dynamics Lab.
RESEARCH ON HYPERSONIC FLOWS Final Report, Sep. 1966 – Sep. 1969
Seymour M. Bogdonoff Wright-Patterson AFB, Ohio ARL Jan. 1970 38 p refs
(Contract F33615-67-C-1065)
(AD-709216; ARL-70-0015) Avail: NTIS CSCL 20/4

The research, both theoretical and experimental, was centered around three basic areas: (a) hypersonic flows, both inviscid and viscous, (b) hypersonic low density flows extending from classical boundary layer problems at low Reynolds number to conditions where the flow may no longer be considered continuum and including ionized gas problems, and (c) studies of separated flows which included details of the separation and reattachment phenomena over a wide range of Mach and Reynolds number. For the major studies which have been completed and published, brief resumes are presented detailing the important results. For the studies which are still in progress or completed only in the preliminary phases, the results obtained thus far and plans for continuation are presented. Author (TAB)

N70-41589* Martin Marietta Corp., Baltimore, Md.
LANDING GEAR Patent
Russell L. Hopping, William R. Forlifer, and Robert P. Gaston, Jr., inventors (to NASA) Issued 3 Jan. 1967 (Filed 10 Nov. 1964) 8 p Cl. 244-100 Sponsored by NASA
(NASA-Case-XMF-01174; US-Patent-3,295,798;
US-Patent-Appl-SN-410331) Avail: US Patent Office CSCL 01C

A landing gear system for vertically descending flight vehicles is described which is applicable to rough as well as smooth surfaces. Energy absorbing struts, arranged in diametrically opposed pairs, are adapted to extend from the vehicle to make initial contact with the landing surface. Each strut is free to slidably retract upon contact. Electrical switches, associated with each pair of struts to actuate a locking means, are series connected so that any given strut is not actuated until its opposed strut has contacted the landing surface. The system assures that the landing forces transferred from the struts to the vehicle are always balanced symmetrically with respect to the vertical axis of the vehicle. The landing may be effected safely even on a sloping surface. P.A.B.

N70-41595# Technische Univ., Berlin (West Germany). Fakultaet fuer Bauingenieurwesen.
DISTANCE REQUIREMENTS DURING TAKEOFFS AND LANDINGS [LAENGENBEDARF BEI STARTS UND LANDUNGEN]
Guenther Bentfeld (Ph.D. Thesis) Mar. 1968 141 p refs In GERMAN
Avail: NTIS

The distances of the takeoff and landing runs, the spacing of the liftoff and touchdown points, and aircraft speed on the runways were investigated with respect to differences in classification of standard runway lengths and distance requirements. Factors considered in clarification of the problem are international standards for classification of airports, formulas by which takeoff distances can be approximately calculated or takeoff motion can be presented in discrete steps, performance nomographs for those aircraft travelling the longest distances, and observational results of takeoff and landing distance requirements in actual operations. The measurement techniques used in the study are described and recommendations are made for additional studies with respect to the changes brought about by increased introduction of jet aircraft into civil aviation. Transl. by R.B.

N70-41602# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
EVALUATION OF SOIL STRENGTH OF UNSURFACED FORWARD-AREA AIRFIELDS BY USE OF GROUND VEHICLES Final Report
George M. Hammitt, II May 1970 46 p refs *Its* Misc. Paper No. S-70-14
(AD-709589) Avail: NTIS CSCL 1/5

The report describes a method for rapidly determining the soil strength at forward-area airfields. Soil strength indications are determined by measuring rut depths created by traffic of standard military ground vehicles. Initially, an office study was conducted that established the potential of such a method. Then limited field verification tests were conducted with four standard military ground vehicles operated on a prepared unsurfaced heavy clay subgrade. First-pass rut depths were measured for each vehicle operated empty and with maximum cross-country loading. The results of this testing indicated the feasibility of predicting soil strength based on one-pass rut depth caused by military ground vehicles. Author (TAB)

N70-41630* Ryan Aeronautical Co., San Diego, Calif.
WING DEPLOYMENT METHOD AND APPARATUS Patent
John Dale Sutliff, inventor (to NASA) Issued 31 Jan. 1967 (Filed 28 Jan. 1965) 6 p Cl. 244-138 Sponsored by NASA

(NASA-Case-XMS-00907; US-Patent-3,301,511; US-Patent-Appl-SN-428890) Avail: US Patent Office CSCL 01C

A deployment method is described in which a flexible wing glider is pulled from its housing in a space vehicle by a pilot chute and then sequentially opened in a controlled and predetermined series of steps until full aerodynamic form is reached, each step occurring with a minimal amount of impact and loading on the system. A mechanism is also provided to orient the spacecraft beneath the wing before its full aerodynamic form is reached in order to achieve an optimal guidance and control position immediately upon full deployment. R.B.

N70-41664# Air Force Office of Scientific Research, Arlington, Va.

IS REAL-TIME, ON-LINE OPTIMAL FLIGHT CONTROL FEASIBLE?

Allen D. Dayton Jun. 1970 85 p refs

(AD-709714; AFOSR-70-1379TR) Avail: NTIS CSCL 1/3

The document discusses an edited transcript of a special panel discussion Is Real-Time, On-line Optimal Flight Control Feasible held by the Theory Committee of the American Automatic Control Council on 5 August 1969 in conjunction with the 1969 Joint Automatic Control Conference, at Boulder, Colorado. The panel considered the problems associated with controlling an aircraft in such a way as to optimize some performance criterion. Specific subjects discussed include optimization theory and techniques, aerospace computer technology, and numerical procedures. A description of a current NASA project in this area is presented. Comments from the audience are also presented. Author (TAB)

N70-41721# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.

AERODYNAMIC TESTING ON CONICAL CONFIGURATIONS USING A MAGNETIC SUSPENSION SYSTEM Final Report, 1 Jun. – 30 Oct. 1969

Milan Vlajinac and George D. Gilliam Wright-Patterson AFB, Ohio ARL Apr. 1970 81 p refs

(Contract AF 33(615)-1470)

(AD-709197; TR-162; ARL-70-0067) Avail: NTIS CSCL 14/2

Tests were conducted to obtain the pitch plane static force and moment coefficients on conical models at subsonic speeds using a prototype magnetic suspension system. Similar tests were also conducted on a 10 deg. half angle cone at Mach 4.25. The static data obtained are presented and were conducted to obtain the damping in pitch coefficients at both subsonic and supersonic speeds. Although the results of these tests were inconclusive, a discussion of the technique used and recommendations for future testing are presented. Author (TAB)

N70-41732# General Dynamics/Convair, San Diego, Calif.

FLOW OVER AIRFOILS IN THE TRANSONIC REGIME. VOLUME 1: PREDICTION OF BUFFET ONSET Final Technical Report, 15 Nov. 1968 – 12 Dec. 1969

Richard Magnus and Hideo Yoshihara 1 Mar. 1970 58 p refs

(Contract F33615-69-C-1180)

(AD-709377; AFFDL-TR-70-16-Vol-1) Avail: NTIS CSCL 1/3

The report is concerned with the calculations of the viscous supercritical flow over planar airfoils, and in particular with the prediction of buffet onset using as a criterion the pressure divergence at the trailing edge. To determine the above flow an iterative procedure is considered in which the initial approximation is obtained by quasi-decoupling the boundary layer flow from the outer inviscid flow. The steady inviscid flow is then calculated by an unsteady finite difference method, in which the desired steady flow is obtained as the asymptotic flow at large times. The inviscid procedure is then applied to two examples with satisfactory results. For the treatment of the boundary layer, the initial laminar portion, and the transition zone are calculated in a conventional way, and an integral procedure based upon the continuity and streamwise momentum equations is suggested for the turbulent portion, containing the shock-induced separation, and for the wake, in which specific empirical input is required. Author (TAB)

N70-41733# General Dynamics/Convair, San Diego, Calif.

FLOW OVER AIRFOILS IN THE TRANSONIC REGIME. VOLUME 2: COMPUTER PROGRAMS Final Report, 15 Nov. 1968 – 12 Dec. 1969

Richard J. Magnus and William H. Gallaher 1 Mar. 1970 362 p refs

(Contract F33615-69-C-1180)

(AD-709378; AFFDL-TR-70-16-Vol-2) Avail: NTIS CSCL 1/3

Digital computer programs for solving two problems are described. The first is for calculating planar inviscid transonic flow over an airfoil by a finite difference method and the second is for calculating the boundary layer on an airfoil for an arbitrary surface velocity distribution by an integral method. The report contains descriptions of the programs and subroutines, program listings and flow charts, and discussion of some of the program features. Author (TAB)

N70-41734# Aeronautical Center, Oklahoma City, Okla.

AVIATION TECHNICAL ASSISTANCE TO PANAMA MARCH/OCTOBER 1969 (ANNEXES A THROUGH D)

[1970] 133 p refs

(AC-70-3187) Avail: NTIS

Four departments in the Directorate of Civil Aeronautics are discussed: (1) the Air Safety Department, (2) Air Traffic Department, (3) Airports Department, and (4) Air Transport Department. Within the Air Safety Department, the flight operations division and aircraft maintenance division are described as to mission, job functions and associated reference material, staffing, and training. In the Air Traffic Department, the air traffic service division and communications and navigation aids maintenance division are explained. A plan for the installation of aeronautical telecommunication facilities between the international Tocumen airport and other Panamanian airports is reprinted, including data on the basic operational requirements and basic technical factors. The Airports Department is discussed with reference to mission, organization and staffing, terminal buildings, training, maintenance and construction, and records system. Important airport development projects are listed. The authorized creation of the Air Transport Department is treated with regard to planned mission; proposed reports, regulations, and laws; present and proposed organization; and international route policy recommendations. P.A.B.

N70-41741# Advisory Group for Aerospace Research and Development, Paris (France).

THE 30TH MEETING OF THE STRUCTURES AND MATERIALS PANEL: SUMMARY RECORD

May 1970 139 p refs Conf. at Athens, 5 – 10 Apr. 1970

Avail: NTIS

A summary is presented of panel meetings on structures and materials, including unsteady aerodynamics, design in brittle materials, composite materials, stress corrosion cracking, electrical conductance of aircraft, acoustic fatigue, fracture mechanics of metallic materials, high temperature testing, and nondestructive inspection methods. R.B.

N70-41750# Inter-Controls, Inc., Washington, D.C.
ENGINE CONTROL SYSTEMS STUDY AS APPLIED TO INTER-ENGINE THRUST CONTROL
Andrew N. Parras and Paul W. Hughett Jan. 1970 247 p refs
(Contract N00019-68-C-0117)
(AD-709411) Avail: NTIS CSCL 21/5

VTOL type aircraft incorporating turbo-fan engines as lifting means do not sensibly lend themselves to the cross-coupling provisions inherently available with the shafting of propeller type engines. An engine failure in the fan engine case is therefore a considerably more precarious matter for which provision for thrust compensation more responsive than a pilot would appear to be required. The study utilizes a very comprehensive hybrid simulation of the WTF-60 engine wherein all engine components are simulated on a performance map basis thereby including all non-linearities as well as permitting the availability of any and all engine parameters for use as controlled variables operating in conjunction with the manipulated variable, fuel flow. Further, realistic acceleration control in the course of large upsets is accomplished thereby permitting a control system analysis which is completely applicable to the detail design of the control system and the selection of components. Author (TAB)

N70-41782# Joint Economic Committee (U.S. Congress).
ECONOMIC ANALYSIS AND THE EFFICIENCY OF GOVERNMENT. PART 4: SUPERSONIC TRANSPORT DEVELOPMENT From the Subcommittee on Economy in Government
Washington GPO 1970 145 p refs Hearings before the Joint Econ. Comm., 91st Congr., 2d Sess., and 11-12 May 1970
Avail: SOD $0.60

Testimony concerning the development of supersonic transports is presented. Cost analysis, potential demand, and financial arrangements for the production of the SST and 747 are discussed. Sonic boom, air pollution, weather changes, and airport noise are considered as well as banning of the Concorde and SST. Economics and national defense implications of the SST are also covered. Correspondence is appended. J.M.

N70-41812* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
DISCRETE LOCAL ALTITUDE SENSING DEVICE Patent
Carlisle C. Campbell, Jr., Joseph A. Chandler, and Thomas M. Grubbs, inventors (to NASA) Issued 7 Feb. 1967 (Filed 23 Dec. 1965) 6 p Cl. 200-61.45
(NASA-Case-XMS-03792; US-Patent-3,303,304;
US-Patent-Appl-SN-516159) Avail: US Patent Office CSCL 01D

A device for use with descending space vehicles as an altitude sensor is described for detecting a predetermined discrete altitude for transmitting a firing signal to the vehicle retrorocket system for reducing the vertical velocity to safe landing speeds on land surfaces. The sensor is deployed by dropping it beneath the vehicle after the parachutes have opened. The length of conduit for holding a hemispherical bumper containing a multiplicity of switches depends on the altitude desired for retrorocket actuation, which occurs upon impact of the bumper with the landing surface. F.O.S.

N70-41863* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLEXIBLE WING DEPLOYMENT DEVICE Patent
Charles E. Libbey, inventor (to NASA) Issued 22 Nov. 1966 (Filed 30 Jun. 1964) 8 p Cl. 244-16
(NASA-Case-XLA-01220; US-Patent-3,286,957;
US-Patent-Appl-SN-379417) Avail: US Patent Office CSCL 01C

A deployment system for a flexible wing with a rigid superstructure is described. The wing has a generally delta shaped planform and includes a nose section, keel, and leading edge members. The leading edge members are hinged to the nose so that they may fold back against the keel. The keel and leading edge members are constructed of telescoping sleeves which are collapsible for packaging and are self-locking upon extension. The telescoping sections of the keel and leading edge members are extended sequentially by a drogue parachute and deployment line severing mechanism. R.B.

N70-41882# National Aeronautical Lab., Bangalore (India).
SPLINE APPROXIMATION AS APPLIED TO AERONAUTICAL PROBLEMS
P. Ramamoorthy and C. L. Narayana Nov. 1969 22 p refs
(NAL-TN-20) Avail: NTIS

A method based on spline approximation is presented for problems of interpolation in aeronautics. This method is programmed for the NAL Sirus computer, and is very reliable compared with existing methods. Analysis of pressure data obtained from wind tunnel testing on wing models or determination of the boundary layer characteristics from a known pressure distribution on an aerofoil are among the problems to which this method is applied. Author

N70-41883# National Aeronautical Lab., Bangalore (India).
A MODIFIED MULTHOPP'S LIFTING SURFACE THEORY AS PROGRAMMED FOR THE NAL SIRIUS COMPUTER
P. Ramamoorthy and C. L. Narayana Oct. 1969 34 p refs
(NAL-TN-17) Avail: NTIS

A modified version of Multhopp's lifting surface theory, programmed for NAL Sirius computer, is presented. Aerodynamic characteristics are determined for a number of composite planforms and compared with those existing in the literature. Some interesting comparisons are made with the results obtained from electrical analog methods. The method is also applied to cambered wings and gives excellent results. Author

N70-41884*# Translation Consultants, Ltd., Arlington, Va.
OPERATIONAL AIR TRAFFIC CONTROL CONSIDERING SEVERAL OPTIMALITY CRITERIA [OPERATIVNOYE UPRAVLENIYE VOZDUSHNYM DVIZHENIYEM S UCHETOM NESKOLKIKH KRITERIYEV OPTIMALNOSTI]
A. I. Volevach et al Washington NASA Oct. 1970 11 p refs Transl. into ENGLISH from the publ. 'Slozhnye Sistemy Upravleniya' Kiev, Naukova Dumka Press, 1969 p 36-43
(Contract NASw-2038)
(NASA-TT-F-13276) Avail: NTIS CSCL 01E

Development of a two level system of air traffic control, which avoids conflicts between aircraft on the runway and in flight and which minimizes deviations from the prescribed landing times, is described. The problem of avoiding conflict between aircraft during flight is reduced to making a complex decision with allowance for several optimality criteria and for a limited number of control inputs. An algorithm for selecting the control parameter on the basis of compromises is proposed. Author

N70-41942*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE L-BAND AIR-TRAFFIC CONTROL SATELLITE SIMULATION EXPERIMENT USING BALLOONS
Jayaram Ramasastry Jul. 1970 54 p refs
(NASA-TM-X-65348; X-551-70-306) Avail: NTIS CSCL 09E

High altitude balloons are used to simulate satellite experiments to obtain data concerning signal multipath, RF noise background, antenna gain factors, and L-band system performance. The data obtained will be used in the design of a preoperational satellite system for air traffic control. The balloon experiment will also satisfy the need for data that cannot be obtained by a satellite experiment. Author

N70-41958*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FERRY SYSTEM Patent Application
Thomas A. Blackstock, inventor (to NASA) 24 Aug. 1970 9 p
(NASA-Case-LAR-10574-1; US-Patent-Appl-SN-66206) Avail: NTIS CSCL 01E

An auxiliary lift system to provide a means of transportation for large lifting entry vehicles is described. A bolt-on ferry package is provided which includes a body member adapted to be received by and connected to the entry vehicle. A pair of swept wings extend from the body member with at least one propulsion engine being attached to each wing. Fuel tanks for the propulsion engines are formed within the wings and body member. The ferry system is calculated to permit transportation of the HL-10 lifting vehicle over approximately 1000 miles to thereby provide economical transportation for the vehicle from site of manufacture to launch or from landing site to refurbishment location. NASA

N70-41963*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOME RESULTS OF RECENT RESEARCH ON FAN AND JET NOISE AT LEWIS RESEARCH CENTER
Newell D. Sanders [1970] 16 p refs Proposed for presentation at the 7th Ann. Meeting of the ASME, New York, 30 Nov.–3 Dec. 1970
(NASA-TM-X-52871) Avail: NTIS CSCL 20A

A six-foot-diameter low-speed fan designed for low-noise production was tested to provide data on noise generation, suppression effects of acoustic treatment, and exhaust jet noise. Preliminary results showed that the overall noise varied with the 5.5 power of the fan speed but was independent of blade loading obtained by varying back pressure at constant speed. The low-velocity jet from the fan produced noise that followed the eighth power law and was lower than predicted by extrapolation of the SAE curve. Modifying the SAE method to eliminate the effects of jet density greatly improved the agreement between prediction and data. Author

N70-41975*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TESTS OF A FULL+SCALE ANNULAR RAM-INDUCTION COMBUSTOR FOR A MACH 3 CRUISE TURBOJET ENGINE
Jerrold D. Wear, Porter J. Perkins, and Donald F. Schultz Washington Oct. 1970 46 p refs
(NASA-TN-D-6041; E-5260) Avail: NTIS CSCL 21E

A 40 in. (1.02 m) diameter primary combustor 30 in. (0.76 m) long operated for 325 hours at simulated supersonic flight conditions with no loss in performance. Tests in a component facility were at inlet-air conditions of (1)1150 F (894 K) and 90 psia (62.0 N/sq cm) (Mach 3.0), and (2) 1050 F (839 K) and 60 psia (4.14 N/sq cm) (Mach 2.7), with 2200 F (1478 K) exit temperatures. Some metal burning occurred. At Mach 3.0 conditions, combustion efficiency was 100 percent, pressure loss 7.4 percent, and exit temperature profiles good. Exit temperature pattern factors were 0.19 and 0.29 at Mach 3 and a simulated takeoff, respectively. These performance parameters (as well as altitude relight limits, heat flux, headplate temperatures, response to rapid increase in fuel flow, and exhaust smoke) were measured over a wide range of operating conditions. Author

N70-41978*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TRAFFIC CONTROL SYSTEM AND METHOD Patent Application
Charles R. Laughlin, Roger C. Hollenbaugh, and Walter K. Allen, inventors (to NASA) Filed 18 Jun. 1970 11 p
(NASA-Case-GSC-10087-4; US-Patent-Appl-SN-47440) Avail: NTIS CSCL 17B

A system and method are disclosed for positioning and deriving centralized air traffic control data for communicating via voice and digital signals between a multiplicity of remote aircraft including supersonic transports and a central station, as well as a peripheral ground station (or stations), through a synchronous satellite relay station. Side tone ranging patterns, as well as the digital and voice signals, are modulated on a carrier transmitted from the central station and received on all of the supersonic transports. Each aircraft communicates with the ground stations via a different frequency multiplexed spectrum. Supersonic transport position is derived from a computer at the central station and supplied to a local air traffic controller. Position is determined in response to variable phase information imposed on the side tones at the aircraft, with a plurality of different side tone techniques being employed, and relayed back to the transports. Common to all of the side tone techniques is Doppler compensation for the supersonic transport velocity. NASA

N70-41985# General Accounting Office, Washington, D.C.
POTENTIAL FOR SAVINGS IN AIRCRAFT MAINTENANCE: DEPARTMENT OF THE NAVY AND DEPARTMENT OF THE AIR FORCE B-152600
7 May 1970 37 p
Avail: Issuing Activity

The Army and the Navy spend approximately $5.5 billion annually to keep their aircraft in operation. Previous work revealed a difference in practices and procedures for the two services which initiated a review to evaluate and compare the way the two services schedule maintenance but did not attempt to evaluate the quality or the effectiveness of the maintenance performed. The review included both organizational maintenance performed by the operating units on a day-to-day basis in support of their own operations and depot-level maintenance by a special facility which provides more comprehensive inspection and overhaul. The review is based on the F-4, a supersonic all-weather aircraft. It was found that the Navy could show a savings if it adopted the Air Force practice of using flight hours for performing organizational inspections and maintenance rather than elapse days. Author

N70-42003* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FATIGUE TESTING DEVICE Patent
Eugene C. Naumann and Emmett L. Bryant, inventors (to NASA) Issued 21 Feb. 1967 (Filed 24 Jun. 1964) 13 p Cl. 73–90
(NASA-Case-XLA-02131; US-Patent-3,304,768;
US-Patent - Appl - SN-377777) Avail: US Patent Office CSCL 20K

A fatigue testing machine is described which applies a predetermined load program, consisting of a series of discrete load levels and programmed on a set of punched cards, to a test specimen. The device produces precise loads of any desired magnitude and can be programmed to perform any fatigue test. A group of potentiometers have adjustable sliders so that each potentiometer produces a discrete electrical signal proportional to one of the discrete load levels. Selection of the output of one of the potentiometers involves switching logic and a group of relays. Means for applying a load to the specimen in accordance with an error electrical signal include a hydraulic ram which applies the load, a pump to supply liquid to the ram, and a servo valve connected between the two and controlled by the error signal. The device is particularly applicable to aircraft structural fatigue tests. P.A.B.

N70-42008# Naval Research Lab., Washington, D.C.
METHODS FOR CALCULATING AND ANALYZING INTERROGATION REPETITION FREQUENCY SETS NONSYNCHRONOUS FOR N INTERROGATIONS Interim Report
William K. Gardner 11 Jun. 1970 45 p refs
(AD-709553; NRL-7071) Avail: NTIS CSCL 17/7

A simple means of using a computer to determine sets of nonsynchronous interrogation repetition frequencies was devised and is presented along with some tables of results. When nonsynchronous interrogation repetition frequencies are used, the interrogations from any interrogator can experience no more than one interference per scan from the interrogations transmitted by any other interrogator. Thus, if k interrogators are beamed toward the same transponder, the interrogations from each can experience at most k - 1 interferences per scan. Application of this principle to beacon systems should eliminate lost targets caused by synchronous interference between interrogations. Author (TAB)

N70-42010*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF VARIABLE TURBINE AREA ON SUBSONIC CRUISE PERFORMANCE OF TURBOJETS DESIGNED FOR SUPERSONIC APPLICATION
Arvid L. Keith, Jr. Washington Oct. 1970 64 p refs
(NASA-TN-D-5962; L-7260) Avail: NTIS CSCL 21E

The specific net thrust and specific fuel consumption of simplified turbojet engine cycles were calculated for a wide range of design compressor pressure ratio (4 to 30) and design turbine-entrance temperature (2260 R (1255 K) to 3460 R (1922 K) through a Mach number range from 0 to 3.6. Partial-power performance for engines with both fixed and variable turbine area was determined for Mach numbers from 0 to 1.0. High-pressure-ratio compressors provided significant improvements in specific fuel consumption throughout the Mach number range; however, important losses in specifid thrust occurred at the higher speeds. Turbine area reductions of up to 40 percent resulted in improvements in partial power minimum specific fuel consumptions of from 10 to 45 percent at subsonic speeds. Author

N70-42013# Douglas Aircraft Co., Inc., Long Beach, Calif.
A FLIGHT SIMULATOR STUDY OF STOL TRANSPORT LATERAL CONTROL CHARACTERISTICS Final Report
Douglas E. Drake, Robert A. Berg, Gary L. Teper, and W. Allen Shirley Sep. 1970 123 p refs
(Contract FA69WA-2186)
(FAA-RD-70-61) Avail: NTIS

A systematic investigation was conducted of STOL transport terminal area lateral control characteristics to identify the significant considerations and establish appropriate lateral control criteria. The investigation consisted of an analysis of applicable existing data and a moving-base flight simulator test program using the NASA Ames Research Center S-16 Moving Cab Transport Simulator. The flight simulator program covered a wide range of vehicle aerodynamic and physical characteristics representative of practical STOL transports ranging in size from 25,000 to 130,000 pounds. Author

N70-42016* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DOUBLE HINGED FLAP Patent
Thomas R. Turner, inventor (to NASA) Issued 23 May 1967 (Filed 31 Aug. 1964) 5 p Cl. 244-42
(NASA-Case-XLA-01290; US-Patent-3,321,157; US-Patent-Appl-SN-393451) Avail: US Patent Office CSCL 01C

A mechanism for boundary layer control over a wing having multiple flap segments is described. The flap comprises two segments individually pivoted to the wing and having a narrow slot between the upper segment and the wing. Release of a high pressure fluid from the slot controls the boundary layer and flow separation over the aft portion of the wing surface. Blowing high pressure air from the slot with the flap undeflected reduces separation over the aft portion of the airfoil, resulting in a higher lift-to-drag ratio for more economical cruising. Blowing air from the same slot with the flap partially or fully deflected increases the lift for takeoff and landing. R.B.

N70-42020*# Scientific Translation Service, Santa Barbara, Calif.
AERODYNAMICS: AN ASYMPTOTIC STUDY OF PERFECT FLUID FLOWS AROUND WEAKLY LIFTING THREE-DIMENSIONAL BODIES, IN THE SONIC REGIME [AERODYNAMIQUE: ETUDE ASYMPTOTIQUE D'ECOULEMENTS DE FLUIDE PARFAIT AUTOUR DE CORPS TRIDIMENSIONNELS FAIBLEMENT PORTANTS, EN REGIME SONIQUE]
G. Tournemine et al Washington NASA Oct. 1970 8 p refs Transl. into ENGLISH from Compt. Rend., Ser. A (Paris), v. 270, 12 Jan. 1970 p 162-165
(Contract NASw-2035)
(NASA-TT-F-13319) Avail: NTIS CSCL 20D

A method is proposed for sonic flows at a large distance from a weakly lifting three-dimensional body, behind the shock wave. The dominant term is a pseudo-rotational flow defined in a previous report. The existence of a lifting boundary layer is proved at infinity downstream, which thus places the problem within the realm of the theory of singular perturbations. An interior expansion is introduced, and because of the definition of different methods of passing to the limit, the matching principle allows determination of the exponents as well as the behavior of the functions. An expression for the lift is given. Author

N70-42037*# Serendipity, Inc., Sherman Oaks, Calif.
A SIMULATOR STUDY OF FLIGHT MANAGEMENT TASK PERFORMANCE DURING LOW VISIBILITY APPROACH AND LANDING USING BASELINE CATEGORY 2 FLIGHT INSTRUMENTATION
Walter B. Gartner Dec. 1969 153 p refs
(Contract NAS2-4406)
(NASA-CR-73478) Avail: NTIS CSCL 01D

The investigation was focused on the command pilot's ability to judge his approach to the authorized Category 2 minimum decision altitude (100 feet above the runway) and on the effects of various flight path offset conditions at this decision height on his ability to carry out the landing maneuver. Twelve currently active senior airline pilots, individually certified for Category 2 operations, flew a total of 252 approach and landing sequences under simulated Category 2 visibility conditions (1200- and 1600-feet RVR) and data was taken on the accuracy of selected estimates and judgments of the flight situation. The approach sequences were flown under various combinations of three alternative pilot operating procedures and three different flight control modes to determine the effects of these variables on the accuracy of flight progress judgments. The data obtained support the contention that baseline flight instrumentation will be inadequate for accurate monitoring and assessment of the approach to Category 2 operating minimums. Author

N70-42052*# Scientific Translation Service, Santa Barbara, Calif.
CHARACTERISTICS AND POSSIBILITIES OF THE LARGE SONIC WIND TUNNEL AT MODANE-AVRIEUX [CARACTERISTIQUES ET POSSIBILITES DE LA GRANDE

SOUFFLERIE SONIQUE DE MODANE-AVRIEUX]
M. Pierre Washington NASA May 1970 80 p refs Transl. into ENGLISH of French report ONERA-NT-134
(Contract NASw-2035)
(NASA-TT-F-12986; ONERA-NT-134) Avail: NTIS CSCL 14B

The characteristics of the 80,000 kW, 8-meter wind tunnel, are presented, as well as the various model installations and the numerous measuring devices, which are permanently developed and multiplied. The tests already carried out are summarily examined, they include conventional aerodynamic measurements, motorized tests with the engines actually running or simulated by air jets, propeller and rotor tests, canopy ejection, habitability without canopy, visibility in the rain and icing and deicing tests. Author

N70-42087*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF AIR-CUSHION MODELS AT VERY LOW GROUND CLEARANCES AND AT FREE-STREAM DYNAMIC PRESSURES EXCEEDING CUSHION PRESSURE
Kalman J. Grunwald and William G. Johnson, Jr. Washington, D.C. Oct. 1970 128 p refs
(NASA-TN-D-6011; L-7369) Avail: NTIS CSCL 20D

Air cushion models employing peripheral jet and plenum cushions of circular, rectangular, and side-by-side planforms were tested in hovering and at forward speed in the 17-foot (5.18-meter) test section of a 300-MPH 7- by 10-foot tunnel. The principal purpose of these tests was to study the characteristics of air cushions when free stream dynamic pressure exceeded air-cushion pressure. Also examined were the hovering performance and the effects of moving ground belt, crosswind, height, and angle of attack. For the configurations tested, there was no significant loss in cushion performance when free stream dynamic pressure exceeded cushion pressure. Author

N70-42113# Grumman Aerospace Corp., Bethpage, N.Y. Fluid Mechanics Section.
EXPLORATORY TESTS USING TEMPERATURE-SENSITIVE PAINTS TO OBTAIN HYPERSONIC HEAT TRANSFER DATA ON SPHERES AND ON FIN-PLATE MODELS
Louis G. Kaufman, II, Jarvis Leng, and Arnold R. Johnson Sep. 1970 44 p refs
(RN-487) Avail: NTIS

Paints that melt at a known temperature were sprayed on Teflon models, which were tested in a Mach 8 wind tunnel. The propagation of the melt line, recorded by motion picture cameras, was used to calculate heating rate distributions. These generally agreed with theoretical heating rate distributions for hemispheres, and gave results in fair agreement with other fin-plate experimental results. The paint indicated quite well the location of maximum heating at shock impingement; the accuracy of the peak heating rate depended on its magnitude and on the phase change temperature paint chosen. Author

N70-42136*# Translation Consultants, Ltd., Arlington, Va.
EXPLICIT SCHEMES OF THE LOCATION METHOD IN THE PROBLEM OF SUPERSONIC FLOWS AROUND A BLUNT BODY [O YAVNYKH SKHEMAKH METODA USTANOVLENIYA V ZADACHE SUERKHZVUKOVOGO OBTEKANIYA ZATUPLENNOGO TELA]
A. P. Kosykh et al Washington NASA Oct. 1970 11 p refs Transl. into ENGLISH from Z. Vychislitelnoi Mat. i Mat. Fiz. (Moscow), v. 10, no. 2, 1970 p 514–520
(Contract NASw-2038)
(NASA-TT-F-13230) Avail: NTIS CSCL 20D

Various schemes of the location method in computing supersonic flows around a blunt body are discussed and compared. Indirect methods indicated low accuracies in the computations, and a comparison of computations using the direct method for three schemes of the integral relation method, the line method, and the location method indicated good agreement of results obtained. Author

N70-42151# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
BIBLIOGRAPHY: NUMBERED REPORTS AND THESES, AERONAUTICAL ENGINEERING AND AEROSPACE AND MECHANICAL SCIENCES, PRINCETON UNIVERSITY, 1947–1970
Alan F. Cook, Sr. Jun. 1970 223 p refs
(AD-709351) Avail: NTIS CSCL 1/2

Reports and theses are listed by identification number, author, title, price and availability. TAB

N70-42168*# Southampton Univ. (England). Inst. of Sound and Vibration Research.
THE TRANSMISSION OF SONIC BOOM SIGNALS INTO ROOMS THROUGH OPEN WINDOWS. PART 2: THE TIME DOMAIN SOLUTIONS
P. G. Vaidya [1970] 59 p refs
(Grant NGR-52-025-003)
(NASA-CR-111787) Avail: NTIS CSCL 20A

The time domain extensions of results previously reported are investigated. Expressions for pressure fields inside rooms due to a delta impulse type excitation were obtained, both by using a normal mode type approach and by using a Helmholtz resonator analogy. The results are applied to the specific case of 'N'-wave type excitations. Author

N70-42174*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL HEAT TRANSFER AND FLOW RESULTS FROM AN AIR-COOLED PLUG NOZZLE SYSTEM
John S. Clark, Edwin J. Graber, and David M. Straight Sep. 1970 63 p refs
(NASA-TM-X-52897) Avail: NTIS CSCL 21H

An air-cooled plug type nozzle system was built and tested on an afterburning turbojet engine. Three and one-half percent of the engine primary airflow, taken from the compressor discharge ports, was used to cool the plug and supporting struts. Exhaust gas temperatures up to 3350 R (1860 K) were successfully run. Extrapolation of the wall temperature data to the average design hot gas temperature of 3500 R (1945 K) indicates that maximum wall temperatures could be maintained below about 2040 R (1133 K). Author

N70-42182*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LASER NET: A SYSTEM FOR MONITORING WINGTIP VORTICES ON RUNWAYS
B. H. Funk and K. D. Johnston 3 Jun. 1970 26 p refs
(NASA-TM-X-64525) Avail: NTIS CSCL 20E

A laser schlieren method is proposed which potentially provides a means for monitoring the strength of vortex wakes on and near runways. The method could provide a gross, continuous assessment of the intensity of disturbances over airport runways and aircraft carriers. Preliminary measurements behind a wingtip

mounted on the wall of a small subsonic wind tunnel indicate that wingtip vortices are readily detectable with this simple system. Author

N70-42183*# Lockheed-Georgia Co., Marietta.
AN APPLICATIONS STUDY OF ADVANCED COMPOSITE MATERIALS TO THE C-130 CENTER WING BOX
P. H. Petit [1970] 160 p refs
(Contract NAS1-9540)
(NASA-CR-66979) Avail: NTIS CSCL 11D

An application study of advanced filamentary composite materials to the C-130 center wing box was performed. The study included three design approaches: (1) composite reinforcement of the existing box while installed on the aircraft, (2) composite reinforcement during fabrication in accordance with a new design, and (3) an all composite design. Consideration of cost, manufacturing feasibility and reliability led to the choice of approach (2). This particular approach enabled a 13 percent weight savings with boron/epoxy reinforcement of aluminum as compared to the current aluminum design. Cost of the composite material largely determined the increased cost over that of the current aluminum design. Preliminary fatigue analysis indicated the life of the composite reinforced box equal to or greater than that of the current aluminum box. A demonstration program designed to provide flight experience for two C-130 aircraft equipped with composite reinforced center wing structure is outlined. Author

N70-42217# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
THE EFFECTS OF TEMPORAL AND SPECTRAL COMBINATIONS ON THE JUDGED NOISINESS OF AIRCRAFT SOUNDS Final Report
Karl S. Pearsons and Ricarda L. Bennett Jun. 1969 81 p refs
(Contract FA68WA-1978)
(FAA-NO-69-3) Avail: NTIS

Three test series were performed in an anechoic chamber using 20 college students to determine the judged noisiness of stimuli varying both temporally and spectrally. The first test series used 30 stimuli with 6 time patterns and 5 spectra. The second test used stimuli selected from the first test but modified to include signal durations ranging from 1 to 100 seconds. Duration in this case is the amount of time the stimuli were within 10 db of the maximum level. The stimuli for the third test consisted of recordings of turboprop, turbofan, turbojet, and helicopter flyovers. The results indicate that the most accurate predictor of the judged noisiness is perceived noise level using a tone correction and an integrated measure of duration. To illustrate the improvement in noisiness predicability of EPNL over PNL, the results of the duration test are used. For this test, 75% of the data was within 4 db of the standard for EPNL with the FAA tone and integrated duration measure as compared to 11 db for PNL. Author

N70-42218# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
NOISE EXPOSURE FORECASTS: EVOLUTION, EVALUATION, EXTENSIONS, AND LAND USE INTERPRETATIONS Final Report
William J. Galloway and Dwight E. Bishop Aug. 1970 79 p refs
(Contract FA-68-WA-1900)
(FAA-NO-70-9) Avail: NTIS

The evolution is described of methods for relating aircraft noise exposure to community response, starting with the original Composite Noise Rating (CNR) concept. The development of CNR procedures for civil and military aircraft utilizing perceived noise level contours and the development of Noise Exposure Forecast (NEF) procedures utilizing effective perceived noise level data are compared. The CNR and NEF procedures are also related to various noise exposure indices developed in other countries. Cross comparisons of the indices allows verification of the numerical values and descriptors used in the CNR and NEF zones for land uses. The noise exposure due to aircraft operations is interpreted as expressed in NEF values, in terms of estimated impact on land uses. Assessments of the land use compatibility with aircraft noise as a function of NEF values are given for land uses provide guides in land use planning, zoning, development, and building construction. To provide for flexibility in setting descriptor limits to fit particular local conditions, the NEF values of the compatibility descriptors boundaries overlap, providing a range of NEF values where boundary limits may be modified by local considerations. Author

N70-42219# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
NOISE EXPOSURE FORECAST CONTOURS FOR 1967, 1970, AND 1975 OPERATIONS AT SELECTED AIRPORTS Final Report
Dwight E. Bishop and Myles A. Simpson Sep. 1970 269 p refs
(Contract FA-68-WA-1900)
(FAA-NO-70-8) Avail: NTIS

Noise Exposure Forecast (NEF) contours resulting from 1967, 1970, and 1975 aircraft operations are depicted for 28 airports. Included are contours for large, medium, and small commercial airports, and general aviation airports. The NEF contours define land areas having different land-use compatibility with respect to aircraft noise; hence, the NEF areas may be used as a guide to land-use planning and zoning and airport development. The NEF contours are based upon the aircraft noise described in terms of effective perceived noise levels (which includes corrections for duration and presence of discrete frequencies) plus adjustments for the number of operations for day-time and nighttime periods. Author

N70-42286# Norges Tekniske Hoegskole, Trondheim. Institutt for Flyteknikk.
WEIGHT OPTIMIZATION OF STRUCTURAL SANDWICH PANELS Final Technical Report, Jun. 1969–Jun. 1970
J. Lockwood Taylor Jun. 1970 47 p refs
(Contract DAJA37-69-C-1224)
(AD-709656; E-1404) Avail: NTIS CSCL 13/13

The report covers the application of a simple method, primarily numerical, to the problem of the optimum design of structural sandwich panels of several types and several materials. Compression and shear loading on flat panels and compression on curved panels have been considered. Including variation of panel proportions, four basic cases are studied for four different face materials, two grades of Al alloy, Ti alloy and stainless steel. The core properties assumed are those appropriate to metal honeycomb. The effect of varying core density is allowed for where such variation seems necessary in order to prevent skin wrinkling of the alternative panel designs whose weight is being compared, subject to an assumed overriding minimum practicable density. The weight penalty arising from increase in core stiffness and density above the minimum differs for different face materials. Author (TAB)

N70-42326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMAL FEASIBILITY OF USING METHANE OR HYDROGEN FUEL FOR DIRECT COOLING OF A FIRST-STAGE TURBINE STATOR
Raymond S. Colladay Washington Oct. 1970 25 p refs
(NASA-TN-D-6042; E-5701) Avail: NTIS CSCL 20M

The feasibility of cooling the first-stage turbine stator directly with cryogenic fuels was investigated based on a numerical

heat transfer analysis of methane and hydrogen-cooled vanes. An insulation barrier between the fuel cooling passages and the external vane surface was required to prevent adverse cooling conditions. The cooling configuration analyzed was that of tubular cooling passages embedded in insulation material surrounded by an outer vane shell. The results indicate that the turbine stator vanes could be adequately cooled with methane or hydrogen fuel at a 2490 F (1639 K) local-hot-spot gas temperature. Author

N70-42338# Colorado State Univ., Fort Collins.
LABORATORY SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER
J. E. Cermak 1 Jul. 1970 13 p refs Presented at 3d Fluid and Plasma Dyn. Conf., Los Angeles, 29 Jun.–1 Jul. 1970 *Its* Paper No. 70-751
(Contract N00014-68-A-0493-0001; Proj. Themis)
(AD-710250) Avail: NTIS CSCL 4/1

Similarity criteria are given for micro-, small-, and meso-scale motion of the atmospheric boundary layer. Requirements for simulation of dispersion of passive contaminants in the atmosphere are discussed. The characteristic features of a unique meteorological wind tunnel having a capability for simulating thermally stratified boundary layers are described. Mean wind speed, mean temperature and turbulence statistics measured in this laboratory facility are found to be similar to corresponding data obtained from measurements in the atmosphere. Examples of simulated dispersion over a variety of surface features including urban areas and complex topography are described. Author (TAB)

N70-42346# Royal Aircraft Establishment, Farnborough (England).
A COMMENTARY UPON AIRCRAFT NAVIGATION SYSTEMS
J. G. Carr and F. S. Stringer Oct. 1969 27 p Presented at the Symp. on Electron. for Civil Aviation, London, Sep. 1969
(RAE-TR-69220) Copyright. Avail: NTIS

Current civil air transport navigation aids are surveyed and it is concluded that a hybrid system, combining two or more dissimilar aids or sensors is desirable. Some of the significant design features and performance characteristics peculiar to the radio sensors chosen for possible inclusion in the hybrid are discussed, and the importance of digital management computers and CRT displays in integrated navigation systems is stressed. The experimental programme in a Comet aircraft is described. Author (ESRO)

N70-42365*# General Electric Co., Schenectady, N.Y. Mechanical Engineering Lab.
HEAT TRANSFER ON A FLAT PLATE IN HELIUM AT MACH NUMBERS 67.3 AND 87.6 AND IN HYPERSONIC CORNER FLOW WITH AIR AT MACH NUMBER OF 19
H. T. Nagamatsu, R. E. Sheer, Jr., and W. T. Pettit 7 Aug. 1970 47 p refs
(Contract NASw-1785)
(NASA-CR-114257) Avail: NTIS CSCL 20D

Local surface heat transfer rates were measured with helium at Mach numbers of 67.3 and 86.8. The strong interaction parameter varied from 730 to 16,500 and leading edge Knudsen numbers were 8.39 and 17.1 respectively. Towards the leading edge region the heating rates were much less than the theoretical prediction due to the rarefied flow effects but much greater than the diffuse free molecule limit. The rates in the corner flow region were determined with air at a Mach number of approximately 19. Tests were conducted at rarefied and continuum flow conditions with unit Reynolds numbers of approximately 900 and 29,000 with corresponding leading edge Knudsen numbers of 35 and 1.0. At low density conditions the local heating rates were increased approximately 35 percent in the vicinity of the corner region, but at continuum flow conditions the heat transfer rates were not increased as much as the rarefied hypersonic flow. By comparing the local heat transfer coefficient in the corner flow region with the strong interaction theory, it was possible to determine the corner flow effects on the heating rates. Author

N70-42386# Royal Aircraft Establishment, Farnborough (England).
HYBRID COMPUTER PROGRAMME FOR PARAMETER OPTIMISATION OF FLIGHT CONTROL SYSTEMS
F. R. Gill and A. M. Whitehead Mar. 1970 59 p refs
(RAE-TR-70043) Copyright. Avail: NTIS

A hybrid program for the parameter optimization of flight control systems is described. Hill climbing procedures, with particular reference to gradient methods, were used in its development. The I.L.S. glide-path autopilot mode for the Hunter aircraft with electrically signalled flying controls was used as an example. Author (ESRO)

N70-42404# Federal Aviation Administration, Washington, D.C.
ANTICOLLISION LIGHTS FOR THE SUPERSONIC TRANSPORT (SST)
Siegfried J. Gerathewohl, Everett W. Morris, and Joseph A. Sirkis May 1970 27 p refs
(FAA-AM-70-9) Avail: NTIS

For visual detection at night, the aircraft must display conspicuous light signals to indicate its presence and course at sufficient distance and time remaining for the pilot to avoid a collision. Considerations about the usefulness of anticollision lights must include such factors as effective light intensity, color, flashing characteristics, field of coverage, and visual detection range as well as flying speed, airplane response, and the pilot's capability to avoid a collision. Results of simulator experiments indicate that the pilot can take evasive actions at relatively high closing speeds under daylight conditions, but no data are available about collision avoidance at night. Author

N70-42407# Commerce Dept., Washington, D.C. Business and Defense Services.
WORLD SURVEY OF CIVIL AVIATION: CANADA
GPO Jun. 1970 47 p *Its* Ser. No. 20
Avail: SOD $0.30

A market survey of civil aircraft and aeronautical products is presented with an evaluation of the role of air transportation in Canada. Fleet composition, flight operations, marketing and investment opportunities are discussed. The Canadian aerospace industry, which is the fourth largest in the free world, and the government support furnished the industry are described. The survey is designed to contribute marketing information which will enhance U.S. ability to maintain its position as worldwide leader in the aerospace industry. Author

N70-42428*# Hamilton Standard, Farmington, Conn.
LINEAR AND ANGULAR VIBRATION MEASUREMENT OF V/STOL AIRCRAFT, VOLUME 1 Final Technical Report
D. Isakson Apr. 1970 142 p
(Contract NAS12-2028)
(NASA-CR-110822) Avail: NTIS CSCL 14B

A system for measuring linear and angular vibration environments in V/STOL aircraft was developed. A measured environment was then processed through an error model of a strapdown inertial guidance system and the resulting system errors tabulated. Three main objectives were attained: (1) Design and fabrication of the sensor package and associated electronics. (2) Measurement of the vibration characteristics of a helicopter. (3)

Prediction of the performance of a strapdown inertial system operating in such an environment. The vibration monitor was used to measure vibrations on several flights. The flight tapes were reduced to oscillograph plots. Flight idle and forward flight conditions were selected for generation of power spectral density plots. A description of the hardware and program summary is presented. Volume 2 contains test descriptions, test results, and raw field data.
Author

N70-42429*# Hamilton Standard, Farmington, Conn.
LINEAR AND ANGULAR VIBRATION MEASUREMENT OF V/STOL AIRCRAFT, VOLUME 2 Final Technical Report
D. Isakson Apr. 1970 300 p
(Contract NAS12-2028)
(NASA-CR-110821) Avail: NTIS CSCL 14B
For abstract, see N70-42428.

N70-42430# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.
REAL-TIME SIMULATION OF AIRCRAFT USING DIGITAL COMPUTERS [ECHTZEIT-SIMULATION VON FLUGZEUGEN MIT DIGITALRECHNERN]
Rudolf Dierke Jun. 1970 52 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-21) Avail: NTIS; ZLDI Munich: 11,50 DM
A time-optimal program for digital aircraft simulation was developed and body-axes were used as the coordinate system for describing the aeroplane in free flight. Quaternions proved to be best method for computing the aircraft attitude. The digital presentation of nonlinear functions is briefly discussed and suitable integration methods for real-time simulation are given. The use of stability cards for estimating the asymptotic behaviour of an integration method (after a high number of steps) is discussed.
Author (ESRO)

N70-42437*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A 10 DEG CONICAL PLUG NOZZLE WITH A STOWED THRUST REVERSER AT MACH NUMBERS FROM 0 TO 2.0
Fred W. Steffen Washington Oct. 1, 1970 refs
(NASA-TM-X-2116) Avail: NTIS CSCL 21H
Nozzles with two throat areas and two shroud lengths were tested. Compared to a hinged iris primary-plug nozzle without a reverser, the plug nozzle with the stowed thrust reverser had higher efficiency at subsonic cruise with the shroud retracted but lower efficiency at higher pressure ratios with the shroud either retracted or extended. The stowed thrust reverser restricted corrected secondary-weight-flow ratio available from the free stream to 0.02 between Mach numbers of 0.4 and 1.1.
Author

N70-42438*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF CONVERGENT AND PLUG NOZZLES AT MACH NUMBERS FROM 0 TO 1.97
Douglas E. Harrington Washington Oct. 1970 36 p refs
(NASA-TM-X-2112) Avail: NTIS CSCL 21H
A parametric variation of projected boattail area and plug area was conducted to determine the effect on performance characteristics. A convergent nozzle with a circular arc boattail and a jet to nacelle area ratio of 0.25 had an efficiency of 98.2 percent at a subsonic cruise Mach number of 0.90 and a nozzle pressure ratio of 2.8. At the same conditions, a plug nozzle with a circular arc boattail and a small plug had an efficiency of 97.3 percent, while a large-plug nozzle without a boattail was 93.9 percent efficient.
Author

N70-42475# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
INSTALLATION FOR THE STUDY OF MULTIPLE FLOW JET EXHAUST NOZZLES [INSTALLATION POUR L'ETUDE DE TUYERES DE REACTEURS A PLUSIEURS FLUX]
Guy Fasso, Maurice Pletin, and Pierre Broussaud 1970 27 p refs In FRENCH; ENGLISH summary
(ONERA-NT-160) Avail: NTIS
The equipment for the study of jet-engine nozzles and after-bodies without external flow or in a blowdown wind tunnel, at transonic speeds or at Mach 2, is described. The Reynolds number obtained is 1/3 of that encountered in flight. The primary flow, which is constant, may reach 18 to 20 kg/sec and the secondary and tertiary flows, which can be varied by steps, are 16% to 30% of the primary flow; the useful duration of a run varies from 1 to 3 minutes. The thrust balance, of 10 kN capacity, is associated with a flow distribution unit (dynalpy balance) and can be installed outside the wind tunnel. The force and pressure measurement pick-ups, the transcription and data handling devices, and also the calibration results, are described in detail. The global absolute accuracy is of the order of + or × 840.2%. More than 1000 runs have been carried out at rest on a 1/10th scale model of the Concorde engine after-bodies.
Author (ESRO)

N70-42500# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
PRESSURE MEASUREMENTS ON A SLENDER RHOMBIC CONE AT INCIDENCE AT MACH NUMBERS FROM 0.4 TO 1.1
J. H. B. Smith and A. G. Kurn London Aeron. Res. Council 1970 37 p refs Supersedes RAE-TR-68171; ARC-30735
(ARC-R/M-3626; RAE-TR-68171; ARC-30735) Copyright. Avail: NTIS; HMSO: 19s; BIS: $3.60
Pressures were measured on a wing in the form of a rhombic cone at two cross-sections and along a single generator. The wing had an aspect ratio of one and a leading-edge angle of 60 deg. Measurements were made at M = 0.4, 0.6, 0.82, 0.9, 1.0 and 1.1, at angles of incidence up to 20 deg and at a Reynolds number of 6 million, based on model length. At the lowest Mach number the tests were repeated at higher Reynolds number. The measured pressure distributions are typical of flow with leading-edge vortices. Two different types of suction peaks were observed and associated, on indirect evidence, with the state of the boundary layer at secondary separation. Within each type, increasing Mach number reduced the magnitude of the peak suction, but had little effect on its spanwise location. At transonic and high subsonic speeds an increase in incidence above 8 deg changed the shape of the suction peak from the type associated with a turbulent secondary separation to that associated with a laminar one.
Author (ESRO)

N70-42525# Aeroplane and Armament Experimental Establishment, Boscombe Down (England). Technical Services Div.
DEVELOPMENT OF FLIGHT LINE TOOL BOX FOR USE AT A AND AEE
N. Spratt 21 Jul. 1969 15 p
(A/AEE-Note-9001) Avail: NTIS
This report describes the development of a machine used to manufacture tool trays from polystyrene sheet using a temperature/vacuum forming technique. The trays, moulded to suit tools selected by individual tradesmen as being needed for first line

servicing of aircraft, enable tradesmen to check quickly that all their tools have been removed from the aircraft on completion of their work. Author (ESRO)

N70-42528# Northern Research and Engineering Corp., Cambridge, Mass.

IGNITION AND SUSTAINING OF COMBUSTION BY ENERGY ADDITION IN TURBULENT SUPERSONIC FLOW Final Scientific Report

Kenneth N. C. Bray and Ronald S. Fletcher Jul. 1970 50 p refs

(Contract F44620-68-C-0058)

(AD-710283; NREC-1132-1; AFOSR-70-1959TR) Avail: NTIS CSCL 21/2

The objective of the study is to obtain data on turbulent, supersonic combustion which will facilitate development of ignition systems for use in scramjet engines under conditions when combustion cannot occur spontaneously. To this end a simple analytical model of a reacting, turbulent flow is presented, based upon the a priori assumption that combustion and turbulent mixing can be uncoupled. Predictions from this model are compared with some new experimental data on the ignition of ethylene in air. Both premixed and unpremixed situations are included. Tests of the validity of the mixing model are made for the nonreacting case by comparing predicted and measured velocity profiles in a duct; a satisfactory agreement is obtained. The predicted ignition requirements also match the measured values in most cases, with mixing- and reaction-rate data taken from the literature. Until uncertainties in these mixing- and reaction-rate expressions can be substantially reduced, the use of more subtle coupling models in the determination of ignition requirements does not appear to be justified. A much simpler model is also presented and used to derive a useful criterion for the prediction of the ignition boundaries in premixed fuel-air flows. Author (TAB)

N70-42529# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

GUST RESPONSE MEASUREMENTS ON A MODEL AIRCRAFT

R. Cansdale and H. Hall London Aeron. Res. Council 1970 24 p refs Supersedes RAE-TR-69273; ARC-31966

(ARC-CP-1113; RAE-TR-69273; ARC-31966) Copyright. Avail: NTIS; HMSO: 7s; BIS: $1.40

Design studies of slender wing configurations showed that gust response might be a serious problem so a technique was developed for investigating the symmetrical response of a model aircraft to an up-gust using a sled propelled by rockets along a track past the mouth of an open-jet wind tunnel. Test results for a rigid slender wing model agreed well with calculations. Author (ESRO)

N70-42532# Aberdeen Proving Ground, Md. Human Engineering Labs.

METHODOLOGY FOR A TACTICAL UTILITY HELICOPTER INFORMATION TRANSFER STUDY

John A. Barnes May 1970 15 p refs

(AD-710248; HEL-TN-4-70) Avail: NTIS CSCL 1/4

The study was an effort to determine what information, available from basic flight instruments, was used by the pilot to perform the various missions that encompass the tactical utility helicopter mission. A UH-1 aircraft, the current U. S. Army tactical utility helicopter, was used as the test vehicle and all measures relate to this vehicle. Author (TAB)

N70-42551# ARO, Inc., Arnold Air Force Station, Tenn.

AERODYNAMIC HOLOGRAPHY Final Report, Jul. 1967–Jul. 1969

J. D. Trolinger and J. E. O'Hare AEDC Aug. 1970 98 p refs

(Contract F40600-71-C-0002)

(AD-709764; AEDC-TR-70-44) Avail: NTIS CSCL 20/4

A summary of the work in holography at AEDC is presented. The work includes basic and applied research with emphasis on the applications of holography to aerodynamic testing. Author (TAB)

N70-42574*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF THREE REPRESENTATIVE HYPERSONIC CRUISE CONFIGURATIONS AT MACH NUMBERS FROM 0.65 TO 10.70

Walter P. Nelms, Jr. and John A. Axelson Washington Oct. 1970 87 p refs

(NASA-TM-X-2113) Avail: NTIS CSCL 01A

An experimental investigation of the aerodynamic characteristics of three representative hypersonic cruise configurations was conducted at Mach numbers from 0.65 to 10.70. The models were designed to the same general specifications for air-breathing, liquid-hydrogen-fueled, hypersonic cruise configurations; two were discrete wing-body concepts and the third resembled a blended wing-body design. This report examines the detailed effects of variations in angle of attack, Mach number, and configuration buildup on the longitudinal aerodynamic characteristics of the three models. Author

N70-42576*# Techtran Corp., Glen Burnie, Md.

UNSTEADY PRESSURE DISTRIBUTION MEASUREMENTS ON AN OSCILLATING WING AT SUBSONIC AND TRANSONIC SPEEDS [INSTATIONAERE DRUCKVERTEILUNGMESSUNGEN AN EINEM SCHWINGENDEN TRAGFLUEGEL IM SUBSONISCHEN UND TRANSSONISCHEN GESCHWINDDIGKEITSBEREICH]

H. Triebstein Washington Oct. 1970 29 p refs Transl. into ENGLISH from Deut. Forschungs (Germany), Jul. 1969 31 p

(Contract NASw-2037)

(NASA-TT-F-13337) Avail: NTIS CSCL 20D

A test stand for the measurement of unsteady pressure distributions in a transonic wind tunnel is described along with the test procedures. Results obtained in the speed range M = 0.5 to 1.2 for a rectangular wing performing pitching oscillations about different spanwise axes and control surface oscillations about the hinge axis are discussed and compared with theory. Good agreement was found in the subsonic region, whereas in the transonic region considerable differences appeared due to local shock waves and transonic buffeting. Finally, it is shown that the unsteady pressure amplitudes behave fairly linear with respect to the vibration amplitude as long as the angles of attack of the wing are relatively small. Author

N70-42586# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

METHODS FOR DETERMINING CONDITIONS IN REAL NITROGEN EXPANDING FLOWS

S. Culotta and B. E. Richards Feb. 1970 156 p refs

(VKI-TN-58) Avail: NTIS

Perfect gas table correction factor charts to take into account the real gas effects in the isentropic expansion of nitrogen gas from high density and temperature conditions are presented. Equilibrium thermodynamic properties based on the Culotta-Enkenhus equation of state were used for the calculations. Charts and tables for

calculating the stream quantities in the test section of a hypersonic wind tunnel where the density and temperature of the gas are sufficiently low that the gas can be considered perfect are also given. A computer program for calculating the real gas conditions in nitrogen expanding from high density and temperature conditions to the Mach number desired, which can be used in the design of a contoured wind tunnel nozzle using the method of characteristics, is also printed. Author (ESRO)

N70-42655# Congress. House. Committee on Government Operations.
PROBLEMS CONFRONTING FAA IN THE DEVELOPMENT OF AN AIR TRAFFIC CONTROL SYSTEM FOR THE 1970'S
Washington GPO 1970 188 p refs Hearing before Comm. on Govt. Operations, 91st Congr., 2d, Sess., 27 Jan. 1970
Avail: Subcomm. on Govt. Activities

The hearings on developing an air traffic control system for the 1970's are reported. Subjects discussed include: (1) general description of air traffic control requirement through 1980, (2) inadequate funding of National Airspace System, (3) technical problems confronting FAA, and (4) collision avoidance. F.O.S.

N70-42737*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFECTS OF WING ELEVATION, INCIDENCE, AND CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF A REPRESENTATIVE HYPERSONIC CRUISE CONFIGURATION AT MACH NUMBERS FROM 0.65 TO 10.70
Walter P. Nelms, Jr. and John A. Axelson Washington Oct. 1970 77 p refs
(NASA-TN-D-6049; A-3701) Avail: NTIS CSCL 01A

A delta wing and body configuration representative of an airbreathing, liquid hydrogen fueled, hypersonic cruise aircraft was tested with the wing in high, mid, and low positions at zero incidence on the body, and the incidence angle was varied from −2 degrees to +2 degrees in the mid position. Wings with positive cambered, symmetrical, and negative cambered airfoil sections were studied for the mid position at zero incidence. The tests were conducted over a nominal angle of attack range from −4 degrees to +12 degrees, and angle of sideslip range from −4 degrees to +10 degrees. The results indicate that variations in wing elevation on the fuselage had little effect on the lift and pitching moment characteristics but had significant effects on the lateral and directional stability at most Mach numbers of the study. Changing wing incidence varied the pitching moment at zero lift over the entire test Mach number range with little or no reduction in the maximum lift drag ratio at supersonic and hypersonic speeds. At transonic and supersonic Mach numbers, wing camber significantly affected the pitching moment at zero lift but only slightly affected this parameter at hypersonic speeds. Author

N70-42738*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
FLIGHT EVALUATION OF GROUND EFFECT ON SEVERAL LOW-ASPECT-RATIO AIRPLANES
Paul A. Baker, William G. Schweikhard, and William R. Young Washington Oct. 1970 48 p refs
(NASA-TN-D-6053; H-550) Avail: NTIS CSCL 01A

A constant angle of attack approach technique was used to measure ground effect on several low aspect ratio aircraft. The flight results were compared with results from constant altitude flybys, wind tunnel studies, and theoretical prediction data. It was found that the constant angle of attack technique provided data that were consistent with data obtained from constant altitude flybys and required fewer runs to obtain the same amount of data. The test results from an F5D-1 airplane modified with an ogee wing, a prototype F5D-1 airplane, two XB-70 airplanes, and an F-104A airplane indicate that theory and wind tunnel results adequately predict the trends caused by ground effect as a function of height and aspect ratio. However, the magnitude of these predictions did not always agree with the flight-measured results. In addition, there was consistent evidence that the aircraft encountered ground effect at a height above one wing span. Author

N70-42747# Iowa Univ., Iowa City. Dept. of Mechanics and Hydraulics.
SOME GENERALIZATION OF SIMPLE WAVES. SIMILARITY SOLUTIONS. HELICOPTER STUDY, 2
Shiang-yu Lee Aug. 1970 13 p refs
(Contract DAAF03-69-C-0014; Proj. Themis)
(AD-710403; Themis-UI-23) Avail: NTIS CSCL 12/1

By adopting the concept of similarity transformations, a class of boundary value problems of hyperbolic partial differential equations can be solved including the classical simple wave solutions as special cases. The new technique may find important applications in engineering problems of fluid and solid dynamics. Author (TAB)

N70-42753# Federal Aviation Administration, Washington, D.C. Engineering and Manufacturing Div.
SECOND CONFERENCE ON FUEL SYSTEM FIRE SAFETY
May 1970 203 p refs Conf. held at Washington, D.C., 6–7 May 1970
(AD-711059) Avail: NTIS CSCL 13/12

CONTENTS:

I. USAF EXPERIENCE WITH POLYURETHANE FOAM INERTING MATERIAL T. Q. Reed (ASD) p 25–73 refs

2. USAF, CI41 AND C-135 FUEL TANK NITROGEN INERTING TESTS W. Q. Brookley (Mil. Airlift Command, Washington, D.C.) p 75–83

3. OXYGEN DILUTION REQUIREMENTS FOR INERTING AIRCRAFT FUEL TANKS J. M. Kuchta (Bureau of Mines, Pittsburgh, Pa.) p 85–115 refs

4. IN-FLIGHT CONTROL OF POWERPLANT FIRES WITH LIQUID NITROGEN E. P. Klueg (Natl. Aviation Facilities Exptl. Center) p 117–139

5. FUEL TANK INERTING USING CATALYTIC COMBUSTION TECHNIQUES R. G. Clodfelter (AFSC, Wright-Patterson AFB) p 141–169 refs

6. LIGHTNING INDUCED VOLTAGES IN ELECTRICAL CIRCUITS ASSOCIATED WITH AIRCRAFT FUEL SYSTEMS J. A. Plumer (GE, Pittsfield, Mass.) p 171–191 refs

7. FAA DC-9 LIQUID NITROGEN FUEL TANK INERTING PROGRAM T. G. Horeff p 193–203

N70-42754# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
USAF EXPERIENCE WITH POLYURETHANE FOAM INERTING MATERIAL
Thomas O. Reed *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 25–73 refs
Avail: NTIS CSCL 13/12

An outline of the Air Force's experience to data with reticulated polyurethane foam as an inerting material in the fuel tanks

of combat aircraft is presented. Background data and experience on the present fully packed concept is included, as well as an outline of the efforts underway to reduce the weight and range penalties associated with the present foam through the use of low density foams and voiding concepts. Author

N70-42755# Military Airlift Command, Washington, D.C.
USAF, C141 AND C-135 FUEL TANK NITROGEN INERTING TESTS
William Q. Brookley *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 75 83
Avail: NTIS CSCL 13/12

A summary of the C-141 and C-135 fuel tank nitrogen inerting tests and, test results obtained to this time is presented. An explanation of instrumentation installation and operation is presented. Tests were established to show proper operation of the components and systems and to prove that in no way could safety of flight of the aircraft be jeopardized by the inerting systems. This included normal operations, any type of failure or by affecting aircraft components or structure. Emphasis was placed on the testing of the vent valve since it was the most critical component in the system and was a newly designed component. Failure of the climb or dive valves to open due to ice was considered the most serious problem. Several severe icing tests were performed to verify that the design was sufficient to prevent failure from icing. Author

N70-42756# Bureau of Mines, Pittsburgh, Pa. Safety Research Center.
OXYGEN DILUTION REQUIREMENTS FOR INERTING AIRCRAFT FUEL TANKS
Joseph M. Kuchta *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 85–115 refs
Avail: NTIS CSCL 13/12

The effectiveness of various inerting agents to prevent ignition and flame propagation are reviewed for hydrocarbon fuel-air systems. Data are presented on the variation of limits of flammability, minimum ignition energies, and minimum autoignition temperatures (AIT's) with oxidant or diluent concentration. The potential explosion hazard that may be encountered over a range of flight temperatures and pressures is discussed, and guidelines are given for specifying safe oxygen concentrations for aircraft fuel tanks. Author

N70-42757# National Aviation Facilities Experimental Center, Atlantic City, N.J.
IN-FLIGHT CONTROL OF POWERPLANT FIRES WITH LIQUID NITROGEN
Eugene P. Klueg *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 117–139
Avail: NTIS CSCL 13/12

The development, design, and criteria evaluation by experimentally establishing the requirements for an effective extinguishing system as influenced by nacelle ventilation and free volume and in terms of agent quantity, discharge rate, discharge conditions and distribution provisions are studied. The effects of an inadvertent discharge, damaged cowling, and the cooling of potential reignition sources are also being investigated under this phase. The work summarizes the findings to date resulting from these efforts and discusses current areas of investigation. Author

N70-42758# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
FUEL TANK INERTING USING CATALYTIC COMBUSTION TECHNIQUES
Robert G. Clodfelter *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 141–169 refs
Avail: NTIS CSCL 13/12

The catalytic combustion technique for inerting of aircraft fuel systems is discussed. The catalytic combustion approach offers potential advantages over other combustion concepts by providing efficient oxygen conversion over a wide range of operating conditions with the generation of only a small amount of corrosive reaction products. The qualitative advantage of lower operating temperature and no combustion flame is also considered. Author

N70-42759*# General Electric Co., Pittsfield, Mass. High Voltage Lab.
LIGHTNING INDUCED VOLTAGES IN ELECTRICAL CIRCUITS ASSOCIATED WITH AIRCRAFT FUEL SYSTEMS
J. A. Plumer *In* FAA 2d Conf. on Fuel System Fire Safety May 1970 p 171–191 refs
(Contract NAS3-12019)
Avail: NTIS CSCL 21B

The characteristics of induced voltages in representative types of aircraft electrical circuits were studied by a series of measurements of lightning-induced voltages in the fuel system electrical circuits within the wing of an aircraft. From these measurements, mathematical expressions for these voltages were derived, relating them to the causative lightning current parameters. Further analysis of the possible effects of these induced voltages upon the fuel system is presented. The experimental procedures and results, as well as the analysis of possible effects on the fuel system are discussed. Author

N70-42760# Federal Aviation Administration, Washington, D.C. Engineering and Safety Div.
FAA DC-9 LIQUID NITROGEN FUEL TANK INERTING PROGRAM
Thomas G. Horeff *In its* 2d Conf. on Fuel System Fire Safety May 1970 p 193–203
Avail: NTIS CSCL 13/12

The feasibility of a proposed nitrogen fuel tank inerting system for commercial aircraft was studied for installation in the FAA DC-9. The system replaces oxygen in the fuel tank vapor spaces and vent lines with nitrogen by discharges of liquid nitrogen into the main fuel tanks through fog nozzles maintaining a pressurization with nitrogen of 0.1 psig. Vent valves open at 0.2 psig to vent the gases overboard. The testing program is expected to generate data on nitrogen inerting systems which will be applicable to all turbine-powered aircraft. F.O.S.

N70-42770# Royal Aircraft Establishment, Farnborough (England). Engineering Physics Dept.
AN INFLATED MOBILE LIFTING SYSTEM FOR AN 8 TON LOAD
I. S. H. Brown and F. T. Kierton London Aeron. Res. Council 1970 24 p refs Supersedes RAE-TR-67190; ARC-29789
(ARC-CP-1092; RAE-TR-67190; ARC-29789) Copyright. Avail: NTIS; HMSO: 6s; BIS: $1.20

A system comprising an inflatable load-lifting canopy of oval planform with buoyancy tube and separate trailer for inflation and towing over water proved feasible for loads of up to 8 tons over smooth ground and calm water. Performance limits in more severe conditions were not determined. The device can be used for transporting heavy machinery and raising and recovering objects, including aircraft, from mud, water, sand, etc. Author (ESRO)

N70-42774*# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.
AIR POLLUTION FROM FUTURE GIANT JETPORTS
James A. Fay May 1970 14 p refs *Its* Fluid Mech. Lab. Publ. No. 70-6
(Grant NGR-22-009-378)
(NASA-CR-110887) Avail: NTIS CSCL 13B

A meteorological model is presented to calculate the average concentration of a pollutant, emitted at a mass rate per unit of vertical ascent and descent during a landing and takeoff cycle, if the frequency of such cycles and wind speed is given. Based on this simple meteorological model, calculations of the ambient levels of nitric oxide and particulates to be expected downwind of a giant jetport show them to be about equal to those in present urban environments. These calculations are based on measured emission rates from jet engines and estimates of aircraft performance and traffic for future jetports. Author

N70-42810*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A PILOTED SIMULATOR INVESTIGATION OF GROUND EFFECT ON THE LANDING MANEUVER OF A LARGE, TAILLESS, DELTA-WING AIRPLANE
C. Thomas Snyder, Fred J. Drinkwater, III, and A. David Jones Washington Oct. 1970 48 p refs Prepared in cooperation with Army Aeronautical Res. Lab.
(NASA-TN-D-6046; A-3171) Avail: NTIS CSCL 01B

The influence of ground effect on the landing flare characteristics of a supersonic transport airplane (SST) was investigated in a fixed cockpit simulator. Simulations of an ogee-modified delta-wing F5D-1 airplane and a subsonic jet transport were used for evaluating the simulator and as reference configurations during landing comparisons. Dynamic responses of the SST to seven different ground-effect models during controls-fixed and constant-attitude descents are also presented, followed by piloted subjective assessments. A summary of ground effects on delta-like wings is included in the appendixes. Author

N70-42824*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A FLOW VELOCITY AND DIRECTION INSTRUMENT
James H. Monteith (M.S. Thesis – Va. Univ.) Aug. 1970 64 p refs
(NASA-TM-X-66391) Avail: NTIS CSCL 14B

Analyses and experimental results are presented on a control system used for positioning a null seeking pressure probe. The probe is to be used in wind tunnels to measure wind velocity magnitude and direction. Two, interacting, positioning servomechanisms were used to control the pressure probe. The analysis of this system was accomplished using vector analysis as well as standard servoanalysis methods. These analyses showed the stability of the system to be dependent on the orientation of the null sensing pressure ports on the probe face. Laboratory and wind tunnel tests showed that the probe yaw and pitch angle measurements were accurate to within + or − deg for angles up to 45 deg. Author

N70-42827 National Lending Library for Science and Technology, Boston Spa (England).
RESIDENTIAL AREAS IN THE VICINITY OF AN AIRPORT [BOLIGSTROEK NAER FLYPLASSER]
G. Oe. Joergen Nov. 1969 11 p refs Transl. into ENGLISH of Norges Buggforskningsinst. Reprint No. 161
(NLL-Lib-Comm-1527-(5196)) Avail: Natl. Lending Library, Boston Spa, Engl.: 1 NLL photocopy coupon

Noise intensity levels in houses and buildings near airports are considered. The problem is considered with respect to the number of houses and buildings that must gradually be condemned due to increasing noise intensity and requirements for insulation to make existing buildings acceptable. Noise zones around airports are also established to determine what types of building are prohibited in the individual zones. The development of criteria for acceptable noise intensity in different situations is also discussed. R.B.

N70-43015# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
LOW-SPEED WIND-TUNNEL TESTS ON AN UNSWEPT WING-FUSELAGE MODEL OF ASPECT RATIO 9.8, WITH TANGENTIAL BLOWING OVER TRAILING-EDGE FLAPS AND AILERONS, INCLUDING THE EFFECT OF SLIPSTREAM
J. A. Lawford London Aeron. Res. Council 1970 61 p refs Supersedes RAE-TR-68111; ARC-30636
(ARC-CP-1108; RAE-TR-68111; ARC-30636) Copyright. Avail: NTIS; HMSO: 16s; BIS: $3.20

Tests were made on an unswept, high-wing wing-fuselage model of aspect ratio 9.8, with boundary layer control by blowing at the shroud of trailing-edge flaps and ailerons. Propeller slipstream was represented during some of the tests. Critical blowing momentum coefficients ranging over 0.015 to 0.05 at flap angles of 30 deg and 60 deg respectively were determined. With slipstream, a critical coefficient defined in terms of slipstream velocity at the propeller disc was substantially independent of thrust coefficient. Increments of lift coefficient, without slipstream, due to a blowing momentum coefficient of 0.1, were 0.65 and 1.82 respectively at flap angles of 0 deg and 60 deg. Author (ESRO)

N70-43030# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.
A NEW APPROACH TO THE SPECIFICATION AND EVALUATION OF FLYING QUALITIES Final Report
Ronald O. Anderson Jun. 1970 74 p refs
(AD-710590; AFFDL-TR-69-120) Avail: NTIS CSCL 1/3

A study of the correlation of pilot model parameters and closed-loop performance with pilot opinion of VTOL hover dynamics was conducted. The encouraging results suggested a pilot-vehicle analysis method of predicting pilot model parameters, closed-loop pilot-vehicle performance with gust inputs, and pilot opinion ratings for a wide range of vehicle dynamics. This approach was, in turn, used to predict ratings for comparison with fixed base, moving base, and flight test results for VFR conditions. Again the results were promising, and a new method of specifying hover dynamics followed naturally. The new pilot-vehicle analysis concept, called the minimum pilot rating method, is discussed in terms of applications to other tasks, flying qualities specification, and control system design. Author (TAB)

N70-43036 Texas Univ., Austin.
WHIRL OF SHAFT-ROTOR SYSTEMS SUPPORTED BY BALL BEARINGS
Harald Portig (Ph.D. Thesis) 1969 117 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 69-21875

Two numerical methods are developed that allow the determination of the whirl characteristics of rotors running on shafts supported by ball bearings. The shafts are considered massless. Their masses are considered to be bulked at the rotor positions. In both approaches every rotor or bearing is separated from another rotor or bearing by a shaft segment. Both methods take into account the internal deflections of balls and races of the bearings.

Major assumptions include: massless bearing balls, no friction between balls and races, no forces due to ball separators, and the balls are evenly spaced around the bearings. To check the validity of the analyses, experiments were performed, the results of which were directly comparable to those of the MIMIC simulation. Solutions from the iterative and simulation approaches were then compared for cases where both applied. Dissert. Abstr.

N70-43048# Glasgow Univ. (Scotland). Dept. of Aeronautics and Fluid Mechanics.
EXPERIMENTAL INVESTIGATION OF A HIGH-LIFT LOW-DRAG AEROFOIL
F. H. Kelling Sep. 1968 43 p refs
(Rept-6802) Avail: NTIS

One low drag airfoil was selected for low speed wind tunnel testing at Reynolds numbers around half a million. Coefficients of lift, drag and pitching moment were obtained for a range of incidence. The maximum section lift coefficient obtained was 1.93 and the minimum profile drag coefficient was 0.0112. Results compared favorably with those deduced theoretically. The addition of a boundary layer trip to the upper surface caused the profile drag to decrease at some incidences. At the design lift coefficient of 1.4, the ratio of lift to profile drag was 108 at a Reynolds number of 0.63 million. The addition of an extended, sealed, flat-plate flap (with a chord one tenth that of the airfoil) at the trailing edge of the airfoil gave favorable results. A maximum ratio of lift to profile drag of 116 was obtained at a lift coefficient of 1.8 with a flap deflection of 17.8 degrees, while the maximum lift coefficient achieved was 2.30. Author

N70-43053# Naval Research Lab., Washington, D.C. Organic Chemistry Branch.
ADHESIVE BOND FAILURES IN AIRCRAFT HONEYCOMB SANDWICH COMPOSITES Interim Report
T. R. Walton and J. E. Cowling 15 Jun. 1970 29 p refs
(AD-710352; NRL-7077) Avail: NTIS CSCL 1/3

A number of approaches were initiated to improve bond strength and durability of honeycomb core-sandwich structures, some of which are described in the report. The overall objective was to determine why and how these composites fail and then determine what can be done to eliminate or reduce these failures. Failure, in part, appears to be caused by an undercutting type of corrosion which destroys the bond. The adhesives themselves appear also to be partially to blame. Although their initial strength is probably sufficient, their durability to environmental conditions is poor. The deficiencies in the adhesive are inadequate moisture resistance, high void content, and brittleness. To correct these problems, corrosion-inhibitive primers and treatments are being studied, new water-resistant resins are being synthesized, and bonding procedures are being studied. Author (TAB)

N70-43087# National Physical Lab., Teddington (England). Aerodynamics Div.
INFLUENCE OF WING ROOT SHAPING ON THE PRESSURE DISTRIBUTION OF SWEPT-WING BODY CONFIGURATIONS
J. Bridgewater and K. H. Wilson London Aeron. Res. Council 1970 17 p refs Supersedes NPL-AERO-NOTE-1082; ARC-31311
(ARC-CP-1109; NPL-AERO-NOTE-1082; ARC-31311) Copyright. Avail: NTIS; HMSO: 5s; BIS $1.00

Swept wing pressure fields calculated by inviscid linearized theory are presented for symmetric wing-body configurations at Mach number 2. The effects of varying the inboard wing shape are investigated, with the aim of minimising the associated body waisting needed to achieve a desirable isobar pattern, and to produce a good overall area distribution. Author (ESRO)

N70-43101*# Advanced Technology Labs., Inc., Jericho, N.Y.
THREE DIMENSIONAL MIXING OF JETS
Edgar Alzner Jul. 1970 45 p
(Contract NAS1-9560)
(NASA-CR-111782; ATL-TR-150) Avail: NTIS CSCL 20D

An analysis of the diffusion process in the region where adjacent injectors interact is presented for scramjet combustion chamber design. Two specific problems are investigated: one dealing with jets or sets of jets with no sweepback and containing only planes of symmetry, and the other with jets or sets of jets with sweepback and containing planes of symmetry and also planes of equivalence. N.E.N.

N70-43132# Hughes Tool Co., Culver City, Calif. Aircraft Div.
ROTOR/WING Final Technical Report
F. J. Briardy, S. V. LaForge, and J. R. Neff Mar. 1970 79 p refs
(Contract Nonr-4588(00))
(AD-710425; HTC-AD-69-12A) Avail: NTIS CSCL 1/3

The report presents the technical status of the rotor/wing concept of a stopped-rotor helicopter configuration. The configuration presents attractive performance characteristics for a high-speed VTOL aircraft. The ability to predict aerodynamic performance characteristics in all flight modes is substantiated by wind-tunnel tests. A major technical problem of 3-per-rev oscillating loads on the rotor/wing pylon was minimized by the effective use of cyclic blade pitch during the high-advance-ratio portion of conversion. High values of oscillating blade-root moments were recorded during testing of a dynamic model. It is not known if there is a schedule of cyclic pitch that will minimize both pylon loads and blade-root loads simultaneously. Author (TAB)

N70-43141# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
AUTOROTATING WINGS: AN EXPERIMENTAL INVESTIGATION Interim Technical Report
Edmund H. Smith (Ph.D. Thesis) Jul. 1970 159 p refs
(Contract DAHC04-68-C-0027)
(AD-710288; Rept-01954-2-T; AROD-5590-4-E) Avail: NTIS CSCL 1/3

The autorotation of a flat plate about its spanwise axis was experimentally studied. Most of the work was done with a model mounted on air bearings in a wind tunnel. The flow pattern differed from that over a static wing. The wing did not stall until it was almost perpendicular to the free stream. At Re = 240,000, the maximum lift coefficient was 4.50, with an average value of 2.20, while the maximum drag coefficient was 4.30 with an average value of 1.60. The angular acceleration was small; the wing rotated at an almost constant angular velocity. The wing nondimensional rotation rate approached an asymptotic limit at 0.35. Applying a driving torque to the wing increased the lift and drag, while a retarding torque reduced them. A variety of wing configurations were tested, with no major changes in the autorotation phenomenon. Freely falling wings were studied and behaved in a manner similar to the fixed axis wings for comparable Reynolds numbers. Author (TAB)

N70-43146*# National Aeronautics and Space Administration. Ames Research Center, Moffet Field, Calif.
INVESTIGATION OF A DIGITAL AUTOMATIC AIRCRAFT LANDING SYSTEM IN TURBULENCE
Frank Neuman and John D. Foster Washington Oct. 1970 59 p refs
(NASA-TN-D-6066; A-3504) Avail: NTIS CSCL 17G

A digital system has been studied for automatically controlling the longitudinal motion of a large transport aircraft during the

landing phase. The study was carried out by means of an all-digital simulation that was chiefly concerned with investigating the effects of gusts and wind shears on aircraft control near the ground. The performance of the automatic control system operating in turbulence was determined by a Monte Carlo technique. With respect to the digital control system, it was found that (1) the basic analog flare mode could be modified to improve its performance under conditions of turbulence and wind shear; (2) for most control modes the computation rate requirement is surprisingly low as indicated by the effects of computer repetition rate on the aircraft performance; (3) the performance degradation that results when a control computation cycle is ocassionally skipped is relatively minor, a fact that is significant when the computer is shared with other systems for which emergency computations may have to be performed. Author

N70-43200# Army Engineer Waterways Experiment Station, Vicksburg, Miss.

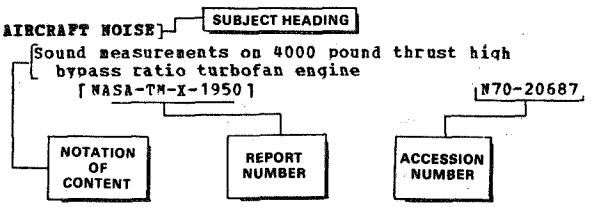
CRITERIA FOR INSPECTION, EVALUATION, CLASSIFICATION, AND REUSE OF USED AIRFIELD LANDING MAT Final Report

Philip J. Vedros and Donald N. Brown May 1970 80 p ref (AD-708891; S-70-2) Avail: NTIS CSCL 1/5

The instruction report presents a method for the systematic separation and classification of used panels of M8AI, AM2, XM18, and XM19 landing mats as reusable or unsuitable for future use as light- or medium-duty landing mat. For cases in which the used mat is not suitable for airfield surfacing, suggested secondary uses are presented. Author (TAB)

SUBJECT INDEX

Typical Subject Index Listing



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A

A-300 AIRCRAFT
European A-300-B Airbus program, discussing technical and economical aspects
A70-36509

A-7 AIRCRAFT
Congressional testimony on falsification of data from laboratory tests of brakes for A-7D aircraft
N70-36152

ABLATIVE MATERIALS
Charring ablators transient heat transfer model, calculating surface temperature and recession and pyrolysis mass loss
[AIAA PAPER 70-1143] A70-40280

ABRASIVES
Erosion by solid particles, discussing impacting velocity effects, natural sand quartz particle size distribution and composition, artificial industrial abrasives, etc
A70-35600

ABSORBERS (MATERIALS)
Static tests of aluminum and steel frangible tube energy absorbers for nuclear aircraft reactors
[NASA-TM-X-52847] N70-34152

ABSTRACTS
Soviet meteorology abstracts, including storm development, aerological sounding, and atmospheric diffusion studies
N70-37882
Annotated bibliography of shock and vibration publications
[AD-700811] N70-40359
Digest of abstracts and literature reviews concerning shock and vibration
[AD-709734] N70-41450

ACCELERATION (PHYSICS)
Full scale aircraft spinning motion, computing static, damping, cross and acceleration aerodynamic characteristics for antispin devices
[AIAA PAPER 70-946] A70-39581
Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209
Atmospheric pressure surface sharp slopes at SST altitudes producing vertical acceleration based on temperature gradients inspection
A70-46050
Engineering approximation of maximum accelerations experienced by planing craft in rough water
[AD-706098] N70-38390

ACCELEROMETERS
Error influence of real accelerometer on measuring accuracy of angular velocity
N70-37791

ACCIDENT PREVENTION
Aircraft accident prevention and investigation, noting economic factors as deterrent to safety measures implementation
A70-35860
Flight recorder role in aircraft accident investigation and prevention, noting audio instruments and data recovery
A70-38613
U.S. Army rotary wing mishap experience for product assurance and accident prevention
A70-38825
Helicopter hazards elimination measures, considering crash resistant fuel systems, flotation devices, redesigned seats, in-flight escape, etc
A70-46383
Activities of National Transportation Safety Board for 1969
N70-41227

ACCURACY
Error influence of real accelerometer on measuring accuracy of angular velocity
N70-37791

ACOUSTIC ATTENUATION
Sound wave radiation and excitation in plane infinite plate by vortices
A70-38722
Acoustic pulse transmission through plane vortex sheet, examining zone of silence, geometrical acoustics and sound radiation
A70-41243
Jet aircraft noise attenuation characteristics of wood-sided and brick-veneered frame houses
[NASA-CR-1637] N70-35694

ACOUSTIC DUCTS
Aircraft acoustical duct treatments - ASA Conference, Philadelphia, April 1969
A70-42528
NASA acoustically treated nacelle program reducing noise under commercial transport flight path near airports
A70-42529
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530
Structural and environmental design criteria for acoustical duct-lining materials in turbofan noise suppression
A70-42531
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533

ACOUSTIC EXCITATION
Sound wave radiation and excitation in plane infinite plate by vortices
A70-38722

ACOUSTIC FATIGUE
Honeycomb panels with fiber reinforced facings, obtaining acoustic fatigue design criteria
[AIAA PAPER 70-897] A70-35814
Aircraft structures acoustic fatigue testing, discussing test facilities, environment simulation, etc

A70-44329
ACOUSTIC MEASUREMENTS
Ground test noise measurements accuracy and repeatability on JT8D turbojet engine
A70-35183
Critical review of aircraft noise characteristics measurement and analysis techniques, noting nonuniformity problems control through standards
A70-37907
Automatic sound monitoring system for measuring aircraft noise in airport vicinity
A70-37908
Computer controlled aircraft noise monitoring system at Stuttgart airport
A70-37909
RMS spectrum analysis system for wideband acoustic data processing, using analog method with digital output
A70-37910
Aircraft noise sources, examining compressors with dynamic pressure devices and jets with turbulence investigations
[ICAS PAPER 70-22] A70-44111
High bypass model jet noise study, describing test setup and noise measurement results as function of secondary/primary flow velocity ratio
A70-44394
Design of test facility and prototype fan for turbofan acoustic research
[NASA-TN-D-5877] N70-32721
Portable recording instrument for measuring and surveying noise and vibration
[AD-707826] N70-40026
Noise environments within multiplace fixed-wing aircraft
[AD-708403] N70-40628
Investigating pressure fields from sonic booms transmitted into rooms through open windows
[NASA-CR-111787] N70-42168
Aircraft noise exposure forecasting procedures and applications
[FAA-NO-70-9] N70-42218
ACOUSTIC PROPERTIES
Aerodynamic and acoustic characteristics of subsonic and supersonic jets from convergent nozzles with room temperature air supply
A70-34460
ACOUSTIC SCATTERING
Aerodynamic noise scattering by semiinfinite compliant plate in turbulent flow, using Lighthill theory and Wiener-Hopf technique
A70-43968
ACOUSTIC SIMULATION
Sonic boom simulation by low pressure sources
[NASA-CR-66969] N70-33864
ACROBATICS
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics
A70-37388
ACTUATOR DISKS
Actuator disk theory and flow field calculations for propeller induced flow with nonuniform circulation distribution
[NASA-CR-1672] N70-38435
ACTUATORS
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
Boeing 2707 SST horizontal tail multiple channel actuation system features
A70-35827
Aircraft auxiliary systems and spacecraft power supplies, considering fly-by-wire control actuators, pyrotechnics and stowable solar array
A70-39669
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785
Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053
Evaluation tests on Boulton-Paul VC-10 aileron integrated flight control actuator
[AD-703471] N70-35080
Nonsteady axisymmetric flow of inviscid, incompressible fluid through heavily loaded actuator disk
[AD-708396] N70-39937
ADAPTIVE CONTROL
Characteristics of adaptive aircraft control system in self-organizing configuration
[AD-703656] N70-32921
Adaptive aircraft control concept modified for helicopters
[AD-703231] N70-34923
Adaptive aircraft control system under large input commands
[AD-705074] N70-36463
Imperfect, reduced-state relay control application to model-reference controller design
[NASA-CR-1645] N70-36916
Variable structure systems and applications to flight automation problems
[AD-706798] N70-38534
ADDITIVES
Jet engines and fuels
[AD-706167] N70-37640
ADHESIVES
Adhesive bonded aircraft structures, discussing methods and requirements for establishment and control of manufacturing procedures
A70-38594
Synthetic resin adhesives for aircraft components fabrication
A70-40532
Airframe skin panels adhesive bonding in wide-bodied jet transports, emphasizing fuselage fatigue and corrosion resistance
[SAE PAPER 700863] A70-45875
AEROBEE ROCKET VEHICLE
Integration, testing, and performance analysis of solar pointing control and telemetry system with flight experiment aboard Aerobee sounding rocket
[AD-709102] N70-40992
AERODYNAMIC BALANCE
L-1011 onboard system for gross weight and center of gravity determination, describing transducers placement, computer design and display panel
[SAWE PAPER 837] A70-40359
Concorde loadability, with comparison of flight balance situation for supersonic and subsonic aircraft, describing fuel system
[SAWE PAPER 835] A70-40365
Fighter aircraft configuration design balancing, comparing weight penalties
[SAWE PAPER 840] A70-40380
Trim changes definition, discussing exact meaning
A70-45436
AERODYNAMIC BRAKES
Ballistic trajectory, packageability, deployment and flight stability of attached ram air inflatable decelerator for high speed/low altitude store delivery
[AIAA PAPER 70-1199] A70-41817
Basket weave fabrics for gliding descent decelerators with polyurethane and nylon coatings for tearing strength and pressure packing
[AIAA PAPER 70-1180] A70-41833
Drag prediction for Ballute and parachute trailing decelerators at supersonic speed and zero angle of attack, using flow field computations
[AIAA PAPER 70-1177] A70-41836
Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837
Hypersonic aerodynamic deceleration devices for axisymmetrical bodies with cylindrical main sections and various front sections, using gun tunnel techniques
[AIAA PAPER 70-1174] A70-41839
Snatch force during lines-first deployment of aerodynamic decelerator, including effects of canopy skirt acceleration and suspension wave propagation characteristics
[AIAA PAPER 70-1171] A70-41842
AERODYNAMIC CHARACTERISTICS
Aerodynamic and acoustic characteristics of subsonic and supersonic jets from convergent nozzles with room temperature air supply
A70-34460

Compressor erosion correlation with aerodynamic parameters in gas turbine engines
A70-34711
Aerodynamic and structural considerations in prop/rotor design for tilt-rotor aircraft, discussing blade twist effect on cruise efficiency and figure of merit
A70-34719
Forcing time functions prediction for structures under shock tube test, relating aerodynamic parameters to mechanics terminology
A70-35180
Aerodynamic characteristics of transonic and supersonic blunt vehicles, reviewing numerical methods
A70-35895
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
Longitudinal dynamics of VTOL aircraft during hover-forward flight transition, using multiple time scale analysis
[AIAA PAPER 69-130] A70-36681
Transpiration cooling for high temperature gas turbines, investigating effects on aerodynamic and thermodynamic performance
[ASME PAPER 70-GT-56] A70-36839
Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors
[ASME PAPER 70-GT-106] A70-36845
Soviet book on wing structures analytical design methods covering thin supersonic wings, mass distribution, aerodynamic characteristics, etc
A70-37025
Soviet book on helicopter aerodynamics covering main rotor operation, types classification and various flight characteristics
A70-37390
High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications
[AIAA PAPER 70-904] A70-37392
Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings, giving low lift-dependent drag
A70-38615
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants
A70-39667
Reentry bodies of revolution subsonic and supersonic aerodynamic characteristics
A70-39704
Merit factor for evaluation of aircraft types and missions, matching aircraft characteristics to mission load, range and speed
[SAWE PAPER 842] A70-40360
Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces
A70-41444
All-flexible parawings aerodynamic performance prediction based on slender wing theory and circular arc approximations for canopy shape
[AIAA PAPER 70-1188] A70-41827
Transonic wind tunnel porous walls, investigating interference effects and aerodynamic characteristics
A70-42337
Aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors including dual jets and cyclic results
[AIAA PAPER 69-741] A70-42705
Horizontal flight speed effects on aerodynamic characteristics of air cushion vehicles with elliptical planform
A70-42801
Aircraft control surface aerodynamic characteristics, considering low aspect ratio wing elevons with variable sweep leading edge as longitudinal and lateral controls
[ICAS PAPER 70-26] A70-44107
Stationary elliptic cylinders in subcritical flow, determining Strouhal number, pressure fluctuations and wake geometry as functions of angle of attack
[AIAA PAPER 69-745] A70-44564
Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions
[AVA-FB-7029] A70-44668
Propeller blade aerodynamic characteristics at zero advance ratio, reducing singular integral equation to nonsingular form for computer solution
A70-44993
Aerodynamic interference effects on half-cone bodies with thin wings in hypersonic flow
[NASA-TN-D-5898] N70-32827
Performance and characteristics of single keel personnel parawings
[NASA-TN-D-5911] N70-32844
Slingshot method of mechanically setting fluids into motion with respect to models
[AD-702052] N70-32870
Variable aspect ratio and variable sweep delta wing planforms for supersonic aircraft
[NASA-CASE-XLA-00221] N70-33266
Aerodynamic characteristics associated with aircraft flight and reentry vehicles
[AD-705584] N70-33694
Wind tunnel characteristics of X-24A aircraft
[NASA-TN-D-5932] N70-34385
Wind tunnel characteristics of ejection seat scale model with rigid wing recovery system
[NASA-TN-D-5922] N70-34399
Estimating aerodynamic properties of airfoil with hinged flap and spoiler
[NASA-TT-F-13131] N70-34693
Aerodynamic characteristics of hypersonic transport configuration at Mach 6.86
[NASA-TN-D-5885] N70-34876
Annotated bibliography on ground effect machines
[AD-704800] N70-35309
Integral equation for calculating oscillations of slender wing in subsonic flow near solid ground plane
[AD-703995] N70-36285
Lift margin display for helicopter landing and takeoff operations
[AD-704601] N70-36384
Aerodynamics of turbulent diffusion flame in coaxial jets, physical model of flameholding on blunt bodies, and diffusion gas flame stability in wake of transverse air jets
[AD-700475] N70-36395
Theoretical analysis of wing lift in wide and circular stripstreams, and engineering method for predicting practical V/STOL configuration characteristics
[NASA-CR-1632] N70-36851
Aerodynamic characteristics of vehicle bodies at crosswind conditions in ground proximity
[NASA-TN-D-5935] N70-37030
Molecular reflection effects on aerodynamic characteristics of blunt bodies in rarefied gas flow
[NASA-TT-F-13250] N70-37535
Computer code for plotting wind tunnel aerodynamic data
[SC-DR-69-690] N70-39164
Outstanding problems and possible methods of solution for parachute technology in western Europe and the United States
[RAE-LIB-TRANS-1447] N70-39271
Wind tunnel measurements of flow field behind model of twin-propeller deflected slipstream STOL aircraft
[NAL-TR-197T] N70-40562
Longitudinal aerodynamic characteristics of twin-turbofan supersonic transport with nacelles mounted under wings
[NASA-TN-D-5971] N70-40689
Aerodynamic design advances for fighter aircraft
N70-40708
Wind tunnel test of canopy construction methods, design details, and canopy slots effects on aerodynamic characteristics of small scale all flexible parawings
[NASA-TN-D-5974] N70-40751
Aerodynamic characteristics of air cushion models at very low ground clearances and at free stream dynamic pressures exceeding cushion pressure

[NASA-TN-D-6011] N70-42087
Wing elevation, incidence, and chamber effects on aerodynamic characteristics of representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737

AERODYNAMIC COEFFICIENTS
Forced vortex impeller in axial flow fan without inlet vanes, presenting lift and drag coefficients of blade sections, loss of head, etc
A70-38222
Monoenergetic nitrogen free molecule beam impingement on solid surface, calculating satellite drag coefficients from momentum transfer measurements
A70-41743
Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877
Aerodynamic lift, drag and momentum coefficients in supersonic regime for rectangular and trapezoidal wings with spanwise variable profile
A70-42615
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515
Bodies of revolution optimal configuration, considering minimum head drag coefficient and low heat transfer at hypersonic speeds, using modified Newtonian and hypersonic flow theories
A70-45021
German monograph on airfoil and wings aerodynamic coefficients calculations, showing advantages of analog computers based on singularity theory and distance functions
A70-45097
Kinematically unsteady aerodynamic coefficients consistent with stiffness and inertia properties of lifting surface in supersonic flow by finite element method
A70-45154
Aerodynamic coefficients for control surface-tab coupling in subsonic, bidimensional, unsteady flow
[NASA-TT-F-12829] N70-32571
Drag coefficients from modified X-15-2 aircraft configurations at speeds up to Mach 6.7
[NASA-TM-X-2056] N70-35693
Turbulent boundary layer in adverse pressure gradient regions and distributed suction for higher aerodynamic lift coefficients
[ARC-R/M-3621] N70-37073
Lift and drag coefficient dependency on angle of attack for bisymmetric lifting vehicles
[AD-708022] N70-40037
Gas-surface interactions and orbital aerodynamic calculations
[NASA-CR-102827] N70-41375

AERODYNAMIC CONFIGURATIONS
Internal efficiency of turbine stages with long twist-varying blades
A70-37250
Digitally controlled milling machine for complex aerodynamic profiles and prismatic blades
A70-43117
Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics
A70-44991
Bodies of revolution optimal configuration, considering minimum head drag coefficient and low heat transfer at hypersonic speeds, using modified Newtonian and hypersonic flow theories
A70-45021
Thermal load of aerodynamic reentry body and resulting optimization and design criteria
[SC-T-70-4015] N70-33249
Short length combustor and diffuser configuration for supersonic cruise turbofan engine
[NASA-CR-72734] N70-33771
Supersonic aircraft configuration providing for variable aspect ratio and variable sweep wings
[NASA-CASE-XLA-00166] N70-34178
Aerodynamic configuration for aircraft capable of high speed flight and low drag for low speed takeoff or landing upon presently existing airfields
[NASA-CASE-XLA-00806] N70-34858
Aerodynamic characteristics of hypersonic transport configuration at Mach 6.86
[NASA-TN-D-5885] N70-34876
Surface pressure measurements of wing immersed in propeller slipstream
[NAE-LR-525] N70-35551
Spinning behavior and recovery from developed 60 degree spin of delta wing aircraft configuration using high speed digital computer
[WRE-TN-HSA-137] N70-36966
Aerodynamic design and calibration of thermal acoustic jet facility-cold flow duct
[NASA-TM-X-53907] N70-37529
Quasiconformal mappings in space
N70-39251
Forces and moments induced on VTOL aircraft wing by intake and jet stream effects of two lift fan configurations
[NASA-TT-F-13277] N70-39849
Aerodynamic testing at subsonic speed on conical configurations using magnetic system
[AD-709197] N70-41721
Wing elevation, incidence, and chamber effects on aerodynamic characteristics of representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737
Rotor/wing concept of stopped-rotor helicopter configuration
[AD-710425] N70-43132

AERODYNAMIC DRAG
Aft tail and canard configurations trim drag considerations for maneuvering aircraft
[AIAA PAPER 70-932] A70-35842
Close-spaced nozzles twin jet configuration, achieving low nozzle and total afterbody drag
[AIAA PAPER 70-934] A70-35844
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results
[AIAA PAPER 70-971] A70-39558
Streamers /drag devices/ tests at subsonic speeds, measuring drag dependence on size, weight, shape and velocity
A70-40282
Low drag supersonic compressors for aircraft engines, calculating start and cruise conditions of quasi-isentropic flow cascades
A70-41405
Dust content effect on hypersonic wind tunnel flow test results, noting drag force on slender and blunt nosed models
A70-42224
Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments
[ICAS PAPER 70-08] A70-44119
Strike fighter aircraft fuselage side air intakes, measuring external drag as function of design at subsonic and supersonic speeds
[ICAS PAPER 70-49] A70-44146
Aerodynamic drag and local convective heat transfer on smooth plate for various flow velocities, determining effects of turbulator in boundary layer transition region
A70-44733
Thermal flux surface distribution lifting bodies, discussing aerodynamic efficiency dependence on drag and zero angle of attack Mach number
A70-45019
Flow rates of slotted engine intakes in upper wing surface
[LR-526] N70-35142
Drag coefficients from modified X-15-2 aircraft configurations at speeds up to Mach 6.7
[NASA-TM-X-2056] N70-35693
Scaling and Reynolds number effects on predicting drag from tests on wind tunnel models
N70-37757
Measurement of sphere drag coefficients in nearly free molecule flow regime
[NAL-TR-191] N70-40442

AERODYNAMIC FORCES
Parameter model of VTOL airplane in transition, considering aerodynamic forces and moments and digital simulation

A70-34724
Unsteady aerodynamics prediction of supersonic elastic aircraft, discussing aerodynamics influence coefficients /AIC/ method refinement
[AIAA PAPER 70-944] A70-39583
Asymmetric rotating bodies mass properties measurement on Dynamic Balancing Machine, taking into account aerodynamic forces
[SAWE PAPER 818] A70-40351
Parachute canopy surfaces transient aerodynamic pressures during unsteady processes, using piston theory
[AIAA PAPER 70-1175] A70-41838
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack
A70-42284
Harmonically oscillating wing linearized motion in subsonic flow, calculating generalized aerodynamic forces
A70-43118
Liquid droplet breakup by aerodynamic forces, obtaining solutions for fluid flow inside droplet and in coupled liquid-gaseous boundary layer
A70-43741
Glauert equations applied to trailing wire shape for steady state aerodynamic forces on aircraft and trailing antennas, discussing computer solutions
A70-43893
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow
[ICAS PAPER 70-03] A70-44117
Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129
Aerodynamic forces and torque on airfoil in potential jet from boundary asymptotes position, determining flow characteristics by electrical analogy
A70-45438
Turbine blades aerodynamic forces theoretical and experimental investigation, noting cascade series interaction induced pressure pulsations
A70-45504
Turbine blades deformation by centrifugal and aerodynamic forces, discussing theory for bending stress free blade design
A70-45505
Determining unsteady aerodynamics of two dimensional jet flap wing
[AD-704722] N70-33274
Force and moment impulses experienced by slender wings in unsteady flow
[NASA-TT-F-13066] N70-34048
Free flight measurement of aerodynamic lateral force and moment coefficients on bombs with freely spinning cruciform and monoplane tails and fixed split skirts
[WRE-TN-HSA-162] N70-36045

AERODYNAMIC HEAT TRANSFER
Stagnation point heat transfer coefficient to elliptical model taking into account pressure, model blunting and diameter, Mach number, etc
A70-39699
Charring ablators transient heat transfer model, calculating surface temperature and recession and pyrolysis mass loss
[AIAA PAPER 70-1143] A70-40280

AERODYNAMIC HEATING
Laminar heating in hypersonic vehicles interior corners, analyzing helium tunnel heat transfer data for various intersecting wedge corners
A70-39700
Thermal flux surface distribution lifting bodies, discussing aerodynamic efficiency dependence on drag and zero angle of attack Mach number
A70-45019
Thermal load of aerodynamic reentry body and resulting optimization and design criteria
[SC-T-70-4015] N70-33249
Convective heat transfer to cones and cylinders at angle of attack
[NASA-CR-102824] N70-37466

AERODYNAMIC LOADS
Subsonic and supersonic aircraft dynamic loads under conditions of variable atmospheric density
A70-34685
Helicopter rotor blade differential pressure and structural load characteristics in transient and steady state maneuvers
A70-34739
Wind tunnel balance for measuring small aerodynamic loads on scale models, describing three component construction
A70-35490
Flight loads data extraction and analysis from damaged magnetic tapes after aircraft crash
A70-35518
Flight loads spectrum data for army CH-47A, UB-1B and CH-54A helicopters components compared with fatigue life spectra
A70-35955
Water ballast effect on glider loads, using concept of characteristic velocities
A70-36253
Structural reliability testing methods and loads prediction for rotary wing vehicle components, considering AH-56A compound helicopter
A70-38612
Concorde loadability, with comparison of flight balance situation for supersonic and subsonic aircraft, describing fuel system
[SAWE PAPER 835] A70-40365
Supersonic jet force acting on target investigated for air and argon using dimensional analysis
A70-40515
Oscillating wing aerodynamic load boundary value problem reduction to sequence of steady lifting-surface problems
A70-42715
Parachute trajectory and opening load prediction based on inflation process and added mass, determining drag area as function of distance
[AIAA PAPER 70-1168] A70-43993
Parachute opening load amplification due to suspension line elasticity, using two-body spring- mass model
A70-44531
Short-term creep and erosion resistance testing of Ti alloy in high speed air flows under aerodynamic vibrations
A70-45826
Directed fluid stream for propeller blade loading control
[NASA-CASE-XAC-00139] N70-34856
Prediction of steady and unsteady airloads on space shuttles
N70-36607
Aerodynamic nonlinearity and turbulent boundary layer effects on hypersonic panel flutter
[NASA-CR-112668] N70-36902
Wind tunnel test data for predicting aerodynamic loads on single engine light aircraft
N70-39253
Mathematical model of rotary wing aircraft for performance, stability, response, and rotor blade load characteristics determination
[AD-707881] N70-39729

AERODYNAMIC NOISE
Laminar boundary layer transition on sharp cone at zero yaw in supersonic wind tunnels, correlating aerodynamic noise disturbances with transition Reynolds numbers
[AIAA PAPER 70-799] A70-34462
Collection of papers on aerodynamic noise covering noise generation, solid boundaries effect, strength distribution, jet noise, perturbation theory, etc
A70-35448
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Flow noise mechanisms, considering discharge, propeller, ventilator, jet engine, boundary layer, water pipe and supersonic aircraft sources
A70-38474
Soviet papers on physics of aerodynamic noise covering axial compressors noise spectra, air intake wall design effects, surface roughness effects, air jets, etc

A70-38651
Discrete components formation in noise spectra of axial turbocompressor intake, considering relationship between blades and rotor disk
A70-38652
Rod surface roughness effect on eddying sound frequency and intensity and on aerodynamic resistance
A70-38654
Supersonic air jet noise spectrum analysis at various pressures
A70-38659
Supersonic air intake unsteady buzz phenomenon, examining shear layer under cowl and boundary layer detachment at shock wave base for design improvement
A70-41262
Sound generation by fluctuating subsonic jet flow, considering field directional characteristics and sound pressure variations with Mach number
A70-41422
Aerodynamic noise scattering by semiinfinite compliant plate in turbulent flow, using Lighthill theory and Wiener-Hopf technique
A70-43968
Lighthill aerodynamic noise theory fundamental equation for acoustic field density distribution, determining flow fields for surfaces in uniform translational motion
A70-45268
Reducing aerodynamic noise and blade-vortex interaction by modifying tip vortex of helicopter rotors
[AD-704804] N70-32556
Space shuttle buffeting and aerodynamic noise
N70-36608
Instability of two dimensional compressible jet
[AD-707257] N70-37667
Summaries of research in aerodynamic noise
N70-38121
Response of acoustically loaded panel excited by supersonically convected turbulence
[NASA-CR-113879] N70-41029
Aerodynamic measurements of radiated noise from sailplanes
[AD-709689] N70-41268
Local pressure field in turbulent shear flow and its relation to aerodynamic noise
[NASA-CR-113881] N70-41283

AERODYNAMIC STABILITY
Aerodynamic stability of branched diffuser systems used in annular combustors of gas turbine engines
[ASME PAPER 70-GT-27] A70-36868
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter
A70-38342
Spike effect on nose drag and static stability of blunt bodies, estimating optimum length for drag reduction at zero angle of attack
A70-39702
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515
Aeroelastic and aerothermoelastic development of winged interorbital space shuttle concerning panel flutter, stability and nonstationary lifting surface theory
A70-44760
Aeroelastic stability for circular cylindrical structures under periodic Karman vortex excitation
A70-44764
Aerodynamic interferences of lifting surfaces harmonically vibrating in subsonic flow
A70-44765
Newtonian aerodynamic coefficients for predicting hypersonic stability characteristics of reentry bodies with various heat shield, afterbody angle and edge geometries
[NASA-TM-X-64332] N70-34532
Using oscillatory aerodynamic theory for calculating dynamic stability derivatives with respect to unsteady lifting surface theory
N70-35873
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems
[NASA-TM-X-52876] N70-37826
Longitudinal aerodynamic stability of three hypersonic aircraft at Mach numbers from 0.065 to 10.70
[NASA-TM-X-2113] N70-42574

AERODYNAMIC STALLING
Helicopter blade sections dynamic stall characteristics, considering accelerated flow generation by nonzero pitch rate
A70-34718
Helicopter rotor blade stall flutter response prediction based on NACA 0012 airfoil aerodynamic data
A70-34734
Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate
A70-36194
Dynamic airfoil stall simulation in wind tunnels, considering pitch rate, Reynolds number, oscillation and test equipment effects
[AIAA PAPER 70-945] A70-39582
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack
A70-42284
Boundary layer calculation on airfoil leading edge separation during stall
[AD-701771] N70-34290
Aerodynamic model for calculating airloads and blade motion of helicopter rotor blades
[AD-707939] N70-39885
Air jet injection through slot at inlet for delaying stall of conical diffuser
[RR-14] N70-40472

AERODYNAMICS
External aerodynamics role in handling qualities of amphibious hovercraft, discussing tests of hull shape, air cushion efflux and hollow models
A70-34919
Aerodynamics theory for separated flow effects on helicopter lift-drag capability, taking into account three dimensional flow and blade aeroelasticity
A70-35956
Significant terms in equations of motion for parachutes inflating in free air and in wind tunnel experiments
[AIAA PAPER 68-924] A70-36449
Soviet book on passenger aircraft aerodynamics covering motions of gases and immersed bodies, similarity laws, boundary layer theory, finite span wing, etc
A70-36507
Thin airfoil theory in magnetoaerodynamics, considering steady two dimensional flow of compressible perfectly conducting inviscid fluid in presence of uniform magnetic field
A70-37597
Soviet papers on kinetics and aerodynamics of fuel combustion processes covering supersonic flow, flame stabilization, fluid atomization, nonequilibrium recombination, etc
A70-39265
Liquid jets aerodynamic atomization at orifice exit in reentry vehicle into gaseous crossflow, investigating critical Weber number variation with Knudsen number
A70-39701
Aerodynamics of steady, inviscid transonic flows around slender bodies and wing-body combinations at free stream Mach number one
[AIAA PAPER 70-798] A70-39900
Large MHD generator channel aerodynamics, discussing pressure distributions to stall and stagnation pressure loss
A70-40002
Newtonian hypersonic aerodynamic theory for arbitrary bodies, discussing computational difficulty for shadowed areas
A70-41866
Supersonic aerodynamic design tools, discussing technological application of high speed computer and limitations
[AIAA PAPER 68-1018] A70-42701
European wind tunnels suitable for Post Apollo Program aerodynamic testing, presenting detailed tabulated information on available facilities

A70-43503
European hypersonic aerodynamic research activities, describing Eurohyp program
A70-43507
Aerodynamic theory of pressure field induced on lifting surface by isotropic atmospheric turbulence, considering transfer function of Concorde aircraft
[ICAS PAPER 70-30] A70-44104
Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades
[ICAS PAPER 70-14] A70-44125
Unsteady aeromechanics and problems with large aircraft at near sonic speed
N70-37755
Research in subsonic aerodynamics
N70-38122
Israeli conference on aeronautics and astronautics, including aerodynamics, aircraft structures, propulsion, and flight control
[AD-707326] N70-39737
Aerodynamic holography
[AD-709764] N70-42551

AEROELASTICITY
Aeroelastic test equipment for Concorde SST using harmonic method and electromagnetic shakers
A70-38548
Unsteady aerodynamics prediction of supersonic elastic aircraft, discussing aerodynamics influence coefficients /AIC/ method refinement
[AIAA PAPER 70-944] A70-39583
Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem
A70-43362
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A70-44157
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A70-38634
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A70-38642
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A70-38643
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A70-38644
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A70-38645
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A70-38646
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A70-41347
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Air traffic control/collision avoidance systems design analysis
N70-40931
Use of computers in air traffic control
N70-41043
Engineering survey and analysis of en route ATC radar/display system errors
[FAA-NA-70-14] N70-41207
Air transport and control problems of Washington DC area
N70-41438
National aviation system planning review conference, including air traffic control,

airport planning, airspace capacity, and ILS development
N70-41526
Federal flight inspection of navigation systems and air traffic control facilities
N70-41531
Reduced terminal IFR separation standards and runway spacings
N70-41532
Control zone establishment for instrument approaches
N70-41533
Collision avoidance systems in air traffic control
N70-41535
Increased enroute air traffic capacity through increased control sectorization
N70-41536
Air traffic control data acquisition concepts
N70-41538
Operational air traffic control considering several optimality criteria
[NASA-TT-F-13276] N70-41884
Ultrahigh frequency air traffic control satellite simulation experiment using high altitude balloons
[NASA-TM-X-65348] N70-41942
System of positioning aircraft by Doppler effect for air traffic control
[NASA-CASE-GSC-10087-4] N70-41978
Hearing on FAA development of air traffic control system for 1970s
N70-42655

AIR TRANSPORTATION
Computerized air transportation service including passenger name record, fare quotation, ticketing, etc
A70-34688
Polish Lot airline long haul air transportation cost analysis
A70-34689
Long haul air transportation profitableness based on Polish Lot airline ton passenger-km computation comparison
A70-34691
Computerized metropolitan air transit system, discussing system redundancy for safety level maintainance and all-weather dependability
A70-34730
Power plant efficiency, size, maintenance and operating economics of propulsion systems for air transport
A70-34917
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers
[AIAA PAPER 70-899] A70-35815
Air transportation growth with regularity and safety - Conference, London, November 1969
A70-35851
Air transport operations and economics in 1970 decade, taking into account cost-revenue ratio and cost effectiveness of various aircraft
A70-35852
Air cargo transport growth, considering deterrents of high freight rates, ground movement time and customs clearance
A70-35853
ATC lag due to air transport growth and associated aircraft design and operations advances, discussing automation, noise abatement effects, etc
A70-35857
Mass air transportation, discussing aircraft characteristics, traffic growth, scheduling, passenger and cargo handling, etc
A70-36656
Legal aspects of suborbital space transports based on air transportation concepts
A70-36661
National air transportation systems approach, emphasizing data acquisition, methodology, planning and policy making
[SAE PAPER 700337] A70-36796
Corporate-executive market for helicopters related to fixed wing business air transportation problems
[SAE PAPER 700285] A70-36814
V/STOL short haul air transportation program in western U.S., assessing public acceptance and economic viability
[AIAA PAPER 70-888] A70-37394
Air freight carrier liabilities in passenger transportation international regulations, noting conflicting interpretations
A70-37562
International civil aviation, discussing ICAO functions, airports and terminal facilities problems
A70-37748
International transportation regional hub airport planning with spin-off parking, circular terminal facilities and high speed interterminal passenger and baggage controls
A70-39673
Aviation in 1970s, discussing traffic increase, airport planning, aircraft design, ballistic transport, noise factors, etc
A70-40157
Air transport regulatory system, considering operational, technological and economic factors
A70-40579
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
Inertial navigation system application to air transportation, discussing system mechanization and compatibility with ATC requirements
A70-42654
Air transport system technical and operational functions optimization
A70-43532
Long range air transport routes, predicting equipment and expenditures modifications
A70-43533
Space systems supporting international air transportation growth, discussing UHF satellite R and D programs on beam antennas
[SAE PAPER 700760] A70-45870
Short haul intercity center facilities air transportation traffic alleviation by VTOL aircraft, emphasizing performance, ground facilities, system operation and economics
[AIAA PAPER 70-1243] A70-45914
U.S. western region short haul air transportation, discussing demand, modal split, STOL and VTOL aircraft, avionics and ground systems
[AIAA PAPER 70-1284] A70-45915
Air transportation beyond 1970, discussing general aviation, short haul systems, STOL, helicopter, V/STOL, subsonic, supersonic and hypersonic aircraft
[AIAA PAPER 70-1262] A70-45918
Planning criteria for optimum metropolitan airport system considering operational, physical, social and economic factors
[AIAA PAPER 70-1266] A70-45921
Airport planning for air transportation in underdeveloped nations, discussing economic, financial, technical and operational factors
[AIAA PAPER 70-1268] A70-45926
Short haul metropolitan air transportation, considering systems engineering as unifying technology
[AIAA PAPER 70-1281] A70-45927
FAA airport and airway capacity improvement program, considering runway-taxiway configurations, surface guidance and control, terminal design, takeoff, approach and landing systems, etc
[AIAA PAPER 70-1315] A70-45946
Demand analysis data generation for V/STOL systems suitable for New York-Philadelphia- Washington business travel market, applying model to selected designs
[AIAA PAPER 70-1241] A70-45961
Air traffic control, future national airspace system improvements in view of air transportation growth, computerized automation technology, etc
[AIAA PAPER 70-1263] A70-45969
STOL aircraft operational constraints, considering economics, short haul market characteristics, community acceptance, speed, propulsion system, takeoff/landing performance and maneuverability
[AIAA PAPER 70-1283] A70-45972

TRANSOP computer program for determination of transportation equilibrium supply and demand levels
[PB-190936] N70-34622
Northeast Corridor transportation facts and data
[PB-190932] N70-34691
Transportation system status and plans for improving intercity transportation in Northeast Corridor
[PB-190931] N70-34741
Unit cost and performance data for US transport aircraft during 1967 and 1968
N70-35380
Senate hearing on improvement and future development of airports and airways
N70-35740
Planning and financing improvements to air transportation system
[H-DOC-91-130] N70-36073
Economic effectiveness of aircraft transportation systems
[AD-703162] N70-36309
Social costs and benefits from Northeast corridor transportation system
[PB-190944] N70-36515
Public address on air transport development
N70-36636
Transportation requirements survey for Northeast Corridor
[PB-190930] N70-36810
Cost analysis for Northeast Corridor transportation system air and highway modes
[PB-190943] N70-36811
Canadian research in science and technology
N70-38116
Bibliography on air travel demand, airport configurations, flow patterns, and ground transportation systems
[AD-708023] N70-40109
Testbed development for evaluating tactical airlift capability
[AD-708722] N70-40276
Statistical analysis of peak day instrument flight rules departures from FAA operated terminals
[AD-710762] N70-40765
Short haul STOL and VTOL air transportation systems study
N70-41032
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
Planning for STOL air transportation system
N70-41086
Predicted wide bodied jet aircraft impact on air transportation system, including Boeing 747, DC 10, and L-1011
N70-41142
Activities of National Transportation Safety Board for 1969
N70-41227
Problems that must be resolved for air transport industry to meet challenges from 1970 to 1975
N70-41394
Air transport and control problems of Washington DC area
N70-41438
Auxiliary lift system providing transportation means for HL-10 reentry vehicle
[NASA-CASE-LAR-10574-1] N70-41958

AIRBORNE EQUIPMENT

Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs
A70-34713
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721
Humidity resistance test method involving flight simulation for airborne equipment in tropical environment
A70-35159
DC-10 airborne flight test PCM data system, discussing capability, onboard operating characteristics and test results
A70-35498
Airborne data acquisition and flight recorder systems, comparing civil and military aircraft requirements
A70-35515
S band CW power amplifier and varactor doubler module for airborne phased arrays
A70-36674
ATC airborne surveillance, communication and control system functioning as CAS after error or failure, discussing minimum parallel runway separation
A70-38241
Boeing 747 transport airplane flight test data system, discussing recording media, major PCM and FM tape systems, etc
A70-38531
Airborne navigation systems operational aspects in ATC, discussing sensors, digital computer, cockpit displays, etc
A70-38640
Airborne electronic equipment, collision avoidance systems, displays, instrumentation, human response and ground based control in air traffic control
A70-39198
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-41257
Aircraft-borne and descent systems performance and weight optimized for midair retrieval
[AIAA PAPER 70-1201] A70-41805
Airborne data acquisition equipment for accident flight path and engine performance recording
A70-41922
Airborne three dimensional area navigation equipment for reducing mid-air collision exposure and for raising landing safety in terminal areas
A70-42296
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-43888
Microwave radiometric airborne measurement of salinity of Mississippi River outflow, using P3A aircraft
A70-45979
Aircraft electrical power systems optimization
[NASA-CR-86410] N70-32051
Aircraft electrical power systems optimization - electric power load supply equipment
N70-32052
Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053
Aircraft electrical power systems optimization - maintainability tradeoff with equipment cost and weight
N70-32054
Aircraft electrical power systems optimization - weighted factors for systems effectiveness
N70-32055
Aircraft electrical power systems optimization - failure prediction, detection, and compensation
N70-32056
Development of effort expended on automatic test equipment for avionics systems
[AGARD-CP-51] N70-32151
Operational requirements for airborne automatic test equipment
N70-32152
Real time measurement of aircraft parameters as part of airborne integrated data system to improve aircraft maintenance
N70-32157
Testing of airborne avionics systems using computer subroutines
N70-32175
Test techniques used for state-of-the-art airborne infrared equipment
N70-32176

Automatic testing of landing aid for VTOL aircraft N70-32177
Test equipment for airborne identification friend/foe interrogators and transponders N70-32179
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft N70-40784

AIRBORNE/SPACEBORNE COMPUTERS
Military aircraft avionics central digital computers, discussing memory capacity, computational speed requirements, cost and tradeoffs A70-34673
Digital computer technology impact on advanced aircraft design, discussing airborne computers, distributed and lumped computer systems, outer loop control, engine control and system integrity A70-34993
Real time computers design tradeoffs in avionics systems A70-35510
Integrated flight management system for commercial aircraft pilot using computer
[AIAA PAPER 70-908] A70-35820
STOL navigation systems, evaluating Vector Analog Computer, Decca Omnitrac IIB and inertial system A70-36513
Aero gas turbine engines digital computer control, discussing special properties, design and safety problems
[ASME PAPER 70-GT-40] A70-36870
Computerized airborne integrated data acquisition and analysis system, discussing hardware, software and airborne-ground elements interfaces
[AIAA PAPER 70-935] A70-37393
Economic payback of AIDS /Aircraft Integrated Data System/ recording for operational performance monitoring and engine analysis A70-37894
Military Airlift Command jet aircraft computerized area navigation system operational procedures A70-38232
Jaguar flight test data processing system, discussing airborne digital computer A70-38536
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests A70-38547
V/STOL aircraft automatic flight control, guidance and navigation by onboard computer, discussing mathematical model and simulation results
[AIAA PAPER 70-1035] A70-39502
Digital fail-operative flight control computers for automatic landings, describing system requirements and problems and flight test program
[AIAA PAPER 70-1032] A70-39505
Pilot/vehicle feedback systems with flight director computer for transport aircraft longitudinal control during landing, discussing design by manual control displays theory
[AIAA PAPER 70-1001] A70-39530
High performance aircraft self adaptive feedback control system, using airborne digital computer with inputs of elevator deflection and pitch rate for effectiveness identification A70-40119
Airborne digital computers in aircraft systems, discussing optimization, design and economic effectiveness A70-41920
Airborne computerized time frequency systems for aircraft range and velocity determination, using stable clocks with ambiguity resolution A70-42659
Avionics digital computer system using associative memory for executive control functions implementation to mechanize task assignment algorithm A70-43105
Airborne/spaceborne computer systems engineering, including digital techniques, design tradeoffs, man machine interfaces, display devices, memory, microprogramming, packaging, and maintainability
[AGARDOGRAPH-127] N70-39489
Modular computer systems architecture for avionic and aerospace applications N70-39496

AIRCRAFT
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals A70-34686
Aircraft capabilities as scientific observation platform in astronomy and geophysics, including instrument adaptation and IR absorber problems A70-43146

AIRCRAFT ACCIDENT INVESTIGATION
Flight loads data extraction and analysis from damaged magnetic tapes after aircraft crash A70-35518
Aircraft accident prevention and investigation, noting economic factors as deterrent to safety measures implementation A70-35860
Flight data recording systems for accident investigation and operational purposes, discussing U.S., British and French regulations A70-36341
Flight/accident data recorders and associated equipment for civil and military aircraft requirements A70-36342
Airborne crash recorders objectives, design and features ensuring crash survival of recordings A70-38518
Flight recorder role in aircraft accident investigation and prevention, noting audio instruments and data recovery A70-38613
Aircraft nighttime and daytime accident rate comparision, considering darkness, flight phase, etc A70-41489
Aircraft accident filing system data analysis using Fortran programs A70-42880
Soviet civil aircraft-bird collisions, stressing hazard forecast and prevention by bird identification and migration patterns A70-45644
Corporate/executive aircraft accident briefs in US general aviation
[PB-190409] N70-34525
Briefs of aircraft accidents involving missing aircraft for 1967
[PB-190412] N70-34571
Aircraft accident briefs involving alcohol as cause factor in 1967 US general aviation
[PB-190413] N70-34576
Statistical summary of corporate/executive aircraft accidents in 1964-1968 US general aviation
[PB-190408] N70-34643
Aircraft accident report for Allegheny Airlines CV-440 near Bradford, Pennsylvania, 6 Jan. 1969
[NTSB-AAR-70-10] N70-35760
Aircraft accident investigation of Convair 880 on takeoff from Moses Lake, Washington
[NTSB-AAR-70-11] N70-36031
Aircraft accident investigation occasioned by improper application of automatic-coupled instrument landing systems
[NTSB-AAR-70-2] N70-36043
Scandinavian aircraft accident investigation and subsequent recommendations
[NTSB-AAR-70-14] N70-36114
Accident of private aircraft near Upland, California - investigations and subsequent recommendations
[NTSB-AAR-70-13] N70-36116
Aircraft accident report for DC-3 near Lone Pine, California on Feb. 18, 1969
[PB-189650] N70-37177
Aircraft accident report for Convair 580 near Bradford, Pennsylvania on Dec. 24, 1968
[PB-189649] N70-37196
Aircraft accident investigation of De Havilland Heron 114-2 crash in mountains of Puerto Rico during ILS approach to San Juan airport
[PB-191991] N70-37334
Accident report data for FH-227C aircraft number N380NE
[PB-191201] N70-37453

Accident investigation of Boeing 707 crash during simulated landing approach
[PB-191318] N70-37486
Accident investigations of Beechcraft and Piper aircraft
[PB-192067] N70-37551
Accident investigations of Cessna aircraft
[PB-192068] N70-37552
Accident investigations of Aero Commander, Beechcraft, Cessna, and Piper aircraft
[PB-192069] N70-37553
Accident investigation of civilian aircraft
[PB-192070] N70-37554
Accident investigation for Sikorsky S-61L in Paramount, California, 22 May 1968
[PB-189143] N70-38226
Civil aircraft accident investigation of collision near Fiarland, Indiana
[NTSB-AAR-70-15] N70-38243
Investigating aircraft accident during incorrect approach maneuver by pilot in mountainous terrain
[NTSB-AAR-70-12] N70-38644

AIRCRAFT ACCIDENTS
European requirements for aircraft accident and maintenance recording systems A70-35517
Bird strikes in U.S.S.R., discussing frequency, damage, etc A70-35986
Birdstrikes as aircraft hazard, discussing structural damage, engine ingestion and various countermeasures A70-36319
Aircraft in-flight and post crash fire protection developments, considering controlled flammability fuel systems and fire fighting methods
[ASME PAPER 70-GT-109] A70-36847
Flight data recording system /FDRS/ for crashes expanded to aircraft integrated data system /AIDS/ for airlines A70-37893
ATA Collision Avoidance System based on time and frequency synchronization via ground stations or other aircraft A70-38239
U.S. Army rotary wing mishap experience for product assurance and accident prevention A70-38825
Aircraft systems safety requirements, consisting of accident probability, confidence level and demonstration test period A70-38840
Airborne data acquisition equipment for accident flight path and engine performance recording A70-41922
Soviet monograph on collision hazards between aircraft and birds covering accidents, damage and preventive measures A70-44099
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects A70-44456
In-flight escape systems and survival equipment reliability in U.S. Navy ejections A70-44460
Briefs of accidents involving amateur/home built aircraft occurring in 1967
[PB-190410] N70-34630
Accident briefs on midair collisions of United States general aviation - 1967
[PB-190411] N70-34684
Fire extinguishing in large cargo aircraft
[FAA-RD-70-42] N70-36871
Aircraft accident investigation of De Havilland Heron 114-2 crash in mountains of Puerto Rico during ILS approach to San Juan airport
[PB-191991] N70-37334
United States of America accident briefs on civil aviation
[PB-188859] N70-37606
Douglas DC-3 accident report - New Orleans International Airport
[PB-189376] N70-37607
Statistical analysis of United States of America civil aviation accidents - 1969
[PB-189247] N70-37608
Display research for aircraft collision warning systems
[NASA-CR-113886] N70-41493

AIRCRAFT ANTENNAS
Glauert equations applied to trailing wire shape for steady state aerodynamic forces on aircraft and trailing antennas, discussing computer solutions A70-43893
Crossed slot antenna array for very high frequency aircraft communication with satellites
[AD-705170] N70-32481
Stub and frame antennas for flight vehicles
[JPRS-50690] N70-32902

AIRCRAFT APPROACH SPACING
Heavy jet effect on airport acceptance rates, discussing various sequencing strategies A70-36209
Maximum throughput-rate capacity for runway and final approach path airspace involving multiple IFR landings A70-38235
Airport capacity analysis for terminal areas, using simulation for alternatives to parallel runway operation A70-38236
ATC airborne surveillance, communication and control system functioning as CAS after error or failure, discussing minimum parallel runway separation A70-38241
IFALPA views on ATC services, emphasizing aircraft approach spacing in North Atlantic airways A70-38632
Reduced terminal IFR separation standards and runway spacings N70-41532

AIRCRAFT BRAKES
SST electrohydraulic primary and standby brake control systems, discussing design and advantages
[AIAA PAPER 70-913] A70-35825
Attached inflated BALLUTE /balloon-parachute/ for stabilization and retardation of aircraft stores, high altitude descent devices and planetary entry vehicles
[AIAA PAPER 70-1200] A70-41816
Drag prediction for Ballute and parachute trailing decelerators at supersonic speed and zero angle of attack, using flow field computations
[AIAA PAPER 70-1177] A70-41836
Snatch force during lines-first deployment of aerodynamic decelerator, including effects of canopy skirt acceleration and suspension wave propagation characteristics
[AIAA PAPER 70-1171] A70-41842
Congressional testimony on falsification of data from laboratory tests of brakes for A-7D aircraft N70-36152
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
Performance of aircraft arresting gear with steel cable energy absorbers
[AD-708760] N70-40298

AIRCRAFT CARRIERS
S-3A carrier based ASW weapons system, discussing onboard equipment, navigation, avionics integration, etc
[AIAA PAPER 70-882] A70-35802
Versatile Avionic Shop Test maintenance system supporting avionic equipment aboard aircraft carriers A70-40772
Statistical data tables on commuter air carrier operators N70-41172

AIRCRAFT COMMUNICATION
Aircraft digital interior communication systems, combining multiplexing techniques with solid state integrated circuits technology and systems integration
[SAE PAPER 700302] A70-36813
Aircraft streamer /spark/ discharges formation, waveforms and RF noise levels, using mathematical model for electric field strength A70-38179

IATA policy on future ATC development, discussing controlled airspace, communications and radar requirements A70-38630
Electromagnetic interference in aircraft communication due to jet engine charging, considering various prevention measures A70-39724
Integrated communication, navigation and identification for worldwide needs of military aircraft A70-41132
Automated airline communications system for collecting, analyzing, storing, transmitting, receiving and presenting information required by ATC and advisory services A70-41347
Airframe and systems design optimization for aeronautical communications systems, considering airplane configurations, structural and electronics technology A70-41349
Airport and air route radar surveillance, beacon systems, microwave links and instrument landing systems, discussing transmission and reception problems A70-43486
Satellite technology applications to ATC, including communications, navigation, surveillance over water and data acquisition
[AIAA PAPER 70-1301] A70-45922
Multichannel interior communication system using time multiplexing, applicable to modern aircraft
[AD-706723] N70-37740
Reduction of precipitation effects on Omega aircraft receivers
[AD-707710] N70-40129
Aeronautical satellite communication, navigation, and surveillance N70-41527

AIRCRAFT COMPARTMENTS
Automatic air conditioning systems for hermetically sealed aircraft cabins, deriving control laws for air pressure, temperature and humidity A70-39843
Flame resistant nonmetallic materials for manned spacecraft and aircraft interiors, considering fibers, polymers, paper and composites A70-42295

AIRCRAFT CONFIGURATIONS
Structural weight reduction and increased aerodynamic efficiency in aircraft design by including flight control technology early in configuration development phase
[AIAA PAPER 70-874] A70-34817
Sonic boom minimization through airstream alteration by force or heat fields and aircraft body shaping
[AIAA PAPER 70-903] A70-35817
Air to air armament selection effect on aircraft configuration
[AIAA PAPER 70-939] A70-35848
Lower bounds for sonic boom, considering negative overpressure region in configuration tailoring A70-36456
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics A70-37388
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369
Airframe and systems design optimization for aeronautical communications systems, considering airplane configurations, structural and electronics technology A70-41349
SST configurations minimizing sonic booms obtainable for given length and weight
[ICAS PAPER 70-23] A70-44110
Aircraft geometry effects on longitudinal flight characteristics calculations, noting wing aspect ratio and horizontal tail changes A70-45437
Noise reduction regulations effects on subsonic transport design and configuration
[SAE PAPER 700806] A70-45876
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957
Hot gas recirculation measurements on four different-size models of simple VTOL configuration
[NASA-TT-F-12604] N70-32535
Aircraft dynamic wheel load effects on airport pavements
[FAA-RD-70-19] N70-32560
Variable sweep wing configuration for supersonic aircraft
[NASA-CASE-XLA-00230] N70-33255
Digital computer program for aircraft configuration plotting
[NASA-TM-X-2074] N70-39376
Analysis of bending loads of hypersonic aircraft
[NASA-TM-X-2092] N70-40808
Wing root shapes and pressure distribution of swept wing aircraft configurations at supersonic speeds
[ARC-CP-1109] N70-43087

AIRCRAFT CONTROL
DC 8 Super 63 aircraft direct lift control flight evaluation A70-35496
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
C-5A aircraft six wheel main landing gear bogie pitching control, emphasizing braking torque compensating mechanism design
[AIAA PAPER 70-914] A70-35826
Concorde aircraft man machine simulation and handling using fixed cabin, variable stability and ground based simulators
[AIAA PAPER 70-923] A70-35834
In-flight evaluation of selected aircraft pilots controllers, noting role in design
[AIAA PAPER 70-925] A70-35836
Aft tail and canard configurations trim drag considerations for maneuvering aircraft
[AIAA PAPER 70-932] A70-35842
Airplane stability and control technology, considering flight research, flying qualities, compressibility and aeroelastic phenomena A70-36441
Necessary and sufficient conditions for optimal control law existence for model following system, discussing applications to aircraft control A70-36443
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes A70-37403
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy A70-38365
Self navigation feasibility in future mass air traffic flow control A70-38643
Bobweights effects on pilot induced oscillations, noting role in flying qualities and control system design
[AIAA PAPER 70-1002] A70-39529
Turbulence effects on lateral directional flying qualities, examining pilot task performance, control workload and compensatory behavior
[AIAA PAPER 70-998] A70-39533
Sensitivity optimization for linear optimal control systems design, describing aircraft lateral-directional control case study
[AIAA PAPER 70-962] A70-39567
Free wing aircraft dynamic characteristics, discussing gust alleviation and handling qualities
[AIAA PAPER 70-947] A70-39580
Aircraft auxiliary systems and spacecraft power supplies, considering fly-by-wire control actuators, pyrotechnics and stowable solar array A70-39669
VTOL aircraft longitudinal motion automatic stabilization in presence of turbulence and internal disturbances, using rotors and jet

engines
A70-39838
Automatic aircraft lateral motion stabilization during flight in perturbed atmosphere by HF invariant systems
A70-39839
Invariant autopilot control system during flight in turbulent atmosphere, allowing for aircraft elastic properties and invariance of coordinates
A70-39845
High performance aircraft self adaptive feedback control system, using airborne digital computer with inputs of elevator deflection and pitch rate for effectiveness identification
A70-40119
Variable wing sweep aircraft angular motion mathematical model, analyzing inertial moments influence on control dynamics
A70-40182
Aircraft flying at constant speed in circular orbits, calculating flight path under effect of uniform velocity wind
A70-40920
Fighter aircraft higher order control system dynamics effects on longitudinal handling qualities evaluated by in-flight simulator for role of pilot induced oscillations tendencies
[AIAA PAPER 69-768] A70-42711
Low and medium power turboprop engines for V/STOL aircraft, discussing development trends concerning operational control
A70-43081
Aircraft control, considering wind gradient effects on takeoff, ascent and overflight conditions
A70-43082
Aircraft control surface aerodynamic characteristics, considering low aspect ratio wing elevons with variable sweep leading edge as longitudinal and lateral controls
[ICAS PAPER 70-26] A70-44107
Stability augmentation in aircraft design for handling and operation benefits, discussing control techniques, autopilot modes and load limitations
[ICAS PAPER 70-24] A70-44109
Aircraft handling qualities specifications and definitions evolution based on test pilot rating correlation with engineering data and piloting ease evaluation with transfer functions
[ICAS PAPER 70-19] A70-44114
Hypersonic aircraft stability and control problems, discussing bulky engines and air intake and exhaust geometry
[ICAS PAPER 70-17] A70-44128
Fluidically augmented artificial feel system for fighter and attack aircraft control, discussing improved handling qualities
[SAE PAPER 700785] A70-45859
Turbojet and turbofan engine control evolution, noting increased complexity and adoption of hybrid fluidics and computer technologies
[SAE PAPER 700825] A70-45894
STOL aircraft guidance and control, discussing area navigation utilization, multiple airways, data links and ground ATC computers
[AIAA PAPER 70-1334] A70-45934
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Aircraft navigation control system by digital computer combined with inertial platform, considering emergency backup, slow drift and system malfunctions
A70-46092
Maneuver demand control using electric signalling feedback technique in Avro 707C and Hunter Mk 12 aircraft
A70-46203
Manual IFR formation flight display system requirements for advanced rotary wing and jet fighter aircraft
[AD-705133] N70-32317
Characteristics of adaptive aircraft control system in self-organizing configuration
[AD-703656] N70-32921
Adaptive aircraft control concept modified for helicopters
[AD-703231] N70-34923
Aircraft control system with four command channels suited to rotary wing aircraft
[NASA-CASE-ERC-10439] N70-36052
Stability and control prediction method for helicopters and stoppable rotor aircraft
[AD-706919] N70-37916
Flight simulation of lateral directional handling qualities for V/STOL aircraft in low speed maneuvering flight
[AD-707831] N70-40002
Situational display suitable for aircraft control
[NASA-CASE-ERC-10350] N70-40019
FAA operational tests of STOL aircraft landing and control characteristics
N70-40777
Discussion on feasibility of real-time on-line optimal flight control
[AD-709714] N70-41664

AIRCRAFT DESIGN
Aerodynamic and structural considerations in prop/rotor design for tilt-rotor aircraft, discussing blade twist effect on cruise efficiency and figure of merit
A70-34719
Manpowered aircraft, considering possibility as future flying sport vehicles
[AIAA PAPER 70-879] A70-34809
High lift flaps for sailplane cross country speed improvement by cruise-climb tradeoffs
[AIAA PAPER 70-878] A70-34814
Airplane performance improvement by flight control system design, discussing ride quality, flutter margin, maneuver load, etc
[AIAA PAPER 70-875] A70-34816
Structural weight reduction and increased aerodynamic efficiency in aircraft design by including flight control technology early in configuration development phase
[AIAA PAPER 70-874] A70-34817
Variable sweep high thrust-weight ratio multirole combat aircraft /MRCA/, discussing British-French cooperation, development programs and requirements
A70-34916
Digital computer technology impact on advanced aircraft design, discussing airborne computers, distributed and lumped computer systems, outer loop control, engine control and system integrity
A70-34993
Aircraft onboard maintenance recording system, discussing design and effectiveness
A70-35516
F-111 high strength steel design experience concerning wing, fuselage and empennage support structure
[AIAA PAPER 70-884] A70-35803
System engineering process for survival enhancement of military aircraft to meet stringent requirements of general nuclear war
[AIAA PAPER 70-893] A70-35810
Wide body commercial jet transport structural design considerations applied to DC 10 aircraft
[AIAA PAPER 70-895] A70-35812
Composite wing section design and fabrication utilizing unidirectional glass reinforcement
[AIAA PAPER 70-919] A70-35813
Safety in airline operations, discussing roles of aircraft designer and pilot
[AIAA PAPER 70-907] A70-35819
Extensible wing flap system for cargo aircraft, discussing structural design details and advantages
[AIAA PAPER 70-911] A70-35823
Boeing 737 aircraft nose gear gravel deflector and engine vortex dissipator
[AIAA PAPER 70-912] A70-35824
Flying qualities criterion for fighter flight control systems design
[AIAA PAPER 70-927] A70-35837
Fighter aircraft design for spin resistance and recovery using analytical approach, wind tunnel and flight tests
[AIAA PAPER 70-928] A70-35838
Air superiority fighter design philosophy, including tradeoffs between armament, detection capability, thrust, speed and load factor
[AIAA PAPER 70-930] A70-35840

Aft tail and canard configurations trim drag considerations for maneuvering aircraft
[AIAA PAPER 70-932] A70-35842
Airframe-inlet integration for supersonic tactical fighters, testing wind tunnel models
[AIAA PAPER 70-933] A70-35843
Subsonic aircraft size effect in conventional design, discussing increased weight increments and economic gain rate
[AIAA PAPER 70-940] A70-35849
Subsonic and supersonic transport aircraft design, discussing supercritical wing concept, fuel consumption reduction, composite aircraft structures, short haul transports, etc
A70-35854
Aircraft designer role in reducing departure delay due to equipment malfunction
A70-35858
Aircraft damage from bird impact and alleviating measures, taking into account windshield and intake guard designs, microwave beams for protection and chemical agents as repellant
A70-35987
Aircraft design minimizing damage by bird strikes to gas turbine engine components, discussing service experience, airworthiness demonstration tests and research programs
A70-35994
YF-12A interceptor aircraft development and testing, discussing titanium alloys application, aerodynamics and thermodynamics, escape systems for high speed and altitude tests
A70-36451
Mass air transportation, discussing aircraft characteristics, traffic growth, scheduling, passenger and cargo handling, etc
A70-36656
Concorde design limitations for commercial success in civil airlines
A70-36665
Solid state multiplexed electrical power distribution system for future generation military and commercial airplanes
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Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems
[SAE PAPER 700303] A70-36811
STOL systems 1975 technical and economic characteristics in terms of passenger market, aircraft design, terminal facilities and ATC capability
[SAE PAPER 700311] A70-36812
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts
[SAE PAPER 700269] A70-36819
Military and commercial transports turbofan propulsion systems impact on future aircraft design and development
[SAE PAPER 700267] A70-36820
V/STOL attitude control system as integral propulsion system part, analyzing design and weight tradeoffs
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Soviet book on wing structures analytical design methods covering thin supersonic wings, mass distribution, aerodynamic characteristics, etc
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High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications
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Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls comfigured vehicle /CCV/ design concepts
A70-37395
Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions
A70-38304
S-65-200 Commercial Compound Aircraft design for dispatch reliability and maintenance
A70-38823
European airbuses designs, considering potential market and financial problems
A70-38952
Composite technology effects on engineering design, emphasizing carbon-carbon materials for aircraft structural weight reduction, performance improvement and high temperature applications
A70-39202
Alloys for aircraft structures design, considering materials strength, corrosion resistance, producibility and cost
A70-39414
Aircraft stability design by parameter plane technique, using for YO-3A aircraft
[AIAA PAPER 70-983] A70-39546
Aircraft design fatigue life and cumulation damage problems, discussing information value of programmed load and random tests
A70-39622
Air cargo container system impact on aircraft requirements, discussing intermodal capability achievement
A70-40128
Aircraft engine design combining turbojet and ramjet features to ensure optimum performance
A70-40148
Weight growth factor in aircraft design, discussing fixed and variable weight, payload, performance, flight quality, structural criteria and life expectancy
[SAWE PAPER 839] A70-40363
Aircraft loadability design by computerized loading program using graphic plotter
[SAWE PAPER 836] A70-40364
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369
Fuselage frames minimum weight analysis by automatic iterative method
[SAWE PAPER 826] A70-40370
Aircraft manufacturing cost estimation in conceptual design phase, using structural synthesis program for cost buildup simulation
[SAWE PAPER 865] A70-40371
Fighter aircraft configuration design balancing, comparing weight penalties
[SAWE PAPER 840] A70-40380
Skew panels supersonic flutter and vibration calculated by matrix displacement method
A70-40586
F-14 carrier based fighter development program requirements, inherent difficulties and variable geometry configuration
A70-41264
Yak-40 business jet design and flight characteristics
A70-42174
SN 600 Corvette business jet design and performance
A70-42175
Supersonic aerodynamic design tools, discussing technological application of high speed computer and limitations
[AIAA PAPER 68-1018] A70-42701
Low and medium power turboprop engines for V/STOL aircraft, discussing development trends concerning operational control
A70-43081
Canadair CL-84 V/STOL aircraft flight characteristics and structural design
A70-44017
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Computer-aided aircraft design, discussing parts geometry data bank, visual display, etc
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Stability augmentation in aircraft design for handling and operation benefits, discussing control techniques, autopilot modes and load limitations
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Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials
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Pilot influence on dynamic aircraft design, taking into account physiological state during various operational tasks
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Flight simulation as aircraft design tool, discussing ground and inflight simulation techniques
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Strike fighter aircraft fuselage side air intakes, measuring external drag as function of design at subsonic and supersonic speeds
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Harrier aircraft development history, discussing V/STOL constraints on transonic flight properties
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Mathematical modeling of atmospheric gusts in stratosphere, mountain wave and thunderstorm conditions relevant to aircraft design
A70-45420
Optimal propeller selection for given aircraft and engine designs, considering aerodynamic and acoustic characteristics
A70-45441
Stationary aeroelastic cases studied in subsonic flow range, providing criteria for aircraft design with required flight characteristics
A70-45443
Noise reduction regulations effects on subsonic transport design and configuration
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OV-10A forward air control and light attack aircraft design, specifications and performance
[SAE PAPER 700837] A70-45883
Boeing 2707 SST design for low community noise, discussing engine-airframe matching effect
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Quiet V/STOL transport aircraft from DC-9-10 modification, discussing flying qualities, propulsion and control system interfaces, configurations, etc
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Aircraft design for low weight, discussing structural failures
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SST sonic boom noise level reduction by thermal simulation of long body aircraft, considering thermal spike or keel
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High Reynolds number, near sonic aircraft design
N70-37758
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N70-40702
Project design of fighter aircraft
N70-40703
Army aircraft development programs and Dassault prototypes
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Tradeoff studies in preliminary fighter aircraft design
N70-40705
Preliminary design considerations and aeroelastic constraints for large supersonic aircraft with canard control
N70-40706
Fluid dynamics considerations in preliminary fighter aircraft design
N70-40707
Aerodynamic design advances for fighter aircraft
N70-40708
Jet engine/airframe interface problems in fighter aircraft design
N70-40709
Multimission fighter aircraft engine design process, with weapon system design approach
N70-40710
Propeller and airframe integration in supersonic fighter aircraft design
N70-40711
Structural problems in fighter aircraft design
N70-40712
Load estimation and aeroelasticity in advanced fighter aircraft design initial stages
N70-40713
Airframe materials advances and influence on military aircraft design
N70-40714
Airframe systems design evaluation for military aircraft
N70-40715
Fighter aircraft flight control design and application to Concorde aircraft
N70-40716
Fighter aircraft flight control system design
N70-40717
Interface of maintainability, reliability, human factors, and system safety in military aircraft design
N70-40718
Avionics design problem in systems integration for terrain following capability in military transport aircraft
N70-40719

AIRCRAFT DETECTION
Satellite based systems for aircraft surveillance, discussing satellite power and bandwidth conservation, pulse techniques and interrogators
A70-36391
Ultrasonic sensor for detecting altitude and vertical velocity of aircraft near ground, applying to helicopter hovering flight or conventional airplane takeoff and landing
[AIAA PAPER 70-1031] A70-39506

AIRCRAFT ENGINES
High strength Ti alloys for aircraft gas turbine engines, determining critical properties for compressor fan blades
A70-34436
Ti alloys use in Olympus 593 engine for Concorde SST, discussing weight saving, mechanical properties and manipulation characteristics
A70-34449
Ti fabrications in aircraft engines, discussing alloys properties, sheet deformation, fusion welding, porosity, etc
A70-34450
Rotary piston engine for powered gliders and light aircraft power source by modifying industrial Wankel engine
A70-34690
V/STOL 5000 hp engine design optimization, considering component arrangements, rotor design, blade cooling method and fuel control
A70-34709
Convertible fan-shaft engine for V/STOL tactical and transport aircraft, discussing design and performance
A70-34710

Aircraft gas turbine propulsion, discussing engine performance characteristics, thermodynamics, noise and installation
[AIAA PAPER 70-873] A70-34810
Aircraft engine failures advanced detection by spectrometric lubricating oil analysis
A70-35481
C-5A propulsion system onboard monitoring for malfunction detection, analysis and subsystem recording
A70-35497
Boeing 747 aircraft JT9D engine deflections and removals during early service experience and maintenance
[AIAA PAPER 70-890] A70-35807
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations
[SAE PAPER 700329] A70-36798
High speed and long life bearings and dampers for future jet engines, considering design factors
[SAE PAPER 700318] A70-36800
Jet transport aircraft turbine engine performance monitoring by flight data, discussing historical highlights and future prospects
[SAE PAPER 700314] A70-36801
High bypass turbofan engine design concepts and development program for airline operation
[SAE PAPER 700292] A70-36804
Olympus 593 engine for Concorde aircraft, describing design and test procedures
[SAE PAPER 700291] A70-36805
High bypass ratio aircraft turbofan engines, discussing program of factory, flight and operational suitability testing
[SAE PAPER 700290] A70-36806
JT9D engine design and performance, describing operational problems
[SAE PAPER 700288] A70-36807
Aircraft turbine engines emission sampling, handling and measurement, evaluating various instruments and techniques
[SAE PAPER 700338] A70-36810
Military aircraft engines performance increase and cost reduction
[SAE PAPER 700272] A70-36817
Aircraft engine production cost estimating techniques, discussing physical, thermodynamic and metallurgical characteristics
[SAE PAPER 700271] A70-36818
Lightweight lift jet engine design, testing and performance for V/STOL aircraft
[ASME PAPER 70-GT-32] A70-36833
Critical aviation gas turbine rotating component life limit determination, describing statistical, maintenance, inspection and life evaluation computer program /SMILE/
[ASME PAPER 70-GT-66] A70-36841
Concorde aircraft powerplant design using fire tunnel test
[ASME PAPER 70-GT-128] A70-36854
Electronic gas turbine diagnostic systems, discussing engine parameters and analysis system
[ASME PAPER 70-GT-131] A70-36857
Control system considerations for small shaft-type aircraft gas turbines providing torque, temperature, load sharing and overspeed limiting functions
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Aero gas turbine engines digital computer control, discussing special properties, design and safety problems
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Soviet book on vibrations in flight vehicle engines covering linear and nonlinear systems, computer methods, etc
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Soviet book on vibration and balancing of aircraft engine rotors covering structural deformation and dynamics of turbine engines and compressors
A70-37237
Aircraft gas turbine engine development, considering gas dynamic and structural parameters
A70-37238
Normalization of mechanical properties of aircraft engine components, increasing weight efficiency and reliability
A70-37254
Exhaust gas ingestion suppression model tests for VTOL lift engines, measuring inlet thermal environment
[AIAA PAPER 70-905] A70-37396
Future aircraft with increased comfort, speed and economy, noting power plant development
A70-38249
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc
A70-38523
High temperature transducer for engine vibration measurement, discussing piezoelectric accelerometers mechanical design, jet engines material evaluation, crystallographic considerations, etc
A70-38527
Gaseous radioactive penetrant inspections for early low cycle fatigue in aircraft engine materials, discussing impact on maintainability
A70-38828
Jumbo jets turbofan engines design, considering fuel consumption, maintenance, reliability, noise reduction, etc
A70-38953
Aircraft gas turbine engine smoke emission measurement, discussing test equipment and procedure standardization
A70-39720
Fuel consumption related to aircraft performance and engine type
A70-42602
Aircraft engine diagnostics and defectoscopy, considering radioactive isotopes testing for component wear and performance
A70-43083
Fuel delivery and speed control systems for aircraft gas turbine engines, discussing control circuit transfers and block diagrams
A70-43116
Aircraft turbine engines durability estimated from rotor blade minimum tip clearance measurements
A70-43529
Aircraft flight propulsion systems performance improvement via materials technology for gas turbine engine components
A70-43573
Aircraft propulsion system test facilities, discussing altitude simulation, large subsonic and supersonic engines and component development
[ICAS PAPER 70-45] A70-44143
NASA research in turbojet aircraft propulsion noting inlet, compressor, combustor, turbine and nozzle component technology
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Temperature distribution in cylinders of aircraft internal combustion rotary piston engine under air cooling
A70-44742
Aircraft engine manufacturing technology, discussing metal cutting and forming, bonding, electrochemical machining and electron beam welding
A70-45298
Computer-aided production engineering involving numerically controlled machines for Rolls-Royce aircraft engines manufacture
A70-45299
Optimal propeller selection for given aircraft and engine designs, considering aerodynamic and acoustic characteristics
A70-45441
High temperature gas turbine aircraft engine control system requirements, noting stoichiometric fuel-air ratio
[SAE PAPER 700823] A70-45895
Propulsion control integration for aircraft power management
[SAE PAPER 700818] A70-45899
TSCP700 aircraft auxiliary power unit design, fuel consumption and maintainability
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Commercial STOL aircraft propulsion systems from airline viewpoint, emphasizing subsystem design, engine selection, thrust deterioration and maintainability
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V/STOL powerplant development, discussion airframe and engine design, application to large aircraft and planned evolutionary process
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German book on aircraft thermal propulsion systems calculation, design and evaluation, covering thermodynamic principles and atmospheric composition and properties
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Turbofan, turbojet and turboprop engine development in aircraft gas turbine evolution, discussing VTOL propulsion, centrifugal and axial compressor engines
A70-46251
Statistical analysis of aircraft engine oil spectrometric data
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Textbook on aircraft engine design
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[NASA-TM-X-2068] N70-36660
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Avionics problems in future Army aviation, discussing communications, navigation, instrumentation, automatic flight control, electronic countermeasures, fire control, etc
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Minimum Equipment List from aircraft manufacturer and airline operations viewpoint
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Aircraft electronic equipment cooling techniques, discussing natural and forced convection, phase change and heat pipes
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Computerized airborne integrated data acquisition and analysis system, discussing hardware, software and airborne-ground elements interfaces
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Soviet book on aircraft electrical and radio systems manufacturing, assembling and testing methods, considering effectiveness and standardization
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Aircraft air conditioning, discussing temperature and humidity control, cooling systems, etc
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L-1011 onboard system for gross weight and center of gravity determination, describing transducers placement, computer design and display panel
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Long range air transport routes, predicting equipment and expenditures modifications
A70-43533
Airline selection of Auxiliary Power Unit /APU/ for transport aircraft, noting benefits of air conditioning during ground operation
[SAE PAPER 700816] A70-45901
Automatic control system for Boeing SST engine air intakes, optimizing engine performance and controlling noise propagation
A70-46214
Feasibility of automatically testing avionic systems
N70-32170
Design study for advanced automatic test equipment
N70-32178
Guide for selection of avionic projects for simulation by hybrid computer facility
[AD-703843] N70-34805
Soviet news releases on cloud study using thermal instrumentation and aircraft electronic phase marker
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[FPRC/MEMO-248] N70-36581
Three-frequency riometer system operation on NASA 711 aircraft during 1969 auroral absorption
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AIRCRAFT FUEL SYSTEMS
Negative g Drone aircraft surface tension fuel system preventing air inclusion in turbojet engine fuel by tank filters /screens/
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Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Aircraft and engine fuel systems deposit formation and microstructure in various test rigs, using electron microscopy
[SAE PAPER 700258] A70-36823
Jet fuel system deposits measurement, noting reliability of oxygen combustion and beta ray backscattering techniques
[SAE PAPER 700257] A70-36824
Jet A kerosene deposit accumulation problem and proposed SST fuel tank design
[SAE PAPER 700256] A70-36825
Catalytic combustion fuel tank inerting techniques for fire protection in military and civilian aircraft
A70-44485
Fluidically controlled aircraft fuel transfer system three-tank model construction, noting maintenance and fail safe operation
[SAE PAPER 700786] A70-45858
Filtration methods for aircraft fuel systems presenting vortex separation principle
[AD-707058] N70-38574
Aircraft fuel system fire safety and prevention, and jet aircraft air pollution
N70-40779
Conference on fuel system fire safety
[AD-711059] N70-42753
Catalytic combustion technique for inerting aircraft fuel systems
N70-42758
Lightning induced voltages in electrical circuits of aircraft fuel systems
N70-42759
Feasibility of nitrogen fuel tank inerting systems for commercial aircraft
N70-42760

AIRCRAFT FUELS
Static charge reducer for aircraft fuels handling safety, discussing performance factors
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Aircraft in-flight and post crash fire protection developments, considering controlled flammability fuel systems and fire fighting methods
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Concorde loadability, with comparison of flight balance situation for supersonic and subsonic aircraft, describing fuel system
[SAWE PAPER 835] A70-40365
Feasibility analysis of various fuels for aircraft engines
[AD-707178] N70-37672
Hypersonic and supersonic aircraft fuels, lubricants, and hydraulic fluids, with bibliographies
[AGARDOGRAPH-108] N70-39638
Supersonic aircraft fuel technical requirements
N70-39640
Using polyurethane foam as inerting material in fuel tanks of combat aircraft
N70-42754
Effectiveness of various inerting agents for preventing ignition and flame propagation of hydrocarbon fuel-air systems
N70-42756

AIRCRAFT GUIDANCE
Visual display and automatic taxi guidance system testing for improved aircraft docking accuracy
[AIAA PAPER 70-916] A70-35828
Commercial aircraft strapdown inertial navigation systems, examining initial self alignment techniques
A70-36442
Pictorial display methods for pilot error reduction in area navigation via guidance control and capability beyond visual field
A70-38234
Time-synchronized approach control, combining aircraft precision navigation and guidance with ATC equipment
A70-38237
Avionics role in STOL air transportation operational capabilities in congested air

traffic environment
A70-38238
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy
A70-38365
V/STOL aircraft automatic flight control, guidance and navigation by onboard computer, discussing mathematical model and simulation results
[AIAA PAPER 70-1035] A70-39502
Aircraft and rocket guidance systems navigation error analysis, discussing numerical integration techniques and computer program
[AIAA PAPER 70-1004] A70-39527
V/STOL guidance and control system with bad weather landing capability, requirements for V/STOL integration into overall air traffic, terminal area guidance procedures, etc
A70-44843
STOL aircraft guidance and control, discussing area navigation utilization, multiple airways, data links and ground ATC computers
[AIAA PAPER 70-1334] A70-45934
Location identification system for identifying particular ground location
[NASA-CASE-ERC-10324] N70-36078
Accident of private aircraft near Upland, California - investigations and subsequent recommendations
[NTSB-AAR-70-13] N70-36116
Holographic display device for aircraft landing approach to aircraft carrier
[AD-703683] N70-36298
Generation of suboptimal closed loop guidance for minimum time aircraft trajectories
N70-37817
Systems of orientation and guidance of aircraft
[AD-696052] N70-38146

AIRCRAFT HAZARDS
Bird hazards to aircraft - Conference, Queens University, Canada, September 1969
A70-35976
Netherlands Air Force bird strike problem and warning system
A70-35977
RAF aircraft damage due to bird strikes in U.K., discussing preventive measures at airfields
A70-35978
German Air Force aircraft bird strikes statistics
A70-35979
West German aircraft bird hazards problems, discussing research activities and recommendations for strike avoidance
A70-35980
Statistical measurement of bird hazards to aircraft in terms of strike rates at airports, considering international strike rate standard
A70-35981
FAA research activities on eliminating birds at airports and improving aircraft components resistance to impact, including interagency committee functions on hazard problems
A70-35982
U.S. Air Force bird-aircraft collisions problem and bird control research
A70-35984
Aircraft bird hazards in New Zealand, discussing ecological research techniques and preventive measures
A70-35985
Bird strikes in U.S.S.R., discussing frequency, damage, etc
A70-35986
Aircraft damage from bird impact and alleviating measures, taking into account windshield and intake guard designs, microwave beams for protection and chemical agents as repellant
A70-35987
Military airlift command bird hazard minimization near airfields by environmental control, including uses of scare devices, chemicals, trapping, etc
A70-35988
Canadian civil aircraft bird hazards problem and alleviating measures including airport surrounding lands control
A70-35989
Aircraft bird hazards minimization by planning airport location and surroundings
A70-35991
Aircraft design minimizing damage by bird strikes to gas turbine engine components, discussing service experience, airworthiness demonstration tests and research programs
A70-35994
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading
A70-35995
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests
A70-35996
International Civil Aviation Organization /ICAO/ work on bird hazard reduction, including aircraft airworthiness specifications, bird data dissemination, etc
A70-35997
Airport bird detection equipment /ABDE/ radar to display airfield map for presence and magnitude of bird groups and vegetation on runway
A70-35998
Birdstrikes as aircraft hazard, discussing structural damage, engine ingestion and various countermeasures
A70-36319
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc
A70-38800
Airport fog layers repetition frequency after low visibility periods
A70-43246
Soviet civil aircraft-bird collisions, stressing hazard forecast and prevention by bird identification and migration patterns
A70-45644
Helicopter hazards elimination measures, considering crash resistant fuel systems, flotation devices, redesigned seats, in-flight escape, etc
A70-46383
Birdproofing aircraft research program using pneumatic cannon firing real and simulated bird carcasses
A70-46398
Simulation of bird impact during flight
N70-33654
Deflector for preventing objects from entering nacelle inlets of jet aircraft
[NASA-CASE-XLE-00388] N70-34788
Wake turbulence dangers to light aircraft
N70-39350
Determination and control of airspace construction creating hazards to STOL flight paths
N70-41082

AIRCRAFT HYDRAULIC SYSTEMS
Automated aircraft flight safety, concerning probabilities and onboard elimination of servomotor failures in hydraulic system due to fuel contamination
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Fluidics for aircraft high pressure hydraulic systems, discussing circuit breaker, feel computer and landing gear sequencing circuit
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Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053

AIRCRAFT INDUSTRY
Cost and time optimization for complex aircraft development projects via network planning
A70-39644
Aircraft engine manufacturing technology, discussing metal cutting and forming, bonding, electrochemical machining and electron beam welding
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Wind tunnel testing of helicopters, and test program for Polish helicopter industry
N70-34028
Forecast indices for 1970 to 1981 in aviation industry and airline operations
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Price and productivity change estimates in aircraft industry

[AD-706885] N70-37723
Market survey of Canadian civil aircraft and aeronautical products
N70-42407

AIRCRAFT INSTRUMENTS
CH-47 cruise guide indicator for displaying fatigue loading to pilots, discussing design and operation
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Heavy lift helicopters cockpit display problems, describing photographic flight research program for data acquisition
A70-34731
Airborne data acquisition on high density computer tape for aircraft handling and flight dynamics research
A70-35499
Fluidic parallel flow low airspeed indicator for V/STOL instrumentation tested in wind tunnel
[AIAA PAPER 70-906] A70-35818
Aircraft perspective display as independent landing monitor based on electronic runway lights, discussing simulator development and flight validation
[AIAA PAPER 70-924] A70-35835
Air safety research effects on operations, training procedures and materials, discussing gust loads, onboard data recording devices, human error, etc
A70-35859
Air total temperature measurement for jet powered aircraft, discussing subsonic and supersonic wind tunnel data for sensor thermal recovery characteristics
A70-37882
Mass flow ion drift anemometer applicable to aircraft speed measurement including V/STOL
A70-37885
Economic payback of AIDS /Aircraft Integrated Data System/ recording for operational performance monitoring and engine analysis
A70-37894
Engine vibration monitoring system for Boeing 747 aircraft, including piezoelectric transducer, transmission assembly and differential charge converter
A70-37898
Electronic attitude director indicator /EADI/ for supersonic transport, employing CRT display, head down TV and microvision sensors
A70-37911
Aerospace instrumentation - Conference, Cranfield Institute of Technology, England, March 1970
A70-38514
Aircraft compressor and turbine vibration monitor, using velocity coil or piezoelectric transducers
A70-38525
Airborne magnetic recording flight test instrumentation of Anglo-French Jaguar aircraft
A70-38535
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests
A70-38547
Airborne electronic equipment, collision avoidance systems, displays, instrumentation, human response and ground based control in air traffic control
A70-39198
Aircraft vertical gyro with hydraulic damping device, calculating ballistic deviations limitation conditions
A70-39733
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109
Aircraft capacitive fuel gage improvement by integration with flowmeter system, DC torquer display and digital techniques, considering other measurement principles
A70-40619
Flow difference sensor for aircraft hydraulic systems damage vulnerability reduction, discussing design, operation and flight tests results
A70-40786
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-41257
Area navigation for aircraft guidance with radio aids, discussing advantages, airborne equipment, Dynamic Map Displays, etc
A70-42658
Airborne computerized time frequency systems for aircraft range and velocity determination, using stable clocks with ambiguity resolution
A70-42659
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within cloud
A70-42775
DR-S Raydist radio location system in fixed wing aircraft for dynamic gravimetry
A70-43661
Gravity measurement errors in high speed aircraft parallel to undulating geoid attributed to associated vertical accelerations
A70-43662
Integrated helicopter gravity measuring system for various terrains, describing instrumentation and recording monitors
A70-43663
Stochastic processes for probabilistic error analysis in airborne gravimetry, using gravity sensing instruments
A70-43666
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-43888
U.S. SST flight deck instrumentation and cockpit displays during flight, discussing economic analysis of operations
[ICAS PAPER 70-59] A70-44155
Aircraft binocular head-up display, discussing system operation, history and potential applications
A70-45349
VTOL aircraft instrument flight in terminal area, defining requirements and operating characteristics for vertical and low speed capabilities
[AIAA PAPER 70-1333] A70-45935
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system
A70-46240
System design of optimal remote oculometer for use in operational aircraft
[NASA-CR-1562] N70-33103
Fire test criteria for aircraft flight data and cockpit voice recorders
[FAA-NA-70-25] N70-33798
In-flight comparison of Kaiser FP-50 flight director with standard C-131 instruments
[AD-702748] N70-36264
High current short circuit testing facilities for aircraft control and protection devices
[AD-705504] N70-36423
Aircraft instrument for indicating malfunctions during takeoff
[NASA-CASE-XLA-00100] N70-36807
Pressure probe for sensing ambient static air pressures
[NASA-CASE-XLA-00481] N70-36824
Aircraft indicator for pilot control of takeoff roll, climbout path and verticle flight path in poor visibility conditions
[NASA-CASE-XLA-00487] N70-40157
Simulation study of three instrument displays to assist airplane thrust management
[NASA-TN-D-5982] N70-41193
Flight evaluation of inertial/DME/DME system
[FAA-RD-70-24] N70-41325

AIRCRAFT LANDING
Aircraft landing and takeoff difficulties and dangers due to mud and water on runways, discussing coping methods
A70-34692

Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845
Precision approach and landing guidance system selection by RTCA committee, discussing aircraft antennas, scan rates, international cooperation, etc
[AIAA PAPER 70-937] A70-35846
Stochastic processes with linear dynamics and quadratic control cost, considering application to aircraft landing approach path optimization
A70-35973
SATRAM, multiple trajectory landing system for aircraft position indication within large airspace
A70-36948
Maximum throughput-rate capacity for runway and final approach path airspace involving multiple IFR landings
A70-38235
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy
A70-38365
Aircraft landing maneuver optimization by in-flight monitoring of approach and landing phases, furnishing decision making display
[AIAA PAPER 70-1000] A70-39531
Boeing 747 pilot transition training, discussing takeoff, landing, eyelevel, flareout taxi speeds, inertial navigation and electrical, fuel and hydraulic systems
A70-40083
Ground Effect Takeoff and Landing /GETOL/ aircraft, evaluating energy absorption capability of air cushion landing gear in touch-down condition
A70-42282
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
V/STOL aircraft landing performance, discussing relationships between approach speeds, rates of descent, structural criteria and weight penalties
[ICAS PAPER 70-53] A70-44149
V/STOL guidance and control system with bad weather landing capability, requirements for V/STOL integration into overall air traffic, terminal area guidance procedures, etc
A70-44843
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Airport accessibility role in planning V/STOL aircraft landing facilities
[AIAA PAPER 70-1311] A70-45947
Commercial STOL aircraft takeoff and landing physical parameters relationships based on wind tunnel and flight tests
[AIAA PAPER 70-1238] A70-45959
Gust effects on dynamics of slender wing aircraft during landing approach
[NASA-TT-F-12751] N70-34017
Computerized simulation and statistical analysis of V/STOL tactical landing system for helicopters
[AD-704324] N70-34849
Aerodynamic configuration for aircraft capable of high speed flight and low drag for low speed takeoff or landing upon presently existing airfields
[NASA-CASE-XLA-00806] N70-34858
Display instrumentation for V/STOL aircraft in simulated landing with steep angle approaches or zero-zero visibility
[NASA-CR-112779] N70-37158
Gust and wind effects near thunderstorms and mountains and during aircraft takeoff and landing
[ARC-CP-1091] N70-37242
Accident investigation of Boeing 707 crash during simulated landing approach
[PB-191318] N70-37486
Comparison of instrument landing systems for space shuttle and aircraft
N70-39607
Capstan analysis computer program and aircraft recovery system, arresting gear capstan drive design
[AD-708759] N70-40257
FAA operational tests of STOL aircraft landing and control characteristics
N70-40777
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft
N70-40784
Visibility measurements for aircraft landings and takeoffs
N70-40785
Flight tests of STOL aircraft operational and performance parameters
N70-41079
Runway lights and markings for STOL ports
N70-41083
Advanced integrated landing system test and evaluation for all-weather landing
[FAA-RD-70-28] N70-41271
Classifying standard runway lengths and distance requirements during takeoffs and landings
N70-41595
Simulator study of flight management task performance during low visibility approach and landing using baseline category 2 flight instrumentation
[NASA-CR-73478] N70-42037
Piloted simulator investigation of ground effect on landing maneuver of large, tailless, delta wing airplane
[NASA-TN-D-6046] N70-42810
Computer programs for determining performance of automatic aircraft landing system in turbulence
[NASA-TN-D-6066] N70-43146

AIRCRAFT LAUNCHING DEVICES
Commercial aircraft launching and arresting systems for airport runway length reduction, discussing safety factors
[SAE PAPER 700264] A70-36821

AIRCRAFT MAINTENANCE
Power plant efficiency, size, maintenance and operating economics of propulsion systems for air transport
A70-34917
Aircraft onboard maintenance recording system, discussing design and effectiveness
A70-35516
European requirements for aircraft accident and maintenance recording systems
A70-35517
Boeing 747 maintenance and inspection program, discussing condition monitoring, test methods, etc
[AIAA PAPER 70-889] A70-35806
Boeing 747 aircraft JT9D engine deflections and removals during early service experience and maintenance
[AIAA PAPER 70-890] A70-35807
Fastener standardization for airline maintenance requirements
[AIAA PAPER 70-894] A70-35811
Airline maintenance department assurance of air service regularity, stressing management role
A70-35855
Aircraft designer role in reducing departure delay due to equipment malfunction
A70-35858
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations
[SAE PAPER 700329] A70-36798
Airlines data reduction using electronic engine maintenance recorders
[ASME PAPER 70-GT-127] A70-36853
Aircraft nonavionic systems performance condition and minimum maintenance duties diagnosis by integrated data system, discussing engine monitoring instruments
A70-37891
Avionics maintenance effectivness logistics, discussing symptom pattern observation technique

/SPOT/ for in-flight data
A70-38399
S-65-200 Commercial Compound Aircraft design for dispatch reliability and maintenance
A70-38823
Helicopter cost reduction by transmission overhaul frequency reduction, discussing savings with on-condition maintenance
A70-38824
RAMMIT /reliability and maintainability management improvement techniques/ for processing maintenance data relevant to Army aircraft operations and support
A70-38826
U.S. Army UH-1/AH-1 helicopter maintainability and reliability field program, including statistical data
A70-38827
Condition Monitored Maintenance program for turbine engines eliminating total overhauls at specified time, using NDT
A70-38830
Airfreighters maintenance and reliability simulation, modeling specific aircraft designs via input data selection
A70-38835
Comparative demand forecasting for military helicopter spare parts, stressing exponential smoothing model
A70-39643
Integrated data systems for aircraft maintenance, noting information retrieval role in maintenance management for cost reduction and safety
A70-39647
Military and commercial aircraft maintenance costs reduction, discussing labor/material ratio, spare parts use, diagnostic systems, etc
A70-40750
Nondestructive testing for aircraft maintenance, considering economics
A70-45677
Nondestructive testing technology impact on military aircraft maintenance, discussing training, applications and advantages
A70-45678
C5 Malfunction Detection Analysis and Recording /MADAR/ subsystem for onboard fault isolation including engines
[SAE PAPER 700820] A70-45898
Aircraft maintenance cost statistical analysis recursive regression model for aircraft failure and manhour cost data
A70-46125
Real time measurement of aircraft parameters as part of airborne integrated data system to improve aircraft maintenance
N70-32157
Analysis of onboard equipment testing methods
N70-32169
Hearings on legislation for expanding and improving airport and airway facilities - Part 1
N70-35626
Hearings on legislation for expanding and improving airport and airway facilities - Part 2
N70-35627
Markov chain analysis of aircraft repair using cannibalization
[AD-707041] N70-37824
X-15 aircraft maintenance schedule and transfer to space shuttle requirements
N70-39605
Potential savings in military aircraft maintenance
N70-41985
Infrared radiation hot working for polystyrene aircraft maintenance tool kit tray manufacture
[A/AEE-NOTE-9001] N70-42525

AIRCRAFT MODELS

Parameter model of VTOL airplane in transition, considering aerodynamic forces and moments and digital simulation
A70-34724
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc
A70-38523
Model testing for helicopters, considering scaling, ditching and rotor performance
A70-38610
Airfreighters maintenance and reliability simulation, modeling specific aircraft designs via input data selection
A70-38835
Variable geometry wind tunnel for testing aircraft models at subsonic speeds
[NASA-CASE-XLA-7430] N70-35678
Airfoil measurements that show behavior of wing sections in low-turbulence stream in Reynolds number range from 20,000 to 170,000
[NASA-TM-X-60976] N70-39001
Ground effect visualization at low speeds around aircraft models in hydrodynamic tunnel
[NASA-TT-F-13254] N70-39296
Aerodynamic characteristics of air cushion models at very low ground clearances and at free stream dynamic pressures exceeding cushion pressure
[NASA-TN-D-6011] N70-42087
Gust response of slender wing aircraft model mounted on rocket propelled sled moving past low speed wind tunnel mouth
[ARC-CP-1113] N70-42529

AIRCRAFT NOISE

Vortex visualization applications in helicopter noise research, using smoke generator in rotor blade tip
A70-34712
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects
A70-34729
Collection of papers on aerodynamic noise covering noise generation, solid boundaries effect, strength distribution, jet noise, perturbation theory, etc
A70-35448
Metropolitan airports environmental considerations, noting aircraft noise role in planning
[SAE PAPER 700253] A70-36826
Critical review of aircraft noise characteristics measurement and analysis techniques, noting nonuniformity problems control through standards
A70-37907
Automatic sound monitoring system for measuring aircraft noise in airport vicinity
A70-37908
Computer controlled aircraft noise monitoring system at Stuttgart airport
A70-37909
Flow noise mechanisms, considering discharge, propeller, ventilator, jet engine, boundary layer, water pipe and supersonic aircraft sources
A70-38474
Transport aircraft noise at three major airports by noise exposure forecast /NEF/ contours methodology
A70-40896
Aircraft acoustical duct treatments - ASA Conference, Philadelphia, April 1969
A70-42528
NASA acoustically treated nacelle program reducing noise under commercial transport flight path near airports
A70-42529
Aircraft noise reduction, discussing generation sources in propulsion system, noise levels and subjective responses
A70-44395
Boeing 2707 SST design for low community noise, discussing engine-airframe matching effect
[SAE PAPER 700808] A70-45906
Computation of total sound pressure field of jet aircraft on ground
[NASA-TT-F-13096] N70-32947
Cockpit noise exposures associated with operation of fixed and rotary wing aircraft
[AD-705964] N70-33974
Perceived noisiness of various types of aircraft by subjects seated outdoors and inside houses
[NASA-CR-1635] N70-35881
Modified calculations for relative perceived noisiness of aircraft by human subjects
[NASA-CR-1636] N70-35898
Noise exposure forecasts for John F. Kennedy, O Hare International, and Los Angeles International airports, including effects of changes in aircraft hardware and procedures

[FAA-NO-70-7] N70-36942
Aircraft noise study of Logan International Airport to determine effects on surrounding community
[PB-190118] N70-37337
Noise environments within multiplace fixed-wing aircraft
[AD-708403] N70-40628
Environmental quality policies concerning aircraft noise and exhaust emission
N70-41542
Temporal and spectral combinations effects on human judgements of aircraft noisiness
[FAA-NO-69-3] N70-42217
Aircraft noise exposure forecasting procedures and applications
[FAA-NO-70-9] N70-42218
Noise exposure forecast contours for 1967, 1970, and 1975 at 28 airports
[FAA-NO-70-8] N70-42219
Considering noise intensity levels in houses and buildings near airports
[NLL-LIB-COMM-1527-/5196/] N70-42827

AIRCRAFT PARTS
Ti alloy aircraft parts heavy press forging, considering mechanical properties, temperature effects, cost factors, etc
A70-34360
High strength Ti alloys depth hardenability, discussing mechanical properties and use in aircraft components
A70-34434
Boeing 737 aircraft nose gear gravel deflector and engine vortex dissipator
[AIAA PAPER 70-912] A70-35824
Flight loads spectrum data for army CH-47A, UB-1B and CH-54A helicopters components compared with fatigue life spectra
A70-35955
Structural reliability testing methods and loads prediction for rotary wing vehicle components, considering AH-56A compound helicopter
A70-38612
Reinforced plastic for aircraft parts, investigating low viscosity polyester resins of styrene crosslinking type
A70-40028
Synthetic resin adhesives for aircraft components fabrication
A70-40532
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience
A70-41137
Load cycle sequences for full scale aircraft structures and components fatique testing
[ICAS PAPER 70-32] A70-44101
Computer-aided aircraft design, discussing parts geometry data bank, visual display, etc
[ICAS PAPER 70-27] A70-44106

AIRCRAFT PERFORMANCE
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems
A70-34672
SST flight efficiency trends, discussing breakthrough and development method and Concorde aerodynamic, propulsion and structural history
[AIAA PAPER 70-871] A70-34811
Aircraft optimal operating procedure development by integral-variational performance analysis methods, discussing flight paths, fuel consumption, mission requirements, etc
[AIAA PAPER 70-876] A70-34812
Maneuver load alleviation /MLA/ configurations for wing bending load relief on transport aircraft, showing improved payload and span performance
[AIAA PAPER 70-877] A70-34813
Airplane performance improvement by flight control system design, discussing ride quality, flutter margin, maneuver load, etc
[AIAA PAPER 70-875] A70-34816
Airborne data acquisition on high density computer tape for aircraft handling and flight dynamics research
A70-35499
Boeing 747 aircraft operation in first three months of service, discussing crew training, instrumentation, navigation system improvement, etc
[AIAA PAPER 70-891] A70-35805
Four-seat two-engined STOL propeller passenger and sport aircraft design and performance
A70-37371
Aircraft nonavionic systems performance condition and minimum maintenance duties diagnosis by integrated data system, discussing engine monitoring instruments
A70-37891
Future aircraft with increased comfort, speed and economy, noting power plant development
A70-38249
Optimal longitudinal takeoff trajectories, formulating obstacle clearance criterion function based on aircraft design parameters effects
[AIAA PAPER 70-963] A70-39566
Merit factor for evaluation of aircraft types and missions, matching aircraft characteristics to mission load, range and speed
[SAWE PAPER 842] A70-40360
Weight growth factor in aircraft design, discussing fixed and variable weight, payload, performance, flight quality, structural criteria and life expectancy
[SAWE PAPER 839] A70-40363
Disposable load drop effect on aircraft range, using Breguet equations for graphic determination of bombing range
A70-40868
Glide and landing performance of twin-keel parawings, discussing wind tunnel, radio flight and simulator tests
[AIAA PAPER 70-1186] A70-41829
Fuel consumption related to aircraft performance and engine type
A70-42602
High temperature liquid metal cooled nuclear reactor for military aircraft with long flight endurance and range
A70-43188
Escape and survivability rates in various aircraft flight envelope regimes, using existing escape statistics and mission profiles
A70-44492
OV-10A forward air control and light attack aircraft design, specifications and performance
[SAE PAPER 700837] A70-45883
Short haul intercity center facilities air transportation traffic alleviation by VTOL aircraft, emphasizing performance, ground facilities, system operation and economics
[AIAA PAPER 70-1243] A70-45914
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Application of steepest descent method to trajectory optimization and aircraft performance problems
[NASA-CR-73366] N70-32760
Evaluation of effect of yaw-rate damper on flying qualities of light twin-engine airplane
[NASA-TN-D-5890] N70-32770
Aerodynamic characteristics associated with aircraft flight and reentry vehicles
[AD-705584] N70-33694
Effects of meteorological parameters and instrument errors on vertical flight performance of supersonic transports
[NASA-CR-1570] N70-34253
Unit cost and performance data for US transport aircraft during 1967 and 1968
N70-35380
Flight tests of STOL aircraft operational and performance parameters
N70-41079
Pilot-vehicle analysis method for specification and evaluation of flying qualities with application to vertical takeoff aircraft

[AD-710590] N70-43030
AIRCRAFT PILOTS
In-flight evaluation of selected aircraft pilots controllers, noting role in design
[AIAA PAPER 70-925] A70-35836
Aircraft crew and pilot in-flight work load measurement and simulator
[ICAS PAPER 70-43] A70-44141
AIRCRAFT PRODUCTION
Alloy applications to Boeing supersonic transport airframe and components, discussing materials characteristics and manufacturing processes
A70-34451
Investment risks and technical impact on aircraft development, world aviation growth and airline costs
A70-34915
Minimum Equipment List from aircraft manufacturer and airline operations viewpoint
[AIAA PAPER 70-900] A70-35816
European A-300-B Airbus program, discussing technical and economical aspects
A70-36509
Fiber reinforced plastics /FRP/ composites applications in Japanese aircraft production and aerospace industries
A70-40057
Description of handbook on Soviet aircraft design and construction
[AD-704280] N70-34862
Congressional report on supersonic transports
N70-41782
AIRCRAFT RELIABILITY
System engineering process for survival enhancement of military aircraft to meet stringent requirements of general nuclear war
[AIAA PAPER 70-893] A70-35810
FAA research activities on eliminating birds at airports and improving aircraft components resistance to impact, including interagency committee functions on hazard problems
A70-35982
Aircraft damage from bird impact and alleviating measures, taking into account windshield and intake guard designs, microwave beams for protection and chemical agents as repellant
A70-35987
S-65-200 Commercial Compound Aircraft design for dispatch reliability and maintenance
A70-38823
U.S. Army UH-1/AH-1 helicopter maintainability and reliability field program, including statistical data
A70-38827
Airfreighters maintenance and reliability simulation, modeling specific aircraft designs via input data selection
A70-38835
Aircraft systems safety requirements, consisting of accident probability, confidence level and demonstration test period
A70-38840
Flow difference sensor for aircraft hydraulic systems damage vulnerability reduction, discussing design, operation and flight tests results
A70-40786
NDT for aircraft service life extension, discussing fatigue tests and crack detection
A70-45719
STOL aircraft FAA airworthiness standards and certification rules, examining noise, control systems, all weather operation, fire protection, handling qualities and performance
[AIAA PAPER 70-1331] A70-45937
Aircraft reliability and excess transport aircraft airspeed analyzed from flight records
[ARC-CP-1088] N70-37163
Research and development of STOL port criteria, airworthiness and operational criteria, and flight test procedures
N70-41085
AIRCRAFT SAFETY
High powered high speed helicopters autorotation entry characteristics, noting capability of meeting control time delay requirement
A70-34715
Safety in airline operations, discussing roles of aircraft designer and pilot
[AIAA PAPER 70-907] A70-35819
Automatic landing system assurance of DH 121 aircraft schedule all-weather regularity through high safety level via redundancy
A70-35856
Air safety research effects on operations, training procedures and materials, discussing gust loads, onboard data recording devices, human error, etc
A70-35859
Nationwide air traffic control, using radar network and real time computer flight information centers for air safety
A70-35880
Data acquisition system applications philosophy, discussing data integrity, expansion facility, flight safety, etc
A70-36339
Optimum approach and departure paths for VTOL aircraft simulated by hybrid computer under constraints
[AIAA PAPER 69-209] A70-36452
Airport capacity and terminal area safety increase by scanning beam instrument landing system, discussing automatic guidance trajectory example
A70-37913
Aircraft systems safety requirements, consisting of accident probability, confidence level and demonstration test period
A70-38840
ATC by scanning beam ILS and onboard control systems, increasing airport capacity and terminal area safety
[AIAA PAPER 70-1033] A70-39504
Airborne three dimensional area navigation equipment for reducing mid-air collision exposure and for raising landing safety in terminal areas
A70-42296
Air traffic safety problems, discussing satellite radiobeacons applications to aerial navigation
A70-42652
Collision Avoidance System /CAS/ and Proximity Warning Indicator /PWI/ for preventing midair aircraft collisions
A70-44175
Air hijacking as aviation safety problem, discussing history, prevention and detection methods and equipment, law enforcement, etc
A70-44496
General aviation expansion and competitive position dependence on safety and utility improvements and simultaneous cost reductions
[AIAA PAPER 70-1220] A70-45953
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Helicopter hazards elimination measures, considering crash resistant fuel systems, flotation devices, redesigned seats, in-flight escape, etc
A70-46383
Flight test and evaluation of airborne collision avoidance system
[AD-705529] N70-33674
Materials for crash-fire resistant aircraft fuel tanks
[NA-69-43] N70-34001
Operational reliability of flight control systems and automatic piloting of aircraft
[NASA-TT-F-610] N70-35169
Technology review on suppression and rescue systems for aircraft fires on ground
[AD-703393] N70-35487
Scandinavian aircraft accident investigation and subsequent recommendations
[NTSB-AAR-70-14] N70-36114
Aircraft hydraulic system circuit breaker for protection against major system leakage
[AD-702172] N70-36652
Aircraft instrument for indicating malfunctions during takeoff
[NASA-CASE-XLA-00100] N70-36807
Basic requirements for system, industrial, aviation, and public safety
[NASA-TM-X-66319] N70-39716
FAA research and development work on runway friction measurement and aircraft safety on

slick runways
N70-40778
Aircraft fuel system fire safety and prevention, and jet aircraft air pollution
N70-40779
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
STOL port arresting gear, fire fighting, and rescue equipment
N70-41084
Xenon flash lamp application in collision avoidance
[AD-709191] N70-41191
Research and development in airport/airway capacity, national airspace system, aircraft safety, and aerospace medicine
N70-41543

AIRCRAFT SPECIFICATIONS
International Civil Aviation Organization /ICAO/ work on bird hazard reduction, including aircraft airworthiness specifications, bird data dissemination, etc
A70-35997
Aircraft handling qualities specifications and definitions evolution based on test pilot rating correlation with engineering data and piloting ease evaluation with transfer functions
[ICAS PAPER 70-19] A70-44114
OV-10A forward air control and light attack aircraft design, specifications and performance
[SAE PAPER 700837] A70-45883
Air Force aircraft structural integrity program with referenced specifications - airplane requirements
[AD-707884] N70-39664

AIRCRAFT STABILITY
Airplane stability and control technology, considering flight research, flying qualities, compressibility and aeroelastic phenomena
A70-36441
Pilot induced oscillation rating regression analysis, examining time delay, slope after and time to first peak and stick force per g
A70-36444
Ground vibration testing for aircraft and missile flutter prevention
[ONERA-TP-816] A70-36508
Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls comfigured vehicle /CCV/ design concepts
A70-37395
Helicopter stabilization systems design, synthesizing controllers by modal control theory
[AIAA PAPER 70-1036] A70-39501
Aircraft stability design by parameter plane technique, using for YO-3A aircraft
[AIAA PAPER 70-983] A70-39546
Full scale aircraft spinning motion, computing static, damping, cross and acceleration aerodynamic characteristics for antispin devices
[AIAA PAPER 70-946] A70-39581
VTOL aircraft longitudinal motion automatic stabilization in presence of turbulence and internal disturbances, using rotors and jet engines
A70-39838
Automatic aircraft lateral motion stabilization during flight in perturbed atmosphere by HF invariant systems
A70-39839
Automatic control systems for aircraft approach to landing path and subsequent stabilization on trajectory, compensating for cross wind action and radio noise disturbances
A70-39842
Aircraft rolling motion /eigenmotion/ in flight at small angle of attack following initial disturbance, discussing response to control action
A70-42515
Fighter aircraft higher order control system dynamics effects on longitudinal handling qualities evaluated by in-flight simulator for role of pilot induced oscillations tendencies
[AIAA PAPER 69-768] A70-42711
Small airplane unsteady motion downwash angle at low speeds, comparing results from rectilinear steady flights
[ICAS PAPER 70-25] A70-44108
Hypersonic aircraft stability and control problems, discussing bulky engines and air intake and exhaust geometry
[ICAS PAPER 70-17] A70-44128
Elastic fuselage flight vehicle dynamic stability at supersonic speeds, using automatic pilot stabilization
A70-44157
ONERA calculations in aeroelasticity including lifting surface optimization, control surface vibration, pressure fields, aircraft transfer functions and panel flutter
A70-44762
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft
A70-45428
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft
[SAE PAPER 700794] A70-45853
Hydrofluidics flight controls for aircraft stability augmentation systems, noting component performance, transfer functions and operation
[SAE PAPER 700793] A70-45854
Stability and control prediction method for helicopters and stoppable rotor aircraft
[AD-706919] N70-37916

AIRCRAFT STRUCTURES
Ti alloy forgings for aircraft industry, utilizing high strength/weight ratio
A70-34357
Ti hot forming, discussing sheet use as aircraft structural material
A70-34444
Aircraft structural materials, considering high strength steels Al and Ti alloys
A70-34675
Materials selection for cost effectiveness in 1980s airframe applications
[AIAA PAPER 70-870] A70-34819
Crack propagation, fatigue damage and interaction effects in aircraft structures and materials under flight simulation loading
A70-34924
F-111 high strength steel design experience concerning wing, fuselage and empennage support structure
[AIAA PAPER 70-884] A70-35803
Thermal effects on aircraft elastic vibration mode shapes, recommending investigation to develop analysis and design tools
A70-36459
HF endurance tests of Al sheet alloy used in welded aircraft structural components, plotting curves for heat treated and untreated specimens
A70-38431
Adhesive bonded aircraft structures, discussing methods and requirements for establishment and control of manufacturing procedures
A70-38594
Alloys for aircraft structures design, considering materials strength, corrosion resistance, producibility and cost
A70-39414
Hydraulic load loops with random force signal for aircraft structures endurance testing
A70-39913
Beta III Ti alloy for aircraft fasteners, describing microstructure and mechanical properties
A70-39966
Finite element stiffness matrix technique for composite structures, discussing airplane component design program
A70-40040
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes
A70-41408
High strength glass for aircraft structures, discussing applications to passenger cabin windows
A70-41891

Optimum light construction design of glider wings, considering spar weight, aluminum honeycomb structure and repair A70-42961

Load cycle sequences for full scale aircraft structures and components fatigue testing [ICAS PAPER 70-32] A70-44101

Aircraft structure fatique load monitoring, discussing strain gage installation in critical areas [ICAS PAPER 70-31] A70-44102

Aircraft wing box beams bending tests to failure loads, considering crushing pressure, bulkhead flexural deformations, structure initial imperfections and instability phenomena [ICAS PAPER 70-33] A70-44103

Fatique strength of stiffened aircraft panels subjected to repeated buckling by compression loads [ICAS PAPER 70-35] A70-44132

Aircraft structures acoustic fatique testing, discussing test facilities, environment simulation, etc A70-44329

Elastic coupling and dynamic equations for flight elastomechanical vibration systems, including tiptanks on aircraft wings A70-44767

Aircraft structures service life estimation, using Ir-192 and Tm-170 gamma ray radiography A70-45725

Aircraft design for low weight, discussing structural failures [AIAA PAPER 70-1232] A70-45917

Calculating frequencies and modes using inertia matrix [AE-276-S] N70-33607

Damping system for control of structural motion in flexible airframes [NASA-CR-1557] N70-34004

Shakers and solid rocket propellant impulse generators for aeroelastic and vibration flight tests of Concorde aircraft structures [ONERA-TP-811] N70-37148

Structural mechanics of bonded and honeycomb structures N70-38124

Electronic strain level counter for aircraft structural members [NASA-TN-D-5944] N70-39377

Israeli conference on aeronautics and astronautics, including aerodynamics, aircraft structures, propulsion, and flight control [AD-707326] N70-39737

Fatique testing device applying random discrete load levels to test specimen and applicable to aircraft structures [NASA-CASE-XLA-02131] N70-42003

Applications of advanced composite materials to C-130 center wing box [NASA-CR-66979] N70-42183

Failure analysis on adhesive bonds of aircraft honeycomb sandwich composites [AD-710352] N70-43053

AIRCRAFT TIRES

Large wheel and tire imperfection effects on nosegear parametric shimmy instability, using Mathieu equation A70-36455

Comparison of cord loads with aircraft tire on grooved and smooth runway surfaces [NASA-CR-1627] N70-33150

Tire-pavement friction coefficients [AD-705987] N70-33636

AIRCRAFT WAKES

Wake turbulence dangers to light aircraft N70-39350

AIRFIELD SURFACE MOVEMENTS

Visual display and automatic taxi guidance system testing for improved aircraft docking accuracy [AIAA PAPER 70-916] A70-35828

Airport capacity and layout, considering air traffic increase, runway occupancy, taxiway and computer simulation A70-38636

Metropolitan area airport capacity analysis for 1980 - Atlanta, Georgia N70-41195

AIRFOIL PROFILES

Plane diffuser grid profiles for subcritical velocities of oncoming flow, using wind tunnel test data A70-36129

Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics A70-37242

Thin airfoil theory in magnetoaerodynamics, considering steady two dimensional flow of compressible perfectly conducting inviscid fluid in presence of uniform magnetic field A70-37597

Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions A70-38304

Turbulent near wake of symmetrical airfoil, determining universal constant in mixing length formula for inner wake A70-40276

Optimum pressure distribution and airfoil profiles for maximum lift without separation in incompressible flow determined by second order theory [AIAA PAPER 69-739] A70-42704

Aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors including dual jets and cyclic results [AIAA PAPER 69-741] A70-42705

Lifting quasi-elliptical airfoils with supercritical shock free flow, discussing Nieuwland hodograph theory to compute profile number [ICAS PAPER 70-15] A70-44126

Lift determination of slender curved periodically recurring airfoils array in plane potential flow of inviscid incompressible fluid A70-44158

Estimating aerodynamic properties of airfoil with hinged flap and spoiler [NASA-TT-F-13131] N70-34693

AIRFOILS

Moving skin boundary layer control on airfoil achieved by moving wetted surface in streamwise direction [AIAA PAPER 70-881] A70-34808

Aerofoil section characteristics in shear flows of arbitrary velocity profile calculated by Glauert image method A70-35957

Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate A70-36194

Dynamic airfoil stall simulation in wind tunnels, considering pitch rate, Reynolds number, oscillation and test equipment effects [AIAA PAPER 70-945] A70-39582

Equations system for determining constants in Sedov integral for conformal mapping of polygonal airfoil lattice onto Riemann surface A70-39767

Subsonic air flow around airfoil in wind tunnel, detecting density gradients by pulsed ruby laser holographic visualization A70-40809

Subcritical viscous flow around arbitrary airfoils, calculating boundary layer effect on pressure distribution from inviscid flow approximation A70-40924

Flat plate airfoil unsteady lift due to chordwise velocity perturbations, using Horlock frozen gust pattern theory A70-42303

Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments [ICAS PAPER 70-08] A70-44119

Plane transonic flow around airfoils, using hodograph based methods for shock free flow and finite difference methods for flow with shock waves [ICAS PAPER 70-12] A70-44123

German monograph on airfoil and wings aerodynamic coefficients calculations, showing advantages of analog computers based on singularity theory and

distance functions
A70-45097
Aerodynamic forces and torque on airfoil in potential jet from boundary asymptotes position, determining flow characteristics by electrical analogy
A70-45438
Boundary layer calculation on airfoil leading edge separation during stall
[AD-701771] N70-34290
Two dimensional flow simulation around airfoils at various angles of attack
[AD-702863] N70-35305
Computer graphics used in airfoil design
N70-37760
Compression surface design for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993
Mathematical model for airfoil pressure distribution in two dimensional, uniformly sheared slipstreams
[AD-709696] N70-41266
Transonic flow over airfoils and prediction of buffet onset
[AD-709377] N70-41732
Computer programs for transonic flow over airfoils
[AD-709378] N70-41733
High lift low drag airfoil investigation
[REPT-6802] N70-43048

AIRFRAME MATERIALS
Aircraft structural materials, considering high strength steels Al and Ti alloys
A70-34675
Materials selection for cost effectiveness in 1980s airframe applications
[AIAA PAPER 70-870] A70-34819
Air safety research effects on operations, training procedures and materials, discussing gust loads, onboard data recording devices, human error, etc
A70-35859
Boron composites development for aircraft structures compared with titanium
[ASME PAPER 70-GT-120] A70-36851
Armor airframed helicopter for aerial armored reconnaissance vehicle, noting design, fabrication and weight
A70-44095
Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials
[ICAS PAPER 70-16] A70-44127
Fireproof nonmetallic materials for spacecraft and aircraft, discussing functional utility, durability and aesthetic requirements relative to environmental conditions
A70-44610
Airframe materials advances and influence on military aircraft design
N70-40714

AIRFRAMES
Alloy applications to Boeing supersonic transport airframe and components, discussing materials characteristics and manufacturing processes
A70-34451
Airframe-inlet integration for supersonic tactical fighters, testing wind tunnel models
[AIAA PAPER 70-933] A70-35843
Airframe and systems design optimization for aeronautical communications systems, considering airplane configurations, structural and electronics technology
A70-41349
Exhaust nozzle/airframe interference test evaluation for twin engine supersonic fighter
[AIAA PAPER 69-430] A70-42702
Airframe installation effects at transonic speeds on underwing supersonic cruise exhaust nozzles, using flight and wind tunnel tests
A70-43274
Airframe skin panels adhesive bonding in wide-bodied jet transports, emphasizing fuselage fatigue and corrosion resistance
[SAE PAPER 700863] A70-45875
Direct drive turbine engine control components and airframe accessories, noting weight and frontal area reduction
[SAE PAPER 700821] A70-45896
V/STOL powerplant development, discussion airframe and engine design, application to large aircraft and planned evolutionary process
[SAE PAPER 700809] A70-45905
Damping system for control of structural motion in flexible airframes
[NASA-CR-1557] N70-34004
Load transfer mechanics between elastic shell and airframe structure
[AD-703641] N70-35374
Finite element analysis for spare frames subjected to axial loads
[AD-704570] N70-36520
General principles of structural strength and fatigue, including airframes, fractures, and stress concentrations
N70-37803
Air Force aircraft structural integrity program with referenced specifications - airplane requirements
[AD-707884] N70-39664
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Jet engine/airframe interface problems in fighter aircraft design
N70-40709
Propeller and airframe integration in supersonic fighter aircraft design
N70-40711
Airframe systems design evaluation for military aircraft
N70-40715

AIRLINE OPERATIONS
Computerized air transportation service including passenger name record, fare quotation, ticketing, etc
A70-34688
Polish Lot airline long haul air transportation cost analysis
A70-34689
Long haul air transportation profitableness based on Polish Lot airline ton passenger-km computation comparison
A70-34691
Investment risks and technical impact on aircraft development, world aviation growth and airline costs
A70-34915
Boeing 747 aircraft operation in first three months of service, discussing crew training, instrumentation, navigation system improvement, etc
[AIAA PAPER 70-891] A70-35805
Boeing 747 ground operations and airport services, discussing computerized check-in, baggage handling equipment, etc
[AIAA PAPER 70-892] A70-35808
Fastener standardization for airline maintenance requirements
[AIAA PAPER 70-894] A70-35811
Minimum Equipment List from aircraft manufacturer and airline operations viewpoint
[AIAA PAPER 70-900] A70-35816
Safety in airline operations, discussing roles of aircraft designer and pilot
[AIAA PAPER 70-907] A70-35819
Large capacity transports influence on air cargo operations, and joint use cargo terminal planning
[AIAA PAPER 70-920] A70-35832
Air transport operations and economics in 1970 decade, taking into account cost-revenue ratio and cost effectiveness of various aircraft
A70-35852
Airline maintenance department assurance of air service regularity, stressing management role
A70-35855
Aircraft designer role in reducing departure delay due to equipment malfunction
A70-35858
Air safety research effects on operations, training procedures and materials, discussing gust loads, onboard data recording devices, human error, etc
A70-35859

Concorde design limitations for commercial success in civil airlines
A70-36665
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations
[SAE PAPER 700329] A70-36798
High bypass turbofan engine design concepts and development program for airline operation
[SAE PAPER 700292] A70-36804
Commercial aircraft launching and arresting systems for airport runway length reduction, discussing safety factors
[SAE PAPER 700264] A70-36821
Airlines data reduction using electronic engine maintenance recorders
[ASME PAPER 70-GT-127] A70-36853
Air freight carrier liabilities in passenger transportation international regulations, noting conflicting interpretations
A70-37562
Flight data recording system /FDRS/ for crashes expanded to aircraft integrated data system /AIDS/ for airlines
A70-37893
Airline area navigation in national airspace system, emphasizing moving map display for navigation charting
A70-38233
Collision avoidance system flight test and evaluation program for airline industry CAS specification
A70-38240
Future aircraft with increased comfort, speed and economy, noting power plant development
A70-38249
Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities
A70-38951
International transportation regional hub airport planning with spin-off parking, circular terminal facilities and high speed interterminal passenger and baggage controls
A70-39673
Air cargo terminal operations analysis, discussing manpower cost reduction
A70-40127
Air transport regulatory system, considering operational, technological and economic factors
A70-40579
Boeing 747 aircraft early operations experience covering airframe, engines and parts, performance, pilot and engineer training, maintenance, etc
[AIAA PAPER 70-886] A70-40740
Military and commercial aircraft maintenance costs reduction, discussing labor/material ratio, spare parts use, diagnostic systems, etc
A70-40750
Automated airline communications system for collecting, analyzing, storing, transmitting, receiving and presenting information required by ATC and advisory services
A70-41347
Air cargo management problems, discussing economics, ground handling, Jumbo jets, terminal facilities, mechanization, document handling, information flow, data systems, etc
A70-43269
Air transport system technical and operational functions optimization
A70-43532
Airline selection of Auxiliary Power Unit /APU/ for transport aircraft, noting benefits of air conditioning during ground operation
[SAE PAPER 700816] A70-45901
Commercial STOL aircraft propulsion systems from airline viewpoint, emphasizing subsystem design, engine selection, thrust deterioration and maintainability
[SAE PAPER 700810] A70-45904
Goals oriented airport planning and design approach, considering air traffic growth, capacity, environment and aircraft noise problems
[AIAA PAPER 70-1264] A70-45924
Short haul metropolitan air transportation, considering systems engineering as unifying technology
[AIAA PAPER 70-1281] A70-45927
Satellite based navigation/air traffic control information systems for short range STOL air carrier aircraft
[AIAA PAPER 70-1338] A70-45930
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Forecast indices for 1970 to 1981 in aviation industry and airline operations
[AD-704842] N70-34925
Aviation activity at air carrier airports in large and medium air traffic hubs - forecast tables for fiscal years 1971, 1976, 1981
N70-41291
Preliminary report on Cleveland Before and After Study to reduce conjestion of highway facilities at airport by rapid rail extension
[PB-184060] N70-41400
Changing patterns of commercial air service and airline economics
N70-41437

AIRPLANE PRODUCTION COSTS
Power plant efficiency, size, maintenance and operating economics of propulsion systems for air transport
A70-34917
Military aircraft engines performance increase and cost reduction
[SAE PAPER 700272] A70-36817
Aircraft manufacturing cost estimation in conceptual design phase, using structural synthesis program for cost buildup simulation
[SAWE PAPER 865] A70-40371
General aviation expansion and competitive position dependence on safety and utility improvements and simultaneous cost reductions
[AIAA PAPER 70-1220] A70-45953
Price and productivity change estimates in aircraft industry
[AD-706885] N70-37723

AIRPORT LIGHTS
Air traffic control, discussing precision instrument landing, approach lighting, collision avoidance, navigation aids, etc
A70-35185

AIRPORT PLANNING
Aircraft landing and takeoff difficulties and dangers due to mud and water on runways, discussing coping methods
A70-34692
Mobile lounges and airport productivity concepts for optimal handling of passengers at airport terminal
[AIAA PAPER 70-918] A70-35830
Large capacity transports influence on air cargo operations, and joint use cargo terminal planning
[AIAA PAPER 70-920] A70-35832
RAF aircraft damage due to bird strikes in U.K., discussing preventive measures at airfields
A70-35978
FAA research activities on eliminating birds at airports and improving aircraft components resistance to impact, including interagency committee functions on hazard problems
A70-35982
Military airlift command bird hazard minimization near airfields by environmental control, including uses of scare devices, chemicals, trapping, etc
A70-35988
Canadian civil aircraft bird hazards problem and alleviating measures including airport surrounding lands control
A70-35989
Aircraft bird hazards minimization by planning airport location and surroundings
A70-35991
Commercial aircraft launching and arresting systems for airport runway length reduction, discussing safety factors
[SAE PAPER 700264] A70-36821
Airport terminal design, describing electromechanical baggage handling and sorting systems
[SAE PAPER 700261] A70-36822

Metropolitan airports environmental considerations, noting aircraft noise role in planning
[SAE PAPER 700253] A70-36826
International civil aviation, discussing ICAO functions, airports and terminal facilities problems
A70-37748
Airport planning and design, discussing role of computers in capacity and site analysis, wind data processing, passenger and baggage flows analysis, etc
A70-37749
Hamburg airport terminal design including circular planets system for large aircraft, efficient intermodal transfer facilities, etc
A70-37750
Air traffic control third generation system upgrading programs increasing airport, en route and terminal airspace capacities
A70-38227
Airport capacity analysis for terminal areas, using simulation for alternatives to parallel runway operation
A70-38236
ATC and general aviation growth, considering airport capacity, radars, navigation, National Airspace System, etc
A70-38631
Airport capacity and layout, considering air traffic increase, runway occupancy, taxiway and computer simulation
A70-38636
ATC by scanning beam ILS and onboard control systems, increasing airport capacity and terminal area safety
[AIAA PAPER 70-1033] A70-39504
International transportation regional hub airport planning with spin-off parking, circular terminal facilities and high speed interterminal passenger and baggage controls
A70-39673
Aviation in 1970s, discussing traffic increase, airport planning, aircraft design, ballistic transport, noise factors, etc
A70-40157
Transport aircraft noise at three major airports by noise exposure forecast /NEF/ contours methodology
A70-40896
Centralized terminal air cargo handling capacity, discussing Jumbo aircraft, airside ramp system, container movement, computer control and automation
A70-43270
STOL operations from city centers, discussing safety requirements, navigation and guidance systems, airport criteria, etc
A70-44174
Financing methods for airport redevelopment and expansion, discussing economic and political framework of operations
[AIAA PAPER 70-1267] A70-45920
Planning criteria for optimum metropolitan airport system considering operational, physical, social and economic factors
[AIAA PAPER 70-1266] A70-45921
Goals oriented airport planning and design approach, considering air traffic growth, capacity, environment and aircraft noise problems
[AIAA PAPER 70-1264] A70-45924
Airport planning for air transportation in underdeveloped nations, discussing economic, financial, technical and operational factors
[AIAA PAPER 70-1268] A70-45926
FAA airport and airway capacity improvement program, considering runway-taxiway configurations, surface guidance and control, terminal design, takeoff, approach and landing systems, etc
[AIAA PAPER 70-1315] A70-45946
Airport accessibility role in planning V/STOL aircraft landing facilities
[AIAA PAPER 70-1311] A70-45947
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Wide-bodied and SST aircraft impact on airport design based on economic, social and environmental considerations
[AIAA PAPER 70-1269] A70-45970
ATC, air navigation facilities and airport design requirements for short haul transportation system
[AIAA PAPER 70-1288] A70-45973
Evaluation of proposed airport sites in Chicago area
[FAA-RD-70-25] N70-32546
Aviation climatology in aviation technology and airport planning
[TT-69-55100] N70-33233
Rapid assessment of soil strength at aircraft landing sites
[AD-705572] N70-33677
Management operations research, and design of present air traffic control system and future research
[NASA-CR-109980] N70-35713
Planning and financing adequate national civil airport system
N70-36030
Congressional hearings on supersonic aircraft and airport planning and development, air traffic control, and aircraft noise
N70-36161
General aviation airport system planning in Florida
[PB-191235] N70-37498
Annual report of Civil Aeronautics Board for 1969
N70-38666
Bibliography on air travel demand, airport configurations, flow patterns, and ground transportation systems
[AD-708023] N70-40109
Research and development plan for increased airport and airspace capacity
[AD-707186] N70-40748
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
Conference on STOL port planning and transportation system
N70-41077
Formulation of design and construction standards for STOL ports
N70-41078
Determination of runway length for STOL ports
N70-41080
Research and development of STOL port criteria, airworthiness and operational criteria, and flight test procedures
N70-41085
Planning for STOL air transportation system
N70-41086
Federal assistance in funding STOL port development
N70-41087
Graphic simulation study of two sites for second major airport in Atlanta area
[FAA-RD-70-63] N70-41198
Airport congestion in United States and Puerto Rico by 1975
N70-41273
Aviation activity at air carrier airports in large and medium air traffic hubs - forecast tables for fiscal years 1971, 1976, 1981
N70-41291
Washington National and Dulles International Airport plans for fiscal years 1970 to 1981
[AD-705087] N70-41302
Preliminary report on Cleveland Before and After Study to reduce congestion of highway facilities at airport by rapid rail extension
[PB-184060] N70-41400
National aviation system planning review conference, including air traffic control, airport planning, airspace capacity, and ILS development
N70-41526
Air facility establishment criteria
N70-41528
Considering noise intensity levels in houses and buildings near airports
[NLL-LIB-COMM-1527-/5196/] N70-42827

AIRPORT TOWERS
Live tests of tower cab radar approach control procedures
[FAA-NA-70-38] N70-36848
Improved flight safety through increased automation in terminal air traffic control facilities
N70-40783

AIRPORTS
Community air pollution from airports, discussing exhaust emissions, pollutant dispersion, etc
A70-35177
Heavy jet effect on airport acceptance rates, discussing various sequencing strategies
A70-36209
Aircraft traffic on ground at airports by digital simulation, investigating influence of constraint represented by infrastructure of taxi tracks
A70-36390
Airport operations effects on total environment, considering jet aircraft noise pollution
[AIAA PAPER 70-887] A70-37391
Automatic sound monitoring system for measuring aircraft noise in airport vicinity
A70-37908
Computer controlled aircraft noise monitoring system at Stuttgart airport
A70-37909
Airport capacity and terminal area safety increase by scanning beam instrument landing system, discussing automatic guidance trajectory example
A70-37913
Runway low visibility and ceilings frequency and duration at German airports, using 1949-1967 statistical data
A70-37925
Airport fog layers repetition frequency after low visibility periods
A70-43246
Air cargo traffic problems, discussing mechanized terminals, automatic handling equipment, direct container delivery, mass traffic and large freighter aircraft
A70-43268
Aircraft dynamic wheel load effects on airport pavements
[FAA-RD-70-19] N70-32560
Possible improvements in air traffic control
[AD-702777] N70-33880
Hearings on legislation for expanding and improving airport and airway facilities - Part 1
N70-35626
Hearings on legislation for expanding and improving airport and airway facilities - Part 2
N70-35627
Climatological summaries of airfields in Alaska and Hawaii
[AD-704607] N70-36250
Mathematical models for Northeast Corridor transportation system
[PB-190933] N70-36452
Numerical fog forecasting method for airport in Yugoslavia
[NLL-M-9052-/5828.4F/] N70-36479
Cost effectiveness analysis of airport snow removal and ice control
[FAA-RD-70-39] N70-36909
Noise exposure forecasts for John F. Kennedy, O Hare International, and Los Angeles International airports, including effects of changes in aircraft hardware and procedures
[FAA-NO-70-7] N70-36942
Aircraft noise study of Logan International Airport to determine effects on surrounding community
[PB-190118] N70-37337
Douglas DC-3 accident report - New Orleans International Airport
[PB-189376] N70-37607
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875
Climatological tables for Tontouta Airfield, New Caledonia - 1951 to 1966
N70-38299
Washington-Baltimore air freight transport system
[AD-708623] N70-40542
Improved flight safety through increased automation in terminal air traffic control facilities
N70-40783
Mechanical and power equipment of airports
[AD-709693] N70-41055
Runway lights and markings for STOL ports
N70-41083
STOL port arresting gear, fire fighting, and rescue equipment
N70-41084
Metropolitan area airport capacity analysis for 1980 - Atlanta, Georgia
N70-41195
Federal policy and services relative to privately owned, publicly used airports
N70-41530
Airport/airway cost allocation study legislation
N70-41537
Airport classification and certification
N70-41540
Panamanian civil aeronautics directorate departments of air safety, air traffic, airports, and air transport, with US technical assistance recommendations
[AC-70-3187] N70-41734
Air pollution from future giant jetports
[NASA-CR-110887] N70-42774

AIRSPACE
Terminal airspace utilization from ATC viewpoint, discussing airport capacity, data acquisition, weather, etc
[SAE PAPER 700281] A70-36809
Air traffic control third generation system upgrading programs increasing airport, en route and terminal airspace capacities
A70-38227
IATA policy on future ATC development, discussing controlled airspace, communications and radar requirements
A70-38630
Research and development plan for increased airport and airspace capacity
[AD-707186] N70-40748
Determination and control of airspace construction creating hazards to STOL flight paths
N70-41082
National aviation system planning review conference, including air traffic control, airport planning, airspace capacity, and ILS development
N70-41526
Increased enroute air traffic capacity through increased control sectorization
N70-41536
Airport/airway cost allocation study legislation
N70-41537
Research and development in airport/airway capacity, national airspace system, aircraft safety, and aerospace medicine
N70-41543

AIRSPEED
Fluidic parallel flow low airspeed indicator for V/STOL instrumentation tested in wind tunnel
[AIAA PAPER 70-906] A70-35818
Mass flow ion drift anemometer applicable to aircraft speed measurement including V/STOL
A70-37885
Aerodynamic configuration for aircraft capable of high speed flight and low drag for low speed takeoff or landing upon presently existing airfields
[NASA-CASE-XLA-00806] N70-34858
Aircraft reliability and excess transport aircraft airspeed analyzed from flight records
[ARC-CP-1088] N70-37163

ALABAMA
Evaluation and forecast of Huntsville air traffic
[NASA-CR-113917] N70-41242

ALASKA
Climatological summaries of airfields in Alaska and Hawaii
[AD-704607] N70-36250

ALCOHOLS
Aircraft accident briefs involving alcohol as cause factor in 1967 US general aviation
[PB-190413] N70-34576

ALGORITHMS
Automatic ATC with feedback, describing

information processing and flight plan algorithm
A70-38161
ALL-WEATHER AIR NAVIGATION
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy
A70-38365
All-weather Autoland control system using inertial smoothing, discussing required redundancy, fault detection, ground beam anomalies compensation, etc
A70-38821
V/STOL guidance and control system with bad weather landing capability, requirements for V/STOL integration into overall air traffic, terminal area guidance procedures, etc
A70-44843
Simulation of continuous runway centerline marking
[FAA-RD-70-40] N70-37021
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft
N70-40784
ALLOCATIONS
Airport/airway cost allocation study legislation
N70-41537
ALLOYS
Alloys for aircraft structures design, considering materials strength, corrosion resistance, producibility and cost
A70-39414
ALPHANUMERIC CHARACTERS
Air traffic control CRT plan position indicators, considering alphanumeric symbols strokes design
A70-38645
ALTIMETERS
Applicability of pulse compression radar to space geodesy altimetry
[NASA-CR-1605] N70-34166
Perturbation scheme for unknown disturbances in orbit affecting sea-surface altimetry accuracy
[AD-705268] N70-36237
Literature review and bibliography on altimetry
[FAA-RD-70-52] N70-41197
ALTITUDE CONTROL
Supersonic flight altitude stability, studying effects of velocity, lift-drag ratio, thrust law, wind direction, engine unstarts, etc
[AIAA PAPER 69-813] A70-42712
Investigating aircraft accident during incorrect approach maneuver by pilot in mountainous terrain
[NTSB-AAR-70-12] N70-38644
ALTITUDE SIMULATION
Aircraft propulsion system test facilities, discussing altitude simulation, large subsonic and supersonic engines and component development
[ICAS PAPER 70-45] A70-44143
ALUMINUM ALLOYS
Aircraft structural materials, considering high strength steels Al and Ti alloys
A70-34675
HF endurance tests of Al sheet alloy used in welded aircraft structural components, plotting curves for heat treated and untreated specimens
A70-38431
Applying Nishiwaki theory of penetration to projectile shapes against aluminum alloy targets
[AD-707837] N70-40024
AMPHIBIOUS VEHICLES
External aerodynamics role in handling qualities of amphibious hovercraft, discussing tests of hull shape, air cushion efflux and hollow models
A70-34919
Hovercraft operational advantages and legal status
A70-43499
AMPLIFICATION
Parachute opening load amplification due to suspension line elasticity, using two-body spring- mass model
A70-44531
ANALOG COMPUTERS
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices
[ICAS PAPER 70-42] A70-44140
German monograph on airfoil and wings aerodynamic coefficients calculations, showing advantages of analog computers based on singularity theory and distance functions
A70-45097
ANALOG DATA
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities
A70-38533
ANALOG SIMULATION
Gas turbine engine dynamic performance simulation, using analog and digital techniques
[ASME PAPER 70-GT-23] A70-36830
Two shaft bypass jet engine analog simulation, determining angular acceleration dependence on angular velocity and fuel consumption
A70-45442
ANALYSIS (MATHEMATICS)
Mathematical methods for calculating service life of aircraft engine lubricating oils
[AD-703999] N70-36225
Theoretical analysis of wing lift in wide and circular stripstreams, and engineering method for predicting practical V/STOL configuration characteristics
[NASA-CR-1632] N70-36851
Equations for determining vortex hazard index
N70-40915
ANEMOMETERS
Mass flow ion drift anemometer applicable to aircraft speed measurement including V/STOL
A70-37885
ANGLE OF ATTACK
Yawed two dimensional wedges in hypersonic stream, including leading edge bluntness, viscous interaction and angle of attack effects
[AIAA PAPER 70-783] A70-34503
Dihedra placed at angle of attack in hypersonic rarefied gas flow, investigating base flow and near wakes
A70-35047
Shock layer and combustion in supersonic flows about conical bodies at various angles of attack
A70-35894
Hypersonic gas flow around blown plane of segmentally blunted cones at large angle of attack, using two dimensional model
A70-36258
Flow field about leading edges of tapered wings set at incident angle of attack, using gas dynamic and Monge equations
A70-36376
Two dimensional time dependent solution for impulsive motion of circular cylinder involving viscous cross flow at moderate angles of attack
A70-36454
High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications
[AIAA PAPER 70-904] A70-37392
Automatic calculations for fuel volume mass properties in tanks at various angles of attack, considering total weight, gravity center moment and inertia product
[SAWE PAPER 850] A70-40376
Steady viscous flow past oblique flat plate at high Reynolds number, using Oseen linearized approximation
A70-41714
Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209
Aircraft rolling motion /eigenmotion/ in flight at small angle of attack following initial disturbance, discussing response to control action
A70-42515
Perfect gas supersonic flow with constant velocity, pressure and density around finite nonaxisymmetric body at small angles of attack
A70-43322
Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations
A70-43323
Stationary elliptic cylinders in subcritical flow, determining Strouhal number, pressure fluctuations and wake geometry as functions of angle of attack

[AIAA PAPER 69-745] A70-44564
Angle of attack and bluntness effects on hypersonic flow over 15 deg semiapex cone in helium
[NASA-TN-D-5903] N70-34073
Two dimensional flow simulation around airfoils at various angles of attack
[AD-702863] N70-35305
Approximation for distribution of flow properties in angle of attack plane of conical flows
[NASA-TN-D-5951] N70-36590
Convective heat transfer to cones and cylinders at angle of attack
[NASA-CR-102824] N70-37466

ANGULAR ACCELERATION
Two shaft bypass jet engine analog simulation, determining angular acceleration dependence on angular velocity and fuel consumption
A70-45442

ANGULAR VELOCITY
Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209
Error influence of real accelerometer on measuring accuracy of angular velocity
N70-37791

ANNULAR FLOW
Test section for use in short duration wind tunnel for simulating high Reynolds numbers over transonic speed range
[NASA-CASE-MFS-20509] N70-35676

ANTENNA ARRAYS
Ferrite phase shifter for array antennas, discussing design trends, production, performance characteristics and future developments
A70-37864

ANTENNA RADIATION PATTERNS
Stub and frame antennas for flight vehicles
[JPRS-50690] N70-32902

ANTHROPOMETRY
Articulated variable link length human model for simulating operator performance in cockpits
[AD-703271] N70-32341

ANTIFRICTION BEARINGS
High speed and long life bearings and dampers for future jet engines, considering design factors
[SAE PAPER 700318] A70-36800
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts
[AD-705127] N70-32265
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts - annotated bibliography
[AD-705128] N70-32266

ANTISUBMARINE WARFARE AIRCRAFT
S-3A carrier based ASW weapons system, discussing onboard equipment, navigation, avionics integration, etc
[AIAA PAPER 70-882] A70-35802

APOLLO APPLICATIONS PROGRAM
European avionics role in Post Apollo program, noting space shuttles, space tugs, space stations and modules
A70-43501
European wind tunnels suitable for Post Apollo Program aerodynamic testing, presenting detailed tabulated information on available facilities
A70-43503

APOLLO SPACECRAFT
Aerodynamic and gravity gradient torque effects on attitude control of Apollo/S-4B configuration in circular earth orbit
[NASA-TM-X-64300] N70-34218

APPLICATIONS TECHNOLOGY SATELLITES
Management organization of European operational application satellite systems, concerning interurban telecommunication and air traffic control
A70-43502

APPROACH
Advanced integrated landing system test and evaluation for all-weather landing
[FAA-RD-70-28] N70-41271

APPROACH CONTROL
Precision approach and landing guidance system selection by RTCA committee, discussing aircraft antennas, scan rates, international cooperation, etc
[AIAA PAPER 70-937] A70-35846
Stochastic processes with linear dynamics and quadratic control cost, considering application to aircraft landing approach path optimization
A70-35973
Time-synchronized approach control, combining aircraft precision navigation and guidance with ATC equipment
A70-38237
Avionics role in STOL air transportation operational capabilities in congested air traffic environment
A70-38238
Category II longitudinal approach system model taking into account inputs, gusts, ILS beam noise, man machine interaction, etc
[AIAA PAPER 70-1034] A70-39503
Pilot/vehicle feedback systems with flight director computer for transport aircraft longitudinal control during landing, discussing design by manual control displays theory
[AIAA PAPER 70-1001] A70-39530
Aircraft landing maneuver optimization by in-flight monitoring of approach and landing phases, furnishing decision making display
[AIAA PAPER 70-1000] A70-39531
Automatic control systems for aircraft approach to landing path and subsequent stabilization on trajectory, compensating for cross wind action and radio noise disturbances
A70-39842
General aviation traffic control, discussing limitations of present system and improvements of position information and area navigation approach procedures
A70-42385
Wheel force and roll moment nonlinearities effect on light STOL aircraft handling qualities during approach
[ICAS PAPER 70-55] A70-44151
Helicopter automatic approach and hover coupler systems, discussing cockpit display devices, handling qualities, pilot workload and fatigue and external load stabilization
A70-44464
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft
A70-45428
Approach guidance method using single onboard optical measurement
[NASA-TN-D-5963] N70-40743
Terminal area guidance techniques for space shuttle landing
N70-40960
Designing terminal area navigation, guidance, and control system suitable for landing space shuttle vehicles under Category 2 conditions
N70-40961
Guidance and control techniques for terminal energy management and automatic horizontal landings of unpowered space shuttle vehicles
N70-40962
Control zone establishment for instrument approaches
N70-41533
Simulator study of flight management task performance during low visibility approach and landing using baseline category 2 flight instrumentation
[NASA-CR-73478] N70-42037

APPROACH INDICATORS
Evaluation of low cost visual approach slope indicator as pilot training aid
[FAA-DS-70-4] N70-32530
Landing approach maneuvering using radio direction finder of 'Svod' system
[JPRS-51258] N70-36101
Scandinavian aircraft accident investigation and subsequent recommendations
[NTSB-AAR-70-14] N70-36114
Holographic display device for aircraft landing approach to aircraft carrier
[AD-703683] N70-36298
Compatibility factors affecting concept development of approach and landing guidance systems

[AD-707129] N70-37993
Rotary wing and vertical takeoff aircraft displays for steep angle approaches
[AD-709475] N70-41477
APPROPRIATIONS
National Aviation System Plan - 1971-1980 N70-37026
Federal assistance in funding STOL port development N70-41087
APPROXIMATION
Approximation for distribution of flow properties in angle of attack plane of conical flows
[NASA-TN-D-5951] N70-36590
Spline approximation as applied to aeronautical problems
[NAL-TN-20] N70-41882
ARC CHAMBERS
Hotshot wind tunnel performance improvement by coating arc chamber with silastene to retard heat loss and metal pollution A70-34774
ARC HEATING
Hypersonic test flow in arc heated wind tunnel, measuring freestream Pitot pressure, mass flux, stagnation point heat transfer rate and wall pressure A70-40270
Dissocited and ionized hypersonic flows of hydrogen heated by electric arc techniques, investigating flows in wind tunnel nozzles A70-42759
ARGON
Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces A70-41444
ARMED FORCES (UNITED STATES)
Army aviation requirements in high intensity conflicts, discussing transportation, communications, intelligence acquisition, organization and suitable aircraft types A70-44855
ARMOR
Armor airframed helicopter for aerial armored reconnaissance vehicle, noting design, fabrication and weight A70-44095
ARRESTING GEAR
Commercial aircraft launching and arresting systems for airport runway length reduction, discussing safety factors
[SAE PAPER 700264] A70-36821
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities A70-38533
Arresting gear concepts for runway use
[AD-701331] N70-34263
Capstan analysis computer program and aircraft recovery system, arresting gear capstan drive design
[AD-708759] N70-40257
Performance of aircraft arresting gear with steel cable energy absorbers
[AD-708760] N70-40298
STOL port arresting gear, fire fighting, and rescue equipment N70-41084
ASCENT TRAJECTORIES
Aircraft climb and descent trajectories approximation compatible with air traffic control operation, noting parameters effects A70-46239
ASPECT RATIO
Variable aspect ratio and variable sweep delta wing planforms for supersonic aircraft
[NASA-CASE-XLA-00221] N70-33266
Supersonic aircraft configuration providing for variable aspect ratio and variable sweep wings
[NASA-CASE-XLA-00166] N70-34178
Supersonic aircraft variable sweep wing planform for varying aspect ratio
[NASA-CASE-XLA-00350] N70-38011
ASPHALT
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
ASSEMBLIES
Aircrew equipment assemblies and type 9 ejection seat for Harrier aircraft
[FPRC/MEMO-248] N70-36581
ASTRONAUTICS
Israeli conference on aeronautics and astronautics, including aerodynamics, aircraft structures, propulsion, and flight control
[AD-707326] N70-39737
ASTRONOMICAL OBSERVATORIES
Aircraft capabilities as scientific observation platform in astronomy and geophysics, including instrument adaptation and IR absorber problems A70-43146
ASYMMETRY
Jet-plume-induced flow separation on asymmetric bodies at 3.00, 4.50, and 6.00 Mach numbers
[NASA-TM-X-2059] N70-34350
ASYMPTOTIC METHODS
Asymptotic study of perfect aerodynamic fluid flows around weakly lifting three-dimensional bodies in sonic regime
[NASA-TT-F-13319] N70-42020
ATLANTIC OCEAN
Satellite-based air traffic control system for North Atlantic, applying stochastic optimal control theory
[AIAA PAPER 70-966] A70-39563
ATMOSPHERIC CIRCULATION
Simulated neutral atmospheric boundary layer measurements in wind tunnel, extending power spectral and correlation determinations A70-40139
Conference on aerodynamics of atmospheric shear flows
[AGARD-AR-24-70] N70-40736
Laboratory simulation of atmospheric boundary layer
[AD-710250] N70-42338
ATMOSPHERIC COMPOSITION
German book on aircraft thermal propulsion systems calculation, design and evaluation, covering thermodynamic principles and atmospheric composition and properties A70-46150
ATMOSPHERIC DENSITY
Subsonic and supersonic aircraft dynamic loads under conditions of variable atmospheric density A70-34685
Parachutes for low density atmospheres, describing low and high altitude test results
[AIAA PAPER 70-1164] A70-41846
ATMOSPHERIC DIFFUSION
Soviet meteorology abstracts, including storm development, aerological sounding, and atmospheric diffusion studies N70-37882
ATMOSPHERIC ELECTRICITY
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc A70-38800
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within cloud A70-42775
Lower atmosphere electric field vertical distribution measurement by combined balloon and rocket soundings A70-42797
ATMOSPHERIC ENTRY
Attached inflated BALLUTE /balloon-parachute/ for stabilization and retardation of aircraft stores, high altitude descent devices and planetary entry vehicles
[AIAA PAPER 70-1200] A70-41816
ATMOSPHERIC ENTRY SIMULATION
Theory and capabilities of magnetically driven flyers
[AD-708449] N70-41131
ATMOSPHERIC HEAT BUDGET
Contrail effects on atmospheric thermal radiation budget in heavy jet traffic regions from airborne IR and solar radiometric observations

A70-44033
ATMOSPHERIC MODELS
Supersonic boom intensity calculation on ground, assuming isobaric inhomogeneous atmosphere and weak shock wave
A70-36380
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models and simulating effects on XV-5 V/STOL aircraft
A70-40784
ATMOSPHERIC PHYSICS
Plastic balloon platforms for atmospheric research and engineering applications, discussing design and use of unreinforced polyethylene and reinforced Mylar types
A70-43650
Laboratory simulation of atmospheric boundary layer
[AD-710250] N70-42338
ATMOSPHERIC PRESSURE
Atmospheric pressure surface sharp slopes at SST altitudes producing vertical acceleration based on temperature gradients inspection
A70-46050
ATMOSPHERIC STRATIFICATION
Atmospheric contaminants dispersion simulation in meteorological wind tunnel with capability to simulate thermally stratified boundary layers
A70-34496
ATMOSPHERIC TEMPERATURE
Air total temperature measurement for jet powered aircraft, discussing subsonic and supersonic wind tunnel data for sensor thermal recovery characteristics
A70-37882
Atmospheric inhomogeneity and temperature gradient effects on sonic booms, discussing displacement, growth rate and shock wave radii refraction
A70-42311
Meteorological wind and temperature distributions on selected routes at Concorde cruising level, noting computer use for flight planning
A70-46204
ATMOSPHERIC TURBULENCE
Invariant autopilot control system during flight in turbulent atmosphere, allowing for aircraft elastic properties and invariance of coordinates
A70-39845
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109
Atmospheric inhomogeneity and temperature gradient effects on sonic booms, discussing displacement, growth rate and shock wave radii refraction
A70-42311
Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703
Aerodynamic theory of pressure field induced on lifting surface by isotropic atmospheric turbulence, considering transfer function of Concorde aircraft
[ICAS PAPER 70-30] A70-44104
Mathematical modeling of atmospheric gusts in stratosphere, mountain wave and thunderstorm conditions relevant to aircraft design
A70-45420
Review of methods used for simulating random load fatigue in laboratory testing
[UTIAS-29] N70-33724
Sonic boom modeling and topographic and atmospheric effects
[MDC-J0734/01] N70-36809
Characteristics of severe turbulence encountered by civil jet transport aircraft
[ARC-CP-1098] N70-37086
ATOMIC STRUCTURE
Plastic strain in metals, including work hardening and recovery, atomic lattice distortions, and metallurgical transformations
N70-37804
ATOMIZING
Liquid jets aerodynamic atomization at orifice exit in reentry vehicle into gaseous crossflow, investigating critical Weber number variation with Knudsen number
A70-39701
ATS 1
ATS-1 VHF communications experimentation
[FAA-RD-70-12] N70-36949
ATS 3
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities
[NASA-TN-D-5908] N70-37168
ATTACK AIRCRAFT
Attack helicopter fire control system with day and night detection, recognition and kill capabilities, discussing system components, operation and reliability
A70-34732
ATTITUDE CONTROL
V/STOL attitude control system as integral propulsion system part, analyzing design and weight tradeoffs
[ASME PAPER 70-GT-31] A70-36832
Aerospace electronics covering fly-by-wire aircraft flight control, ATC, star trackers for spacecraft attitude control, etc
A70-39668
Aerodynamic and gravity gradient torque effects on attitude control of Apollo/S-4B configuration in circular earth orbit
[NASA-TM-X-64300] N70-34218
Attitude sensing head using short protuding tubes in transonic wind tunnel at Mach numbers 0.5 to 1.1
[ARL/A-321] N70-39023
Integration, testing, and performance analysis of solar pointing control and telemetry system with flight experiment aboard Aerobee sounding rocket
[AD-709102] N70-40992
ATTITUDE GYROS
Aircraft vertical gyro with hydraulic damping device, calculating ballistic deviations limitation conditions
A70-39733
ATTITUDE INDICATORS
Electronic attitude director indicator /EADI/ for supersonic transport, employing CRT display, head down TV and microvision sensors
A70-37911
Wind tunnel measurements of hemisphere cylinder yawmeter sensitivity at transonic speeds and Reynolds numbers
[ARL/A-320] N70-39031
AUDITORY PERCEPTION
Perceived noisiness of various types of aircraft by subjects seated outdoors and inside houses
[NASA-CR-1635] N70-35881
Modified calculations for relative perceived noisiness of aircraft by human subjects
[NASA-CR-1636] N70-35898
AUDITORY TASKS
Temporal and spectral combinations effects on human judgements of aircraft noisiness
[FAA-NO-69-3] N70-42217
AURORAL ABSORPTION
Three-frequency riometer system operation on NASA 711 aircraft during 1969 auroral absorption
[NASA-CR-112356] N70-36632
AUTOGYROS
NACA/NASA rotary wing aircraft research covering autogyro and helicopter development, noting flight safety
A70-44851
AUTOMATA THEORY
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836
AUTOMATIC CONTROL
Variable loads programming by semicomputers/ semihardware method for 747 fatigue testing
A70-35511
Visual display and automatic taxi guidance system testing for improved aircraft docking accuracy
[AIAA PAPER 70-916] A70-35828
Automated baggage handling and processing, requiring total aviation community participation
[AIAA PAPER 70-917] A70-35829
Automated radar terminal system, ARTS-III Beacon Tracking Level for continuous aircraft identity

on controllers radar display
A70-36393
Data processing system for automatic air traffic control, describing hardware and software
A70-36395
National airspace system /NAS/, describing en route stage A automated air traffic control
A70-36399
Aero gas turbine engines digital computer control, discussing special properties, design and safety problems
[ASME PAPER 70-GT-40] A70-36870
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes
A70-37403
Automatic sound monitoring system for measuring aircraft noise in airport vicinity
A70-37908
Computer controlled aircraft noise monitoring system at Stuttgart airport
A70-37909
C-5A engineering flight test /EFT/ computer controlled data processing system operation, illustrating capability, performance and limitations
A70-37917
Digital electrodynamic vibration exciter control for sinusoidal, random and shock spectrum testing of aircraft, missiles and satellites
A70-37920
Automatic ATC with feedback, describing information processing and flight plan algorithm
A70-38161
Avionic systems automatic test equipment, discussing maintenance, reliability, cost and time reduction
A70-38544
ATC automation in France, applying method of filters for controller feed, radar and accident avoidance
A70-38635
Signal automatic air traffic control system /SATCO/ for flight plan processing, using multi-processing real time computer, electronic displays and software facilities
A70-38646
VTOL aircraft longitudinal motion automatic stabilization in presence of turbulence and internal disturbances, using rotors and jet engines
A70-39838
Automatic control systems for aircraft approach to landing path and subsequent stabilization on trajectory, compensating for cross wind action and radio noise disturbances
A70-39842
Automatic air conditioning systems for hermetically sealed aircraft cabins, deriving control laws for air pressure, temperature and humidity
A70-39843
Invariant systems structural synthesis for automatic control of plant motion, deriving control laws for thrust and angle of attack
A70-39844
Italian automated ATC system /ATCAS/, discussing subsystem functions, display devices, data acquisition, information distribution, etc
A70-40911
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836
Computerized air cargo clearing, discussing London Airport Cargo Electronic-data- processing Scheme
A70-43272
Queueing requirements in automatic radar target detection system operating with narrow bandwidth data link
A70-43489
Automatic conflict detection and resolution in ATC planning, discussing flight paths, zones of protection, etc
[ICAS PAPER 70-58] A70-44154
Automatic Data Processing and Display System for ATC over Belgium, Holland and Germany, relieving traffic controller routine tasks
A70-44860
Automatic control system for Boeing SST engine air intakes, optimizing engine performance and controlling noise propagation
A70-46214
Upper Air Space Control Center Automatic Data Processing and Display System for air traffic control
A70-46238
Development of effort expended on automatic test equipment for avionics systems
[AGARD-CP-51] N70-32151
Application of automated testing and troubleshooting in electronic manufacturing plant
N70-32155
Technique of analysis of effective testability of elements of avionics systems
N70-32156
Built-in test equipment for advanced flight guidance systems
N70-32160
Method for designing and incorporating automatic built-in test equipment into avionic communications equipment
N70-32161
Feasibility of automatically testing avionic systems
N70-32170
Classification of software and hardware examples for automatic test equipment
N70-32171
Automatic test equipment implementation techniques to realize cost effectiveness support
N70-32172
Software and hardware specifications for automatic test equipment
N70-32173
Automatic testing of landing aid for VTOL aircraft
N70-32177
Design study for advanced automatic test equipment
N70-32178
Test equipment for airborne identification friend/foe interrogators and transponders
N70-32179
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft
N70-40784
Use of computers in air traffic control
N70-41043
Computer programs for determining performance of automatic aircraft landing system in turbulence
[NASA-TN-D-6066] N70-43146

AUTOMATIC FLIGHT CONTROL

V/STOL aircraft automatic flight control, guidance and navigation by onboard computer, discussing mathematical model and simulation results
[AIAA PAPER 70-1035] A70-39502
Automatic aircraft lateral motion stabilization during flight in perturbed atmosphere by HF invariant systems
A70-39839
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
Maneuver demand control using electric signalling feedback technique in Avro 707C and Hunter Mk 12 aircraft
A70-46203
Adaptive aircraft control concept modified for helicopters
[AD-703231] N70-34923
Operational reliability of flight control systems and automatic piloting of aircraft
[NASA-TT-F-610] N70-35169
Variable structure systems and applications to flight automation problems
[AD-706798] N70-38534

AUTOMATIC LANDING CONTROL

Automatic landing system assurance of DH 121 aircraft schedule all-weather regularity through high safety level via redundancy
A70-35856
All-weather Autoland control system using inertial smoothing, discussing required redundancy, fault detection, ground beam anomalies compensation, etc

A70-38821
Digital fail-operative flight control computers for automatic landings, describing system requirements and problems and flight test program
[AIAA PAPER 70-1032] A70-39505
AUTOMATIC PILOTS
Invariant autopilot control system during flight in turbulent atmosphere, allowing for aircraft elastic properties and invariance of coordinates
A70-39845
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices
[ICAS PAPER 70-42] A70-44140
Elastic fuselage flight vehicle dynamic stability at supersonic speeds, using automatic pilot stabilization
A70-44157
Aircraft accident investigation occasioned by improper application of automatic-coupled instrument landing systems
[NTSB-AAR-70-2] N70-36043
AUTOMATIC TEST EQUIPMENT
Papers on automation in electronic test equipment, Volume 7, covering factory and depot for incoming inspection, production testing, quality control, maintenance and rebuilding
A70-40766
General Purpose Automatic Test System using building block concept for avionic systems evaluation at military depot level
A70-40771
AUTOMATION
Computerized air transportation service including passenger name record, fare quotation, ticketing, etc
A70-34688
National Airspace System air traffic control automation program for en route and terminal facilities
A70-37914
Automatic test technology for avionics systems, discussing equipment and cost reduction
A70-38543
Avionics hardware design guidelines to meet automated testing constraints including malfunction isolation, block requirements, packaging, etc
A70-44538
Air traffic control, future national airspace system improvements in view of air transportation growth, computerized automation technology, etc
[AIAA PAPER 70-1263] A70-45969
Improved flight safety through increased automation in terminal air traffic control facilities
N70-40783
AUTOROTATION
High powered high speed helicopters autorotation entry characteristics, noting capability of meeting control time delay requirement
A70-34715
Autorotation of flat plate wing model about spanwise axis
[AD-710288] N70-43141
AUXILIARY POWER SOURCES
Airline selection of Auxiliary Power Unit /APU/ for transport aircraft, noting benefits of air conditioning during ground operation
[SAE PAPER 700816] A70-45901
TSCP700 aircraft auxiliary power unit design, fuel consumption and maintainability
[SAE PAPER 700815] A70-45902
Review of electrical power systems on existing commercial aircraft
[NASA-CR-110693] N70-32344
Design consideration for air breathing gas turbine engine as third propulsion system of space shuttle
N70-39637
AVIONICS
Military aircraft avionics central digital computers, discussing memory capacity, computational speed requirements, cost and tradeoffs
A70-34673
Avionics problems in future Army aviation, discussing communications, navigation, instrumentation, automatic flight control, electronic countermeasures, fire control, etc
A70-34725
Aerospace industry instrumentation - Conference, Las Vegas, May 1969, Volume 15
A70-35476
Real time computers design tradeoffs in avionics systems
A70-35510
Flight/accident data recorders and associated equipment for civil and military aircraft requirements
A70-36342
Aircraft electronic equipment cooling techniques, discussing natural and forced convection, phase change and heat pipes
A70-36763
Aircraft digital interior communication systems, combining multiplexing techniques with solid state integrated circuits technology and systems integration
[SAE PAPER 700302] A70-36813
Computerized airborne integrated data acquisition and analysis system, discussing hardware, software and airborne-ground elements interfaces
[AIAA PAPER 70-935] A70-37393
Avionics role in STOL air transportation operational capabilities in congested air traffic environment
A70-38238
Avionics maintenance effectivness logistics, discussing symptom pattern observation technique /SPOT/ for in-flight data
A70-38399
Automatic test technology for avionics systems, discussing equipment and cost reduction
A70-38543
Avionic systems automatic test equipment, discussing maintenance, reliability, cost and time reduction
A70-38544
Avionics hardware operational effectiveness assessment method, considering inertial navigation system LN-12D
A70-38837
Aerospace electronics covering fly-by-wire aircraft flight control, ATC, star trackers for spacecraft attitude control, etc
A70-39668
General Purpose Automatic Test System using building block concept for avionic systems evaluation at military depot level
A70-40771
Versatile Avionic Shop Test maintenance system supporting avionic equipment aboard aircraft carriers
A70-40772
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-41257
Avionics digital computer system using associative memory for executive control functions implementation to mechanize task assignment algorithm
A70-43105
European avionics role in Post Apollo program, noting space shuttles, space tugs, space stations and modules
A70-43501
Aircraft electronics and instrumentation history, discussing anemometer, barometric altimeter, radar, communications systems, computers, flying control and various flight conditions
A70-43888
Avionics system for fighter aircraft, discussing weapons design, navigation-attack systems integration, etc
A70-44413
Avionics hardware design guidelines to meet automated testing constraints including

malfunction isolation, block requirements, packaging, etc
A70-44538
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules
A70-44542
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques
A70-44543
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design
A70-44544
Avionic components reliability, determining nonsteady cooling air environment effects
A70-44744
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft
A70-45428
Development of effort expended on automatic test equipment for avionics systems
[AGARD-CP-51] N70-32151
Operational requirements for airborne automatic test equipment
N70-32152
Integrated dynamic tests at flight line maintenance echelon for weapon systems
N70-32153
Impact of management of automatic test equipment in avionic repair organization
N70-32154
Application of automated testing and troubleshooting in electronic manufacturing plant
N70-32155
Technique of analysis of effective testability of elements of avionics systems
N70-32156
Real time measurement of aircraft parameters as part of airborne integrated data system to improve aircraft maintenance
N70-32157
Interdependence of built-in, onboard, and ground based test facilities
N70-32158
Interrelation of onboard and ground automatic test equipment in achieving effective overall support system
N70-32159
Built-in test equipment for advanced flight guidance systems
N70-32160
Method for designing and incorporating automatic built-in test equipment into avionic communications equipment
N70-32161
Individually built-in self test techniques as applied to terrain following radar systems
N70-32162
Role of built-in test equipment in performance monitoring and fault detection
N70-32163
Hardware and software approach techniques for achieving high level of built-in test equipment
N70-32164
Constraints placed on circuits and system design by various testing situations encountered during life of avionics equipment
N70-32165
Onboard checkout systems approach to avionic systems self-test
N70-32167
Checkout methods in digital control systems using control computer as test set
N70-32168
Analysis of onboard equipment testing methods
N70-32169
Feasibility of automatically testing avionic systems
N70-32170
Classification of software and hardware examples for automatic test equipment
N70-32171
Software and hardware specifications for automatic test equipment
N70-32173
Application of programmer-comparator to avionics systems off-line testing
N70-32174
Testing of airborne avionics systems using computer subroutines
N70-32175
Test techniques used for state-of-the-art airborne infrared equipment
N70-32176
Theory of functional electric networks and microminiaturization for avionics system
[AD-705677] N70-34957
Modular computer systems architecture for avionic and aerospace applications
N70-39496
Avionics design problem in systems integration for terrain following capability in military transport aircraft
N70-40719
Minimizing cost and schedule problems of integrating software of avionics system
N70-40954

AVRO 707 AIRCRAFT
Maneuver demand control using electric signalling feedback technique in Avro 707C and Hunter Mk 12 aircraft
A70-46203
Low speed flight tests on longitudinal stability and control of Avro 707 delta wing aircraft
[ARC-CP-1105] N70-37164

AXIAL FLOW
Forced vortex impeller in axial flow fan without inlet vanes, presenting lift and drag coefficients of blade sections, loss of head, etc
A70-38222
Three dimensional flow through rotor of axial vortex flow fan, using airfoil method for design
A70-38248
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584
Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics
A70-44991

AXIAL FLOW TURBINES
Annulus wall boundary layers in axial flow turbomachines, taking into account boundary layer growth and associated secondary flows
[ASME PAPER 70-GT-92] A70-36877
Blade root design for axial flow compressors and turbines, avoiding tensile stress concentration
A70-38616
Multistage multiple reentry axial flow reaction turbine with reverse flow reentry ducting
[NASA-CASE-XLE-00170] N70-36412
Multistage, multiple reentry, single rotor, axial flow turbine
[NASA-CASE-XLE-00085] N70-39895

AXIAL LOADS
Joint strength of three layer fiberglass reinforced plastic panels with bilateral adhesive patches under linear axial force
A70-42812
Finite element analysis for spare frames subjected to axial loads
[AD-704570] N70-36520

AXIAL STRAIN
Axial and centrifugal moments of inertia arising from static balancing of gyroscopes
N70-37788

AXISYMMETRIC BODIES
Blunt based right circular cylindrical body at subsonic speed, investigating turbulent near wake in wind tunnel
A70-34463
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel
[AIAA PAPER 70-796] A70-34464
Stress concentration on axisymmetric annular wings calculated using method of singularities
A70-36377

Hypersonic aerodynamic deceleration devices for axisymmetrical bodies with cylindrical main sections and various front sections, using gun tunnel techniques
[AIAA PAPER 70-1174] A70-41839
Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics
A70-44991
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943
Turbulent near-wake of blunt based, right circular cylinder immersed in uniform subsonic flow
[AD-705687] N70-34978

AXISYMMETRIC FLOW
Nonsteady axisymmetric flow of inviscid, incompressible fluid through heavily loaded actuator disk
[AD-708396] N70-39937

B

B-70 AIRCRAFT
Damping system for control of structural motion in flexible airframes
[NASA-CR-1557] N70-34004
Frequency functions and power spectra of XB-70 aircraft response to gusts
[NASA-CR-1621] N70-35659

BAC AIRCRAFT
Flight tests of low speed controllability of BAC slender variable sweep wing research aircraft
[ARC-CP-1102] N70-37062

BACKSCATTERING
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721
Positron annihilation in quenched Cd metal from radar backscatter intensities in aircraft model compared with anechoic chamber measurements
A70-46257

BAGGAGE
Automated baggage handling and processing, requiring total aviation community participation
[AIAA PAPER 70-917] A70-35829
Airport terminal design, describing electromechanical baggage handling and sorting systems
[SAE PAPER 700261] A70-36822

BAILOUT
Pilot airborne recovery device /PARD/ midair rescue system, discussing buoyance, midair pickup, seat ejection energy absorber, homing avionics and human factors
[AIAA PAPER 70-1206] A70-41812

BALANCE
Wind tunnel balance for measuring small aerodynamic loads on scale models, describing three component construction
A70-35490

BALANCING
Tungsten filled urethane in aircraft areas as balancing agent
A70-35418
Soviet book on vibration and balancing of aircraft engine rotors covering structural deformation and dynamics of turbine engines and compressors
A70-37237
Asymmetric rotating bodies mass properties measurement on Dynamic Balancing Machine, taking into account aerodynamic forces
[SAWE PAPER 818] A70-40351
Axial and centrifugal moments of inertia arising from static balancing of gyroscopes
N70-37788
Dynamic balancing of rotors
N70-37790

BALL BEARINGS
Angular contact bearing balls track position on aero gas turbine engines shaft measurement in test rig at high speeds
A70-40141
Numerical methods for determining whirl characteristics of rotors running on shafts supported by ball bearings
N70-43036

BALLAST (MASS)
Water ballast effect on glider loads, using concept of characteristic velocities
A70-36253
Water ballast loadings on sailplane Cobra 17, considering wing, aileron, tailplane, fuselage and landing gear
A70-42962

BALLISTIC TRAJECTORIES
Ballistic trajectory, packageability, deployment and flight stability of attached ram air inflatable decelerator for high speed/low altitude store delivery
[AIAA PAPER 70-1199] A70-41817

BALLISTICS
German book on principal characteristics of flight mechanics and ballistics covering mirror symmetric aircraft and axisymmetric bodies such as projectiles and missiles
A70-40738

BALLOON SOUNDING
PCM command control system for high altitude ballooning operations, discussing component equipment
A70-40085

BALLOONS
Plastic balloon platforms for atmospheric research and engineering applications, discussing design and use of unreinforced polyethylene and reinforced Mylar types
A70-43650

BALLUTES
Attached inflated BALLUTE /balloon-parachute/ for stabilization and retardation of aircraft stores, high altitude descent devices and planetary entry vehicles
[AIAA PAPER 70-1200] A70-41816
Drag prediction for Ballute and parachute trailing decelerators at supersonic speed and zero angle of attack, using flow field computations
[AIAA PAPER 70-1177] A70-41836
Design of parachutes and ballutes for decelerating atmospheric entries at supersonic velocities
[NASA-CR-66909] N70-32884

BARRIERS
Optimal longitudinal takeoff trajectories, formulating obstacle clearance criterion function based on aircraft design parameters effects
[AIAA PAPER 70-963] A70-39566

BASE FLOW
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel
[AIAA PAPER 70-796] A70-34464
Dihedra placed at angle of attack in hypersonic rarefied gas flow, investigating base flow and near wakes
A70-35047

BASE PRESSURE
Cylindrical afterbodies base pressure drag under powered supersonic flight, modifying Korst flow model recompression criterion
A70-42713

BAYES THEOREM
Computer program for assessment and modification of mechanical component life predictions by discrete formulation of Bayes theorem
A70-38816

BEARING (DIRECTION)
Symposium on geographic orientation of pilots during air operations
[AD-709124] N70-41056

BEARINGS
Pliability calculation of elastic bearings for turbomachines
[AD-700690] N70-35204
Endurance test on two phase flow rotor bearing system for turbomachinery
[MTI-70-TR-33] N70-40214

BEECHCRAFT AIRCRAFT
Accident investigations of Beechcraft and Piper aircraft
[PB-192067] N70-37551
Accident investigations of Aero Commander, Beechcraft, Cessna, and Piper aircraft
[PB-192069] N70-37553

BENDING
Aircraft wing box beams bending tests to failure loads, considering crushing pressure, bulkhead flexural deformations, structure initial imperfections and instability phenomena
[ICAS PAPER 70-33] A70-44103

BENDING MOMENTS
Helicopter rotor blades flapwise bending moments prediction by transfer function/superposition techniques
A70-34704
Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls comfigured vehicle /CCV/ design concepts
A70-37395
Analysis of bending loads of hypersonic aircraft
[NASA-TM-X-2092] N70-40808

BENDING VIBRATION
Nodal patterns on thin elastic circular plate vibrating in flexure, considering natural and compounded modes
A70-38245
Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276

BERYLLIUM
Be production, development, potential uses and properties
[ASM PAPER GG8-102] A70-39970

BESSEL FUNCTIONS
Method for calculating interaction of cylindrical wall with circular straight section with flow from doublet placed in wall
[NASA-TT-F-13155] N70-33808

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BINARY CODES
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BIRDS
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A70-35976
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A70-35977
RAF aircraft damage due to bird strikes in U.K., discussing preventive measures at airfields
A70-35978
German Air Force aircraft bird strikes statistics
A70-35979
West German aircraft bird hazards problems, discussing research activities and recommendations for strike avoidance
A70-35980
Statistical measurement of bird hazards to aircraft in terms of strike rates at airports, considering international strike rate standard
A70-35981
FAA research activities on eliminating birds at airports and improving aircraft components resistance to impact, including interagency committee functions on hazard problems
A70-35982
U.S. Air Force bird-aircraft collisions problem and bird control research
A70-35984
Aircraft bird hazards in New Zealand, discussing ecological research techniques and preventive measures
A70-35985
Bird strikes in U.S.S.R., discussing frequency, damage, etc
A70-35986
Aircraft damage from bird impact and alleviating measures, taking into account windshield and intake guard designs, microwave beams for protection and chemical agents as repellant
A70-35987
Military airlift command bird hazard minimization near airfields by environmental control, including uses of scare devices, chemicals, trapping, etc
A70-35988
Canadian civil aircraft bird hazards problem and alleviating measures including airport surrounding lands control
A70-35989
Aircraft bird hazards minimization by planning airport location and surroundings
A70-35991
Aircraft design minimizing damage by bird strikes to gas turbine engine components, discussing service experience, airworthiness demonstration tests and research programs
A70-35994
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading
A70-35995
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests
A70-35996
International Civil Aviation Organization /ICAO/ work on bird hazard reduction, including aircraft airworthiness specifications, bird data dissemination, etc
A70-35997
Airport bird detection equipment /ABDE/ radar to display airfield map for presence and magnitude of bird groups and vegetation on runway
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A70-36319
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A70-45644
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BLADE TIPS
Swept tip rotor blade design, discussing wind tunnel-whirl stand correlations
A70-34736
Reynolds number effect on tip losses
[AD-700578] N70-36419

BLAST LOADS
Shock wave diffraction by moving thin wing over flat terrains, discussing aircraft blast encounter
A70-36195
Gas turbine engine response to blast wave overpressures
[DRES-267] N70-36951

BLOWDOWN WIND TUNNELS
Blowdown, supersonic, and hypervelocity wind tunnel apparatus at the Centre Ricerche Aerospaziali, Rome, Italy N70-37016
Calibration of blowdown wind tunnel for Concorde aircraft jet exhaust nozzle studies [ONERA-NT-160] N70-42475
BLOWERS
Comparative load capacity of disk models of natural gas blowers of different designs under plastic strain A70-43941
BLOWING
High lift airfoils boundary layer separation suppression by blowing, describing wall jets streamwise development prediction methods [AIAA PAPER 70-872] A70-34818
Flow field model for large surface blowing problem accounting for upstream and downstream effects with large rate normal injection near trailing edge A70-40110
Wing lift increase by spanwise blowing along upper surface, causing flow reattachment on wing and vortex induced effective aerodynamic camber increase [ICAS PAPER 70-09] A70-44120
Low speed wind tunnel tests on high aspect ratio unswept wings with boundary layer control by blowing over ailerons and trailing-edge flaps [ARC-CP-1108] N70-43015
BLUNT BODIES
Blunt based right circular cylindrical body at subsonic speed, investigating turbulent near wake in wind tunnel A70-34463
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel [AIAA PAPER 70-796] A70-34464
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers A70-34465
Aerodynamic characteristics of transonic and supersonic blunt vehicles, reviewing numerical methods A70-35895
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind tunnel flow A70-35962
Hypersonic gas flow around blown plane of segmentally blunted cones at large angle of attack, using two dimensional model A70-36258
Stagnation point heat transfer coefficient to elliptical model taking into account pressure, model blunting and diameter, Mach number, etc A70-39699
Spike effect on nose drag and static stability of blunt bodies, estimating optimum length for drag reduction at zero angle of attack A70-39702
Calculation of supersonic flow around blunted bodies with detached shock wave [NASA-TT-F-13026] N70-32533
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Schemes of location method in computing supersonic flows around blunt bodies [NASA-TT-F-13230] N70-42136
BOATTAILS
Minimum-drag boattail configurations optimization for supersonic flow, determining wave drag coefficients A70-42714
Boattail and plug area variation effect on convergent and plug nozzle efficiency at Mach 0 to 1.97 [NASA-TM-X-2112] N70-42438
BODIES OF REVOLUTION
Flow field on suction side of slender body of revolution with/without wings, investigating by directional probe in wind tunnel A70-35924
Modified linearized transonic flow theory application to pressure coefficient distribution on circular arc bodies of revolution A70-39614
Reentry bodies of revolution subsonic and supersonic aerodynamic characteristics A70-39704
Continuous surface of revolution parachute for supersonic/hypersonic speeds, performing wind tunnel tests [AIAA PAPER 70-1173] A70-41840
Conducting fluid supersonic flow past slender body of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem A70-42669
Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations A70-43323
Entrainment theory for incompressible turbulent boundary layer velocity and drag on bodies of revolution employed in fuselage, submersible and cowlings for propulsion design A70-44400
Bodies of revolution optimal configuration, considering minimum head drag coefficient and low heat transfer at hypersonic speeds, using modified Newtonian and hypersonic flow theories A70-45021
Hydroelastic analysis of circular cylinder/lift on bodies of revolution [AD-708434] N70-40252
BODY-WING AND TAIL CONFIGURATIONS
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference A70-36445
Aerodynamics of steady, inviscid transonic flows around slender bodies and wing-body combinations at free stream Mach number one [AIAA PAPER 70-798] A70-39900
Unsteady supersonic flow around oscillating cross-shaped wing-fuselage system, determining perturbation velocities and pressure distributions A70-42609
Short wing lift investigated via lateral fluid jets fired in wind tunnel for various lengths A70-42614
BOEING AIRCRAFT
Boeing 2707 SST horizontal tail multiple channel actuation system features A70-35827
BOEING 2707 AIRCRAFT
Boeing 2707 SST design for low community noise, discussing engine-airframe matching effect [SAE PAPER 700808] A70-45906
BOEING 707 AIRCRAFT
Accident investigation of Boeing 707 crash during simulated landing approach [PB-191318] N70-37486
BOEING 737 AIRCRAFT
Boeing 737 aircraft nose gear gravel deflector and engine vortex dissipator [AIAA PAPER 70-912] A70-35824
BOEING 747 AIRCRAFT
Variable loads programming by semicomputers/ semihardware method for 747 fatigue testing A70-35511
Boeing 747 aircraft operation in first three months of service, discussing crew training,

instrumentation, navigation system improvement, etc
[AIAA PAPER 70-891] A70-35805
Boeing 747 maintenance and inspection program, discussing condition monitoring, test methods, etc
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Boeing 747 aircraft JT9D engine deflections and removals during early service experience and maintenance
[AIAA PAPER 70-890] A70-35807
Boeing 747 ground operations and airport services, discussing computerized check-in, baggage handling equipment, etc
[AIAA PAPER 70-892] A70-35808
Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Engine vibration monitoring system for Boeing 747 aircraft, including piezoelectric transducer, transmission assembly and differential charge converter
A70-37898
Boeing 747 wing panels shot peening process, discussing machine, control technique and operational requirements
A70-38498
Boeing 747 transport airplane flight test data system, discussing recording media, major PCM and FM tape systems, etc
A70-38531
Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities
A70-38951
Boeing 747 pilot transition training, discussing takeoff, landing, eyelevel, flareout taxi speeds, inertial navigation and electrical, fuel and hydraulic systems
A70-40083
Boeing 747 aircraft early operations experience covering airframe, engines and parts, performance, pilot and engineer training, maintenance, etc
[AIAA PAPER 70-886] A70-40740
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques
A70-44543
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design
A70-44544
Boeing 747 flight test certification program, describing methods, data systems, inertial navigation, engines, flutter, etc
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Flight test data for vortex wake characteristics of transport aircraft
N70-40914
Predicted wide bodied jet aircraft impact on air transportation system, including Boeing 747, DC 10, and L-1011
N70-41142

BOMBS (ORDNANCE)
Free flight measurement of aerodynamic lateral force and moment coefficients on bombs with freely spinning cruciform and monoplane tails and fixed split skirts
[WRE-TN-HSA-162] N70-36045

BONDING
IR NDT bond inspection system for helicopter rotor blade honeycomb box assemblies, using closed circuit slow scan video system to detect bondline voids
A70-35184
Failure analysis on adhesive bonds of aircraft honeycomb sandwich composites
[AD-710352] N70-43053

BOOSTER ROCKET ENGINES
Hybrid combustion ram rocket drives, discussing booster initial acceleration, exhaust gas use as fuel and payload gain
[ICAS PAPER 70-50] A70-44147

BORON
Boron composites development for aircraft structures compared with titanium
[ASME PAPER 70-GT-120] A70-36851

BOUNDARY LAYER CONTROL
Moving skin boundary layer control on airfoil achieved by moving wetted surface in streamwise direction
[AIAA PAPER 70-881] A70-34808
High lift airfoils boundary layer separation suppression by blowing, describing wall jets streamwise development prediction methods
[AIAA PAPER 70-872] A70-34818
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448
Supersonic flow field over aeroelastic ogive cylinder model with boundary layer control
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Double hinged flap for boundary layer control over trailing edges of wings
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BOUNDARY LAYER FLOW
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies
A70-35035
Boundary layer momentum thickness growth in channels with adverse pressure gradients by stepwise integration of Truckenbrodt equation and extending Gruschwitz-Schmidbauer separation criterion
[ASME PAPER 70-GT-12] A70-36864
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A70-40139
Subcritical viscous flow around arbitrary airfoils, calculating boundary layer effect on pressure distribution from inviscid flow approximation
A70-40924
Liquid droplet breakup by aerodynamic forces, obtaining solutions for fluid flow inside droplet and in coupled liquid-gaseous boundary layer
A70-43741
Calculating laminar boundary layer flow on highly swept delta wing at high incidence
[ARC-CP-1096] N70-37138
Turbulence effects on flow past rigid circular cylinder at subcritical Reynolds number
[AD-704121] N70-38155
Computer programs for transonic flow over airfoils
[AD-709378] N70-41733

BOUNDARY LAYER SEPARATION
Hypersonic cruise vehicles viscous interactions areas, examining compression corners, shock interactions, laminar and turbulent flow, boundary layer separation, etc
[AIAA PAPER 70-781] A70-34475
Analytical model for jet interaction induced separation of supersonic turbulent boundary layers, conducting flat plat tests at Mach 4
[AIAA PAPER 70-765] A70-34486
Transitional flow separation upstream of compression corner at trailing edge of sharp leading edge flat plate
[AIAA PAPER 70-764] A70-34487
High lift airfoils boundary layer separation suppression by blowing, describing wall jets streamwise development prediction methods
[AIAA PAPER 70-872] A70-34818
Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate
A70-36194
Three dimensional boundary layer on lee- and windside of prolate spheroid, emphasizing separation and embedded streamwise vortices
A70-39359
Loads induced by terminal shock boundary layer interaction on cone-cylinder bodies, discussing

angle of attack effect
A70-41863
Perfect gas three dimensional boundary layer separation on circular cone at incidence, comparing numerical calculation and experimental results
A70-44207
Boundary layer calculation on airfoil leading edge separation during stall
[AD-701771] N70-34290
Jet-plume-induced flow separation on asymmetric bodies at 3.00, 4.50, and 6.00 Mach numbers
[NASA-TM-X-2059] N70-34350
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities
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BOUNDARY LAYER STABILITY
Multilayered and multiple supersonic jets, deriving dispersion equations for boundaries stability
A70-38663

BOUNDARY LAYER TRANSITION
Laminar boundary layer transition on sharp cone at zero yaw in supersonic wind tunnels, correlating aerodynamic noise disturbances with transition Reynolds numbers
[AIAA PAPER 70-799] A70-34462
Vapor volume entrained in liquid bulk from boundary layer boiling on vertical plate in low gravity field
A70-41055
Boundary layer transition region of flat plate in incompressible flow by subsonic wind tunnel tests, demonstrating harmonic wall perturbation effect
A70-41440
Free stream disturbances influence on hypersonic boundary layer transition Reynolds number in heated and unheated flows
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Wind tunnel testing at transonic speeds, discussing boundary layer transition and dynamic sting interference
A70-44581
Aerodynamic drag and local convective heat transfer on smooth plate for various flow velocities, determining effects of turbulator in boundary layer transition region
A70-44733
High altitude flow visualization of boundary layer transition and shock waves using oil coatings
[ARC-CP-1090] N70-37173
Boundary layer transition on lifting reentry vehicles at high angles of attack
N70-37843

BOUNDARY LAYERS
Atmospheric contaminants dispersion simulation in meteorological wind tunnel with capability to simulate thermally stratified boundary layers
A70-34496
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
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Soviet book on passenger aircraft aerodynamics covering motions of gases and immersed bodies, similarity laws, boundary layer theory, finite span wing, etc
A70-36507
Annulus wall boundary layers in axial flow turbomachines, taking into account boundary layer growth and associated secondary flows
[ASME PAPER 70-GT-92] A70-36877
End wall boundary layers effect included in performance prediction method for multistage axial compressors
[ASME PAPER 70-GT-80] A70-36884
Thermal load of aerodynamic reentry body and resulting optimization and design criteria
[SC-T-70-4015] N70-33249
Buffet boundaries on aircraft wings in transonic velocity determined using boundary layer theory
[NRC-TT-1408] N70-33426

BOUNDARY VALUE PROBLEMS
Oscillating wing aerodynamic load boundary value problem reduction to sequence of steady lifting-surface problems
A70-42715
Similarity transformations and boundary value problems of hyperbolic partial differential equations with wave solutions
[AD-710403] N70-42747

BOW WAVES
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock
A70-40288

BOX BEAMS
Aircraft wing box beams bending tests to failure loads, considering crushing pressure, bulkhead flexural deformations, structure initial imperfections and instability phenomena
[ICAS PAPER 70-33] A70-44103
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc
A70-45147

BRAKES (FOR ARRESTING MOTION)
Solid cloth personnel parachutes opening forces, discussing loading conditions, flight path shock parameters, mass ratio variations and elasticity of system
[AIAA PAPER 70-1167] A70-43992
Design of parachutes and ballutes for decelerating atmospheric entries at supersonic velocities
[NASA-CR-66909] N70-32884
Energy dissipating shock absorbing system for land payload recovery or vehicle braking
[NASA-CASE-XLA-00754] N70-34850

BRAKING
C-5A aircraft six wheel main landing gear bogie pitching control, emphasizing braking torque compensating mechanism design
[AIAA PAPER 70-914] A70-35826
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
Calculating velocity distribution with altitude while braking bodies in atmosphere
[AD-706171] N70-38655

BRAYTON CYCLE
Brayton engine electrical subsystem design and computerized technique used to document wiring
[NASA-TM-X-2079] N70-39388

BUCKLING
Flutter design charts for isotropic panels stressed to verge of buckling for tropical values of structural damping
A70-36446
Fatigue strength of stiffened aircraft panels subjected to repeated buckling by compression loads
[ICAS PAPER 70-35] A70-44132
Static testing and creep, including tensile tests, plastic deformation, and buckling
N70-37805

BUFFETING
Buffet boundaries on aircraft wings in transonic velocity determined using boundary layer theory
[NRC-TT-1408] N70-33426
Space shuttle buffeting and aerodynamic noise
N70-36608
Transonic flow over airfoils and prediction of buffet onset
[AD-709377] N70-41732

BUILDINGS
Sonic boom effects on building structures, using Concorde measurements and explosion simulation studies
A70-45151

BUS CONDUCTORS
Multiplex data bus subsystem for improving reliability and reducing weight of space shuttle avionics system
N70-40957

BYPASSES
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629

C

C-130 AIRCRAFT
Applications of advanced composite materials to C-130 center wing box
[NASA-CR-66979] N70-42183

C-135 AIRCRAFT
Summary of C-141 and C-135 aircraft fuel tank nitrogen inerting tests
N70-42755

C-141 AIRCRAFT
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft
N70-40784
Summary of C-141 and C-135 aircraft fuel tank nitrogen inerting tests
N70-42755

C-5 AIRCRAFT
C-5A propulsion system onboard monitoring for malfunction detection, analysis and subsystem recording
A70-35497
C-5A aircraft six wheel main landing gear bogie pitching control, emphasizing braking torque compensating mechanism design
[AIAA PAPER 70-914] A70-35826
C-5 aircraft cargo loading system for terminals minimizing ground time
A70-35831
C-5 flight simulation program for design of basic aircraft, flight control and guidance subsystems
[AIAA PAPER 70-922] A70-35833
C-5A engineering flight test /EFT/ computer controlled data processing system operation, illustrating capability, performance and limitations
A70-37917
Extraction parachute deployment for airdropping multiple loads from C-5A aircraft
[AIAA PAPER 70-1203] A70-41814
Ultrasonic crack detection in fastener holes in C-5A wings
A70-45571
C5 Malfunction Detection Analysis and Recording /MADAR/ subsystem for onboard fault isolation including engines
[SAE PAPER 700820] A70-45898

CABIN ATMOSPHERES
Closed compartment fire mathematical model to analyze combustion parameter effects, atmosphere pressure and temperature during fire
A70-35646

CABLES (ROPES)
Dynamic control model of lift helicopters with two cable sling loads using multiple part motion equations
[AIAA PAPER 70-929] A70-35839
Performance of aircraft arresting gear with steel cable energy absorbers
[AD-708760] N70-40298

CADMIUM
Positron annihilation in quenched Cd metal from radar backscatter intensities in aircraft model compared with anechoic chamber measurements
A70-46257

CALCULUS OF VARIATIONS
Generation of suboptimal closed loop guidance for minimum time aircraft trajectories
N70-37817

CALIBRATING
ILS glide slope calibration using optically projected digital codes as reference
A70-37912
Intermittent, single jack, flexible nozzle supersonic wind tunnel calibration at Mach numbers 1.5 to 3.0
[TAE-110] N70-36965

CALIFORNIA
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875

CANADA
Canadian civil aircraft bird hazards problem and alleviating measures including airport surrounding lands control
A70-35989

CANADAIR AIRCRAFT
Digital data acquisition system for CF-5A flight test program, discussing recording system design
A70-38532

CANARD CONFIGURATIONS
Ground effects investigation of STOL air-sea transport model with blowing over canard and wing flaps
[NASA-TN-D-5988] N70-40690
Preliminary design considerations and aeroelastic constraints for large supersonic aircraft with canard control
N70-40706

CANOPIES
Parawing canopy behavior during deployment in free flight at specific altitudes and dynamic pressures
[AIAA PAPER 70-1189] A70-41804
Hi-glide personnel canopy /Para-Foil, Parawing, Sailwing, Volplane/ technology capability requirements identification from performance parameters tradeoffs
[AIAA PAPER 70-1194] A70-41822
Parachute canopy surfaces transient aerodynamic pressures during unsteady processes, using piston theory
[AIAA PAPER 70-1175] A70-41838
Snatch force during lines-first deployment of aerodynamic decelerator, including effects of canopy skirt acceleration and suspension wave propagation characteristics
[AIAA PAPER 70-1171] A70-41842

CANTILEVER PLATES
Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276

CAPACITIVE FUEL GAGES
Aircraft capacitive fuel gage improvement by integration with flowmeter system, DC torquer display and digital techniques, considering other measurement principles
A70-40619

CAPTIVE TESTS
Propeller static performance tests for V/STOL aircraft
[AD-708501] N70-40939

CARBON
Composite technology effects on engineering design, emphasizing carbon-carbon materials for aircraft structural weight reduction, performance improvement and high temperature applications
A70-39202

CARBON DIOXIDE
Underexpanded carbon dioxide free jet expanding into vacuum from conical nozzles
A70-35246

CARGO AIRCRAFT
Extensible wing flap system for cargo aircraft, discussing structural design details and advantages
[AIAA PAPER 70-911] A70-35823
Swing tail cargo aircraft fuselage section stress analysis by finite element method, discussing displacement models, deformation modes and economics
A70-41260
Prototype cargo-recovery parachute assembly for airdropping heavy unit loads - design study
[AD-701004] N70-33952
Fire extinguishing in large cargo aircraft
[FAA-RD-70-42] N70-36871

CASCADE FLOW
Two dimensional compressor cascades of double circular arc and wedge shape blades testing performance in transonic and supersonic wind tunnels
[ASME PAPER 70-GT-7] A70-36829

Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors
[ASME PAPER 70-GT-106] A70-36845
Axial flow compressor cascades, predicting total pressure losses for inlet relative Mach number greater than unity
[ASME PAPER 70-GT-57] A70-36872
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
Two dimensional cascades for incompressible plane potential flows with given velocity distribution
[ASME PAPER 70-GT-87] A70-36880
Low drag supersonic compressors for aircraft engines, calculating start and cruise conditions of quasi-isentropic flow cascades
A70-41405
Low aspect ratio compressor blade cascade performance at blade span center, discussing pressure loss, angle of attack and staggering
A70-42272
Two dimensional turbine cascade air flow, examining boundary layer regime, thickness, velocity and pressure coefficient at any point by Mach-Zehnder interferometer
A70-42344
Transonic turbine cascades exit flow parameters taking into account blade profile
A70-42346
Turbine blades aerodynamic forces theoretical and experimental investigation, noting cascade series interaction induced pressure pulsations
A70-45504
Transonic compressor cascades - influence of compressibility and static pressure
N70-39094

CASCADE WIND TUNNELS
Supersonic cascade wind tunnel performance evaluation, using compressor blades of simple geometric shapes
[ASME PAPER 70-GT-110] A70-36848
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption
[ASME PAPER 70-GT-79] A70-36885

CASCADES
German monograph on supersonic strongly deflecting retardation cascades covering flow geometry and application to axial flow compressor stage
A70-45095

CATALYSIS
Research on surface catalysis in nonequilibrium flow
[AD-704814] N70-33275

CATALYSTS
Catalytic combustion fuel tank inerting techniques for fire protection in military and civilian aircraft
A70-44485

CATAPULTS
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities
A70-38533

CATHODE RAY TUBES
Air traffic control CRT plan position indicators, considering alphanumeric symbols strokes design
A70-38645

CAVITIES
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities
[NASA-TN-D-5908] N70-37168

CEILINGS (METEOROLOGY)
Runway low visibility and ceilings frequency and duration at German airports, using 1949-1967 statistical data
A70-37925
Ceiling and visibility atlas for Southeast Asia /1000 ft and 2 1/2 mi/
[AD-707496] N70-37708
Ceiling and visibility atlas for Southeast Asia /5000 ft and 5 mi/
[AD-707494] N70-37709

CENTER OF GRAVITY
L-1011 onboard system for gross weight and center of gravity determination, describing transducers placement, computer design and display panel
[SAWE PAPER 837] A70-40359

CENTRIFUGAL COMPRESSORS
Radial compressor diffusers design and technology
[ASME PAPER 70-GT-116] A70-36850
Pressure balanced rotor flow path design for mixed flow centrifugal compressors, calculating losses in rotor and diffuser section
[ASME PAPER 70-GT-12] A70-36863
Turbofan, turbojet and turboprop engine development in aircraft gas turbine evolution, discussing VTOL propulsion, centrifugal and axial compressor engines
A70-46251
Design calculations for interblade channels in centrifugal compressors
[NLL-RTS-5564] N70-34769
Basic elements for advanced design of radial flow compressors
N70-39096
Supersonic radial diffusers for centrifugal compressors
N70-39097

CENTRIFUGAL FORCE
Turbine blades deformation by centrifugal and aerodynamic forces, discussing theory for bending stress free blade design
A70-45505
Axial and centrifugal moments of inertia arising from static balancing of gyroscopes
N70-37788

CERAMICS
Ceramic materials for low cost high inlet temperature gas turbine engine components
[ASME PAPER 70-GT-105] A70-36889

CERTIFICATION
Boeing 747 flight test certification program, describing methods, data systems, inertial navigation, engines, flutter, etc
[SAE PAPER 700828] A70-45891
STOL aircraft FAA airworthiness standards and certification rules, examining noise, control systems, all weather operation, fire protection, handling qualities and performance
[AIAA PAPER 70-1331] A70-45937
Airport classification and certification
N70-41540

CESSNA AIRCRAFT
Accident investigations of Cessna aircraft
[PB-192068] N70-37552
Accident investigations of Aero Commander, Beechcraft, Cessna, and Piper aircraft
[PB-192069] N70-37553

CH-46 HELICOPTER
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft
A70-45428

CH-47 HELICOPTER
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design
A70-34702
CH-47 cruise guide indicator for displaying fatigue loading to pilots, discussing design and operation
A70-34705

CH-54 HELICOPTER
CH-54A helicopter gas turbine engine air particle separator /EAPS/ field service in Vietnam, noting time before engine removal for erosion
[ASME PAPER 70-GT-97] A70-36844

CHANNEL FLOW
Critical height phenomenon for vertical jet exhausting into horizontal parallel plates channel simulating aircraft surfaces
A70-36709
Boundary layer momentum thickness growth in channels with adverse pressure gradients by stepwise integration of Truckenbrodt equation and extending Gruschwitz-Schmidbauer separation criterion
[ASME PAPER 70-GT-12] A70-36864
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results
[AIAA PAPER 70-971] A70-39558
Large MHD generator channel aerodynamics, discussing pressure distributions to stall and

stagnation pressure loss
A70-40002
Indirect method of determining air flow through inside channel and gas temperature in front of double flow turbine
[NASA-TT-F-12982] N70-34312
CHARRING
Charring ablators transient heat transfer model, calculating surface temperature and recession and pyrolysis mass loss
[AIAA PAPER 70-1143] A70-40280
CHARTS
Area navigation system charting, discussing effect on flight information publications
A70-38231
CHECKOUT
Live tests of tower cab radar approach control procedures
[FAA-NA-70-38] N70-36848
CHEMICAL COMPOSITION
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes
A70-43439
CIRCUIT BOARDS
Constraints placed on circuits and system design by various testing situations encountered during life of avionics equipment
N70-32165
CIRCUIT BREAKERS
Fluidics for aircraft high pressure hydraulic systems, discussing circuit breaker, feel computer and landing gear sequencing circuit
[SAE PAPER 700784] A70-45860
Aircraft hydraulic system circuit breaker for protection against major system leakage
[AD-702172] N70-36652
CIRCUIT PROTECTION
High current short circuit testing facilities for aircraft control and protection devices
[AD-705504] N70-36423
CIRCULAR CONES
Perfect gas three dimensional boundary layer separation on circular cone at incidence, comparing numerical calculation and experimental results
A70-44207
CIRCULAR CYLINDERS
Two dimensional time dependent solution for impulsive motion of circular cylinder involving viscous cross flow at moderate angles of attack
A70-36454
Local heat transfer between heated circular cylinder and air in transverse slip flow at low Reynolds and Mach numbers
A70-41035
Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter
A70-42603
Aeroelastic stability for circular cylindrical structures under periodic Karman vortex excitation
A70-44764
Turbulent near-wake of blunt based, right circular cylinder immersed in uniform subsonic flow
[AD-705687] N70-34978
CIRCULAR ORBITS
Aircraft flying at constant speed in circular orbits, calculating flight path under effect of uniform velocity wind
A70-40920
CIRCULAR PLATES
Nodal patterns on thin elastic circular plate vibrating in flexure, considering natural and compounded modes
A70-38245
CIRCULAR SHELLS
Circular cylindrical shell flutter analysis review, with bibliographies
[TT-6917] N70-39330
CIRCULAR TUBES
Noise and sound propagation and nonlinear signal distortion in circular tubes
[NPL-AERO-AC-43] N70-35068
CIRCULATION
Hot gas recirculation measurements on four different-size models of simple VTOL configuration
[NASA-TT-F-12604] N70-32535
Scaling comparison of recirculation effects of VTOL YJ-85 lift engine pod with similar small-scale simulated engine pod
[NASA-CR-1625] N70-35846
CIVIL AVIATION
Concorde design limitations for commercial success in civil airlines
A70-36665
International civil aviation, discussing ICAO functions, airports and terminal facilities problems
A70-37748
Aeronautical satellite system for civil flight safety, discussing operational, technical and economic aspects
A70-41131
Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703
FAA airport and airway capacity improvement program, considering runway-taxiway configurations, surface guidance and control, terminal design, takeoff, approach and landing systems, etc
[AIAA PAPER 70-1315] A70-45946
Research and development in air traffic control systems for civil aviation
[AD-704475] N70-34255
Briefs of accidents involving amateur/home built aircraft occurring in 1967
[PB-190410] N70-34630
Forecast indices for 1970 to 1981 in aviation industry and airline operations
[AD-704842] N70-34925
Hearings on legislation for expanding and improving airport and airway facilities - Part 1
N70-35626
Hearings on legislation for expanding and improving airport and airway facilities - Part 2
N70-35627
Management operations research, and design of present air traffic control system and future research
[NASA-CR-109980] N70-35713
Reports of U.S. civil aircraft accidents
N70-35934
Planning and financing adequate national civil airport system
N70-36030
Planning and financing improvements to air transportation system
[H-DOC-91-130] N70-36073
Congressional hearings on general aviation role in social and economic systems, and future developments
N70-36155
Commercial air service and miscellaneous air laws
N70-36198
Public address on air transport development
N70-36636
National Aviation System Plan - 1971-1980
N70-37026
Characteristics of severe turbulence encountered by civil jet transport aircraft
[ARC-CP-1098] N70-37086
Accident report data for FH-227C aircraft number N380NE
[PB-191201] N70-37453
Accident investigation of civilian aircraft
[PB-192070] N70-37554
United States of America accident briefs on civil aviation
[PB-188859] N70-37606
Statistical analysis of United States of America civil aviation accidents - 1969
[PB-189247] N70-37608
Civil aircraft accident investigation of collision near Fiarland, Indiana
[NTSB-AAR-70-15] N70-38243
Annual report of Civil Aeronautics Board for 1969
N70-38666
General aviation flying occupant load factors
[REPT-70-9] N70-40800
Recommendations concerning Panamanian civil aeronautics directorate

[AC-70-3188] N70-41143
Metropolitan area airport capacity analysis for 1980 - Atlanta, Georgia N70-41195
Pollution, air traffic control systems, airport locations, and advanced aircraft development effects on airline industry N70-41439
National aviation system policy and plan N70-41544
Panamanian civil aeronautics directorate departments of air safety, air traffic, airports, and air transport, with US technical assistance recommendations
[AC-70-3187] N70-41734
Market survey of Canadian civil aircraft and aeronautical products N70-42407

CL-84 AIRCRAFT
Canadair CL-84 V/STOL aircraft flight characteristics and structural design A70-44017

CLASSIFICATIONS
Airport classification and certification N70-41540

CLEAR AIR TURBULENCE
Highly localized clear air turbulence at aircraft flight level over Mediterranean, noting simultaneous temperature rise A70-38948
Clear air turbulence detection by IR radiometry of thermal gradients, using staggered receivers for panoramic visualization A70-46093
Cloud and synoptic parameters associated with clear air turbulence
[NASA-CR-111778] N70-40766

CLEARANCES
Aircraft turbine engines durability estimated from rotor blade minimum tip clearance measurements A70-43529

CLEARING
Computerized air cargo clearing, discussing London Airport Cargo Electronic-data- processing Scheme A70-43272

CLIMATOLOGY
Aviation climatology in aviation technology and airport planning
[TT-69-55100] N70-33233
Climatological summaries of airfields in Alaska and Hawaii
[AD-704607] N70-36250
Climatological summaries for selected airfields in Southeast Asia
[AD-705355] N70-38207
Climatological tables for Tontouta Airfield, New Caledonia - 1951 to 1966 N70-38299

CLIMBING FLIGHT
Dynamic soaring - influence of airspeed, wind shear, lift drag ratio, and angle of inclination
[NASA-TT-F-13217] N70-36081
Aircraft indicator for pilot control of takeoff roll, climbout path and verticle flight path in poor visibility conditions
[NASA-CASE-XLA-00487] N70-40157

CLOUD COVER
Soviet news releases on cloud study using thermal instrumentation and aircraft electronic phase marker N70-34885

CLOUD PHYSICS
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within cloud A70-42775

CLOUD SEEDING
Weather modification by jet aircraft contrails, discussing cloud seeding observations in Alaska A70-45421
Performance and economics of supercooled propane fog dispersion system at Orly airport
[FAA-RD-70-16] N70-32366
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875

CLOUDS (METEOROLOGY)
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc A70-38800
Cloud and synoptic parameters associated with clear air turbulence
[NASA-CR-111778] N70-40766

COATINGS
High altitude flow visualization of boundary layer transition and shock waves using oil coatings
[ARC-CP-1090] N70-37173

COCKPIT SIMULATORS
Piloted simulator investigation of ground effect on landing maneuver of large, tailless, delta wing airplane
[NASA-TN-D-6046] N70-42810

COCKPITS
Heavy lift helicopters cockpit display problems, describing photographic flight research program for data acquisition A70-34731
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
U.S. SST flight deck instrumentation and cockpit displays during flight, discussing economic analysis of operations
[ICAS PAPER 70-59] A70-44155
Computerized simulation of dynamic man model for evaluating cockpit geometry
[AD-703268] N70-32338
Computer program for evaluating cockpit configurations using articulated human model
[AD-703269] N70-32339
Articulated variable link length human model for simulating operator performance in cockpits
[AD-703271] N70-32341

COEFFICIENT OF FRICTION
Turbulent boundary layer on cone in supersonic flow in presence of inflowing foreign substance, considering local surface friction coefficient A70-39814
Tire-pavement friction coefficients
[AD-705987] N70-33636

COLD FLOW TESTS
Aerodynamic design and calibration of thermal acoustic jet facility-cold flow duct
[NASA-TM-X-53907] N70-37529

COLLISION AVOIDANCE
Air traffic control, discussing precision instrument landing, approach lighting, collision avoidance, navigation aids, etc A70-35185
West German aircraft bird hazards problems, discussing research activities and recommendations for strike avoidance A70-35980
ATA Collision Avoidance System based on time and frequency synchronization via ground stations or other aircraft A70-38239
Collision avoidance system flight test and evaluation program for airline industry CAS specification A70-38240
ATC airborne surveillance, communication and control system functioning as CAS after error or failure, discussing minimum parallel runway separation A70-38241
Ground and cockpit initiated collision avoidance commands system based on satellites surveillance of aircraft position and velocity data A70-38242
Airborne electronic equipment, collision avoidance systems, displays, instrumentation, human response and ground based control in air traffic control A70-39198
Airborne three dimensional area navigation equipment for reducing mid-air collision exposure and for raising landing safety in terminal areas A70-42296

Automatic conflict detection and resolution in ATC planning, discussing flight paths, zones of protection, etc
[ICAS PAPER 70-58] A70-44154
Collision Avoidance System /CAS/ and Proximity Warning Indicator /PWI/ for preventing midair aircraft collisions
A70-44175
Soviet civil aircraft-bird collisions, stressing hazard forecast and prevention by bird identification and migration patterns
A70-45644
Flight test and evaluation of airborne collision avoidance system
[AD-705529] N70-33674
Vertically polarized stacked array of independently fed omnidirectional antennas for use in radar collision warning on commercial aircraft
[NASA-CASE-LAR-10545-1] N70-35524
Civil aircraft accident investigation of collision near Fiarland, Indiana
[NTSB-AAR-70-15] N70-38243
Collision prevention conference, including pilot warning indicators, air traffic control systems, and collision avoidance systems
N70-40927
Air traffic collision avoidance systems engineering
N70-40930
Air traffic control/collision avoidance systems design analysis
N70-40931
Project objectives for visual collision avoidance problem solution with pilot warning instrument
N70-40932
Xenon flash lamp application in collision avoidance
[AD-709191] N70-41191
Near midair collision report of 1968
N70-41290
Collision avoidance systems in air traffic control
N70-41535
Anticollision lights for supersonic transport
[FAA-AM-70-9] N70-42404

COLLISION RATES
Statistical measurement of bird hazards to aircraft in terms of strike rates at airports, considering international strike rate standard
A70-35981

COLLISIONS
Corporate/executive aircraft accident briefs in US general aviation
[PB-190409] N70-34525

COMBAT
AH-1G helicopters combat flight loads from onboard oscillograph data recording, defining performance in terms of critical variables
A70-34706
Computerized air combat simulation with comparison of analog and digital approaches, noting Air to Air Combat Fort Worth
A70-36453

COMBUSTIBLE FLOW
Shock layer and combustion in supersonic flows about conical bodies at various angles of attack
A70-35894

COMBUSTION
Research in combustion, explosions and hypervelocity
N70-38119

COMBUSTION CHAMBERS
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629
Flameout and ignition correlation for diffusion fuel burnup behind angled stabilizers in annular turbine combustion chamber
A70-36127
Aerodynamic stability of branched diffuser systems used in annular combustors of gas turbine engines
[ASME PAPER 70-GT-27] A70-36868
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone
A70-37246
Gas turbine engine combustion chamber efficiency dependence on injector characteristics, temperature and fuel physicochemical properties
A70-37247
Air-mechanical fuel injection effect on gas turbine engine combustion chamber working process, investigating heat generation coefficient, temperature field nonuniformity and combustion efficiency
A70-37248
Jet engine combustor design and efficiency, discussing heat transfer, cooling and engine materials
A70-39648
Gas turbine combustion chamber convective and radiant heat transmission, examining steam film cooling of flame tube
A70-43199
Gas turbine engine combustion chamber starting, discussing effects of temperature, nozzle characteristics and fuel physicochemical properties
A70-43356
Jet engine air pollution in U.S., discussing fuel types, additives and burner design for smoke emission reduction
A70-44200
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients
A70-45444
Jet engine combustion chamber pressure loss, flow velocity through flare tube holes and air supply calculation, noting adaptation for computer use
A70-45446
Reduced smoke combustion chambers for jet aircraft engines tested in full scale JT8D engine
A70-46387
Short length combustor and diffuser configuration for supersonic cruise turbofan engine
[NASA-CR-72734] N70-33771
Air feed jet combustion chamber operations under unstable conditions
[AD-700801] N70-36450
Burning properties and effects of kerosene fuels used in jet aircraft engines
[AD-708352] N70-39926
Performance results of operating full annulus swirl-can primary combustor near stoichiometric temperature
[NASA-TM-X-52902] N70-40624
Full-scale annular ram-induction combustor tests for Mach 3 cruise turbojet engine
[NASA-TN-D-6041] N70-41975
Three dimensional jet mixing analysis for combustion chamber design
[NASA-CR-111782] N70-43101

COMBUSTION CONTROL
Catalytic combustion fuel tank inerting techniques for fire protection in military and civilian aircraft
A70-44485

COMBUSTION EFFICIENCY
Gas turbine engine combustion chamber efficiency dependence on injector characteristics, temperature and fuel physicochemical properties
A70-37247
Air-mechanical fuel injection effect on gas turbine engine combustion chamber working process, investigating heat generation coefficient, temperature field nonuniformity and combustion efficiency
A70-37248
Jet engine combustor design and efficiency, discussing heat transfer, cooling and engine materials
A70-39648
Combustion efficiency of natural gas turbojet combustor with inlet air deoxygenation
[NASA-TM-X-52711] N70-33746
Full-scale annular ram-induction combustor tests for Mach 3 cruise turbojet engine
[NASA-TN-D-6041] N70-41975

COMBUSTION PHYSICS
Closed compartment fire mathematical model to analyze combustion parameter effects, atmosphere pressure and temperature during fire
A70-35646

Soviet papers on kinetics and aerodynamics of fuel combustion processes covering supersonic flow, flame stabilization, fluid atomization, nonequilibrium recombination, etc
A70-39265
Aerodynamics and gas jet calculations of gas flame theory
[AD-706646] N70-38635
COMBUSTION PRODUCTS
Conference on kinetics and thermodynamics of combustion and high temperature gases
[NASA-SP-239] N70-32106
COMET 4 AIRCRAFT
Air navigation aids and hybrid navigation systems for transport and Comet 4 aircraft
[RAE-TR-69220] N70-42346
COMMAND AND CONTROL
Ground and cockpit initiated collision avoidance commands system based on satellites surveillance of aircraft position and velocity data
A70-38242
PCM command control system for high altitude ballooning operations, discussing component equipment
A70-40085
COMMERCIAL AIRCRAFT
Investment risks and technical impact on aircraft development, world aviation growth and airline costs
A70-34915
Airborne data acquisition and flight recorder systems, comparing civil and military aircraft requirements
A70-35515
Wide body commercial jet transport structural design considerations applied to DC 10 aircraft
[AIAA PAPER 70-895] A70-35812
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers
[AIAA PAPER 70-899] A70-35815
Integrated flight management system for commercial aircraft pilot using computer
[AIAA PAPER 70-908] A70-35820
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
Commercial aircraft strapdown inertial navigation systems, examining initial self alignment techniques
A70-36442
Military and commercial transports turbofan propulsion systems impact on future aircraft design and development
[SAE PAPER 700267] A70-36820
Military and commercial aircraft maintenance costs reduction, discussing labor/material ratio, spare parts use, diagnostic systems, etc
A70-40750
Commercial transport aircraft fatigue loading data from NASA VGH /airspeed-acceleration-altitude/ program, discussing instrumentation, sample sizes, etc
A70-44548
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft
[SAE PAPER 700794] A70-45853
Commercial STOL aircraft propulsion systems from airline viewpoint, emphasizing subsystem design, engine selection, thrust deterioration and maintainability
[SAE PAPER 700810] A70-45904
Military helicopter test program application to commercial VTOL operations, discussing military-civil design and development relationships
[AIAA PAPER 70-1242] A70-46327
Review of electrical power systems on existing commercial aircraft
[NASA-CR-110693] N70-32344
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[NASA-CASE-LAR-10545-1] N70-35524
Commercial air service and miscellaneous air laws
N70-36198
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[PB-189649] N70-37196
Review of commercial aircraft technology and potential application to space shuttle
N70-39604
General aviation flying occupant load factors
[REPT-70-9] N70-40800
Evaluation and forecast of Huntsville air traffic
[NASA-CR-113917] N70-41242
Changing patterns of commercial air service and airline economics
N70-41437
Pollution, air traffic control systems, airport locations, and advanced aircraft development effects on airline industry
N70-41439
In-flight liquid nitrogen fire extinguishers for commercial aircraft
N70-42757
Feasibility of nitrogen fuel tank inerting systems for commercial aircraft
N70-42760
COMMUNICATING
Methodology for tactical utility helicopter information transfer study
[AD-710248] N70-42532
COMMUNICATION CABLES
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design
A70-44544
COMMUNICATION SATELLITES
Telecommunication, ATC and navigation satellite systems, examining economic bases for aeronautical and maritime space systems
A70-39407
Communication satellites systems for civil application, considering ground stations design, regional communication, ATC and maritime communications and navigation
A70-39409
Small ground stations in communication satellite systems involving regional telecommunication, TV distribution, air traffic and maritime applications, data exchange, weather and education service
A70-40764
Management organization of European operational application satellite systems, concerning interurban telecommunication and air traffic control
A70-43502
Using communication satellites for onboard navigation and air traffic control over North Atlantic
N70-32235
COMPATIBILITY
Compatibility of gelled and emulsified aircraft turbine fuels
[NA-70-11] N70-32365
COMPONENT RELIABILITY
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals
A70-34686
Critical aviation gas turbine rotating component life limit determination, describing statistical, maintenance, inspection and life evaluation computer program /SMILE/
[ASME PAPER 70-GT-66] A70-36841
Normalization of mechanical properties of aircraft engine components, increasing weight efficiency and reliability
A70-37254
Failure and defect formation in gas turbine engine disks made of steel alloys, stressing fabrication methods effect on reliability
A70-38469
Computer program for assessment and modification of mechanical component life predictions by discrete formulation of Bayes theorem
A70-38816
Helicopter parts and assemblies fatigue life estimation and testing, discussing loading spectra, service conditions, etc

A70-43119
Avionic components reliability, determining nonsteady cooling air environment effects
A70-44744
COMPOSITE MATERIALS
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design
A70-34702
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests
[AHS PREPRINT 451] A70-34703
Boron composites development for aircraft structures compared with titanium
[ASME PAPER 70-GT-120] A70-36851
Hydrofoil and hovering craft design by fiber technology, discussing composite materials, whisker mechanical properties, polycrystalline fibers, matrix materials, etc
A70-38941
Composite technology effects on engineering design, emphasizing carbon-carbon materials for aircraft structural weight reduction, performance improvement and high temperature applications
A70-39202
High thermal stability glass fibers alternatives improving stiffness-to-weight ratio of resin and Al-based composites used in F-111 boron epoxy wings
A70-42480
Summary record of panel meetings on structures and materials used in aerospace research
N70-41741
Applications of advanced composite materials to C-130 center wing box
[NASA-CR-66979] N70-42183
COMPOSITE STRUCTURES
Composite compression tubes for VTOL aircraft components, describing weight parameters and mechanical properties
[AIAA PAPER 70-898] A70-35809
Composite wing section design and fabrication utilizing unidirectional glass reinforcement
[AIAA PAPER 70-919] A70-35813
Honeycomb panels with fiber reinforced facings, obtaining acoustic fatigue design criteria
[AIAA PAPER 70-897] A70-35814
Finite element stiffness matrix technique for composite structures, discussing airplane component design program
A70-40040
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience
A70-41137
Failure analysis on adhesive bonds of aircraft honeycomb sandwich composites
[AD-710352] N70-43053
COMPOUND HELICOPTERS
Second generation helicopter design, considering compound, convertible and electrically powered configurations
A70-35549
H3-E Sprinter semicompound helicopter with pneumatic rotor drive and side mounted fans for forward flight
A70-35626
Structural reliability testing methods and loads prediction for rotary wing vehicle components, considering AH-56A compound helicopter
A70-38612
S-65-200 Commercial Compound Aircraft design for dispatch reliability and maintenance
A70-38823
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
COMPRESSIBILITY EFFECTS
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects
A70-34729
Transonic compressor cascades - influence of compressibility and static pressure
N70-39094
COMPRESSIBLE FLOW
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
A70-35923
Compressible fluids flow with conductivity tensor in presence of thin wing under orthogonal fields, reducing integral equation to Fredholm equation
A70-37599
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible working fluids
A70-45096
Instability of two dimensional compressible jet
[AD-707257] N70-37667
Compressibility effects in helicopter rotor blade flutter
[AD-706243] N70-38173
COMPRESSION LOADS
Fatigue strength of stiffened aircraft panels subjected to repeated buckling by compression loads
[ICAS PAPER 70-35] A70-44132
COMPRESSOR BLADES
High strength Ti alloys for aircraft gas turbine engines, determining critical properties for compressor fan blades
A70-34436
Pure impulse principle applied to axial compressor impellers with high solidity high camber blades
A70-36647
Two dimensional compressor cascades of double circular arc and wedge shape blades testing performance in transonic and supersonic wind tunnels
[ASME PAPER 70-GT-7] A70-36829
Supersonic cascade wind tunnel performance evaluation, using compressor blades of simple geometric shapes
[ASME PAPER 70-GT-110] A70-36848
Vibration characteristics of low aspect ratio compressor blades, using thin shell theory and Rayleigh-Ritz method
[ASME PAPER 70-GT-94] A70-36876
Boundary layer optimization for high turning axial flow compressor blades, using flow theory and conformal mapping
[ASME PAPER 70-GT-88] A70-36879
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption
[ASME PAPER 70-GT-79] A70-36885
Blade root design for axial flow compressors and turbines, avoiding tensile stress concentration
A70-38616
Turbocompressor disk materials selection by low cycle fatigue tests, discussing stop and start repetition and cracks in stress concentration zones
A70-41261
Low aspect ratio compressor blade cascade performance at blade span center, discussing pressure loss, angle of attack and staggering
A70-42272
German monograph on three dimensional flow and blade pressure measurements at axial flow compressor casing wall, discussing test control and digital data processing
A70-45093
Turbine compressor blades vibration mode measurements by holographic interferometry
A70-45563
Design calculations for interblade channels in centrifugal compressors
[NLL-RTS-5564] N70-34769
Axial compressor airfoils for supersonic Mach numbers
[AD-707144] N70-37673
Three-dimensional stress concentration in rotating anisotropic disks with radial compressor blades using finite element method
[DLR-FB-70-16] N70-38484
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry

[AGARD-LS-39-70] N70-39091
Application of through-flow theories to radial wheel design N70-39099
Blunt trailing edge blading analysis in low and high speed flows
[AD-709472] N70-41476

COMPRESSOR EFFICIENCY
Axial flow compressor off-design performance optimization by adjustable inlet guide vanes with variable trailing edge flaps A70-36846
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor
[ASME PAPER 70-GT-39] A70-36869
Axial flow compressor stage efficiency under rotary separation conditions, investigating dependence on flow rate A70-37252
Matching of compressors and turbine parameters in gas turbine aircraft engines
[AD-701978] N70-32490
Inlet pressure oscillation effects on turbofan engine compressor
[NASA-TM-X-2081] N70-39421

COMPRESSOR ROTORS
Pressure balanced rotor flow path design for mixed flow centrifugal compressors, calculating losses in rotor and diffuser section
[ASME PAPER 70-GT-12] A70-36863
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption
[ASME PAPER 70-GT-79] A70-36885
Off-design pressure losses in single stage axial flow compressor, using test rotor in annular duct
[ASME PAPER 70-GT-78] A70-36886
Gas turbine engine compressor rotor roller bearing operation conditions analysis by computer calculation of thermal regime A70-41777
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry
[AGARD-LS-39-70] N70-39091
Basic elements for advanced design of radial flow compressors N70-39096
Application of through-flow theories to radial wheel design N70-39099

COMPRESSORS
Soviet book on vibration and balancing of aircraft engine rotors covering structural deformation and dynamics of turbine engines and compressors A70-37237
Aircraft noise sources, examining compressors with dynamic pressure devices and jets with turbulence investigations
[ICAS PAPER 70-22] A70-44111
Rotating stall study in turbine engine compressors
[AD-708484] N70-40756

COMPUTATION
Computation of total sound pressure field of jet aircraft on ground
[NASA-TT-F-13096] N70-32947

COMPUTER DESIGN
Real time computers design tradeoffs in avionics systems A70-35510
Airborne digital computers in aircraft systems, discussing optimization, design and economic effectiveness A70-41920

COMPUTER GRAPHICS
Aircraft loadability design by computerized loading program using graphic plotter
[SAWE PAPER 836] A70-40364
Computer graphics used in aircraft design N70-37759
Computer graphics used in airfoil design N70-37760

COMPUTER PROGRAMMING
Computer-aided production engineering involving numerically controlled machines for Rolls-Royce aircraft engines manufacture A70-45299
Application of programmer-comparator to avionics systems off-line testing N70-32174
Computer programming aids for determining performance characteristics of helicopters
[AD-706374] N70-38357
Modified Multhopp lifting surface theory as programmed for NAL Sirius computer
[NAL-TN-17] N70-41883
Computerized calculations of interrogation repetition frequency sets nonsynchronous for N interrogations
[AD-709553] N70-42008

COMPUTER PROGRAMS
Critical aviation gas turbine rotating component life limit determination, describing statistical, maintenance, inspection and life evaluation computer program /SMILE/
[ASME PAPER 70-GT-66] A70-36841
Computer program for assessment and modification of mechanical component life predictions by discrete formulation of Bayes theorem A70-38816
Weapon systems effective reliability analysis, using degraded mode evaluation and deterministic computer program A70-38833
Aircraft and rocket guidance systems navigation error analysis, discussing numerical integration techniques and computer program
[AIAA PAPER 70-1004] A70-39527
Aircraft loadability design by computerized loading program using graphic plotter
[SAWE PAPER 836] A70-40364
Horizontal Situation Display /HSD/ map computer mechanization transforming earth location to X, Y coordinates for Lambert conformal projection
[AIAA PAPER 69-987] A70-42710
Aircraft accident filing system data analysis using Fortran programs A70-42880
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Air traffic flow digital computer simulation model including departure, enroute and arrival phases for collision avoidance, weather effects and control constraints
[AIAA PAPER 70-1316] A70-45945
Hardware and software approach techniques for achieving high level of built-in test equipment N70-32164
Classification of software and hardware examples for automatic test equipment N70-32171
TRANSOP computer program for determination of transportation equilibrium supply and demand levels
[PB-190936] N70-34622
Digital computer program for Newtonian aerodynamics of body composed of flat plate segments
[NASA-TM-X-64431] N70-35621
Computer program for pressure distribution on thin wing in supersonic flow
[NLR-TR-G-50] N70-37079
Computer program for predicting performance of helicopters
[AD-706918] N70-37696
Computer program for system reliability
[AD-706827] N70-37871
Computer code for plotting wind tunnel aerodynamic data
[SC-DR-69-690] N70-39164
Digital computer program for aircraft configuration plotting
[NASA-TM-X-2074] N70-39376
Brayton engine electrical subsystem design and computerized technique used to document wiring
[NASA-TM-X-2079] N70-39388
Capstan analysis computer program and aircraft recovery system, arresting gear capstan drive design
[AD-708759] N70-40257

Computer programs for transonic flow over airfoils
[AD-709378] N70-41733
Hybrid computer program for optimization of flight control systems and instrument landing system glide path automatic pilot mode for F-2 aircraft
[RAE-TR-70043] N70-42386
COMPUTER STORAGE DEVICES
Military aircraft avionics central digital computers, discussing memory capacity, computational speed requirements, cost and tradeoffs
A70-34673
Avionics digital computer system using associative memory for executive control functions implementation to mechanize task assignment algorithm
A70-43105
Computer-aided aircraft design, discussing parts geometry data bank, visual display, etc
[ICAS PAPER 70-27] A70-44106
COMPUTERIZED DESIGN
Airport planning and design, discussing role of computers in capacity and site analysis, wind data processing, passenger and baggage flows analysis, etc
A70-37749
Aircraft loadability design by computerized loading program using graphic plotter
[SAWE PAPER 836] A70-40364
Aircraft manufacturing cost estimation in conceptual design phase, using structural synthesis program for cost buildup simulation
[SAWE PAPER 865] A70-40371
Supersonic aerodynamic design tools, discussing technological application of high speed computer and limitations
[AIAA PAPER 68-1018] A70-42701
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Computer-aided aircraft design, discussing parts geometry data bank, visual display, etc
[ICAS PAPER 70-27] A70-44106
Computer graphics used in aircraft design
N70-37759
Computer graphics used in airfoil design
N70-37760
Computerized design of gas turbine mainshaft seals for operation to 500 ft/sec
[NASA-TM-X-52886] N70-40807
COMPUTERIZED SIMULATION
Computerized simulation role in air traffic control
A70-36398
Optimum approach and departure paths for VTOL aircraft simulated by hybrid computer under constraints
[AIAA PAPER 69-209] A70-36452
Computerized air combat simulation with comparison of analog and digital approaches, noting Air to Air Combat Fort Worth
A70-36453
Airport capacity analysis for terminal areas, using simulation for alternatives to parallel runway operation
A70-38236
Airport capacity and layout, considering air traffic increase, runway occupancy, taxiway and computer simulation
A70-38636
Operational analysis and real time computer simulation models in ATC development
A70-38637
ATC simulation at EUROCONTROL Experimental Center, discussing dynamic simulator, data processor and display
A70-38638
Gliding parachute air cargo systems using nonproportional and proportional automatic manual control, estimating wind effects on ground track and impact computer simulation
[AIAA PAPER 70-1193] A70-41823
STOL system traffic analysis simulation model for interurban transportation system as tool for flight hardware evaluation
A70-43731
Computerized simulation and hardware for propulsion control of turbine engines
[SAE PAPER 700827] A70-45892
Computerized simulation of dewinding of hovering helicopter
[AD-704349] N70-32069
Computerized simulation of dynamic man model for evaluating cockpit geometry
[AD-703268] N70-32338
Computer program for evaluating cockpit configurations using articulated human model
[AD-703269] N70-32339
Mathematical model for positioning and moving articulated human model in crewstation environment
[AD-703270] N70-32340
Articulated variable link length human model for simulating operator performance in cockpits
[AD-703271] N70-32341
Guide for selection of avionic projects for simulation by hybrid computer facility
[AD-703843] N70-34805
Computerized simulation and statistical analysis of V/STOL tactical landing system for helicopters
[AD-704324] N70-34849
Generation of suboptimal closed loop guidance for minimum time aircraft trajectories
N70-37817
Simulation study of optical pilot warning indicator in terminal area traffic
N70-40928
Computerized flight simulation to determine resolution of pilot warning indicator device
[NASA-CR-113808] N70-41040
Turbofan engine thrust control simulation
[AD-709411] N70-41750
COMPUTERS
Use of computers in air traffic control
N70-41043
CONCORDE AIRCRAFT
Ti alloys use in Olympus 593 engine for Concorde SST, discussing weight saving, mechanical properties and manipulation characteristics
A70-34449
Concorde aircraft man machine simulation and handling using fixed cabin, variable stability and ground based simulators
[AIAA PAPER 70-923] A70-35834
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration
A70-36345
Suborbital space transports problem solution by recoverable jet orbital or jet assisted aircraft, discussing implications of Concorde supersonic flight
A70-36663
Concorde design limitations for commercial success in civil airlines
A70-36665
Olympus 593 engine for Concorde aircraft, describing design and test procedures
[SAE PAPER 700291] A70-36805
Concorde aircraft powerplant design using fire tunnel test
[ASME PAPER 70-GT-128] A70-36854
Concorde prototype 002 flight test data recording instrumentation, emphasizing digital system for quasistatic parameters
A70-38545
Aeroelastic test equipment for Concorde SST using harmonic method and electromagnetic shakers
A70-38548
Concorde loadability, with comparison of flight balance situation for supersonic and subsonic aircraft, describing fuel system
[SAWE PAPER 835] A70-40365
Concorde aircraft flight test program for verifying design features of wing vortices, fuel transfer, longitudinal stability, etc
A70-40580
Concorde SST horizontal navigation, discussing data sources, equipment specifications, flight rules, man-machine interaction, etc
A70-42660
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel

honeycomb construction
A70-43213
Sonic boom effects on building structures, using Concorde measurements and explosion simulation studies
A70-45151
Concorde thrust control by employment of variable area nozzle and reheat system, discussing crew work load
[SAE PAPER 700817] A70-45900
Meteorological wind and temperature distributions on selected routes at Concorde cruising level, noting computer use for flight planning
A70-46204
Concorde research pilot simulator
[NLL-M-9223-/5828.4F/] N70-36216
Fighter aircraft flight control design and application to Concorde aircraft
N70-40716
Calibration of blowdown wind tunnel for Concorde aircraft jet exhaust nozzle studies
[ONERA-NT-160] N70-42475

CONDENSATION
Condensation in contoured nozzle shock tunnel
[AD-708475] N70-40655

CONDUCTING FLUIDS
Thin airfoil theory in magnetoaerodynamics, considering steady two dimensional flow of compressible perfectly conducting inviscid fluid in presence of uniform magnetic field
A70-37597
Compressible fluids flow with conductivity tensor in presence of thin wing under orthogonal fields, reducing integral equation to Fredholm equation
A70-37599

CONES
Turbulent boundary layer on cone in supersonic flow in presence of inflowing foreign substance, considering local surface friction coefficient
A70-39814
Convective heat transfer to cones and cylinders at angle of attack
[NASA-CR-102824] N70-37466
Hypersonic wake studies, including two dimensional wakes, sphere wakes, and sharp and blunt cone wakes
[AD-708757] N70-40162

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A70-35476
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A70-35851
Bird hazards to aircraft - Conference, Queens University, Canada, September 1969
A70-35976
Air traffic control - Conference, Versailles, June 1970
A70-36396
Electronic packaging - IEEE Conference, Cambridge, Massachusetts, June 1970
A70-36758
Instrumentation in aerospace industry - Conference, Seattle, May 1970
A70-37873
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A70-38226
Aerospace instrumentation - Conference, Cranfield Institute of Technology, England, March 1970
A70-38514
Air traffic control - Conference, Stockholm, March 1969
A70-38629
Reliability and maintainability - Conference, Detroit, July 1970, Volume 9, Assurance technology spinoffs
A70-38815
Magnetohydrodynamics - JPL Conference, Padasena, March 1970
A70-40001
Position finding and navigation in space, air and sea - Conference, Hamburg, October 1969, Volume 1
A70-41126
Aircraft acoustical duct treatments - ASA Conference, Philadelphia, April 1969
A70-42528
Applied mechanics - Conference, Bucharest, June 1969
A70-42601
Applied mechanics - Conference, Bucharest, June 1969
A70-42610
Air cargo - Conference, Frankfurt am Main, September 1970
A70-43267
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A70-43656
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A70-44326
Applied mechanics - Conference, Bucharest, June 1969
A70-45586
Nondestructive testing - Conference, Hanover, June 1970, General problems
A70-45676
Nondestructive testing - Conference, Hanover, June 1970, Material properties determination
A70-45717
Conference on kinetics and thermodynamics of combustion and high temperature gases
[NASA-SP-239] N70-32106
Development of effort expended on automatic test equipment for avionics systems
[AGARD-CP-51] N70-32151
Dynamics and aeroelasticity for space shuttles
[NASA-TM-X-52876-VOL-2] N70-36595
Aircraft and engine design problems for high Reynolds number, high speed, large subsonic aircraft - conference
[AGARD-LS-37-70] N70-37753
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems
[NASA-TM-X-52876] N70-37826
AGARD technical meeting outline for 1970, publications in 1969, and membership lists
[AGARD-BULL-70-1] N70-38493
Israeli conference on aeronautics and astronautics, including aerodynamics, aircraft structures, propulsion, and flight control
[AD-707326] N70-39737
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Conference on aerodynamics of atmospheric shear flows
[AGARD-AR-24-70] N70-40736
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft
N70-40776
Collision prevention conference, including pilot warning indicators, air traffic control systems, and collision avoidance systems
N70-40927
Symposium on geographic orientation of pilots during air operations
[AD-709124] N70-41056
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
Conference on STOL port planning and transportation system
N70-41077
National aviation system planning review conference, including air traffic control, airport planning, airspace capacity, and ILS development
N70-41526
Summary record of panel meetings on structures and materials used in aerospace research
N70-41741

Conference on fuel system fire safety
[AD-711059] N70-42753

CONFIDENCE LIMITS
Aircraft systems safety requirements, consisting of accident probability, confidence level and demonstration test period
A70-38840

CONFORMAL MAPPING
Equations system for determining constants in Sedov integral for conformal mapping of polygonal airfoil lattice onto Riemann surface
A70-39767
Horizontal Situation Display /HSD/ map computer mechanization transforming earth location to X, Y coordinates for Lambert conformal projection
[AIAA PAPER 69-987] A70-42710
Quasiconformal mappings in space
N70-39251

CONGESTION
Airport congestion in United States and Puerto Rico by 1975
N70-41273

CONGRESS
Manned space flights, satellite observations, space sciences, and air traffic control - NASA report to Congress for 1 Jan. to 30 June 1969
[NASA-TM-X-64292] N70-33962
Hearings on legislation for expanding and improving airport and airway facilities - Part 1
N70-35626
Hearings on legislation for expanding and improving airport and airway facilities - Part 2
N70-35627
Senate hearing on improvement and future development of airports and airways
N70-35740
Congressional hearings on general aviation role in social and economic systems, and future developments
N70-36155
Congressional hearings on aeronautical research and development
[REPT-91-932] N70-36160
Congressional hearings on supersonic aircraft and airport planning and development, air traffic control, and aircraft noise
N70-36161
Congressional hearings on federal transportation expenditure
N70-41516
Hearing on FAA development of air traffic control system for 1970s
N70-42655

CONICAL BODIES
Hypersonic flow field around yawed half angle cone from wind tunnel measurements including surface pressure distributions and flow visualization photographs
A70-34485
Steady supersonic flow past conical bodies at yaw, adapting Telenin numerical method
A70-35889
Shock layer and combustion in supersonic flows about conical bodies at various angles of attack
A70-35894
Hypersonic gas flow around blown plane of segmentally blunted cones at large angle of attack, using two dimensional model
A70-36258
Turbulent mixing in supersonic cone near wake, using laser planogram technique for flow visualization
A70-37529
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution
A70-40918
Loads induced by terminal shock boundary layer interaction on cone-cylinder bodies, discussing angle of attack effect
A70-41863
Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877
Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects
A70-45592
Aerodynamic interference effects on half-cone bodies with thin wings in hypersonic flow
[NASA-TN-D-5898] N70-32827
Angle of attack and bluntness effects on hypersonic flow over 15 deg semiapex cone in helium
[NASA-TN-D-5903] N70-34073
Pressure distribution of spherically-blunted 60 deg half-angle cone in hypersonic flow
[NASA-CR-109982] N70-35952
Aerodynamic testing at subsonic speed on conical configurations using magnetic system
[AD-709197] N70-41721

CONICAL CAMBER
Quasi-conical supersonic wings with curved subsonic leading edges, discussing perturbation potential, boundary conditions, homogeneous flow and gothic and ogee planforms
A70-42108

CONICAL FLOW
Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics
A70-44991
Method of characteristics analytical technique for flow predictions of supersonic cross flows over conical bodies
[NASA-TN-D-5884] N70-32004
Approximation for distribution of flow properties in angle of attack plane of conical flows
[NASA-TN-D-5951] N70-36590
Calculating laminar boundary layer flow on highly swept delta wing at high incidence
[ARC-CP-1096] N70-37138

CONICAL INLETS
Air jet injection through slot at inlet for delaying stall of conical diffuser
[RR-14] N70-40472

CONICAL NOZZLES
Underexpanded carbon dioxide free jet expanding into vacuum from conical nozzles
A70-35246
Conical convergent nozzles discharge coefficient for varying pressure ratios
A70-38243
Low angle conical plug nozzle with stowed thrust reverser performance at Mach 0 to 2.0
[NASA-TM-X-2116] N70-42437

CONICAL SHELLS
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc
A70-45147

CONSERVATION EQUATIONS
Displacement interacting boundary layer in symmetry plane region of flat hypersonic delta wing by control volume balances for mass, momentum and energy
A70-34975

CONSTRUCTION
Formulation of design and construction standards for STOL ports
N70-41078

CONSTRUCTION MATERIALS
Ti hot forming, discussing sheet use as aircraft structural material
A70-34444
Polymers industrial applications in textiles, building materials, furniture, aviation, automobile industry and packaging
A70-38700
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc
A70-43084

CONTAINERS
Air cargo container system impact on aircraft requirements, discussing intermodal capability achievement
A70-40128
Air freight containers in continuous air/land transportation chain, discussing weight, performance, cost, technical concepts and inter and nonintermodal prototypes
A70-43273

CONTAMINANTS
Gas turbines, dust and air cleaners

interrelationship in preventing failure due to air contaminants
[ASME PAPER 70-GT-104] A70-36890
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles
A70-37228

CONTOURS
Transport aircraft noise at three major airports by noise exposure forecast /NEF/ contours methodology
A70-40896

CONTRAILS
Aircraft condensation trails formation by interactions of exhaust emission, vorticity of wing induced downwash and ambient atmosphere
A70-42684
Contrail effects on atmospheric thermal radiation budget in heavy jet traffic regions from airborne IR and solar radiometric observations
A70-44033
Weather modification by jet aircraft contrails, discussing cloud seeding observations in Alaska
A70-45421

CONTROL BOARDS
Pilot influence on dynamic aircraft design, taking into account physiological state during various operational tasks
[ICAS PAPER 70-37] A70-44134

CONTROL EQUIPMENT
Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls configured vehicle /CCV/ design concepts
A70-37395
Bobweights effects on pilot induced oscillations, noting role in flying qualities and control system design
[AIAA PAPER 70-1002] A70-39529
PCM command control system for high altitude ballooning operations, discussing component equipment
A70-40085
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785
Fuel delivery and speed control systems for aircraft gas turbine engines, discussing control circuit transfers and block diagrams
A70-43116
Engine control concepts for augmented turbofan, discussing integrated electrical/hydromechanical system
[SAE PAPER 700826] A70-45893
Automatic control system for Boeing SST engine air intakes, optimizing engine performance and controlling noise propagation
A70-46214

CONTROL SIMULATION
Fighter aircraft higher order control system dynamics effects on longitudinal handling qualities evaluated by in-flight simulator for role of pilot induced oscillations tendencies
[AIAA PAPER 69-768] A70-42711
Imperfect, reduced-state relay control application to model-reference controller design
[NASA-CR-1645] N70-36916

CONTROL STABILITY
Variable wing sweep aircraft angular motion mathematical model, analyzing inertial moments influence on control dynamics
A70-40182

CONTROL SURFACES
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory
A70-41407
Aircraft control surface aerodynamic characteristics, considering low aspect ratio wing elevons with variable sweep leading edge as longitudinal and lateral controls
[ICAS PAPER 70-26] A70-44107
Unsteady aerodynamic loading of wings with control surfaces, discussing Kuessner integral equation of subsonic lifting theory
A70-44761
ONERA calculations in aeroelasticity including lifting surface optimization, control surface vibration, pressure fields, aircraft transfer functions and panel flutter
A70-44762
High subsonic and transonic effects on pressure distributions for swept wing with oscillating control surface
A70-44763
Pressure measurements on harmonically vibrating sweptback wing with two control surfaces in incompressible flow
A70-44768
Inviscid hypersonic flow fields past lower /compression/ surface of delta wing calculated by one strip approximation of integral relations method
A70-46245
Scale effects on oscillatory control surface stability derivatives and three dimensional wind tunnel model tests without boundary layer transition
[NPL-AERO-1283] N70-34928
Preliminary design considerations and aeroelastic constraints for large supersonic aircraft with canard control
N70-40706
Fighter aircraft flight control design and application to Concorde aircraft
N70-40716
Fighter aircraft flight control system design
N70-40717

CONTROLLABILITY
External aerodynamics role in handling qualities of amphibious hovercraft, discussing tests of hull shape, air cushion efflux and hollow models
A70-34919
Pilot induced oscillation rating regression analysis, examining time delay, slope after and time to first peak and stick force per g
A70-36444
Stability augmentation in aircraft design for handling and operation benefits, discussing control techniques, autopilot modes and load limitations
[ICAS PAPER 70-24] A70-44109
Wheel force and roll moment nonlinearities effect on light STOL aircraft handling qualities during approach
[ICAS PAPER 70-55] A70-44151
Fluidically augmented artificial feel system for fighter and attack aircraft control, discussing improved handling qualities
[SAE PAPER 700785] A70-45859
STOL aircraft low speed handling characteristics described via approach and landing profiles, power requirements, wind effects, etc
[AIAA PAPER 70-1332] A70-45936
Longitudinal handling qualities of variable stability flight simulator
[AD-703225] N70-35288
Flight tests of low speed controllability of BAC slender variable sweep wing research aircraft
[ARC-CP-1102] N70-37062

CONTROLLERS
Helicopter stabilization systems design, synthesizing controllers by modal control theory
[AIAA PAPER 70-1036] A70-39501
Imperfect, reduced-state relay control application to model-reference controller design
[NASA-CR-1645] N70-36916
Mathematical theory of control of nonlinear processes emphasizing controller design techniques for systems with distributed parameters and time delays
[AD-706908] N70-37666

CONVAIR 880 AIRCRAFT
Aircraft accident investigation of Convair 880 on takeoff from Moses Lake, Washington
[NTSB-AAR-70-11] N70-36031

CONVECTIVE HEAT TRANSFER
Aircraft electronic equipment cooling techniques, discussing natural and forced convection, phase change and heat pipes
A70-36763
Gas turbine combustion chamber convective and radiant heat transmission, examining steam film cooling of flame tube
A70-43199

Aerodynamic drag and local convective heat transfer on smooth plate for various flow velocities, determining effects of turbulator in boundary layer transition region A70-44733
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities [NASA-TN-D-5908] N70-37168
Convective heat transfer to cones and cylinders at angle of attack [NASA-CR-102824] N70-37466

CONVERGENT NOZZLES
Aerodynamic and acoustic characteristics of subsonic and supersonic jets from convergent nozzles with room temperature air supply A70-34460
Conical convergent nozzles discharge coefficient for varying pressure ratios A70-38243
Boattail and plug area variation effect on convergent and plug nozzle efficiency at Mach 0 to 1.97 [NASA-TM-X-2112] N70-42438

CONVERGENT-DIVERGENT NOZZLES
Optimum nozzle geometry for minimum heat transfer to convergent-divergent nozzle wall from high enthalpy flow A70-35238

COOLING
Aircraft electronic equipment cooling techniques, discussing natural and forced convection, phase change and heat pipes A70-36763

COOLING SYSTEMS
Stepwise heat removal for increased continuous combustion gas turbine engine cycle efficiency, deriving equations describing cycles A70-43372
Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials [ICAS PAPER 70-16] A70-44127
Turbine-compressor system for active cooling of hypersonic aircraft [NASA-CR-66930] N70-33268
Analysis of capabilities and limitations of film air cooling methods for turbine engines [NASA-TN-D-5992] N70-40659
Methane or hydrogen fuel direct cooling of first stage stator of SST aircraft turbine - numerical heat transfer analysis [NASA-TN-D-6042] N70-42326

COORDINATE TRANSFORMATIONS
Horizontal Situation Display /HSD/ map computer mechanization transforming earth location to X, Y coordinates for Lambert conformal projection [AIAA PAPER 69-987] A70-42710

CORDAGE
Comparison of cord loads with aircraft tire on grooved and smooth runway surfaces [NASA-CR-1627] N70-33150

CORRELATION
Simulated neutral atmospheric boundary layer measurements in wind tunnel, extending power spectral and correlation determinations A70-40139

CORRELATION DETECTION
Correlation detection methods providing information for ILS in terminal area congestion, discussing role in aircrew-ATC cooperation A70-42667

CORROSION
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines A70-43574

CORROSION RESISTANCE
Alloys for aircraft structures design, considering materials strength, corrosion resistance, producibility and cost A70-39414

COST ANALYSIS
Polish Lot airline long haul air transportation cost analysis A70-34689
Long haul air transportation profitableness based on Polish Lot airline ton passenger-km computation comparison A70-34691
Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities A70-38951
Long range air transport routes, predicting equipment and expenditures modifications A70-43533
Aircraft maintenance cost statistical analysis recursive regression model for aircraft failure and manhour cost data A70-46125
Unit cost and performance data for US transport aircraft during 1967 and 1968 N70-35380
Cost analysis of high speed ground transportation modes [PB-190942] N70-35446
Cost analysis for Northeast Corridor transportation system air and highway modes [PB-190943] N70-36811
Congressional report on supersonic transports N70-41782

COST EFFECTIVENESS
Materials selection for cost effectiveness in 1980s airframe applications [AIAA PAPER 70-870] A70-34819
Subsonic aircraft size effect in conventional design, discussing increased weight increments and economic gain rate [AIAA PAPER 70-940] A70-35849
Air transport operations and economics in 1970 decade, taking into account cost-revenue ratio and cost effectiveness of various aircraft A70-35852
Air cargo transport growth, considering deterrents of high freight rates, ground movement time and customs clearance A70-35853
Cost and time optimization for complex aircraft development projects via network planning A70-39644
Airborne digital computers in aircraft systems, discussing optimization, design and economic effectiveness A70-41920
U.S. SST flight deck instrumentation and cockpit displays during flight, discussing economic analysis of operations [ICAS PAPER 70-59] A70-44155
Application of automated testing and troubleshooting in electronic manufacturing plant N70-32155
Technique of analysis of effective testability of elements of avionics systems N70-32156
Automatic test equipment implementation techniques to realize cost effectiveness support N70-32172
Economic effectiveness of aircraft transportation systems [AD-703162] N70-36309
Social costs and benefits from Northeast corridor transportation system [PB-190944] N70-36515
Cost effectiveness analysis of airport snow removal and ice control [FAA-RD-70-39] N70-36909

COST ESTIMATES
Aircraft engine production cost estimating techniques, discussing physical, thermodynamic and metallurgical characteristics [SAE PAPER 700271] A70-36818
Aircraft manufacturing cost estimation in conceptual design phase, using structural synthesis program for cost buildup simulation [SAWE PAPER 865] A70-40371
Evaluation of low cost visual approach slope indicator as pilot training aid [FAA-DS-70-4] N70-32530
Price and productivity change estimates in aircraft industry [AD-706885] N70-37723

COST REDUCTION
Military aircraft engines performance increase and cost reduction [SAE PAPER 700272] A70-36817

Multiaircraft flight test program time compression by management techniques, discussing program length and costs
A70-38530
Helicopter cost reduction by transmission overhaul frequency reduction, discussing savings with on-condition maintenance
A70-38824
Air cargo terminal operations analysis, discussing manpower cost reduction
A70-40127
Military and commercial aircraft maintenance costs reduction, discussing labor/material ratio, spare parts use, diagnostic systems, etc
A70-40750
High strength glass for aircraft structures, discussing applications to passenger cabin windows
A70-41891
General aviation expansion and competitive position dependence on safety and utility improvements and simultaneous cost reductions
[AIAA PAPER 70-1220] A70-45953
Potential savings in military aircraft maintenance
N70-41985

COSTS
Planning and financing improvements to air transportation system
[H-DOC-91-130] N70-36073
Airport/airway cost allocation study legislation
N70-41537

COUNTERS
Electronic strain level counter for aircraft structural members
[NASA-TN-D-5944] N70-39377

CRACK INITIATION
Static strength of notched or cracked structural components, including fatigue crack initiation and elastic stress distribution in thin sheets
N70-37806

CRACK PROPAGATION
Crack propagation, fatigue damage and interaction effects in aircraft structures and materials under flight simulation loading
A70-34924
Structural fatigue manual, including plastic strain, static tests, and notched or cracked component strength, for aircraft applicability and with bibliographies
[AGARD-MAN-8-70-VOL-1] N70-37802
Physical changes and damage during fatigue, including plastic processes and crack propagation
N70-37807

CRACKING (FRACTURING)
NDT for aircraft service life extension, discussing fatigue tests and crack detection
A70-45719

CRASH LANDING
Aircraft in-flight and post crash fire protection developments, considering controlled flammability fuel systems and fire fighting methods
[ASME PAPER 70-GT-109] A70-36847
Accident investigation of Boeing 707 crash during simulated landing approach
[PB-191318] N70-37486

CREEP ANALYSIS
Low aspect ratio wings under conditions of creep, calculating stress by method of strains
A70-37244

CREEP PROPERTIES
Ti-Al-Cr-Fe tensile, fatigue and creep properties at various temperatures, considering industrial applications
A70-34428
Short-term creep and erosion resistance testing of Ti alloy in high speed air flows under aerodynamic vibrations
A70-45826
Static testing and creep, including tensile tests, plastic deformation, and buckling
N70-37805

CRITERIA
Air facility establishment criteria
N70-41528
Operational air traffic control considering several optimality criteria
[NASA-TT-F-13276] N70-41884
Inspection, evaluation, classification, and reuse criteria for used airfield landing mats
[AD-708891] N70-43200

CRITICAL LOADING
Finite element analysis of critical stress distribution in canopy of deployed twin keel parawing, predicting failure stress levels
[AIAA PAPER 70-1196] A70-41820

CRITICAL POINT
Critical height phenomenon for vertical jet exhausting into horizontal parallel plates channel simulating aircraft surfaces
A70-36709

CRITICAL TEMPERATURE
Performance results of operating full annulus swirl-can primary combustor near stoichiometric temperature
[NASA-TM-X-52902] N70-40624

CROSS COUPLING
Elevon design for lifting reentry vehicles to eliminate cross coupling and yaw at supersonic and hypersonic speeds
[NASA-CASE-XLA-89670] N70-36056

CROSS FLOW
Two dimensional time dependent solution for impulsive motion of circular cylinder involving viscous cross flow at moderate angles of attack
A70-36454
Liquid jets aerodynamic atomization at orifice exit in reentry vehicle into gaseous crossflow, investigating critical Weber number variation with Knudsen number
A70-39701
Method of characteristics analytical technique for flow predictions of supersonic cross flows over conical bodies
[NASA-TN-D-5884] N70-32004
Aerodynamic characteristics of vehicle bodies at crosswind conditions in ground proximity
[NASA-TN-D-5935] N70-37030
Calculating laminar boundary layer flow on highly swept delta wing at high incidence
[ARC-CP-1096] N70-37138

CROSS SECTIONS
Cross section deformation effect on helicopter rotor blade torsional vibration, using differential equations of vibrating beam
A70-35959

CRUISING FLIGHT
Thermal protection system based on radiation cooling for high altitude cruising hypersonic flight, achieving zero net mass transfer
A70-41745
Subsonic high lift cruise wing optimal design using kernel function method of planar lifting surface theory
A70-42709
Supersonic flight altitude stability, studying effects of velocity, lift-drag ratio, thrust law, wind direction, engine unstarts, etc
[AIAA PAPER 69-813] A70-42712
Space shuttle transition trajectory optimization for cruising flight entry, considering longitudinal control, pitchup instability and angle of attack
A70-44623
Meteorological wind and temperature distributions on selected routes at Concorde cruising level, noting computer use for flight planning
A70-46204
Flight investigation of roll requirements for transport airplanes in cruising flight
[NASA-TN-D-5957] N70-38625

CRYOGENIC ROCKET PROPELLANTS
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants
A70-39667

CUES
Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845

CUMULONIMBUS CLOUDS
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within

cloud
A70-42775
CURTAINS
Jet curtain flow recirculation model based on air-bubble flow visualization technique, determining minimum power for air cushion vehicle
A70-42278
CURVATURE
Steady incompressible turbulent boundary layer form on permeable curvilinear surface with uniform suction, assuming small pressure gradients
A70-42803
CV-440 AIRCRAFT
Aircraft accident report for Allegheny Airlines CV-440 near Bradford, Pennsylvania, 6 Jan. 1969
[NTSB-AAR-70-10] N70-35760
CYCLES
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes
A70-43439
CYCLIC LOADS
Turbocompressor disk materials selection by low cycle fatigue tests, discussing stop and start repetition and cracks in stress concentration zones
A70-41261
Load cycle sequences for full scale aircraft structures and components fatigue testing
[ICAS PAPER 70-32] A70-44101
CYCLONES
Occurrence of typhoons and tropical storms at selected locations for years 1949 to 1969
[AD-706408] N70-37861
CYLINDRICAL BODIES
Blunt based right circular cylindrical body at subsonic speed, investigating turbulent near wake in wind tunnel
A70-34463
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel
[AIAA PAPER 70-796] A70-34464
Loads induced by terminal shock boundary layer interaction on cone-cylinder bodies, discussing angle of attack effect
A70-41863
Wind pressure measurements on wind tunnel models of closely-spaced cylindrical silos
[NPL-AERO-NOTE-1088] N70-34941
Convective heat transfer to cones and cylinders at angle of attack
[NASA-CR-102824] N70-37466
Turbulence effects on flow past rigid circular cylinder at subcritical Reynolds number
[AD-704121] N70-38155
Hydroelastic analysis of circular cylinder/lift on bodies of revolution
[AD-708434] N70-40252
CYLINDRICAL SHELLS
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter
A70-38342
Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter
A70-42603
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc
A70-45147
Circular cylindrical shell flutter analysis review, with bibliographies
[TT-6917] N70-39330
Supersonic flow field over aeroelastic ogive cylinder model with boundary layer control
[AD-708485] N70-40297

D

DAMAGE
Liability for damages due to supersonic flight sonic booms, discussing pertinent provisions in Dutch and international law
A70-37561
DAMPING
Evaluation of effect of yaw-rate damper on flying qualities of light twin-engine airplane
[NASA-TN-D-5890] N70-32770
Accident investigation for Sikorsky S-61L in Paramount, California, 22 May 1968
[PB-189143] N70-38226
DASSAULT AIRCRAFT
Army aircraft development programs and Dassault prototypes
N70-40704
DATA ACQUISITION
Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs
A70-34713
Airborne data acquisition on high density computer tape for aircraft handling and flight dynamics research
A70-35499
Airborne data acquisition and flight recorder systems, comparing civil and military aircraft requirements
A70-35515
Ground simulations data of jet lift V/STOL compared with visual flight results, noting hover, lateral quick start and stop maneuver
A70-35954
Data acquisition system applications philosophy, discussing data integrity, expansion facility, flight safety, etc
A70-36339
Flight data recorders and system integration, discussing data replay system backing flight recording
A70-36340
Underwater recovery requirements for flight data recorders, suggesting compressed air instead of explosive charges for ejection force
A70-36343
Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors
[ASME PAPER 70-GT-106] A70-36845
Digital data acquisition system for CF-5A flight test program, discussing recording system design
A70-38532
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities
A70-38533
Data collection system for prototype flight tests of Fokker F-28 based on DC-8 aircraft digital system
A70-38546
Airborne data acquisition equipment for accident flight path and engine performance recording
A70-41922
Commercial transport aircraft fatigue loading data from NASA VGH /airspeed-acceleration-altitude/ program, discussing instrumentation, sample sizes, etc
A70-44548
Satellite technology applications to ATC, including communications, navigation, surveillance over water and data acquisition
[AIAA PAPER 70-1301] A70-45922
Data acquisition and communications task in air traffic control
[AD-707137] N70-38709
Air traffic control data acquisition concepts
N70-41538
DATA CORRELATION
Heat transfer measurements compared in free flight and in hypersonic wind tunnel at similar Reynolds number and temperature ratios
[ICAS PAPER 70-06] A70-44115
DATA LINKS
Optical communications in space, considering multiple access low earth orbit-to-synchronous and synchronous-to-synchronous links
A70-37878
ATC data link communications system speeding information flow between controller and pilot
A70-41348
Queueing requirements in automatic radar target detection system operating with narrow bandwidth data link

A70-43489

DATA PROCESSING
Computerized air transportation service including passenger name record, fare quotation, ticketing, etc
A70-34688
Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs
A70-34713
Associative processor concept for air traffic control, discussing tracking and correlation problem
A70-36392
Data processing system for automatic air traffic control, describing hardware and software
A70-36395
Automatic ATC with feedback, describing information processing and flight plan algorithm
A70-38161
Jaguar flight test data processing system, discussing airborne digital computer
A70-38536
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment
A70-38537
ATC simulation at EUROCONTROL Experimental Center, discussing dynamic simulator, data processor and display
A70-38638
Digital extraction of primary and secondary radar data for air traffic control
A70-38644
Signal automatic air traffic control system /SATCO/ for flight plan processing, using multi-processing real time computer, electronic displays and software facilities
A70-38646
RAMMIT /reliability and maintainability management improvement techniques/ for processing maintenance data relevant to Army aircraft operations and support
A70-38826
Automatic calculations for fuel volume mass properties in tanks at various angles of attack, considering total weight, gravity center moment and inertia product
[SAWE PAPER 850] A70-40376
Automatic Data Processing and Display System for ATC over Belgium, Holland and Germany, relieving traffic controller routine tasks
A70-44860
Sapuc-Salut system for evaluating test data measured onboard Viggen aircraft
A70-46229
Upper Air Space Control Center Automatic Data Processing and Display System for air traffic control
A70-46238
Unit cost and performance data for US transport aircraft during 1967 and 1968
N70-35380

DATA PROCESSING EQUIPMENT
RMS spectrum analysis system for wideband acoustic data processing, using analog method with digital output
A70-37910
C-5A engineering flight test /EFT/ computer controlled data processing system operation, illustrating capability, performance and limitations
A70-37917
Boeing 747 transport airplane flight test data system, discussing recording media, major PCM and FM tape systems, etc
A70-38531
ATC radar data processing and display systems equipment and operation, emphasizing economy
A70-45044
Multiplex data bus subsystem for improving reliability and reducing weight of space shuttle avionics system
N70-40957

DATA RECORDERS
Fire test criteria for aircraft flight data and cockpit voice recorders
[FAA-NA-70-25] N70-33798

DATA RECORDING
Digital flight data recording, considering aircraft integrated data systems /AIDS/
A70-37892
Economic payback of AIDS /Aircraft Integrated Data System/ recording for operational performance monitoring and engine analysis
A70-37894
Boeing 747 transport airplane flight test data system, discussing recording media, major PCM and FM tape systems, etc
A70-38531
Concorde prototype 002 flight test data recording instrumentation, emphasizing digital system for quasistatic parameters
A70-38545

DATA REDUCTION
Static weight tare compensation for V/STOL wind tunnel models, using accelerometer outputs
A70-35500
Airlines data reduction using electronic engine maintenance recorders
[ASME PAPER 70-GT-127] A70-36853
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109
Aircraft accident filing system data analysis using Fortran programs
A70-42880

DATA STORAGE
Checkout methods in digital control systems using control computer as test set
N70-32168

DATA SYSTEMS
Low pressure measuring system for aerodynamic models tested in Mach 12-14 wind tunnel, discussing transducers and high speed digital recording and data processing system
A70-35493
On-line final V/STOL Wind Tunnel Data Encoding and Evaluation System /WINDEE/ for complex powered models, using computer monitoring
A70-35494
DC-10 airborne flight test PCM data system, discussing capability, onboard operating characteristics and test results
A70-35498
Flight data recording systems for accident investigation and operational purposes, discussing U.S., British and French regulations
A70-36341
Computerized airborne integrated data acquisition and analysis system, discussing hardware, software and airborne-ground elements interfaces
[AIAA PAPER 70-935] A70-37393
Aircraft nonavionic systems performance condition and minimum maintenance duties diagnosis by integrated data system, discussing engine monitoring instruments
A70-37891
Digital flight data recording, considering aircraft integrated data systems /AIDS/
A70-37892
Flight data recording system /FDRS/ for crashes expanded to aircraft integrated data system /AIDS/ for airlines
A70-37893
Economic payback of AIDS /Aircraft Integrated Data System/ recording for operational performance monitoring and engine analysis
A70-37894
RMS spectrum analysis system for wideband acoustic data processing, using analog method with digital output
A70-37910
Digital computer for high speed wind tunnel data acquisition, processing and operations control
A70-37923
Data collection system for prototype flight tests of Fokker F-28 based on DC-8 aircraft digital system
A70-38546
Integrated data systems for aircraft maintenance, noting information retrieval role in maintenance management for cost reduction and safety
A70-39647

Automated air cargo and data flow system with on-line computers, discussing handling, document management, load planning, information transmission, storage and mechanized freight systems
A70-43271

General aviation data systems
N70-41534

DAYTIME
Aircraft nighttime and daytime accident rate comparision, considering darkness, flight phase, etc
A70-41489

DC 3 AIRCRAFT
Aircraft accident report for DC-3 near Lone Pine, California on Feb. 18, 1969
[PB-189650] N70-37177

Douglas DC-3 accident report - New Orleans International Airport
[PB-189376] N70-37607

DC 8 AIRCRAFT
DC 8 Super 63 aircraft direct lift control flight evaluation
A70-35496

Economics of using gelled fuels in commercial jet transport
[FAA-NA-70-45] N70-34002

DC 9 AIRCRAFT
Quiet V/STOL transport aircraft from DC-9-10 modification, discussing flying qualities, propulsion and control system interfaces, configurations, etc
[AIAA PAPER 70-1409] A70-45916

DC 10 AIRCRAFT
DC-10 airborne flight test PCM data system, discussing capability, onboard operating characteristics and test results
A70-35498

Wide body commercial jet transport structural design considerations applied to DC 10 aircraft
[AIAA PAPER 70-895] A70-35812

Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities
A70-38951

Noise suppression for high-bypass ratio CF6 turbofan engine in DC-10 airplane, considering effect on engine design
[SAE PAPER 700804] A70-45878

Predicted wide bodied jet aircraft impact on air transportation system, including Boeing 747, DC 10, and L-1011
N70-41142

DE HAVILLAND AIRCRAFT
Aircraft accident investigation of De Havilland Heron 114-2 crash in mountains of Puerto Rico during ILS approach to San Juan airport
[PB-191991] N70-37334

DECCA NAVIGATION
STOL navigation systems, evaluating Vector Analog Computer, Decca Omnitrac IIB and inertial system
A70-36513

DECELERATION
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects
A70-44456

Outstanding problems and possible methods of solution for parachute technology in western Europe and the United States
[RAE-LIB-TRANS-1447] N70-39271

Device for use in descending spacecraft as altitude sensor for actuating deceleration retrorockets
[NASA-CASE-XMS-03792] N70-41812

DECISION MAKING
Technique of analysis of effective testability of elements of avionics systems
N70-32156

DEFLECTORS
Boeing 737 aircraft nose gear gravel deflector and engine vortex dissipator
[AIAA PAPER 70-912] A70-35824

Deflector for preventing objects from entering nacelle inlets of jet aircraft
[NASA-CASE-XLE-00388] N70-34788

Aircraft wheel spray drag alleviator for dual tandem landing gear
[NASA-CASE-XLA-01583] N70-36825

DEFORMATION
Cross section deformation effect on helicopter rotor blade torsional vibration, using differential equations of vibrating beam
A70-35959

Turbine blades deformation by centrifugal and aerodynamic forces, discussing theory for bending stress free blade design
A70-45505

DEGREES OF FREEDOM
Flutter analysis of n degrees of freedom system, basing stability criteria on energy balance considerations
A70-38244

Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703

DEICING
VFR and IFR training program and ice prevention and removal for general purpose aircraft
N70-40781

DELTA WINGS
Displacement interacting boundary layer in symmetry plane region of flat hypersonic delta wing by control volume balances for mass, momentum and energy
A70-34975

Hypersonic flow around delta wings of finite thickness with supersonic leading edges
A70-36260

Mathematical model of three dimensional separated flows with applications to small aspect ratio delta wing and flat plate
A70-36438

Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings, giving low lift-dependent drag
A70-38615

Hypersonic flow pattern past windward side of triangular wing with supersonic leading edges, joining potential and vortex regions behind shock wave
A70-40609

Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions
[AVA-FB-7029] A70-44668

Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects
A70-45592

Inviscid hypersonic flow fields past lower /compression/ surface of delta wing calculated by one strip approximation of integral relations method
A70-46245

Iterative solution for supersonic compressed flow around triangular wing surface
N70-35137

Spinning behavior and recovery from developed 60 degree spin of delta wing aircraft configuration using high speed digital computer
[WRE-TN-HSA-137] N70-36966

Pressure and supersonic heat transfer measurements on delta wing at incidence and sweepbacks using free flight test apparatus
[ARC-R/M-3625] N70-37071

Calculating laminar boundary layer flow on highly swept delta wing at high incidence
[ARC-CP-1096] N70-37138

Low speed flight tests on longitudinal stability and control of Avro 707 delta wing aircraft
[ARC-CP-1105] N70-37164

Pressure measurements and boundary layer separation studies on slender cone delta wing at different Mach and Reynolds numbers
[ARC-R/M-3626] N70-42500

DEMAND (ECONOMICS)
Demand analysis data generation for V/STOL systems suitable for New York-Philadelphia- Washington business travel market, applying model to selected designs
[AIAA PAPER 70-1241] A70-45961

Evaluation of proposed airport sites in Chicago area
[FAA-RD-70-25] N70-32546

DENSITY DISTRIBUTION
Subsonic air flow around airfoil in wind tunnel, detecting density gradients by pulsed ruby laser holographic visualization A70-40809
Lighthill aerodynamic noise theory fundamental equation for acoustic field density distribution, determining flow fields for surfaces in uniform translational motion A70-45268

DEOXYGENATION
Combustion efficiency of natural gas turbojet combustor with inlet air deoxygenation [NASA-TM-X-52711] N70-33746

DEPOSITS
Aircraft and engine fuel systems deposit formation and microstructure in various test rigs, using electron microscopy [SAE PAPER 700258] A70-36823
Jet fuel system deposits measurement, noting reliability of oxygen combustion and beta ray backscattering techniques [SAE PAPER 700257] A70-36824

DESCENT TRAJECTORIES
Aircraft climb and descent trajectories approximation compatible with air traffic control operation, noting parameters effects A70-46239
Aircraft simulation of lunar excursion module landing approach trajectories [NASA-TM-X-64433] N70-35662
Calculating velocity distribution with altitude while braking bodies in atmosphere [AD-706171] N70-38655

DETECTION
Fire and overheat detection system design for turbine powered vehicles [ASME PAPER 70-GT-125] A70-36891
Air hijacking as aviation safety problem, discussing history, prevention and detection methods and equipment, law enforcement, etc A70-44496

DEW
Thermistor and dew cell as remote air temperature and dewpoint measurement at airports A70-40760

DH 121 AIRCRAFT
Automatic landing system assurance of DH 121 aircraft schedule all-weather regularity through high safety level via redundancy A70-35856

DIFFERENTIAL EQUATIONS
Free jet stream effect on thin jet-flapped airfoil with fully developed wake, using linear theory A70-43737

DIFFUSERS
Plane diffuser grid profiles for subcritical velocities of oncoming flow, using wind tunnel test data A70-36129
Air jet injection through slot at inlet for delaying stall of conical diffuser [RR-14] N70-40472

DIGITAL COMPUTERS
Military aircraft avionics central digital computers, discussing memory capacity, computational speed requirements, cost and tradeoffs A70-34673
Digital computer technology impact on advanced aircraft design, discussing airborne computers, distributed and lumped computer systems, outer loop control, engine control and system integrity A70-34993
Computerized air combat simulation with comparison of analog and digital approaches, noting Air to Air Combat Fort Worth A70-36453
Aero gas turbine engines digital computer control, discussing special properties, design and safety problems [ASME PAPER 70-GT-40] A70-36870
Digital electrodynamic vibration exciter control for sinusoidal, random and shock spectrum testing of aircraft, missiles and satellites A70-37920
Digital computer for high speed wind tunnel data acquisition, processing and operations control A70-37923
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment A70-38537
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests A70-38547
Digital fail-operative flight control computers for automatic landings, describing system requirements and problems and flight test program [AIAA PAPER 70-1032] A70-39505
Airborne digital computers in aircraft systems, discussing optimization, design and economic effectiveness A70-41920
Avionics digital computer system using associative memory for executive control functions implementation to mechanize task assignment algorithm A70-43105
Automated air cargo and data flow system with on-line computers, discussing handling, document management, load planning, information transmission, storage and mechanized freight systems A70-43271
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices [ICAS PAPER 70-42] A70-44140
Research and development activities of National Aeronautical Laboratory in 1968-1969 N70-35198
Spinning behavior and recovery from developed 60 degree spin of delta wing aircraft configuration using high speed digital computer [WRE-TN-HSA-137] N70-36966
Digital computer program for aircraft configuration plotting [NASA-TM-X-2074] N70-39376
Airborne/spaceborne computer systems engineering, including digital techniques, design tradeoffs, man machine interfaces, display devices, memory, microprogramming, packaging, and maintainability [AGARDOGRAPH-127] N70-39489
Computer programs for transonic flow over airfoils [AD-709378] N70-41733

DIGITAL DATA
Digital flight data recording, considering aircraft integrated data systems /AIDS/ A70-37892
Digital data acquisition system for CF-5A flight test program, discussing recording system design A70-38532
Data collection system for prototype flight tests of Fokker F-28 based on DC-8 aircraft digital system A70-38546
Digital extraction of primary and secondary radar data for air traffic control A70-38644

DIGITAL NAVIGATION
Aircraft navigation control system by digital computer combined with inertial platform, considering emergency backup, slow drift and system malfunctions A70-46092

DIGITAL SIMULATION
Aircraft traffic on ground at airports by digital simulation, investigating influence of constraint represented by infrastructure of taxi tracks A70-36390
Gas turbine engine dynamic performance simulation, using analog and digital techniques [ASME PAPER 70-GT-23] A70-36830
Air traffic flow digital computer simulation model including departure, enroute and arrival phases for collision avoidance, weather effects and control constraints [AIAA PAPER 70-1316] A70-45945
Real time simulation of aircraft in free flight using digital computers [DLR-FB-70-21] N70-42430

DIGITAL SYSTEMS
Aircraft digital interior communication systems, combining multiplexing techniques with solid state integrated circuits technology and systems integration
[SAE PAPER 700302] A70-36813
Concorde prototype 002 flight test data recording instrumentation, emphasizing digital system for quasistatic parameters
A70-38545
DIGITAL TECHNIQUES
Associative processor concept for air traffic control, discussing tracking and correlation problem
A70-36392
ILS glide slope calibration using optically projected digital codes as reference
A70-37912
Aircraft capacitive fuel gage improvement by integration with flowmeter system, DC torquer display and digital techniques, considering other measurement principles
A70-40619
Digitally controlled milling machine for complex aerodynamic profiles and prismatic blades
A70-43117
Checkout methods in digital control systems using control computer as test set
N70-32168
DIPOLE ANTENNAS
Stub and frame antennas for flight vehicles
[JPRS-50690] N70-32902
DIRECT CURRENT
Feasibility of high voltage dc electrical power in aircraft electrical systems
[AD-709079] N70-40339
DIRECTIONAL CONTROL
Main rotor wake adverse effects on tail rotor directional control in low velocity wind
A70-44323
DIRECTIONAL STABILITY
Hovercraft wind directional stability and control by cam operated fin-tab assembly
A70-38942
Turbulence effects on lateral directional flying qualities, examining pilot task performance, control workload and compensatory behavior
[AIAA PAPER 70-998] A70-39533
Wind tunnel investigation of V/STOL transport model with four pod-mounted lift fans
[NASA-TN-D-5942] N70-34100
Nose gear steering system for vehicles with main skids to provide directional stability after loss of aerodynamic control
[NASA-CASE-XLA-01804] N70-34160
DISCHARGE COEFFICIENT
Conical convergent nozzles discharge coefficient for varying pressure ratios
A70-38243
DISKS (SHAPES)
Comparative load capacity of disk models of natural gas blowers of different designs under plastic strain
A70-43941
Nonsteady axisymmetric flow of inviscid, incompressible fluid through heavily loaded actuator disk
[AD-708396] N70-39937
DISPERSING
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875
DISPERSION
Performance and economics of supercooled propane fog dispersion system at Orly airport
[FAA-RD-70-16] N70-32366
DISPLAY DEVICES
CH-47 cruise guide indicator for displaying fatigue loading to pilots, discussing design and operation
A70-34705
Heavy lift helicopters cockpit display problems, describing photographic flight research program for data acquisition
A70-34731
Visual display and automatic taxi guidance system testing for improved aircraft docking accuracy
[AIAA PAPER 70-916] A70-35828
Aircraft perspective display as independent landing monitor based on electronic runway lights, discussing simulator development and flight validation
[AIAA PAPER 70-924] A70-35835
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
Automated radar terminal system, ARTS-III Beacon Tracking Level for continuous aircraft identity on controllers radar display
A70-36393
Electronic attitude director indicator /EADI/ for supersonic transport, employing CRT display, head down TV and microvision sensors
A70-37911
Airline area navigation in national airspace system, emphasizing moving map display for navigation charting
A70-38233
Pictorial display methods for pilot error reduction in area navigation via guidance control and capability beyond visual field
A70-38234
ATC simulation at EUROCONTROL Experimental Center, discussing dynamic simulator, data processor and display
A70-38638
Aircraft landing maneuver optimization by in-flight monitoring of approach and landing phases, furnishing decision making display
[AIAA PAPER 70-1000] A70-39531
Aircraft capacitive fuel gage improvement by integration with flowmeter system, DC torquer display and digital techniques, considering other measurement principles
A70-40619
Area navigation for aircraft guidance with radio aids, discussing advantages, airborne equipment, Dynamic Map Displays, etc
A70-42658
Horizontal Situation Display /HSD/ map computer mechanization transforming earth location to X, Y coordinates for Lambert conformal projection
[AIAA PAPER 69-987] A70-42710
Computer-aided aircraft design, discussing parts geometry data bank, visual display, etc
[ICAS PAPER 70-27] A70-44106
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices
[ICAS PAPER 70-42] A70-44140
U.S. SST flight deck instrumentation and cockpit displays during flight, discussing economic analysis of operations
[ICAS PAPER 70-59] A70-44155
Automatic Data Processing and Display System for ATC over Belgium, Holland and Germany, relieving traffic controller routine tasks
A70-44860
ATC radar data processing and display systems equipment and operation, emphasizing economy
A70-45044
Aircraft binocular head-up display, discussing system operation, history and potential applications
A70-45349
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Upper Air Space Control Center Automatic Data Processing and Display System for air traffic control
A70-46238
Manual IFR formation flight display system requirements for advanced rotary wing and jet fighter aircraft
[AD-705133] N70-32317
Holographic display device for aircraft landing approach to aircraft carrier
[AD-703683] N70-36298
Display instrumentation for V/STOL aircraft in simulated landing with steep angle approaches or zero-zero visibility
[NASA-CR-112779] N70-37158

Situational display suitable for aircraft control
[NASA-CASE-ERC-10350] N70-40019
Computerized flight simulation to determine resolution of pilot warning indicator device
[NASA-CR-113808] N70-41040
Engineering survey and analysis of en route ATC radar/display system errors
[FAA-NA-70-14] N70-41207
Display research for aircraft collision warning systems
[NASA-CR-113886] N70-41493

DISTANCE
Classifying standard runway lengths and distance requirements during takeoffs and landings
N70-41595

DISTANCE MEASURING EQUIPMENT
Eurocontrol evaluation of navigational aid systems air traffic control, examining HARCO and VORDAC systems
A70-38641
Ultrasonic sensor for detecting altitude and vertical velocity of aircraft near ground, applying to helicopter hovering flight or conventional airplane takeoff and landing
[AIAA PAPER 70-1031] A70-39506
Onboard velocity sensors for VOR/DME navigation systems positional accuracy improvement, describing optimal and suboptimal data filtering
[AIAA PAPER 70-1024] A70-39511
Implementation of 50 kHz frequency separation standard for ILS/VOR/DME frequency assignments
N70-41529

DISTRICT OF COLUMBIA
Washington National and Dulles International Airport plans for fiscal years 1970 to 1981
[AD-705087] N70-41302
Air transport and control problems of Washington DC area
N70-41438

DITCHING (LANDING)
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738
Model testing for helicopters, considering scaling, ditching and rotor performance
A70-38610

DOCUMENT STORAGE
Aircraft accident filing system data analysis using Fortran programs
A70-42880

DOORS
Emergency life saving instant exits for transport aircraft, using electromechanical confined transfer shaped explosive device
A70-44487

DOPPLER EFFECT
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system
A70-46240
Laser Doppler velocimeter for low speed V/STOL wind tunnel
[AD-708717] N70-40796
System of positioning aircraft by Doppler effect for air traffic control
[NASA-CASE-GSC-10087-4] N70-41978

DOUGLAS AIRCRAFT
Flight check console tests using DC-6B aircraft N-114
[FAA-NA-70-57] N70-36849

DOWNWASH
Aircraft condensation trails formation by interactions of exhaust emission, vorticity of wing induced downwash and ambient atmosphere
A70-42684
Downwash angle behind straight wing for unsteady aperiodic flight at subsonic speeds, using vorticity model
A70-42802
Small airplane unsteady motion downwash angle at low speeds, comparing results from rectilinear steady flights
[ICAS PAPER 70-25] A70-44108

DRAG
Parachute trajectory and opening load prediction based on inflation process and added mass, determining drag area as function of distance
[AIAA PAPER 70-1168] A70-43993
Bodies of revolution optimal configuration, considering minimum head drag coefficient and low heat transfer at hypersonic speeds, using modified Newtonian and hypersonic flow theories
A70-45021

DRAG CHUTES
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device
[AIAA PAPER 70-1209] A70-41809
Deployment system for flexible wing with rigid superstructure
[NASA-CASE-XLA-01220] N70-41863

DRAG DEVICES
Streamers /drag devices/ tests at subsonic speeds, measuring drag dependence on size, weight, shape and velocity
A70-40282
Euler buckling of inflated toroidal drag bodies, including packaging and load deflection tests for Mylar, dacron-neoprene and stainless steel-silicone fabrics
[AIAA PAPER 70-1198] A70-41818

DRAG MEASUREMENT
Cylindrical afterbodies base pressure drag under powered supersonic flight, modifying Korst flow model recompression criterion
A70-42713
Strike fighter aircraft fuselage side air intakes, measuring external drag as function of design at subsonic and supersonic speeds
[ICAS PAPER 70-49] A70-44146
Entrainment theory for incompressible turbulent boundary layer velocity and drag on bodies of revolution employed in fuselage, submersible and cowlings for propulsion design
A70-44400
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584
Measurement of sphere drag coefficients in nearly free molecule flow regime
[NAL-TR-191] N70-40442

DRAG REDUCTION
Drag optimal stern section of plane body at supersonic flow, allowing for friction forces
A70-36261
Spike effect on nose drag and static stability of blunt bodies, estimating optimum length for drag reduction at zero angle of attack
A70-39702
Minimum-drag boattail configurations optimization for supersonic flow, determining wave drag coefficients
A70-42714
Directed fluid stream for propeller blade loading control
[NASA-CASE-XAC-00139] N70-34856
Aircraft wheel spray drag alleviator for dual tandem landing gear
[NASA-CASE-XLA-01583] N70-36825

DRONE AIRCRAFT
Negative q Drone aircraft surface tension fuel system preventing air inclusion in turbojet engine fuel by tank filters /screens/
[AIAA PAPER 70-910] A70-35822

DROP TESTS
Prototype cargo-recovery parachute assembly for airdropping heavy unit loads - design study
[AD-701004] N70-33952

DROPS (LIQUIDS)
Liquid droplet breakup by aerodynamic forces, obtaining solutions for fluid flow inside droplet and in coupled liquid-gaseous boundary layer
A70-43741

DUCTED FAN ENGINES
NASA acoustically treated nacelle program reducing noise under commercial transport flight path near airports
A70-42529
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530
Structural and environmental design criteria for acoustical duct-lining materials in turbofan noise suppression

A70-42531
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533
DUCTED FANS
Shock wave radiation from supersonic ducted rotor, determining sound power at blade passing harmonic frequency
A70-38614
Secondary inlet downstream of air gap for separating wing from efflux ducting for fan in wing aircraft
[NRC-11446] N70-40470
DUCTED FLOW
Sound transmission and suppression in turbomachinery fans and compressor ducts, using three dimensional wave equation
[ASME PAPER 70-GT-58] A70-36873
DUCTS
Design calculations for interblade channels in centrifugal compressors
[NLL-RTS-5564] N70-34769
Aerodynamic design and calibration of thermal acoustic jet facility-cold flow duct
[NASA-TM-X-53907] N70-37529
DURABILITY
HF endurance tests of Al sheet alloy used in welded aircraft structural components, plotting curves for heat treated and untreated specimens
A70-38431
Statistical analysis of durability data of heat resistant alloys for gas turbine engines, using long term strength tests of melts in mass production
A70-43940
DUST
Gas turbines, dust and air cleaners interrelationship in preventing failure due to air contaminants
[ASME PAPER 70-GT-104] A70-36890
Dust content effect on hypersonic wind tunnel flow test results, noting drag force on slender and blunt nosed models
A70-42224
DYNAMIC CHARACTERISTICS
Free wing aircraft dynamic characteristics, discussing gust alleviation and handling qualities
[AIAA PAPER 70-947] A70-39580
NACA/NASA rotating wing aircraft research history 1915-1970, Part 2, autogyro flight test experiences, rotor blade dynamics research, interest in helicopters, etc
A70-44852
Dynamic soaring - influence of airspeed, wind shear, lift drag ratio, and angle of inclination
[NASA-TT-F-13217] N70-36081
Dynamic balancing of rotors
N70-37790
DYNAMIC CONTROL
Dynamic control model of lift helicopters with two cable sling loads using multiple part motion equations
[AIAA PAPER 70-929] A70-35839
German monograph on dynamic control behavior of jet engines covering computation for normal external actions and perturbation effects
A70-44396
DYNAMIC LOADS
Variable loads programming by semicomputers/ semihardware method for 747 fatigue testing
A70-35511
Aircraft dynamic wheel load effects on airport pavements
[FAA-RD-70-19] N70-32560
DYNAMIC MODELS
Necessary and sufficient conditions for optimal control law existence for model following system, discussing applications to aircraft control
A70-36443
Model gas turbine engine blades fatigue strength under stress conditions, considering tensile stresses reproducibility from centrifugal loads
A70-38459
Dynamic airfoil stall simulation in wind tunnels, considering pitch rate, Reynolds number, oscillation and test equipment effects
[AIAA PAPER 70-945] A70-39582
DYNAMIC PRESSURE
Parawing canopy behavior during deployment in free flight at specific altitudes and dynamic pressures
[AIAA PAPER 70-1189] A70-41804
Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877
Aerodynamic characteristics of air cushion models at very low ground clearances and at free stream dynamic pressures exceeding cushion pressure
[NASA-TN-D-6011] N70-42087
DYNAMIC RESPONSE
Tracked air cushion vehicle dynamic heave response, examining flow characteristics, active lip control, guideway contact, acceleration response, etc
A70-35178
Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703
Wind tunnel response tests of cup, vane and propeller wind sensors, determining wind direction and speed parameters, damped and natural frequencies, etc
A70-42914
Gust effects on dynamics of slender wing aircraft during landing approach
[NASA-TT-F-12751] N70-34017
Dynamics and aeroelasticity for space shuttles
[NASA-TM-X-52876-VOL-2] N70-36595
Mathematical model of rotary wing aircraft for performance, stability, response, and rotor blade load characteristics determination
[AD-707881] N70-39729
DYNAMIC STABILITY
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models
[AIAA PAPER 69-350] A70-35657
Dynamic unbalance effects in rigid body rotors, discussing lubricant temperature changes and instability hysteresis
[ASME PAPER 69-LUB-14] A70-37606
Inlet data for engine stability analyses, developing technical management procedure patterns for pretest test and posttest results
[AIAA PAPER 70-1214] A70-41320
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion
[AIAA PAPER 70-1191] A70-41825
Dynamic systems stability with periodically varying parameters analyzed by Hill type infinite determinant, exemplifying helicopter rotor aeroelastic stability in forward flight
A70-44556
Prevention and elimination of vibration of rotary machines
[AD-703063] N70-35499
DYNAMIC STRUCTURAL ANALYSIS
Skew panels supersonic flutter and vibration calculated by matrix displacement method
A70-40586
DYNAMIC TESTS
Helicopter dynamic tests for aeroelastic and mechanical instabilities and forced vibration problems
A70-40583
Integrated dynamic tests at flight line maintenance echelon for weapon systems
N70-32153

E

EARTH ATMOSPHERE
Aircraft condensation trails formation by interactions of exhaust emission, vorticity of wing induced downwash and ambient atmosphere
A70-42684

Earth/atmosphere system outgoing microwave radiation calculations, surveying aircraft/satellite measurements at various wavelengths A70-45192

EARTH ORBITS
Aerodynamic and gravity gradient torque effects on attitude control of Apollo/S-4B configuration in circular earth orbit
[NASA-TM-X-64300] N70-34218

EARTH SURFACE
Conference on aerodynamics of atmospheric shear flows
[AGARD-AR-24-70] N70-40736

ECOLOGY
Aircraft bird hazards in New Zealand, discussing ecological research techniques and preventive measures A70-35985

ECONOMICS
Long haul air transportation profitableness based on Polish Lot airline ton passenger-km computation comparison A70-34691
Power plant efficiency, size, maintenance and operating economics of propulsion systems for air transport A70-34917
Air transport operations and economics in 1970 decade, taking into account cost-revenue ratio and cost effectiveness of various aircraft A70-35852
Aircraft accident prevention and investigation, noting economic factors as deterrent to safety measures implementation A70-35860
STOL systems 1975 technical and economic characteristics in terms of passenger market, aircraft design, terminal facilities and ATC capability
[SAE PAPER 700311] A70-36812
Telecommunication, ATC and navigation satellite systems, examining economic bases for aeronautical and maritime space systems A70-39407
Air transport regulatory system, considering operational, technological and economic factors A70-40579
Aeronautical satellite system for civil flight safety, discussing operational, technical and economic aspects A70-41131
Nondestructive testing for aircraft maintenance, considering economics A70-45677
Wide-bodied and SST aircraft impact on airport design based on economic, social and environmental considerations
[AIAA PAPER 70-1269] A70-45970
Economics of using gelled fuels in commercial jet transport
[FAA-NA-70-45] N70-34002
Changing patterns of commercial air service and airline economics N70-41437
Congressional hearings on federal transportation expenditure N70-41516

ECONOMY
Economy of large high speed subsonic aircraft and design problems N70-37754

EFFICIENCY
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369
Blade efficiency in producing vortex flow within two dimensional supersonic rotor blade sections
[NASA-TM-X-2095] N70-39419

EGRESS
High energy emergency exit systems for passenger survival in aircraft accidents A70-44466

EJECTION
In-flight escape systems and survival equipment reliability in U.S. Navy ejections A70-44460

EJECTION SEATS
AERCAB /Aircrew Escape/Rescue Capability/ flying ejection seat, considering rotary wings, fixed wings and parawings
[AIAA PAPER 70-1213] A70-41806
SIIIS-3 ejection seat escape system design, considering minimum weight, cost and maximum performance
[AIAA PAPER 70-1211] A70-41808
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device
[AIAA PAPER 70-1209] A70-41809
Optimum drogue gun firing angle of stabilization times for MEW /Minimal Envelope and Weight/ ejection seat system, considering zero and high velocities
[AIAA PAPER 70-1208] A70-41810
Pilot airborne recovery device /PARD/ midair rescue system, discussing buoyance, midair pickup, seat ejection energy absorber, homing avionics and human factors
[AIAA PAPER 70-1206] A70-41812
Modularized multiple use SIIIS-3 ejection seat escape system, discussing weight, envelope and low cost A70-44499
Wind tunnel characteristics of ejection seat scale model with rigid wing recovery system
[NASA-TN-D-5922] N70-34399
Aircrew equipment assemblies and type 9 ejection seat for Harrier aircraft
[FPRC/MEMO-248] N70-36581

EJECTORS
Underwater recovery requirements for flight data recorders, suggesting compressed air instead of explosive charges for ejection force A70-36343
Two stream ejector type propelling nozzles for supersonic aircraft, investigating various configuration effects over range of secondary/primary air flow ratios
[ICAS PAPER 70-48] A70-44145
VTOL aircraft ejector thrust augmentors, discussing configurations in wing root section
[ICAS PAPER 70-56] A70-44152

ELASTIC BODIES
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc A70-45147

ELASTIC PLATES
Nodal patterns on thin elastic circular plate vibrating in flexure, considering natural and compounded modes A70-38245

ELASTIC PROPERTIES
Invariant autopilot control system during flight in turbulent atmosphere, allowing for aircraft elastic properties and invariance of coordinates A70-39845
Spacecraft parachute stress analysis, using finite elements with nonlinear elastic properties to obtain shape and load distribution
[AIAA PAPER 70-1195] A70-41821
Parachute opening load amplification due to suspension line elasticity, using two-body spring- mass model A70-44531

ELASTIC SHEETS
Hot-wire anemometer study of turbulent boundary layer flow characteristics over elastic sheets N70-40556

ELASTIC SHELLS
Load transfer mechanics between elastic shell and airframe structure
[AD-703641] N70-35374

ELASTIC SYSTEMS
Thermal effects on aircraft elastic vibration mode shapes, recommending investigation to develop analysis and design tools A70-36459
Linear elastomechanical systems natural vibration parameters by harmonic excitation method A70-43200
Solid cloth personnel parachutes opening forces, discussing loading conditions, flight path shock parameters, mass ratio variations and elasticity of system
[AIAA PAPER 70-1167] A70-43992

ELASTODYNAMICS
Elastic coupling and dynamic equations for flight elastomechanical vibration systems, including tiptanks on aircraft wings
A70-44767
ELECTRIC ARCS
Dissocited and ionized hypersonic flows of hydrogen heated by electric arc techniques, investigating flows in wind tunnel nozzles
A70-42759
ELECTRIC CONNECTORS
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design
A70-44544
Superjet airliners wiring connectors for power distribution, signal circuitry and self ejecting push buttons for passenger seats
A70-44545
ELECTRIC CONTROL
SST electrohydraulic primary and standby brake control systems, discussing design and advantages
[AIAA PAPER 70-913] A70-35825
ELECTRIC CURRENT
Heating estimation of aircraft wing from lightning bolt using Joule heating
[AD-705645] N70-33442
ELECTRIC EQUIPMENT
Aircraft electrical power systems optimization
[NASA-CR-86410] N70-32051
Aircraft electrical power systems optimization - electric power load supply equipment
N70-32052
Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053
Aircraft electrical power systems optimization - maintainability tradeoff with equipment cost and weight
N70-32054
Aircraft electrical power systems optimization - weighted factors for systems effectiveness
N70-32055
Aircraft electrical power systems optimization - failure prediction, detection, and compensation
N70-32056
ELECTRIC EQUIPMENT TESTS
Soviet book on aircraft electrical and radio systems manufacturing, assembling and testing methods, considering effectiveness and standardization
A70-37405
High current short circuit testing facilities for aircraft control and protection devices
[AD-705504] N70-36423
ELECTRIC FIELDS
Lower atmosphere electric field vertical distribution measurement by combined balloon and rocket soundings
A70-42797
ELECTRIC GENERATORS
Feasibility of high voltage dc electrical power in aircraft electrical systems
[AD-709079] N70-40339
ELECTRIC NETWORKS
Theory of functional electric networks and microminiaturization for avionics system
[AD-705677] N70-34957
ELECTRIC POTENTIAL
Lightning induced voltages in electrical circuits of aircraft fuel systems
N70-42759
ELECTRIC POWER TRANSMISSION
Solid state multiplexed electrical power distribution system for future generation military and commercial airplanes
[SAE PAPER 700301] A70-36803
Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems
[SAE PAPER 700303] A70-36811
Brayton engine electrical subsystem design and computerized technique used to document wiring
[NASA-TM-X-2079] N70-39388
ELECTRIC SPARKS
Aircraft streamer /spark/ discharges formation, waveforms and RF noise levels, using mathematical model for electric field strength
A70-38179
ELECTRIC SWITCHES
Pressure operated electrical switch for positioning protective cone in front of model in hypersonic wind tunnel
[NASA-CASE-LAR-10137-1] N70-35597
ELECTRIC WIRE
Flat conductor feeder tests and evaluation
[AD-705969] N70-34072
ELECTRICAL FAULTS
Aircraft electrical power systems optimization - failure prediction, detection, and compensation
N70-32056
ELECTRICAL IMPEDANCE
Flat conductor feeder tests and evaluation
[AD-705969] N70-34072
ELECTRIFICATION
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc
A70-38800
ELECTRO-OPTICS
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems
A70-34672
ELECTROCHEMICAL MACHINING
Electrochemical machining /ECM/ effects on components surface integrity, discussing jet engine materials
[ASME PAPER 70-GT-111] A70-36849
ELECTROMAGNETIC COMPATIBILITY
Compatibility factors affecting concept development of approach and landing guidance systems
[AD-707129] N70-37993
ELECTROMAGNETIC INTERFERENCE
Electromagnetic interference in aircraft communication due to jet engine charging, considering various prevention measures
A70-39724
Theorem proving and interference reduction between two sequences of periodic events
[AD-702734] N70-34878
ELECTROMAGNETIC MEASUREMENT
Lower atmosphere electric field vertical distribution measurement by combined balloon and rocket soundings
A70-42797
ELECTROMAGNETIC NOISE
Aircraft streamer /spark/ discharges formation, waveforms and RF noise levels, using mathematical model for electric field strength
A70-38179
Automatic control systems for aircraft approach to landing path and subsequent stabilization on trajectory, compensating for cross wind action and radio noise disturbances
A70-39842
ELECTROMECHANICAL DEVICES
Airport terminal design, describing electromechanical baggage handling and sorting systems
[SAE PAPER 700261] A70-36822
Digital electrodynamic vibration exciter control for sinusoidal, random and shock spectrum testing of aircraft, missiles and satellites
A70-37920
ELECTRON BEAMS
ONERA low pressure wind tunnel equipped with electron beam probing device to visualize flows too rarefied for optical methods
A70-37208
Time varying flow properties effects on hypersonic wind tunnel spectroscopic measurements, considering direct emission and electron beam techniques
A70-40271
ELECTRON PROBES
ONERA low pressure wind tunnel equipped with electron beam probing device to visualize flows too rarefied for optical methods
A70-37208

ELECTRONIC CONTROL
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques
A70-44543
ELECTRONIC EQUIPMENT
Papers on automation in electronic test equipment, Volume 7, covering factory and depot for incoming inspection, production testing, quality control, maintenance and rebuilding
A70-40766
Soviet news releases on cloud study using thermal instrumentation and aircraft electronic phase marker
N70-34885
Electronic strain level counter for aircraft structural members
[NASA-TN-D-5944] N70-39377
ELECTRONIC EQUIPMENT TESTS
Avionic systems automatic test equipment, discussing maintenance, reliability, cost and time reduction
A70-38544
General Purpose Automatic Test System using building block concept for avionic systems evaluation at military depot level
A70-40771
Versatile Avionic Shop Test maintenance system supporting avionic equipment aboard aircraft carriers
A70-40772
Avionics hardware design guidelines to meet automated testing constraints including malfunction isolation, block requirements, packaging, etc
A70-44538
Avionic components reliability, determining nonsteady cooling air environment effects
A70-44744
ELECTRONIC MODULES
S band CW power amplifier and varactor doubler module for airborne phased arrays
A70-36674
Modular computer systems architecture for avionic and aerospace applications
N70-39496
ELECTRONIC PACKAGING
Electronic packaging - IEEE Conference, Cambridge, Massachusetts, June 1970
A70-36758
Avionics hardware design guidelines to meet automated testing constraints including malfunction isolation, block requirements, packaging, etc
A70-44538
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules
A70-44542
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques
A70-44543
ELECTRONIC RECORDING SYSTEMS
Airlines data reduction using electronic engine maintenance recorders
[ASME PAPER 70-GT-127] A70-36853
ELECTROPHYSICS
Scientific research in materials science, general science, electronics, and oceanography
[AD-706718] N70-38374
ELECTROSTATIC CHARGE
Supersonic air flow control by electrostatic discharges tested by Mach 3 wind tunnels, using schlieren system for bow shock wave
[AIAA PAPER 70-759] A70-34492
Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Electromagnetic interference in aircraft communication due to jet engine charging, considering various prevention measures
A70-39724
ELEVATORS (CONTROL SURFACES)
High performance aircraft self adaptive feedback control system, using airborne digital computer with inputs of elevator deflection and pitch rate for effectiveness identification
A70-40119
ELEVONS
Elevon design for lifting reentry vehicles to eliminate cross coupling and yaw at supersonic and hypersonic speeds
[NASA-CASE-XLA-89670] N70-36056
ELLIPSOIDS
Two dimensional shock theory for predicting pressures on elliptic cones at supersonic speeds
[NASA-TN-D-5952] N70-35926
ELLIPTICAL CYLINDERS
Stationary elliptic cylinders in subcritical flow, determining Strouhal number, pressure fluctuations and wake geometry as functions of angle of attack
[AIAA PAPER 69-745] A70-44564
ELLIPTICITY
Angle of attack and bluntness effects on hypersonic flow over 15 deg semiapex cone in helium
[NASA-TN-D-5903] N70-34073
EMERGENCY BREATHING TECHNIQUES
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage
A70-44465
EMERGENCY LIFE SUSTAINING SYSTEMS
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage
A70-44465
High energy emergency exit systems for passenger survival in aircraft accidents
A70-44466
Presentation styles of passenger emergency evacuation briefing cards, noting preference for sequential action graphic displays with minimum keywording
A70-44486
Emergency life saving instant exits for transport aircraft, using electromechanical confined transfer shaped explosive device
A70-44487
Modularized multiple use SIIIS-3 ejection seat escape system, discussing weight, envelope and low cost
A70-44499
EMULSIONS
Compatibility of gelled and emulsified aircraft turbine fuels
[NA-70-11] N70-32365
END PLATES
Planar wing with end plates in ground effect, calculating minimum induced drag by approximation theory
A70-40919
ENERGY ABSORPTION
Ground Effect Takeoff and Landing /GETOL/ aircraft, evaluating energy absorption capability of air cushion landing gear in touch-down condition
A70-42282
Static tests of aluminum and steel frangible tube energy absorbers for nuclear aircraft reactors
[NASA-TM-X-52847] N70-34152
ENERGY DISSIPATION
Energy dissipating shock absorbing system for land payload recovery or vehicle braking
[NASA-CASE-XLA-00754] N70-34850
ENERGY TRANSFER
Energy transfer methods for hybrid air breathing ramjet propulsion systems with rocket motor S gas source
[ICAS PAPER 70-61] A70-44156
Turbulent mixing of supersonic jets investigated for momentum and energy equations
[AD-708735] N70-40679
Ignition and sustaining of combustion by energy addition in turbulent supersonic flow
[AD-710283] N70-42528
ENGINE CONTROL
Helicopter gas turbine governor systems for engine and rotor speed control, minimizing pilot activity
[ASME PAPER 70-GT-37] A70-36835

Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests
[ASME PAPER 70-GT-38] A70-36836
Control system considerations for small shaft-type aircraft gas turbines providing torque, temperature, load sharing and overspeed limiting functions
[ASME PAPER 70-GT-132] A70-36858
Aero gas turbine engines digital computer control, discussing special properties, design and safety problems
[ASME PAPER 70-GT-40] A70-36870
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques
A70-37241
Gas turbine propulsion systems design, performance and applications for industrial and military uses, discussing sensors for measurement and control of critical engine parameters
A70-37881
Low and medium power turboprop engines for V/STOL aircraft, discussing development trends concerning operational control
A70-43081
Fuel delivery and speed control systems for aircraft gas turbine engines, discussing control circuit transfers and block diagrams
A70-43116
German monograph on dynamic control behavior of jet engines covering computation for normal external actions and perturbation effects
A70-44396
Computerized simulation and hardware for propulsion control of turbine engines
[SAE PAPER 700827] A70-45892
Engine control concepts for augmented turbofan, discussing integrated electrical/hydromechanical system
[SAE PAPER 700826] A70-45893
High temperature gas turbine aircraft engine control system requirements, noting stoichiometric fuel-air ratio
[SAE PAPER 700823] A70-45895
Direct drive turbine engine control components and airframe accessories, noting weight and frontal area reduction
[SAE PAPER 700821] A70-45896
Propulsion control integration for aircraft power management
[SAE PAPER 700818] A70-45899

ENGINE COOLANTS

Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials
[ICAS PAPER 70-16] A70-44127
Methane or hydrogen fuel direct cooling of first stage stator of SST aircraft turbine - numerical heat transfer analysis
[NASA-TN-D-6042] N70-42326

ENGINE DESIGN

Ti alloys use in jet engines design, considering weight, structural stability, useful temperature range, cost, etc
A70-34448
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629
V/STOL 5000 hp engine design optimization, considering component arrangements, rotor design, blade cooling method and fuel control
A70-34709
Convertible fan-shaft engine for V/STOL tactical and transport aircraft, discussing design and performance
A70-34710
Aircraft design minimizing damage by bird strikes to gas turbine engine components, discussing service experience, airworthiness demonstration tests and research programs
A70-35994
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests
A70-35996
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
High speed and long life bearings and dampers for future jet engines, considering design factors
[SAE PAPER 700318] A70-36800
High bypass turbofan engine design concepts and development program for airline operation
[SAE PAPER 700292] A70-36804
Olympus 593 engine for Concorde aircraft, describing design and test procedures
[SAE PAPER 700291] A70-36805
JT9D engine design and performance, describing operational problems
[SAE PAPER 700288] A70-36807
Aircraft engine production cost estimating techniques, discussing physical, thermodynamic and metallurgical characteristics
[SAE PAPER 700271] A70-36818
Lightweight lift jet engine design, testing and performance for V/STOL aircraft
[ASME PAPER 70-GT-32] A70-36833
Helicopter gas turbine engines protection against salt spray, dust, sand, ice, cut grass, etc
[ASME PAPER 70-GT-96] A70-36843
Concorde aircraft powerplant design using fire tunnel test
[ASME PAPER 70-GT-128] A70-36854
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption
[ASME PAPER 70-GT-79] A70-36885
Aircraft gas turbine engine development, considering gas dynamic and structural parameters
A70-37238
Jumbo jets turbofan engines design, considering fuel consumption, maintenance, reliability, noise reduction, etc
A70-38953
Jet engine combustor design and efficiency, discussing heat transfer, cooling and engine materials
A70-39648
Aircraft engine design combining turbojet and ramjet features to ensure optimum performance
A70-40148
Single stage gas turbines rational design based on minimum diametric dimensions
A70-41768
M 3.5 two dimensional mixed compression inlet system with self restart using flexible variable ramp system
[AIAA PAPER 69-447] A70-42707
Allison/Rolls-Royce TF41 turbofan engine improved power and reduced weight versions, comparing afterburning Model 912-B23 to nonafterburning TF41-A-2
A70-44596
Optimal propeller selection for given aircraft and engine designs, considering aerodynamic and acoustic characteristics
A70-45441
Turbine blades deformation by centrifugal and aerodynamic forces, discussing theory for bending stress free blade design
A70-45505
L-1011 aircraft optimum minimum noise pod design, describing technology, restraints and system requirements
[SAE PAPER 700805] A70-45877
Noise suppression for high-bypass ratio CF6 turbofan engine in DC-10 airplane, considering effect on engine design
[SAE PAPER 700804] A70-45878
TSCP700 aircraft auxiliary power unit design, fuel consumption and maintainability
[SAE PAPER 700815] A70-45902
V/STOL powerplant development, discussion airframe and engine design, application to large aircraft and planned evolutionary process
[SAE PAPER 700809] A70-45905
Noise reduction design for subsonic transport turbofan engines
[SAE PAPER 700807] A70-45907
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency

A70-46012
German book on aircraft thermal propulsion systems calculation, design and evaluation, covering thermodynamic principles and atmospheric composition and properties
A70-46150
Textbook on aircraft engine design
[AD-704730] N70-32985
Aircraft and engine design problems for high Reynolds number, high speed, large subsonic aircraft - conference
[AGARD-LS-37-70] N70-37753
Engine performance design considerations for large subsonic transport with high by-pass ratio
N70-37761
Aerodynamics of engine component design problems for large subsonic aircraft
N70-37762
Design consideration for air breathing gas turbine engine as third propulsion system of space shuttle
N70-39637
Multimission fighter aircraft engine design process, with weapon system design approach
N70-40710

ENGINE FAILURE
Vibration monitoring for turbine engine malfunction detection
A70-35480
Aircraft engine failures advanced detection by spectrometric lubricating oil analysis
A70-35481
Boeing 747 aircraft JT9D engine deflections and removals during early service experience and maintenance
[AIAA PAPER 70-890] A70-35807
Gas turbines, dust and air cleaners interrelationship in preventing failure due to air contaminants
[ASME PAPER 70-GT-104] A70-36890
Automated aircraft flight safety, concerning probabilities and onboard elimination of servomotor failures in hydraulic system due to fuel contamination
A70-42804
Analysis of oil sample data obtained from aircraft engines by spectrometry
[AD-706697] N70-38036

ENGINE INLETS
High temperature and pressure hot gas source for testing fluidic temperature sensor used in gas turbine engine inlet simulation
A70-35157
Airframe-inlet integration for supersonic tactical fighters, testing wind tunnel models
[AIAA PAPER 70-933] A70-35843
Aerodynamic stability of branched diffuser systems used in annular combustors of gas turbine engines
[ASME PAPER 70-GT-27] A70-36868
Ceramic materials for low cost high inlet temperature gas turbine engine components
[ASME PAPER 70-GT-105] A70-36889
Inlet data for engine stability analyses, developing technical management procedure patterns for pretest test and posttest results
[AIAA PAPER 70-1214] A70-41320
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533
Subsonic jet engine intake duct radar cross section calculation using waveguide model
A70-43584
Automatic control system for Boeing SST engine air intakes, optimizing engine performance and controlling noise propagation
A70-46214
Flow rates of slotted engine intakes in upper wing surface
[LR-526] N70-35142
Low speed inducers for rocket engine feed system
[NASA-CR-72716] N70-41058

ENGINE MONITORING INSTRUMENTS
Vibration monitoring for turbine engine malfunction detection
A70-35480
C-5A propulsion system onboard monitoring for malfunction detection, analysis and subsystem recording
A70-35497
Jet transport aircraft turbine engine performance monitoring by flight data, discussing historical highlights and future prospects
[SAE PAPER 700314] A70-36801
Airlines data reduction using electronic engine maintenance recorders
[ASME PAPER 70-GT-127] A70-36853
Electronic gas turbine diagnostic systems, discussing engine parameters and analysis system
[ASME PAPER 70-GT-131] A70-36857
Gas turbine propulsion systems design, performance and applications for industrial and military uses, discussing sensors for measurement and control of critical engine parameters
A70-37881
Aircraft nonavionic systems performance condition and minimum maintenance duties diagnosis by integrated data system, discussing engine monitoring instruments
A70-37891
Economic payback of AIDS /Aircraft Integrated Data System/ recording for operational performance monitoring and engine analysis
A70-37894
Engine vibration monitoring system for Boeing 747 aircraft, including piezoelectric transducer, transmission assembly and differential charge converter
A70-37898
Aircraft compressor and turbine vibration monitor, using velocity coil or piezoelectric transducers
A70-38525
Airborne data acquisition equipment for accident flight path and engine performance recording
A70-41922
C5 Malfunction Detection Analysis and Recording /MADAR/ subsystem for onboard fault isolation including engines
[SAE PAPER 700820] A70-45898

ENGINE NOISE
Aircraft gas turbine propulsion, discussing engine performance characteristics, thermodynamics, noise and installation
[AIAA PAPER 70-873] A70-34810
Ground test noise measurements accuracy and repeatability on JT8D turbojet engine
A70-35183
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Flow noise mechanisms, considering discharge, propeller, ventilator, jet engine, boundary layer, water pipe and supersonic aircraft sources
A70-38474
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
Test rig vehicle design for noise research on single stage high bypass ratio fans for quieter turbofan power plants
[AIAA PAPER 69-492] A70-42708
Jet engine compressor noise analysis, noting inlet swirl role
A70-42725
Aircraft noise reduction, discussing generation sources in propulsion system, noise levels and subjective responses
A70-44395
Jet engine noise propagation near porous surface, predicting anomalous LF dip from direct and reflected waves interference with phase delay
A70-46068
Noise exposure forecasts for John F. Kennedy, O Hare International, and Los Angeles International airports, including effects of changes in aircraft hardware and procedures
[FAA-NO-70-7] N70-36942
Noise environments within multiplace fixed-wing aircraft
[AD-708403] N70-40628

ENGINE PARTS
Ti fabrications in aircraft engines, discussing alloys properties, sheet deformation, fusion welding, porosity, etc A70-34450
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations [SAE PAPER 700329] A70-36798
Critical aviation gas turbine rotating component life limit determination, describing statistical, maintenance, inspection and life evaluation computer program /SMILE/ [ASME PAPER 70-GT-66] A70-36841
Electrochemical machining /ECM/ effects on components surface integrity, discussing jet engine materials [ASME PAPER 70-GT-111] A70-36849
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques A70-37241
Jet engine roller bearings retainer candidate cage materials and coatings evaluation on test rig simulating engine conditions [ASLE PREPRINT 70AM 2D-1] A70-38805
Aircraft engine diagnostics and defectoscopy, considering radioactive isotopes testing for component wear and performance A70-43083
Aircraft flight propulsion systems performance improvement via materials technology for gas turbine engine components A70-43573
NASA research in turbojet aircraft propulsion noting inlet, compressor, combustor, turbine and nozzle component technology [ICAS PAPER 70-46] A70-44144
Turbojet engine RD-3 M-500 data and operating conditions [AD-700477] N70-36415
Aerodynamics of engine component design problems for large subsonic aircraft N70-37762

ENGINE STARTERS
M 3.5 two dimensional mixed compression inlet system with self restart using flexible variable ramp system [AIAA PAPER 69-447] A70-42707
Gas turbine engine combustion chamber starting, discussing effects of temperature, nozzle characteristics and fuel physicochemical properties A70-43356

ENGINE TESTING LABORATORIES
Aircraft propulsion system test facilities, discussing altitude simulation, large subsonic and supersonic engines and component development [ICAS PAPER 70-45] A70-44143

ENGINE TESTS
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations [SAE PAPER 700329] A70-36798
Jet transport aircraft turbine engine performance monitoring by flight data, discussing historical highlights and future prospects [SAE PAPER 700314] A70-36801
Olympus 593 engine for Concorde aircraft, describing design and test procedures [SAE PAPER 700291] A70-36805
High bypass ratio aircraft turbofan engines, discussing program of factory, flight and operational suitability testing [SAE PAPER 700290] A70-36806
Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests [ASME PAPER 70-GT-38] A70-36836
Concorde aircraft powerplant design using fire tunnel test [ASME PAPER 70-GT-128] A70-36854
Inlet data for engine stability analyses, developing technical management procedure patterns for pretest test and posttest results [AIAA PAPER 70-1214] A70-41320
Aircraft engine diagnostics and defectoscopy, considering radioactive isotopes testing for component wear and performance A70-43083
Two stage gas turbine engine optimal tuning for RPM, thrust, fuel rate and gas temperature, describing automated bench tests A70-43361
Scaling comparison of recirculation effects of VTOL YJ-85 lift engine pod with similar small-scale simulated engine pod [NASA-CR-1625] N70-35846
Turbojet engine RD-3 M-500 data and operating conditions [AD-700477] N70-36415
Gas turbine engine response to blast wave overpressures [DRES-267] N70-36951

ENTHALPY
Optimum nozzle geometry for minimum heat transfer to convergent-divergent nozzle wall from high enthalpy flow A70-35238

ENTRAINMENT
Entrainment theory for incompressible turbulent boundary layer velocity and drag on bodies of revolution employed in fuselage, submersible and cowlings for propulsion design A70-44400

ENVIRONMENT MODELS
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data [AIAA PAPER 70-948] A70-39579

ENVIRONMENT SIMULATION
Atmospheric contaminants dispersion simulation in meteorological wind tunnel with capability to simulate thermally stratified boundary layers A70-34496
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading A70-35995
Jet engine roller bearings retainer candidate cage materials and coatings evaluation on test rig simulating engine conditions [ASLE PREPRINT 70AM 2D-1] A70-38805
Simulated neutral atmospheric boundary layer measurements in wind tunnel, extending power spectral and correlation determinations A70-40139
Evaluation of proposed airport sites in Chicago area [FAA-RD-70-25] N70-32546

ENVIRONMENTAL CONTROL
Statistical measurement of bird hazards to aircraft in terms of strike rates at airports, considering international strike rate standard A70-35981
U.S. Air Force bird-aircraft collisions problem and bird control research A70-35984
Military airlift command bird hazard minimization near airfields by environmental control, including uses of scare devices, chemicals, trapping, etc A70-35988
Canadian civil aircraft bird hazards problem and alleviating measures including airport surrounding lands control A70-35989
Aircraft bird hazards minimization by planning airport location and surroundings A70-35991
Wide-bodied and SST aircraft impact on airport design based on economic, social and environmental considerations [AIAA PAPER 70-1269] A70-45970
Environmental quality policies concerning aircraft noise and exhaust emission N70-41542

ENVIRONMENTAL ENGINEERING
Aircraft bird hazards minimization by planning airport location and surroundings A70-35991
Metropolitan airports environmental considerations, noting aircraft noise role in planning [SAE PAPER 700253] A70-36826
Structural and environmental design criteria for acoustical duct-lining materials in turbofan

noise suppression
A70-42531
Environmental engineering - Conference, Delft University, Netherlands, April 1970
A70-44326
Fireproof nonmetallic materials for spacecraft and aircraft, discussing functional utility, durability and aesthetic requirements relative to environmental conditions
A70-44610

ENVIRONMENTAL INDEX
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530

ENVIRONMENTAL TESTS
Humidity resistance test method involving flight simulation for airborne equipment in tropical environment
A70-35159
Forcing time functions prediction for structures under shock tube test, relating aerodynamic parameters to mechanics terminology
A70-35180
Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests
[ASME PAPER 70-GT-38] A70-36836
Helicopter gas turbine engines protection against salt spray, dust, sand, ice, cut grass, etc
[ASME PAPER 70-GT-96] A70-36843
CH-54A helicopter gas turbine engine air particle separator /EAPS/ field service in Vietnam, noting time before engine removal for erosion
[ASME PAPER 70-GT-97] A70-36844

ENVIRONMENTS
Airport operations effects on total environment, considering jet aircraft noise pollution
[AIAA PAPER 70-887] A70-37391

ENZYME ACTIVITY
Field test for microbiological contamination of jet fuel, discussing phosphates detection
A70-36344

EQUATIONS OF MOTION
Independent integrals of perturbed motion equations of spatial gyrohorizon compass
A70-35344
Significant terms in equations of motion for parachutes inflating in free air and in wind tunnel experiments
[AIAA PAPER 68-924] A70-36449
Invariant systems structural synthesis for automatic control of plant motion, deriving control laws for thrust and angle of attack
A70-39844
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515
Classical flutter problem possible solutions and comments
[RAE-LIB-TRANS-1296] N70-32148
Stability of motion of wing near interface of two media
[AD-702836] N70-35650
Variable structure systems and applications to flight automation problems
[AD-706798] N70-38534

EQUIPMENT SPECIFICATIONS
Collision avoidance system flight test and evaluation program for airline industry CAS specification
A70-38240
Differential pressure cell insensitive to changes in ambient temperature and extreme overload
[NASA-CASE-XAC-00042] N70-34816

EROSION
Compressor erosion correlation with aerodynamic parameters in gas turbine engines
A70-34711
Erosion by solid particles, discussing impacting velocity effects, natural sand quartz particle size distribution and composition, artificial industrial abrasives, etc
A70-35600
CH-54A helicopter gas turbine engine air particle separator /EAPS/ field service in Vietnam, noting time before engine removal for erosion
[ASME PAPER 70-GT-97] A70-36844
Helicopter gas turbine engine protection against sand and dust erosion using particle separators, screens and coatings
[SAE PAPER 700705] A70-42671
Sand and dust erosion reduction in gas turbine engines by coatings, sleeves and inserts
[SAE PAPER 700706] A70-42672
Short-term creep and erosion resistance testing of Ti alloy in high speed air flows under aerodynamic vibrations
A70-45826
Burning properties and effects of kerosene fuels used in jet aircraft engines
[AD-708352] N70-39926

ERROR ANALYSIS
Ground test noise measurements accuracy and repeatability on JT8D turbojet engine
A70-35183
Navigation errors and time delays in prediction techniques for air traffic control
A70-38642
Aircraft and rocket guidance systems navigation error analysis, discussing numerical integration techniques and computer program
[AIAA PAPER 70-1004] A70-39527
Stochastic processes for probabilistic error analysis in airborne gravimetry, using gravity sensing instruments
A70-43666
Engineering survey and analysis of en route ATC radar/display system errors
[FAA-NA-70-14] N70-41207

ESCAPE (ABANDONMENT)
Escape and survivability rates in various aircraft flight envelope regimes, using existing escape statistics and mission profiles
A70-44492

ESCAPE CAPSULES
F-111 aircraft crew cockpit escape module design for maximum efficiency, including survival equipment after ejection
A70-44491
Helicopter personnel escape capsule system feasibility by UH-25B helicopter, discussing incorporation into CH-46 and UH-1
[SAE PAPER 700832] A70-45890

ESCAPE ROCKETS
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device
[AIAA PAPER 70-1209] A70-41809

ESCAPE SYSTEMS
F-111 crew escape module, describing main parachute and pyrotechnics severance improvements, parachute deployment and inflation, etc
[AIAA PAPER 70-1210] A70-41807
SIIIS-3 ejection seat escape system design, considering minimum weight, cost and maximum performance
[AIAA PAPER 70-1211] A70-41808
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device
[AIAA PAPER 70-1209] A70-41809
Hi-glide personnel canopy /Para-Foil, Parawing, Sailwing, Volplane/ technology capability requirements identification from performance parameters tradeoffs
[AIAA PAPER 70-1194] A70-41822
In-flight escape systems and survival equipment reliability in U.S. Navy ejections
A70-44460
High energy emergency exit systems for passenger survival in aircraft accidents
A70-44466
Stretch fabric materials for personnel high speed escape parachute systems
A70-44482
Modularized multiple use SIIIS-3 ejection seat escape system, discussing weight, envelope and low cost
A70-44499
Aerospace pyrotechnics applications, considering pressure controlled propellant actuated device for escape systems
[SAE PAPER 700831] A70-45889

Helicopter personnel escape capsule system feasibility by UH-25B helicopter, discussing incorporation into CH-46 and UH-1
[SAE PAPER 700832] A70-45890
EULER BUCKLING
Euler buckling of inflated toroidal drag bodies, including packaging and load deflection tests for Mylar, dacron-neoprene and stainless steel-silicone fabrics
[AIAA PAPER 70-1198] A70-41818
EUROPEAN SPACE PROGRAMS
Dioscures satellite navigation system for aircraft and ships, discussing coverage, radio links, project costs, etc
A70-42657
European avionics role in Post Apollo program, noting space shuttles, space tugs, space stations and modules
A70-43501
Management organization of European operational application satellite systems, concerning interurban telecommunication and air traffic control
A70-43502
European wind tunnels suitable for Post Apollo Program aerodynamic testing, presenting detailed tabulated information on available facilities
A70-43503
EVACUATING (TRANSPORTATION)
Presentation styles of passenger emergency evacuation briefing cards, noting preference for sequential action graphic displays with minimum keywording
A70-44486
EVALUATION
Graphic simulation study of two sites for second major airport in Atlanta area
[FAA-RD-70-63] N70-41198
EVAPORATION
Fog dissipation on aircraft runways, using aircraft jet engine exhaust heat and mixing properties
A70-35929
EVOLUTION (DEVELOPMENT)
Aircraft handling qualities specifications and definitions evolution based on test pilot rating correlation with engineering data and piloting ease evaluation with transfer functions
[ICAS PAPER 70-19] A70-44114
Public address on air transport development
N70-36636
EXHAUST DIFFUSERS
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
EXHAUST GASES
Community air pollution from airports, discussing exhaust emissions, pollutant dispersion, etc
A70-35177
Optimum adaptation of propulsion gas generators to power jet driven rotors with blown flap control, considering jet engine, fanjet and engine driven compressor
A70-35661
Fog dissipation on aircraft runways, using aircraft jet engine exhaust heat and mixing properties
A70-35929
Aircraft turbine engines emission sampling, handling and measurement, evaluating various instruments and techniques
[SAE PAPER 700338] A70-36810
Gas turbine emissions analysis for air pollutants, determining species distribution and concentration
[ASME PAPER 70-GT-81] A70-36883
Exhaust gas ingestion suppression model tests for VTOL lift engines, measuring inlet thermal environment
[AIAA PAPER 70-905] A70-37396
Aircraft gas turbine engine smoke emission measurement, discussing test equipment and procedure standardization
A70-39720
Aircraft condensation trails formation by interactions of exhaust emission, vorticity of wing induced downwash and ambient atmosphere
A70-42684
Jet engine air pollution in U.S., discussing fuel types, additives and burner design for smoke emission reduction
A70-44200
Conference on kinetics and thermodynamics of combustion and high temperature gases
[NASA-SP-239] N70-32106
Survey of jet engine exhaust and trailing vortex wakes
[AD-707118] N70-38206
Environmental quality policies concerning aircraft noise and exhaust emission
N70-41542
Catalytic combustion technique for inerting aircraft fuel systems
N70-42758
EXHAUST NOZZLES
Exhaust nozzle/airframe interference test evaluation for twin engine supersonic fighter
[AIAA PAPER 69-430] A70-42702
Airframe installation effects at transonic speeds on underwing supersonic cruise exhaust nozzles, using flight and wind tunnel tests
A70-43274
Two stream ejector type propelling nozzles for supersonic aircraft, investigating various configuration effects over range of secondary/primary air flow ratios
[ICAS PAPER 70-48] A70-44145
Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft
[NASA-TM-X-2034] N70-32047
Penshaped, supersonic exhaust nozzle design
[NASA-CASE-XLE-00057] N70-38711
Calibration of blowdown wind tunnel for Concorde aircraft jet exhaust nozzle studies
[ONERA-NT-160] N70-42475
EXHAUST SYSTEMS
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533
Optimum manifold and injector hole area of pulsed exhaust systems of two cycle engine with turbosupercharger
A70-42809
EXPANDABLE STRUCTURES
Foldable conduit capable of springing back as self erecting structural member
[NASA-CASE-XLE-00620] N70-41579
EXPERIMENTAL DESIGN
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry
[AGARD-LS-39-70] N70-39091
EXPLOSIONS
Research in combustion, explosions and hypervelocity
N70-38119
EXPLOSIVE DEVICES
Emergency life saving instant exits for transport aircraft, using electromechanical confined transfer shaped explosive device
A70-44487

F

F-111 AIRCRAFT
F-111 high strength steel design experience concerning wing, fuselage and empennage support structure
[AIAA PAPER 70-884] A70-35803
F-111 crew escape module, describing main parachute and pyrotechnics severance improvements, parachute deployment and inflation, etc
[AIAA PAPER 70-1210] A70-41807
F-111 aircraft crew cockpit escape module design for maximum efficiency, including survival equipment after ejection
A70-44491
F-14 AIRCRAFT
F-14 carrier based fighter development program requirements, inherent difficulties and variable geometry configuration
A70-41264

F-2 AIRCRAFT
Hybrid computer program for optimization of flight control systems and instrument landing system glide path automatic pilot mode for F-2 aircraft
[RAE-TR-70043] N70-42386
F-5 AIRCRAFT
Digital data acquisition system for CF-5A flight test program, discussing recording system design
A70-38532
F-28 TRANSPORT AIRCRAFT
Data collection system for prototype flight tests of Fokker F-28 based on DC-8 aircraft digital system
A70-38546
FABRICS
Polymers industrial applications in textiles, building materials, furniture, aviation, automobile industry and packaging
A70-38700
Basket weave fabrics for gliding descent decelerators with polyurethane and nylon coatings for tearing strength and pressure packing
[AIAA PAPER 70-1180] A70-41833
FAIL-SAFE SYSTEMS
Digital fail-operative flight control computers for automatic landings, describing system requirements and problems and flight test program
[AIAA PAPER 70-1032] A70-39505
FAILURE
Markov chain analysis of aircraft repair using cannibalization
[AD-707041] N70-37824
FAILURE ANALYSIS
Failure and defect formation in gas turbine engine disks made of steel alloys, stressing fabrication methods effect on reliability
A70-38469
Finite element analysis of critical stress distribution in canopy of deployed twin keel parawing, predicting failure stress levels
[AIAA PAPER 70-1196] A70-41820
Aircraft electrical power systems optimization - failure prediction, detection, and compensation
N70-32056
Role of built-in test equipment in performance monitoring and fault detection
N70-32163
Tradeoffs between various configurations of onboard fault detection and fault isolation systems
N70-32166
FAIRCHILD-HILLER AIRCRAFT
Accident report data for FH-227C aircraft number N380NE
[PB-191201] N70-37453
FAN IN WING AIRCRAFT
Secondary inlet downstream of air gap for separating wing from efflux ducting for fan in wing aircraft
[NRC-11446] N70-40470
FANS
Forced vortex impeller in axial flow fan without inlet vanes, presenting lift and drag coefficients of blade sections, loss of head, etc
A70-38222
Three dimensional flow through rotor of axial vortex flow fan, using airfoil method for design
A70-38248
FASTENERS
Fastener standardization for airline maintenance requirements
[AIAA PAPER 70-894] A70-35811
Beta III Ti alloy for aircraft fasteners, describing microstructure and mechanical properties
A70-39966
Ultrasonic crack detection in fastener holes in C-5A wings
A70-45571
Bonded honeycomb sandwich structure fastening techniques in aerospace design, noting application to aircraft and spacecraft structures
[SAE PAPER 700850] A70-45882
FATIGUE (MATERIALS)
CH-47 cruise guide indicator for displaying fatigue loading to pilots, discussing design and operation
A70-34705
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data
[AIAA PAPER 70-948] A70-39579
Research and development activities of National Aeronautical Laboratory in 1968-1969
N70-35198
Structural fatigue manual, including plastic strain, static tests, and notched or cracked component strength, for aircraft applicability and with bibliographies
[AGARD-MAN-8-70-VOL-1] N70-37802
General principles of structural strength and fatigue, including airframes, fractures, and stress concentrations
N70-37803
Static strength of notched or cracked structural components, including fatigue crack initiation and elastic stress distribution in thin sheets
N70-37806
Physical changes and damage during fatigue, including plastic processes and crack propagation
N70-37807
Fatigue load monitoring of military aircraft in NATO countries
[AGARD-AR-28] N70-40069
FATIGUE LIFE
Flight loads spectrum data for army CH-47A, UB-1B and CH-54A helicopters components compared with fatigue life spectra
A70-35955
Model gas turbine engine blades fatigue strength under stress conditions, considering tensile stresses reproducibility from centrifugal loads
A70-38459
Aircraft design fatigue life and cumulation damage problems, discussing information value of programmed load and random tests
A70-39622
Helicopter parts and assemblies fatigue life estimation and testing, discussing loading spectra, service conditions, etc
A70-43119
Fatigue strength of stiffened aircraft panels subjected to repeated buckling by compression loads
[ICAS PAPER 70-35] A70-44132
Review of methods used for simulating random load fatigue in laboratory testing
[UTIAS-29] N70-33724
Endurance test on two phase flow rotor bearing system for turbomachinery
[MTI-70-TR-33] N70-40214
FATIGUE TESTING MACHINES
Variable loads programming by semicomputers/ semihardware method for 747 fatigue testing
A70-35511
FATIGUE TESTS
Crack propagation, fatigue damage and interaction effects in aircraft structures and materials under flight simulation loading
A70-34924
Turbocompressor disk materials selection by low cycle fatigue tests, discussing stop and start repetition and cracks in stress concentration zones
A70-41261
Load cycle sequences for full scale aircraft structures and components fatigue testing
[ICAS PAPER 70-32] A70-44101
Aircraft structure fatigue load monitoring, discussing strain gage installation in critical areas
[ICAS PAPER 70-31] A70-44102
Helicopter rotors fatigue testing using small scale models of full scale components
[ICAS PAPER 70-34] A70-44131
Aircraft structures acoustic fatigue testing, discussing test facilities, environment simulation, etc
A70-44329
Commercial transport aircraft fatigue loading data from NASA VGH /airspeed-acceleration-altitude/ program, discussing instrumentation, sample

sizes, etc
A70-44548
NDT for aircraft service life extension, discussing fatigue tests and crack detection
A70-45719
Fatigue testing device applying random discrete load levels to test specimen and applicable to aircraft structures
[NASA-CASE-XLA-02131] N70-42003
FD 2 AIRCRAFT
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161
FEED SYSTEMS
Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Air feed jet combustion chamber operations under unstable conditions
[AD-700801] N70-36450
FEEDBACK CONTROL
Pilot/vehicle feedback systems with flight director computer for transport aircraft longitudinal control during landing, discussing design by manual control displays theory
[AIAA PAPER 70-1001] A70-39530
High performance aircraft self adaptive feedback control system, using airborne digital computer with inputs of elevator deflection and pitch rate for effectiveness identification
A70-40119
Stability augmentation in aircraft design for handling and operation benefits, discussing control techniques, autopilot modes and load limitations
[ICAS PAPER 70-24] A70-44109
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft
[SAE PAPER 700794] A70-45853
Hydrofluidics flight controls for aircraft stability augmentation systems, noting component performance, transfer functions and operation
[SAE PAPER 700793] A70-45854
FEEDERS
Low speed inducers for rocket engine feed system
[NASA-CR-72716] N70-41058
FERRITES
Ferrite phase shifter for array antennas, discussing design trends, production, performance characteristics and future developments
A70-37864
FIGHTER AIRCRAFT
VAK 191 B VTOL aircraft fitting NATO Basic Military Requirements for low level reconnaissance-fighter operations developed from Fiat G-91
A70-34992
Flying qualities criterion for fighter flight control systems design
[AIAA PAPER 70-927] A70-35837
Fighter aircraft design for spin resistance and recovery using analytical approach, wind tunnel and flight tests
[AIAA PAPER 70-928] A70-35838
Air superiority fighter design philosophy, including tradeoffs between armament, detection capability, thrust, speed and load factor
[AIAA PAPER 70-930] A70-35840
Airframe-inlet integration for supersonic tactical fighters, testing wind tunnel models
[AIAA PAPER 70-933] A70-35843
Computerized air combat simulation with comparison of analog and digital approaches, noting Air to Air Combat Fort Worth
A70-36453
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data
[AIAA PAPER 70-948] A70-39579
Fighter aircraft higher order control system dynamics effects on longitudinal handling qualities evaluated by in-flight simulator for role of pilot induced oscillations tendencies
[AIAA PAPER 69-768] A70-42711
Strike fighter aircraft fuselage side air intakes, measuring external drag as function of design at subsonic and supersonic speeds
[ICAS PAPER 70-49] A70-44146
Avionics system for fighter aircraft, discussing weapons design, navigation-attack systems integration, etc
A70-44413
Effects of pointed nose on spin characteristics of fighter aircraft model and correlation of free flight test results with theoretical data
[NASA-TN-D-5291] N70-37395
Use of fighter aircraft to provide zero gravity environment in support of space manufacturing experiments
[NASA-TM-X-53896] N70-37570
Minimax study of aim angle for proportional navigation missile - planar case
[AD-708167] N70-39778
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Project design of fighter aircraft
N70-40703
Tradeoff studies in preliminary fighter aircraft design
N70-40705
Fluid dynamics considerations in preliminary fighter aircraft design
N70-40707
Aerodynamic design advances for fighter aircraft
N70-40708
Jet engine/airframe interface problems in fighter aircraft design
N70-40709
Multimission fighter aircraft engine design process, with weapon system design approach
N70-40710
Propeller and airframe integration in supersonic fighter aircraft design
N70-40711
Structural problems in fighter aircraft design
N70-40712
Load estimation and aeroelasticity in advanced fighter aircraft design initial stages
N70-40713
Fighter aircraft flight control design and application to Concorde aircraft
N70-40716
Fighter aircraft flight control system design
N70-40717
FIGURE OF MERIT
Merit factor for evaluation of aircraft types and missions, matching aircraft characteristics to mission load, range and speed
[SAWE PAPER 842] A70-40360
FILLERS
Magnesium aluminum alloy as filler material in steel welds for rotor construction
[M70-111-ROM/VDT/NAT] N70-35540
FILM BOILING
Vapor volume entrained in liquid bulk from boundary layer boiling on vertical plate in low gravity field
A70-41055
FILM COOLING
Gas turbine combustion chamber convective and radiant heat transmission, examining steam film cooling of flame tube
A70-43199
Convection, transpiration and full coverage film cooling methods for various local turbine inlet temperatures, gas pressures and cooling air temperatures
A70-43275
Analysis of capabilities and limitations of film air cooling methods for turbine engines
[NASA-TN-D-5992] N70-40659
FILTERS
Water separation index modified /WSIM/ test for jet fuel surface active materials in relation to filter/separator performance
[SAE PAPER 700279] A70-36815
FILTRATION
Filtration methods for aircraft fuel systems presenting vortex separation principle
[AD-707058] N70-38574

FINANCE
European airbuses designs, considering potential market and financial problems A70-38952
Financing methods for airport redevelopment and expansion, discussing economic and political framework of operations [AIAA PAPER 70-1267] A70-45920
FINENESS RATIO
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models [AIAA PAPER 69-350] A70-35657
FINITE DIFFERENCE THEORY
Plane transonic flow around airfoils, using hodograph based methods for shock free flow and finite difference methods for flow with shock waves [ICAS PAPER 70-12] A70-44123
FINITE ELEMENT METHOD
Finite element stiffness matrix technique for composite structures, discussing airplane component design program A70-40040
Swing tail cargo aircraft fuselage section stress analysis by finite element method, discussing displacement models, deformation modes and economics A70-41260
Finite element analysis of critical stress distribution in canopy of deployed twin keel parawing, predicting failure stress levels [AIAA PAPER 70-1196] A70-41820
Spacecraft parachute stress analysis, using finite elements with nonlinear elastic properties to obtain shape and load distribution [AIAA PAPER 70-1195] A70-41821
Kinematically unsteady aerodynamic coefficients consistent with stiffness and inertia properties of lifting surface in supersonic flow by finite element method A70-45154
Report including finite element analysis of shells, pressure molding foam, and flight impact simulator [DME/NAE-1969/4/] N70-33651
Finite element analysis for spare frames subjected to axial loads [AD-704570] N70-36520
Three-dimensional stress concentration in rotating anisotropic disks with radial compressor blades using finite element method [DLR-FB-70-16] N70-38484
FINS
Hovercraft wind directional stability and control by cam operated fin-tab assembly A70-38942
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and fin-plate models [RM-487] N70-42113
FIRE CONTROL
Attack helicopter fire control system with day and night detection, recognition and kill capabilities, discussing system components, operation and reliability A70-34732
OV-10A forward air control and light attack aircraft design, specifications and performance [SAE PAPER 700837] A70-45883
Catalytic combustion technique for inerting aircraft fuel systems N70-42758
FIRE EXTINGUISHERS
Fire extinguishing in large cargo aircraft [FAA-RD-70-42] N70-36871
In-flight liquid nitrogen fire extinguishers for commercial aircraft N70-42757
FIRE FIGHTING
Technology review on suppression and rescue systems for aircraft fires on ground [AD-703393] N70-35487
STOL port arresting gear, fire fighting, and rescue equipment N70-41084
FIRE PREVENTION
Aircraft in-flight and post crash fire protection developments, considering controlled flammability fuel systems and fire fighting methods [ASME PAPER 70-GT-109] A70-36847
Fire and overheat detection system design for turbine powered vehicles [ASME PAPER 70-GT-125] A70-36891
Catalytic combustion fuel tank inerting techniques for fire protection in military and civilian aircraft A70-44485
Materials for crash-fire resistant aircraft fuel tanks [NA-69-43] N70-34001
Technology review on suppression and rescue systems for aircraft fires on ground [AD-703393] N70-35487
Aircraft fuel system fire safety and prevention, and jet aircraft air pollution N70-40779
Conference on fuel system fire safety [AD-711059] N70-42753
FIREPROOFING
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage A70-44465
Fireproof nonmetallic materials for spacecraft and aircraft, discussing functional utility, durability and aesthetic requirements relative to environmental conditions A70-44610
FIRES
Closed compartment fire mathematical model to analyze combustion parameter effects, atmosphere pressure and temperature during fire A70-35646
FIXED WINGS
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy A70-38365
AERCAB /Aircrew Escape/Rescue Capability/ flying ejection seat, considering rotary wings, fixed wings and parawings [AIAA PAPER 70-1213] A70-41806
Noise environments within multiplace fixed-wing aircraft [AD-708403] N70-40628
FLAME HOLDERS
Aerodynamic holder stabilized smoke flames to avoid intermittent flaming and thick puffs for incinerator air pollution reduction A70-40887
Turbofan engines afterburner flame stabilization at low inlet temperature, noting flame holder geometry role A70-42336
FLAME PROPAGATION
Effectiveness of various inerting agents for preventing ignition and flame propagation of hydrocarbon fuel-air systems N70-42756
FLAME STABILITY
Aerodynamic holder stabilized smoke flames to avoid intermittent flaming and thick puffs for incinerator air pollution reduction A70-40887
Turbofan engines afterburner flame stabilization at low inlet temperature, noting flame holder geometry role A70-42336
Aerodynamics of turbulent diffusion flame in coaxial jets, physical model of flameholding on blunt bodies, and diffusion gas flame stability in wake of transverse air jets [AD-700475] N70-36395
FLAMEOUT
Flameout and ignition correlation for diffusion fuel burnup behind angled stabilizers in annular turbine combustion chamber A70-36127
FLAMES
Aerodynamics and gas jet calculations of gas flame theory [AD-706646] N70-38635
FLAPPING HINGES
Estimating aerodynamic properties of airfoil with hinged flap and spoiler [NASA-TT-F-13131] N70-34693

FLAPS (CONTROL SURFACES)
High lift flaps for sailplane cross country speed improvement by cruise-climb tradeoffs
[AIAA PAPER 70-878] A70-34814
Optimum adaptation of propulsion gas generators to power jet driven rotors with blown flap control, considering jet engine, fanjet and engine driven compressor
A70-35661
Upper surface, external flow, jet-augmented flap configuration for high wing jet aircraft for noise reduction
[NASA-CASE-XLA-00087] N70-33332
FLASH LAMPS
Xenon flash lamp application in collision avoidance
[AD-709191] N70-41191
FLAT CONDUCTORS
Flat conductor feeder tests and evaluation
[AD-705969] N70-34072
FLAT PLATES
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone
A70-34466
Transitional flow separation upstream of compression corner at trailing edge of sharp leading edge flat plate
[AIAA PAPER 70-764] A70-34487
Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate
A70-36194
Mathematical model of three dimensional separated flows with applications to small aspect ratio delta wing and flat plate
A70-36438
Sound wave radiation and excitation in plane infinite plate by vortices
A70-38722
Bearing force and moment produced by motion of inclined plate supported by compressed air in ground effect machines with small angle of attack
A70-39140
Boundary layer transition region of flat plate in incompressible flow by subsonic wind tunnel tests, demonstrating harmonic wall perturbation effect
A70-41440
Steady viscous flow past oblique flat plate at high Reynolds number, using Oseen linearized approximation
A70-41714
Flat plate airfoil unsteady lift due to chordwise velocity perturbations, using Horlock frozen gust pattern theory
A70-42303
Two phase plume at various incidence angles on fla plate, determining impinging particle mass flux, forces and damage
A70-44566
Three dimensional boundary layer and flow resistance of flat plate with slip
N70-32335
Heat transfer in turbulent boundary layer in wind tunnel with air flowing over partially heated aerodynamically smooth flat plate
N70-32346
Digital computer program for Newtonian aerodynamics of body composed of flat plate segments
[NASA-TM-X-64431] N70-35621
Hypersonic heat transfer rates on flat plates in helium and in corner flow region with air
[NASA-CR-114257] N70-42365
Autorotation of flat plate wing model about spanwise axis
[AD-710288] N70-43141
FLEXIBILITY
Parachute flexibility as performance parameter, discussing stiffness-weight index, inflation process, squidding, etc
[AIAA PAPER 70-1166] A70-41845
FLEXIBLE BODIES
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes
A70-41408
All-flexible parawings aerodynamic performance prediction based on slender wing theory and circular arc approximations for canopy shape
[AIAA PAPER 70-1188] A70-41827
FLEXIBLE WINGS
Packable near weightless nylon cloth wings without rigid members for improved aeronautical efficiency in cargo delivery, powered flight and rocket and spacecraft recovery
[AIAA PAPER 70-880] A70-34815
Wings flexural deformability influence on longitudinal stability of glider, using small perturbation theory
A70-35190
Deployment system for flexible wing with rigid superstructure
[NASA-CASE-XLA-01220] N70-41863
FLIGHT ALTITUDE
Supersonic flight altitude stability, studying effects of velocity, lift-drag ratio, thrust law, wind direction, engine unstarts, etc
[AIAA PAPER 69-813] A70-42712
Lower ILS altitude and visibility minimums for light aircraft
[AD-708294] N70-41156
FLIGHT CHARACTERISTICS
UH-1C, AH-1G and UH-1H helicopters combat operational flight profiles, considering airspeed, altitude, rotor speed, load factor, etc
A70-34717
Tilt-fold-proprotor VTOL aircraft characteristics, stability and control, emphasizing flying qualities
A70-34722
SST flight efficiency trends, discussing breakthrough and development method and Concorde aerodynamic, propulsion and structural history
[AIAA PAPER 70-871] A70-34811
Flying qualities criterion for fighter flight control systems design
[AIAA PAPER 70-927] A70-35837
Fighter aircraft design for spin resistance and recovery using analytical approach, wind tunnel and flight tests
[AIAA PAPER 70-928] A70-35838
Soviet book on VTOL design covering aerodynamic and weight characteristics, turboprop and turbojet engines, flight regimes, etc
A70-37233
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics
A70-37388
Soviet book on helicopter aerodynamics covering main rotor operation, types classification and various flight characteristics
A70-37390
Bobweights effects on pilot induced oscillations, noting role in flying qualities and control system design
[AIAA PAPER 70-1002] A70-39529
Flight characteristics and performance calculation of single rotor helicopters by digital computers, considering wobble plate steering margin, compressibility, ground effects, separation and autorotation
A70-39716
German book on principal characteristics of flight mechanics and ballistics covering mirror symmetric aircraft and axisymmetric bodies such as projectiles and missiles
A70-40738
Yak-40 business jet design and flight characteristics
A70-42174
SN 600 Corvette business jet design and performance
A70-42175
Para-foil application programs and test results, discussing flight and glide performance, turn control, deployment inflation, etc
A70-42706
Downwash angle behind straight wing for unsteady aperiodic flight at subsonic speeds, using vorticity model
A70-42802

Canadair CL-84 V/STOL aircraft flight characteristics and structural design A70-44017
Small airplane unsteady motion downwash angle at low speeds, comparing results from rectilinear steady flights
[ICAS PAPER 70-25] A70-44108
Harrier aircraft development history, discussing V/STOL constraints on transonic flight properties
[ICAS PAPER 70-51] A70-44148
Aircraft geometry effects on longitudinal flight characteristics calculations, noting wing aspect ratio and horizontal tail changes A70-45437
Stationary aeroelastic cases studied in subsonic flow range, providing criteria for aircraft design with required flight characteristics A70-45443
Commercial STOL aircraft takeoff and landing physical parameters relationships based on wind tunnel and flight tests
[AIAA PAPER 70-1238] A70-45959
Viggen aircraft testing for flight properties, discussing measuring instruments, analog and digital recording, preprogrammed control, etc A70-46228

FLIGHT CLOTHING
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals A70-44488

FLIGHT CONDITIONS
Jet transport aircraft turbine engine performance monitoring by flight data, discussing historical highlights and future prospects
[SAE PAPER 700314] A70-36801

FLIGHT CONTROL
Airplane performance improvement by flight control system design, discussing ride quality, flutter margin, maneuver load, etc
[AIAA PAPER 70-875] A70-34816
Structural weight reduction and increased aerodynamic efficiency in aircraft design by including flight control technology early in configuration development phase
[AIAA PAPER 70-874] A70-34817
Integrated flight management system for commercial aircraft pilot using computer
[AIAA PAPER 70-908] A70-35820
Flying qualities criterion for fighter flight control systems design
[AIAA PAPER 70-927] A70-35837
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
Aerospace electronics covering fly-by-wire aircraft flight control, ATC, star trackers for spacecraft attitude control, etc A70-39668
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems A70-40785
Hydrofluidics flight controls for aircraft stability augmentation systems, noting component performance, transfer functions and operation
[SAE PAPER 700793] A70-45854
Built-in test equipment for advanced flight guidance systems N70-32160
Constraints placed on circuits and system design by various testing situations encountered during life of avionics equipment N70-32165
Checkout methods in digital control systems using control computer as test set N70-32168
Automatic testing of landing aid for VTOL aircraft N70-32177
Evaluation tests on Boulton-Paul VC-10 aileron integrated flight control actuator
[AD-703471] N70-35080
Adaptive aircraft control system under large input commands
[AD-705074] N70-36463
Aircraft indicator for pilot control of takeoff roll, climbout path and verticle flight path in poor visibility conditions
[NASA-CASE-XLA-00487] N70-40157
Fighter aircraft flight control design and application to Concorde aircraft N70-40716
Fighter aircraft flight control system design N70-40717
Flight tests of spiral divergence and bank angle control of executive jet aircraft N70-40780
Federal flight inspection of navigation systems and air traffic control facilities N70-41531
Discussion on feasibility of real-time on-line optimal flight control
[AD-709714] N70-41664
Hybrid computer program for optimization of flight control systems and instrument landing system glide path automatic pilot mode for F-2 aircraft
[RAE-TR-70043] N70-42386

FLIGHT CREWS
F-111 crew escape module, describing main parachute and pyrotechnics severance improvements, parachute deployment and inflation, etc
[AIAA PAPER 70-1210] A70-41807
Aircraft crew and pilot in-flight work load measurement and simulator
[ICAS PAPER 70-43] A70-44141
F-111 aircraft crew cockpit escape module design for maximum efficiency, including survival equipment after ejection A70-44491
Concorde thrust control by employment of variable area nozzle and reheat system, discussing crew work load
[SAE PAPER 700817] A70-45900
Cockpit noise exposures associated with operation of fixed and rotary wing aircraft
[AD-705964] N70-33974
Scandinavian aircraft accident investigation and subsequent recommendations
[NTSB-AAR-70-14] N70-36114
Aircrew equipment assemblies and type 9 ejection seat for Harrier aircraft
[FPRC/MEMO-248] N70-36581

FLIGHT HAZARDS
Netherlands Air Force bird strike problem and warning system A70-35977
U.S. Air Force bird-aircraft collisions problem and bird control research A70-35984
Soviet monograph on collision hazards between aircraft and birds covering accidents, damage and preventive measures A70-44099
Near midair collision report of 1968 N70-41290

FLIGHT INSTRUMENTS
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
Jaguar flight test instrumentation methods, discussing Anglo-French participation A70-38534
Concorde prototype 002 flight test data recording instrumentation, emphasizing digital system for quasistatic parameters A70-38545
VTOL aircraft instrument flight in terminal area, defining requirements and operating characteristics for vertical and low speed capabilities
[AIAA PAPER 70-1333] A70-45935
Manual IFR formation flight display system requirements for advanced rotary wing and jet fighter aircraft
[AD-705133] N70-32317
Computerized flight simulation to determine resolution of pilot warning indicator device
[NASA-CR-113808] N70-41040
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339

FLIGHT LOAD RECORDERS
AH-1G helicopters combat flight loads from onboard oscillograph data recording, defining

performance in terms of critical variables A70-34706
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data [AIAA PAPER 70-948] A70-39579

FLIGHT MECHANICS
German book on principal characteristics of flight mechanics and ballistics covering mirror symmetric aircraft and axisymmetric bodies such as projectiles and missiles A70-40738
High velocity flight mechanics, hypersonic aerodynamic predictions, and optimization of hypersonic lifting bodies and cruise vehicles [AD-708133] N70-39844

FLIGHT OPTIMIZATION
Aircraft optimal operating procedure development by integral-variational performance analysis methods, discussing flight paths, fuel consumption, mission requirements, etc [AIAA PAPER 70-876] A70-34812
Weight growth factor in aircraft design, discussing fixed and variable weight, payload, performance, flight quality, structural criteria and life expectancy [SAWE PAPER 839] A70-40363

FLIGHT PATHS
Optimum approach and departure paths for VTOL aircraft simulated by hybrid computer under constraints [AIAA PAPER 69-209] A70-36452
Area navigation system charting, discussing effect on flight information publications A70-38231
Highly localized clear air turbulence at aircraft flight level over Mediterranean, noting simultaneous temperature rise A70-38948
Aircraft flying at constant speed in circular orbits, calculating flight path under effect of uniform velocity wind A70-40920
Airborne data acquisition equipment for accident flight path and engine performance recording A70-41922
Dynamic soaring - influence of airspeed, wind shear, lift drag ratio, and angle of inclination [NASA-TT-F-13217] N70-36081
Flight dynamics and trajectory calculations for winged rocket aircraft [AD-706663] N70-38629
Determination and control of airspace construction creating hazards to STOL flight paths N70-41082

FLIGHT PLANS
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers [AIAA PAPER 70-899] A70-35815
Automatic ATC with feedback, describing information processing and flight plan algorithm A70-38161
Signal automatic air traffic control system /SATCO/ for flight plan processing, using multi-processing real time computer, electronic displays and software facilities A70-38646
Meteorological wind and temperature distributions on selected routes at Concorde cruising level, noting computer use for flight planning A70-46204

FLIGHT RECORDERS
Airborne data acquisition and flight recorder systems, comparing civil and military aircraft requirements A70-35515
Flight data recorders and system integration, discussing data replay system backing flight recording A70-36340
Flight data recording systems for accident investigation and operational purposes, discussing U.S., British and French regulations A70-36341
Flight/accident data recorders and associated equipment for civil and military aircraft requirements A70-36342
Underwater recovery requirements for flight data recorders, suggesting compressed air instead of explosive charges for ejection force A70-36343
Digital flight data recording, considering aircraft integrated data systems /AIDS/ A70-37892
Flight data recording system /FDRS/ for crashes expanded to aircraft integrated data system /AIDS/ for airlines A70-37893
Airborne crash recorders objectives, design and features ensuring crash survival of recordings A70-38518
Flight recorder role in aircraft accident investigation and prevention, noting audio instruments and data recovery A70-38613
Aircraft reliability and excess transport aircraft airspeed analyzed from flight records [ARC-CP-1088] N70-37163

FLIGHT SAFETY
Air transportation growth with regularity and safety - Conference, London, November 1969 A70-35851
Data acquisition system applications philosophy, discussing data integrity, expansion facility, flight safety, etc A70-36339
Aeronautical satellite system for civil flight safety, discussing operational, technical and economic aspects A70-41131
Automated aircraft flight safety, concerning probabilities and onboard elimination of servomotor failures in hydraulic system due to fuel contamination A70-42804
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage A70-44465
Individually built-in self test techniques as applied to terrain following radar systems N70-32162
Senate hearing on improvement and future development of airports and airways N70-35740
Lift margin display for helicopter landing and takeoff operations [AD-704601] N70-36384
Annual report of Civil Aeronautics Board for 1969 N70-38666
Basic requirements for system, industrial, aviation, and public safety [NASA-TM-X-66319] N70-39716
Improved flight safety through increased automation in terminal air traffic control facilities N70-40783
Determination and control of airspace construction creating hazards to STOL flight paths N70-41082
Literature review and bibliography on altimetry [FAA-RD-70-52] N70-41197
Panamanian civil aeronautics directorate departments of air safety, air traffic, airports, and air transport, with US technical assistance recommendations [AC-70-3187] N70-41734

FLIGHT SIMULATION
Crack propagation, fatigue damage and interaction effects in aircraft structures and materials under flight simulation loading A70-34924
Humidity resistance test method involving flight simulation for airborne equipment in tropical environment A70-35159
C-5 flight simulation program for design of basic aircraft, flight control and guidance subsystems [AIAA PAPER 70-922] A70-35833
Runway test vehicle for lifting rotor performance in simulated forward flight, comparing with wind tunnel tests A70-38611
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models

and simulating effects on XV-5 V/STOL aircraft A70-40784
Flight simulation as aircraft design tool, discussing ground and inflight simulation techniques
[ICAS PAPER 70-41] A70-44139
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices
[ICAS PAPER 70-42] A70-44140
Report including finite element analysis of shells, pressure molding foam, and flight impact simulator
[DME/NAE-1969/4/] N70-33651
Simulation of bird impact during flight N70-33654
Computerized simulation and statistical analysis of V/STOL tactical landing system for helicopters
[AD-704324] N70-34849
Simulation of continuous runway centerline marking
[FAA-RD-70-40] N70-37021
Computerized flight simulation to determine resolution of pilot warning indicator device
[NASA-CR-113808] N70-41040
Display research for aircraft collision warning systems
[NASA-CR-113886] N70-41493
Ultrahigh frequency air traffic control satellite simulation experiment using high altitude balloons
[NASA-TM-X-65348] N70-41942
Flight simulator study of STOL transport lateral control characteristics
[FAA-RD-70-61] N70-42013
Real time simulation of aircraft in free flight using digital computers
[DLR-FB-70-21] N70-42430

FLIGHT SIMULATORS
Concorde aircraft man machine simulation and handling using fixed cabin, variable stability and ground based simulators
[AIAA PAPER 70-923] A70-35834
Ground simulations data of jet lift V/STOL compared with visual flight results, noting hover, lateral quick start and stop maneuver A70-35954
Aircraft crew and pilot in-flight work load measurement and simulator
[ICAS PAPER 70-43] A70-44141
Flight simulator for evaluating pilot performance
[AD-703638] N70-32650
Longitudinal handling qualities of variable stability flight simulator
[AD-703225] N70-35288
Concorde research pilot simulator
[NLL-M-9223-/5828.4F/] N70-36216
Flight simulation of lateral directional handling qualities for V/STOL aircraft in low speed maneuvering flight
[AD-707831] N70-40002
Simulator study of flight management task performance during low visibility approach and landing using baseline category 2 flight instrumentation
[NASA-CR-73478] N70-42037

FLIGHT STABILITY TESTS
Blade flexibility effects on static stability derivatives of prop/rotors in propeller flight mode A70-34701
AH-1G Hueycobra helicopter stability, control, performance, vibration and structural loads characteristics during controlled steady state maneuvers A70-34716
Flight tests of spiral divergence and bank angle control of executive jet aircraft N70-40780

FLIGHT TEST INSTRUMENTS
DC-10 airborne flight test PCM data system, discussing capability, onboard operating characteristics and test results A70-35498
Flight test instrumentation for V/STOL stability derivatives extraction, noting instrument errors and required compensation A70-35502
Airborne magnetic recording flight test instrumentation of Anglo-French Jaguar aircraft A70-38535
Viggen aircraft testing for flight properties, discussing measuring instruments, analog and digital recording, preprogrammed control, etc A70-46228

FLIGHT TESTS
Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs A70-34713
Two-point suspension system with longitudinally displaced cargo hooks for handling helicopter loads, discussing wind tunnel and flight tests A70-34714
DC 8 Super 63 aircraft direct lift control flight evaluation A70-35496
Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests
[ASME PAPER 70-GT-38] A70-36836
C-5A engineering flight test /EFT/ computer controlled data processing system operation, illustrating capability, performance and limitations A70-37917
Collision avoidance system flight test and evaluation program for airline industry CAS specification A70-38240
Multiaircraft flight test program time compression by management techniques, discussing program length and costs A70-38530
Boeing 747 transport airplane flight test data system, discussing recording media, major PCM and FM tape systems, etc A70-38531
Digital data acquisition system for CF-5A flight test program, discussing recording system design A70-38532
Jaguar flight test instrumentation methods, discussing Anglo-French participation A70-38534
Jaguar flight test data processing system, discussing airborne digital computer A70-38536
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment A70-38537
Concorde prototype 002 flight test data recording instrumentation, emphasizing digital system for quasistatic parameters A70-38545
Data collection system for prototype flight tests of Fokker F-28 based on DC-8 aircraft digital system A70-38546
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests A70-38547
Concorde aircraft flight test program for verifying design features of wing vortices, fuel transfer, longitudinal stability, etc A70-40580
High speed track facility for V/STOL aircraft tests, discussing characteristics and design A70-40581
Flow difference sensor for aircraft hydraulic systems damage vulnerability reduction, discussing design, operation and flight tests results A70-40786
Parafoil flight performance predictions and test results based on wind tunnel data and manned free flight
[AIAA PAPER 70-1190] A70-41826
Glide and landing performance of twin-keel parawings, discussing wind tunnel, radio flight and simulator tests
[AIAA PAPER 70-1186] A70-41829
Parachutes for low density atmospheres, describing low and high altitude test results
[AIAA PAPER 70-1164] A70-41846

Radar inertial system flight evaluation, discussing V/STOL program for approach and landing by use of ground based radar for updating onboard inertial navigator
A70-42651
Harrier flight testing in terms of V/STOL capability compared with conventional aircraft
A70-42975
Flight simulation as aircraft design tool, discussing ground and inflight simulation techniques
[ICAS PAPER 70-41] A70-44139
NACA/NASA rotary wing aircraft research history 1915-1970, Part 3, covering rotor and helicopter theory, related flight and wind tunnel testing, etc
A70-44853
Boeing 747 flight test certification program, describing methods, data systems, inertial navigation, engines, flutter, etc
[SAE PAPER 700828] A70-45891
Sapuc-Salut system for evaluating test data measured onboard Viggen aircraft
A70-46229
Computerized simulation of dewinding of hovering helicopter
[AD-704349] N70-32069
Integrated dynamic tests at flight line maintenance echelon for weapon systems
N70-32153
Individually built-in self test techniques as applied to terrain following radar systems
N70-32162
Aerodynamic characteristics associated with aircraft flight and reentry vehicles
[AD-705584] N70-33694
In-flight comparison of Kaiser FP-50 flight director with standard C-131 instruments
[AD-702748] N70-36264
Flight check console tests using DC-6B aircraft N-114
[FAA-NA-70-57] N70-36849
ATS-1 VHF communications experimentation
[FAA-RD-70-12] N70-36949
Flight tests of low speed controllability of BAC slender variable sweep wing research aircraft
[ARC-CP-1102] N70-37062
Shakers and solid rocket propellant impulse generators for aeroelastic and vibration flight tests of Concorde aircraft structures
[ONERA-TP-811] N70-37148
Low speed flight tests on longitudinal stability and control of Avro 707 delta wing aircraft
[ARC-CP-1105] N70-37164
Wind tunnel tests and flight performance of different models of VTOL aircraft
[NASA-TT-F-13181] N70-37542
Wind tunnel and flight evaluation Rosemount shielded pitot static tube model 850N
[AD-708859] N70-40514
Wind tunnel model and flight tests of parawing lifting body landing system
[NASA-TN-D-5893] N70-40667
FAA operational tests of STOL aircraft landing and control characteristics
N70-40777
Flight tests of airborne system for all-weather automatic control landing of C-141 aircraft
N70-40784
Flight test data of turbulent wakes for jet transport aircraft
N70-40911
Flight test evaluation of wing vortex wake generated by large jet transport aircraft
N70-40912
Results of flight test investigation of vortex wake turbulence generated by large jet transport aircraft
N70-40913
Flight test data for vortex wake characteristics of transport aircraft
N70-40914
Flight tests of STOL aircraft operational and performance parameters
N70-41079
Research and development of STOL port criteria, airworthiness and operational criteria, and flight test procedures
N70-41085
Moving graph instrument display evaluation for landing approaches with helicopter
[NASA-TN-D-6025] N70-41183
Advanced integrated landing system test and evaluation for all-weather landing
[FAA-RD-70-28] N70-41271
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - test data
[NASA-CR-110821] N70-42429
Methodology for tactical utility helicopter information transfer study
[AD-710248] N70-42532
Wing elevation, incidence, and chamber effects on aerodynamic characteristics of representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737
Flight evaluation of ground effect on low aspect ratio airplanes
[NASA-TN-D-6053] N70-42738

FLIGHT TIME
Generation of suboptimal closed loop guidance for minimum time aircraft trajectories
N70-37817

FLIGHT VEHICLES
Soviet book on vibrations in flight vehicle engines covering linear and nonlinear systems, computer methods, etc
A70-37229
German book on principal characteristics of flight mechanics and ballistics covering mirror symmetric aircraft and axisymmetric bodies such as projectiles and missiles
A70-40738

FLOQUET THEOREM
Lifting rotor blade motions stability computation using Floquet transition matrix
A70-34726

FLOTATION
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738

FLOW CHARACTERISTICS
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel
[AIAA PAPER 70-796] A70-34464
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone
A70-34466
Continuous variation measurements of wind tunnel parameters minimizing testing time, discussing flow characteristics measurements during angle of attack variation
A70-34775
Flow velocity and pressure on thin wing of small span width near sonic speed, using parabolic type linear equation
A70-36374
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations
A70-36382
Transonic turbine cascades exit flow parameters taking into account blade profile
A70-42346
Jet-ambient air mixing effect on flow characteristics around thin airfoil with jet flap
A70-45439
Sonic boom, discussing characteristic flow phenomena, intensity, effects on buildings and animals, human reactions, etc
A70-45786
Hot-wire anemometer study of turbulent boundary layer flow characteristics over elastic sheets
N70-40556

FLOW CHARTS
Computer programs for transonic flow over airfoils
[AD-709378] N70-41733

FLOW DEFLECTION
Conducting fluid supersonic flow past slender body

of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem
A70-42669
Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model
[ICAS PAPER 70-52] A70-45500

FLOW DISTORTION
Free stream disturbances influence on hypersonic boundary layer transition Reynolds number in heated and unheated flows
[AIAA PAPER 69-704] A70-41744
Designing transonic compressors for investigating distortion tolerance of high tip speed fan stages
[NASA-CR-72720] N70-32895

FLOW DISTRIBUTION
Hypersonic flow field around yawed half angle cone from wind tunnel measurements including surface pressure distributions and flow visualization photographs
A70-34485
Flow field on suction side of slender body of revolution with/without wings, investigating by directional probe in wind tunnel
A70-35924
Flow field about leading edges of tapered wings set at incident angle of attack, using gas dynamic and Monge equations
A70-36376
Pressure balanced rotor flow path design for mixed flow centrifugal compressors, calculating losses in rotor and diffuser section
[ASME PAPER 70-GT-12] A70-36863
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
Flow field model for large surface blowing problem accounting for upstream and downstream effects with large rate normal injection near trailing edge
A70-40110
Hypersonic flow pattern past windward side of triangular wing with supersonic leading edges, joining potential and vortex regions behind shock wave
A70-40609
Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack
A70-42284
Near field flow effects on sonic boom for incident triangular wing with constant lift distribution
[ICAS PAPER 70-20] A70-44113
Lighthill aerodynamic noise theory fundamental equation for acoustic field density distribution, determining flow fields for surfaces in uniform translational motion
A70-45268
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients
A70-45444
Inviscid hypersonic flow fields past lower /compression/ surface of delta wing calculated by one strip approximation of integral relations method
A70-46245
Actuator disk theory and flow field calculations for propeller induced flow with nonuniform circulation distribution
[NASA-CR-1672] N70-38435
Prediction performance of axial flow compressors using flow-through analysis
N70-39092
Mass flow limitations in supersonic compressors
N70-39093
Supersonic flow field over aeroelastic ogive cylinder model with boundary layer control
[AD-708485] N70-40297
Wind tunnel measurements of flow field behind model of twin-propeller deflected slipstream STOL aircraft
[NAL-TR-197T] N70-40562
Compression surface design for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993
Velocity mapping at successive cross-sectional planes in open-jet wind tunnel test section
[AD-709158] N70-41001

FLOW EQUATIONS
Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations
A70-43323
Magnetic fields and electrically conducting fluids interaction with emphasis on magnetodynamics equations, investigating rectilinear flows in pipes and nozzles, shock waves, etc
A70-44098
Method of characteristics analytical technique for flow predictions of supersonic cross flows over conical bodies
[NASA-TN-D-5884] N70-32004
Calculations on thin profile oscillations in subsonic flow near rigid boundary
[NASA-TT-F-12966] N70-34182
Approximation for distribution of flow properties in angle of attack plane of conical flows
[NASA-TN-D-5951] N70-36590
Lift and side force acting on bodies in transonic flow
N70-37314
Flow turbulence effect on turbine blade system efficiency
[NASA-TT-F-13180] N70-37524
Application of through-flow theories to radial wheel design
N70-39099
Asymptotic study of perfect aerodynamic fluid flows around weakly lifting three-dimensional bodies in sonic regime
[NASA-TT-F-13319] N70-42020

FLOW GEOMETRY
German monograph on supersonic strongly deflecting retardation cascades covering flow geometry and application to axial flow compressor stage
A70-45095
Mass flow limitations in supersonic compressors
N70-39093
Application of through-flow theories to radial wheel design
N70-39099

FLOW MEASUREMENT
Interaction zone between gas flow and injected air jets, measuring turbulence characteristics by thermoanemometer
A70-41773
Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions
[AVA-FB-7029] A70-44668

FLOW RESISTANCE
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution
A70-38350

FLOW STABILITY
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers
A70-34465
Time varying flow properties effects on hypersonic wind tunnel spectroscopic measurements, considering direct emission and electron beam techniques
A70-40271
Mechanism for avoiding supersonic air intake instability and approaches for eliminating drag
[ARL/ME-313] N70-39012
Secondary flow losses in axial compressors
N70-39095

FLOW THEORY
Steady state laminar flow model for near wake of slender body in supersonic flow
A70-34467
Laminar incompressible separating and reattaching flows, correlating finite difference solutions with experimentation

[AIAA PAPER 70-763] A70-34488
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results
[AIAA PAPER 70-971] A70-39558
Modified linearized transonic flow theory application to pressure coefficient distribution on circular arc bodies of revolution
A70-39614
Cylindrical afterbodies base pressure drag under powered supersonic flight, modifying Korst flow model recompression criterion
A70-42713
Perfect gas supersonic flow with constant velocity, pressure and density around finite nonaxisymmetric body at small angles of attack
A70-43322
Free jet stream effect on thin jet-flapped airfoil with fully developed wake, using linear theory
A70-43737
German book on propeller theory covering airfoil theory, propeller flow and pressure fields, propeller vibrations, shrouded and tilted propellers, helicopter rotors, etc
A70-44097
Measurement of sphere drag coefficients in nearly free molecule flow regime
[NAL-TR-191] N70-40442

FLOW VELOCITY
Helicopter blade sections dynamic stall characteristics, considering accelerated flow generation by nonzero pitch rate
A70-34718
Aerofoil section characteristics in shear flows of arbitrary velocity profile calculated by Glauert image method
A70-35957
Turbojet engines noise-suppressing nozzles flow rate and thrust characteristics calculation
A70-43371
Gas turbine engines flow velocity fields, comparing various calculation methods
A70-44735
Jet engine combustion chamber pressure loss, flow velocity through flare tube holes and air supply calculation, noting adaptation for computer use
A70-45446
Flow rates of slotted engine intakes in upper wing surface
[LR-526] N70-35142
ONERA hypersonic wind tunnels for flow studies related to space shuttles
N70-37832

FLOW VISUALIZATION
Vortex visualization applications in helicopter noise research, using smoke generator in rotor blade tip
A70-34712
Subsonic flow visualization, using steam and cold nitrogen gas mixture and normal tunnel lighting
A70-36460
ONERA low pressure wind tunnel equipped with electron beam probing device to visualize flows too rarefied for optical methods
A70-37208
Turbulent mixing in supersonic cone near wake, using laser planogram technique for flow visualization
A70-37529
Subsonic air flow around airfoil in wind tunnel, detecting density gradients by pulsed ruby laser holographic visualization
A70-40809
Jet curtain flow recirculation model based on air-bubble flow visualization technique, determining minimum power for air cushion vehicle
A70-42278
Spark tracing in gaseous flows in flames, wind tunnels, nozzles and pneumatic valves, using pulse transformer
[SMPTE PREPRINT 41] A70-43041
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients
A70-45444
High altitude flow visualization of boundary layer transition and shock waves using oil coatings
[ARC-CP-1090] N70-37173
Ground effect visualization at low speeds around aircraft models in hydrodynamic tunnel
[NASA-TT-F-13254] N70-39296
Velocity mapping at successive cross-sectional planes in open-jet wind tunnel test section
[AD-709158] N70-41001

FLOWMETERS
Aircraft capacitive fuel gage improvement by integration with flowmeter system, DC torquer display and digital techniques, considering other measurement principles
A70-40619
Laser Doppler velocimeter for low speed V/STOL wind tunnel
[AD-708717] N70-40796

FLUID DYNAMICS
German book on propeller theory covering airfoil theory, propeller flow and pressure fields, propeller vibrations, shrouded and tilted propellers, helicopter rotors, etc
A70-44097
Theoretical scheme for calculating effect of transverse stream contraction in compressor or turbine cascade on supersonic flow across cascade
[NASA-TT-F-13260] N70-39939
Fluid dynamics considerations in preliminary fighter aircraft design
N70-40707

FLUID FLOW
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter
A70-38342
Flow noise mechanisms, considering discharge, propeller, ventilator, jet engine, boundary layer, water pipe and supersonic aircraft sources
A70-38474
Sound field produced in uniform moving ideal fluid stream by nonuniform oscillating elastic wall
A70-38657
Liquid droplet breakup by aerodynamic forces, obtaining solutions for fluid flow inside droplet and in coupled liquid-gaseous boundary layer
A70-43741
Schemes of location method in computing supersonic flows around blunt bodies
[NASA-TT-F-13230] N70-42136

FLUID INJECTION
Flow field model for large surface blowing problem accounting for upstream and downstream effects with large rate normal injection near trailing edge
A70-40110

FLUID JETS
Liquid jets aerodynamic atomization at orifice exit in reentry vehicle into gaseous crossflow, investigating critical Weber number variation with Knudsen number
A70-39701
Short wing lift investigated via lateral fluid jets fired in wind tunnel for various lengths
A70-42614
Directed fluid stream for propeller blade loading control
[NASA-CASE-XAC-00139] N70-34856

FLUID MECHANICS
Boundary layer momentum thickness growth in channels with adverse pressure gradients by stepwise integration of Truckenbrodt equation and extending Gruschwitz-Schmidbauer separation criterion
[ASME PAPER 70-GT-12] A70-36864
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and fin-plate models
[RM-487] N70-42113

FLUIDICS
Fluidic parallel flow low airspeed indicator for V/STOL instrumentation tested in wind tunnel
[AIAA PAPER 70-906] A70-35818
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft
A70-45428
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft

[SAE PAPER 700794] A70-45853
Hydrofluidics flight controls for aircraft stability augmentation systems, noting component performance, transfer functions and operation
[SAE PAPER 700793] A70-45854
Fluidically controlled aircraft fuel transfer system three-tank model construction, noting maintenance and fail safe operation
[SAE PAPER 700786] A70-45858
Fluidically augmented artificial feel system for fighter and attack aircraft control, discussing improved handling qualities
[SAE PAPER 700785] A70-45859
Fluidics for aircraft high pressure hydraulic systems, discussing circuit breaker, feel computer and landing gear sequencing circuit
[SAE PAPER 700784] A70-45860
Turbojet and turbofan engine control evolution, noting increased complexity and adoption of hybrid fluidics and computer technologies
[SAE PAPER 700825] A70-45894

FLUTTER
Lifting and control surface flutter on space shuttles
N70-36605
Compressibility effects in helicopter rotor blade flutter
[AD-706243] N70-38173

FLUTTER ANALYSIS
Rotor blade flutter in forward flight accounting for wake unsteady aerodynamic effect
A70-34727
Helicopter rotor blade stall flutter response prediction based on NACA 0012 airfoil aerodynamic data
A70-34734
Nonlinear balance mass solutions for tab-aileron flutter free operation of jet trainer for arbitrary store configuration
A70-34923
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference
A70-36445
Flutter design charts for isotropic panels stressed to verge of buckling for tropical values of structural damping
A70-36446
Ground vibration testing for aircraft and missile flutter prevention
[ONERA-TP-816] A70-36508
Flutter analysis of n degrees of freedom system, basing stability criteria on energy balance considerations
A70-38244
Sweptback thin cantilever wing transonic flutter characteristics, investigating concentrated mass spanwise location effects
A70-42274
Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack
A70-42284
Elastic coupling and dynamic equations for flight elastomechanical vibration systems, including tiptanks on aircraft wings
A70-44767
Classical flutter problem possible solutions and comments
[RAE-LIB-TRANS-1296] N70-32148
Using oscillatory aerodynamic theory for calculating dynamic stability derivatives with respect to unsteady lifting surface theory
N70-35873
Circular cylindrical shell flutter analysis review, with bibliographies
[TT-6917] N70-39330
Nacelle induced flutter effects in elastodynamic scaled model of fan jet transport aircraft mounted in wind tunnel
[NASA-TN-D-6003] N70-39907

FLYING PERSONNEL
Solid cloth personnel parachutes opening forces, discussing loading conditions, flight path shock parameters, mass ratio variations and elasticity of system
[AIAA PAPER 70-1167] A70-43992
Performance and characteristics of single keel personnel parawings
[NASA-TN-D-5911] N70-32844

FLYING PLATFORMS
AERCAB /Aircrew Escape/Rescue Capability/ flying ejection seat, considering rotary wings, fixed wings and parawings
[AIAA PAPER 70-1213] A70-41806
Aircraft capabilities as scientific observation platform in astronomy and geophysics, including instrument adaptation and IR absorber problems
A70-43146
Plastic balloon platforms for atmospheric research and engineering applications, discussing design and use of unreinforced polyethylene and reinforced Mylar types
A70-43650

FOAMS
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage
A70-44465

FOCUSING
Reflection and focusing of sonic booms by two dimensional curved surfaces
[NASA-CR-110727] N70-32893

FOG
Fog dissipation on aircraft runways, using aircraft jet engine exhaust heat and mixing properties
A70-35929
Airport fog layers repetition frequency after low visibility periods
A70-43246
Performance and economics of supercooled propane fog dispersion system at Orly airport
[PAA-RD-70-16] N70-32366
Numerical fog forecasting method for airport in Yugoslavia
[NLL-M-9052-/5828.4F/] N70-36479
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875

FOLDING STRUCTURES
Reefing systems for Parawings, Sailwings, Para-Flyers, Paraplanes and Volplanes, discussing performance tests
[AIAA PAPER 70-1192] A70-41824
Foldable conduit capable of springing back as self erecting structural member
[NASA-CASE-XLE-00620] N70-41579
Method for deployment of flexible wing glider from space vehicle with minimum impact and loading
[NASA-CASE-XMS-00907] N70-41630

FORCE DISTRIBUTION
Lifting and side force distributions acting on body in transonic flow
A70-35696
Sonic boom minimization through airstream alteration by force or heat fields and aircraft body shaping
[AIAA PAPER 70-903] A70-35817
Bearing force and moment produced by motion of inclined plate supported by compressed air in ground effect machines with small angle of attack
A70-39140
Supersonic jet force acting on target investigated for air and argon using dimensional analysis
A70-40515
Lift and side force acting on bodies in transonic flow
N70-37314

FORCED VIBRATION
Pilot induced oscillation rating regression analysis, examining time delay, slope after and time to first peak and stick force per g
A70-36444
Helicopter dynamic tests for aeroelastic and mechanical instabilities and forced vibration problems
A70-40583

FORECASTING
Transport aircraft noise at three major airports by noise exposure forecast /NEF/ contours

methodology
A70-40896
Forecast indices for 1970 to 1981 in aviation industry and airline operations
[AD-704842] N70-34925
Noise exposure forecasts for John F. Kennedy, O Hare International, and Los Angeles International airports, including effects of changes in aircraft hardware and procedures
[FAA-NO-70-7] N70-36942
Metropolitan area airport capacity analysis for 1980 - Atlanta, Georgia
N70-41195
Evaluation and forecast of Huntsville air traffic
[NASA-CR-113917] N70-41242
Aircraft noise exposure forecasting procedures and applications
[FAA-NO-70-9] N70-42218
Noise exposure forecast contours for 1967, 1970, and 1975 at 28 airports
[FAA-NO-70-8] N70-42219

FORGING
Ti alloy forgings for aircraft industry, utilizing high strength/weight ratio
A70-34357
Ti alloy aircraft parts heavy press forging, considering mechanical properties, temperature effects, cost factors, etc
A70-34360
Forged alpha/beta Ti alloys, investigating relationship between mechanical properties and microstructures produced by heating
A70-34427
Fatigue characteristics of Ti alloy forgings for rotary wing vehicles, discussing effects of welding, annealing, reduction, surface finish and shot peening
A70-34441

FORMING TECHNIQUES
Report including finite element analysis of shells, pressure molding foam, and flight impact simulator
[DME/NAE-1969/4/] N70-33651
Molding model crash position indicators for use in supersonic wind tunnel tests
N70-33653

FOUNDATIONS
Rapid assessment of soil strength at aircraft landing sites
[AD-705572] N70-33677

FOURIER SERIES
Method for calculating interaction of cylindrical wall with circular straight section with flow from doublet placed in wall
[NASA-TT-F-13155] N70-33808

FRACTOGRAPHY
Annotated bibliography of tests and applications of pressure vessels - Vol. 1
[AD-702600] N70-33795

FRACTURES (MATERIALS)
General principles of structural strength and fatigue, including airframes, fractures, and stress concentrations
N70-37803

FREDHOLM EQUATIONS
Compressible fluids flow with conductivity tensor in presence of thin wing under orthogonal fields, reducing integral equation to Fredholm equation
A70-37599

FREE ATMOSPHERE
Significant terms in equations of motion for parachutes inflating in free air and in wind tunnel experiments
[AIAA PAPER 68-924] A70-36449

FREE BOUNDARIES
Ducted propeller subsonic rotational flow with free boundaries, presenting second-order partial differential equation solution without linearizing assumptions
A70-45269

FREE FLIGHT
Parawing canopy behavior during deployment in free flight at specific altitudes and dynamic pressures
[AIAA PAPER 70-1189] A70-41804
Heat transfer measurements compared in free flight and in hypersonic wind tunnel at similar Reynolds number and temperature ratios
[ICAS PAPER 70-06] A70-44115
Free flight measurement of aerodynamic lateral force and moment coefficients on bombs with freely spinning cruciform and monoplane tails and fixed split skirts
[WRE-TN-HSA-162] N70-36045
Effects of pointed nose on spin characteristics of fighter aircraft model and correlation of free flight test results with theoretical data
[NASA-TN-D-5291] N70-37395
Real time simulation of aircraft in free flight using digital computers
[DLR-FB-70-21] N70-42430

FREE FLIGHT TEST APPARATUS
Free flight wind tunnel test for feasibility of hypersonic drogue deployment into reentry vehicle wake
[AIAA PAPER 70-587] A70-35195
Pressure and supersonic heat transfer measurements on delta wing at incidence and sweepbacks using free flight test apparatus
[ARC-R/M-3625] N70-37071

FREE FLOW
Hypersonic test flow in arc heated wind tunnel, measuring freestream Pitot pressure, mass flux, stagnation point heat transfer rate and wall pressure
A70-40270
Free stream disturbances influence on hypersonic boundary layer transition Reynolds number in heated and unheated flows
[AIAA PAPER 69-704] A70-41744
Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837

FREE JETS
Underexpanded carbon dioxide free jet expanding into vacuum from conical nozzles
A70-35246
Discrete components of noise frequency spectrum of free supersonic jet
A70-38661
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584

FREE MOLECULAR FLOW
Monoenergetic nitrogen free molecule beam impingement on solid surface, calculating satellite drag coefficients from momentum transfer measurements
A70-41743

FREIGHT COSTS
Air cargo transport growth, considering deterrents of high freight rates, ground movement time and customs clearance
A70-35853
Air freight containers in continuous air/land transportation chain, discussing weight, performance, cost, technical concepts and inter and nonintermodal prototypes
A70-43273

FRENCH SPACE PROGRAMS
Dioscures project for ATC over Atlantic Ocean, describing distance measurement by simultaneous use of two geostationary satellites
A70-41258

FREQUENCY ANALYZERS
Three-frequency riometer system operation on NASA 711 aircraft during 1969 auroral absorption
[NASA-CR-112356] N70-36632

FREQUENCY ASSIGNMENT
Implementation of 50 kHz frequency separation standard for ILS/VOR/DME frequency assignments
N70-41529

FREQUENCY RESPONSE
Frequency functions and power spectra of XB-70 aircraft response to gusts
[NASA-CR-1621] N70-35659

FREQUENCY SYNCHRONIZATION
ATA Collision Avoidance System based on time and frequency synchronization via ground stations or other aircraft
A70-38239

FRICTION DRAG
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible

working fluids
A70-45096

FRICTION FACTOR
Drag optimal stern section of plane body at supersonic flow, allowing for friction forces
A70-36261

FRICTION MEASUREMENT
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
FAA research and development work on runway friction measurement and aircraft safety on slick runways
N70-40778

FUEL COMBUSTION
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone
A70-37246
Gas turbine engine combustion chamber efficiency dependence on injector characteristics, temperature and fuel physicochemical properties
A70-37247
Soviet papers on kinetics and aerodynamics of fuel combustion processes covering supersonic flow, flame stabilization, fluid atomization, nonequilibrium recombination, etc
A70-39265
Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model
[ICAS PAPER 70-52] A70-45500

FUEL CONSUMPTION
Optimum approach and departure paths for VTOL aircraft simulated by hybrid computer under constraints
[AIAA PAPER 69-209] A70-36452
Fuel consumption related to aircraft performance and engine type
A70-42602
Two shaft bypass jet engine analog simulation, determining angular acceleration dependence on angular velocity and fuel consumption
A70-45442
TSCP700 aircraft auxiliary power unit design, fuel consumption and maintainability
[SAE PAPER 700815] A70-45902
Effects of variable turbine area on subsonic cruise performance of turbojets designed for supersonic application
[NASA-TN-D-5962] N70-42010

FUEL CONTAMINATION
Field test for microbiological contamination of jet fuel, discussing phosphates detection
A70-36344
Water separation index modified /WSIM/ test for jet fuel surface active materials in relation to filter/separator performance
[SAE PAPER 700279] A70-36815
Aircraft and engine fuel systems deposit formation and microstructure in various test rigs, using electron microscopy
[SAE PAPER 700258] A70-36823
Automated aircraft flight safety, concerning probabilities and onboard elimination of servomotor failures in hydraulic system due to fuel contamination
A70-42804
Burning properties and effects of kerosene fuels used in jet aircraft engines
[AD-708352] N70-39926

FUEL CONTROL
V/STOL 5000 hp engine design optimization, considering component arrangements, rotor design, blade cooling method and fuel control
A70-34709
Fluidically controlled aircraft fuel transfer system three-tank model construction, noting maintenance and fail safe operation
[SAE PAPER 700786] A70-45858

FUEL CORROSION
Jet fuel system deposits measurement, noting reliability of oxygen combustion and beta ray backscattering techniques
[SAE PAPER 700257] A70-36824

FUEL FLOW
Fuel delivery and speed control systems for aircraft gas turbine engines, discussing control circuit transfers and block diagrams
A70-43116
Indirect method of determining air flow through inside channel and gas temperature in front of double flow turbine
[NASA-TT-F-12982] N70-34312

FUEL INJECTION
Air-mechanical fuel injection effect on gas turbine engine combustion chamber working process, investigating heat generation coefficient, temperature field nonuniformity and combustion efficiency
A70-37248
Integrated double oblique shock scramjet for supersonic combustion tests and instrumentation development, discussing fuel injection through sonic orifices, combustion data, etc
[AIAA PAPER 69-827] A70-41752

FUEL OILS
Analysis of oil sample data obtained from aircraft engines by spectrometry
[AD-706697] N70-38036

FUEL SYSTEMS
Jet fuels ground handling at airfields, describing flow monitors, filters, fueling techniques, etc
A70-43093
Feasibility analysis of various fuels for aircraft engines
[AD-707178] N70-37672

FUEL TANK PRESSURIZATION
Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Feasibility of nitrogen fuel tank inerting systems for commercial aircraft
N70-42760

FUEL TANKS
Jet A kerosene deposit accumulation problem and proposed SST fuel tank design
[SAE PAPER 700256] A70-36825
Automatic calculations for fuel volume mass properties in tanks at various angles of attack, considering total weight, gravity center moment and inertia product
[SAWE PAPER 850] A70-40376
Catalytic combustion fuel tank inerting techniques for fire protection in military and civilian aircraft
A70-44485
Fluidically controlled aircraft fuel transfer system three-tank model construction, noting maintenance and fail safe operation
[SAE PAPER 700786] A70-45858
Materials for crash-fire resistant aircraft fuel tanks
[NA-69-43] N70-34001
Using polyurethane foam as inerting material in fuel tanks of combat aircraft
N70-42754
Summary of C-141 and C-135 aircraft fuel tank nitrogen inerting tests
N70-42755
Effectiveness of various inerting agents for preventing ignition and flame propagation of hydrocarbon fuel-air systems
N70-42756
In-flight liquid nitrogen fire extinguishers for commercial aircraft
N70-42757

FUEL-AIR RATIO
High temperature gas turbine aircraft engine control system requirements, noting stoichiometric fuel-air ratio
[SAE PAPER 700823] A70-45895

FUSELAGES
Ti sheet welded construction for transport aircraft fuselages, assuming use of electron beam and plasma arc equipment
A70-34452
Fuselage frames minimum weight analysis by automatic iterative method
[SAWE PAPER 826] A70-40370
Swing tail cargo aircraft fuselage section stress analysis by finite element method, discussing displacement models, deformation modes and economics
A70-41260

Elastic fuselage flight vehicle dynamic stability at supersonic speeds, using automatic pilot stabilization
A70-44157

G

G-91 AIRCRAFT
VAK 191 B VTOL aircraft fitting NATO Basic Military Requirements for low level reconnaissance-fighter operations developed from Fiat G-91
A70-34992

GALLIUM ARSENIDE LASERS
Gallium arsenide laser ranging system for helicopters obstacle warning
A70-34720

GAMMA RAYS
Aircraft structures service life estimation, using Ir-192 and Tm-170 gamma ray radiography
A70-45725

GAS ANALYSIS
Aircraft turbine engines emission sampling, handling and measurement, evaluating various instruments and techniques
[SAE PAPER 700338] A70-36810
Gas turbine emissions analysis for air pollutants, determining species distribution and concentration
[ASME PAPER 70-GT-81] A70-36883

GAS DISSOCIATION
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics
A70-37242

GAS DYNAMICS
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies
A70-35035
Slingshot method of mechanically setting fluids into motion with respect to models
[AD-702052] N70-32870
Nonisentropic gas dynamics measurements and probe development
[AD-705655] N70-36489
Techniques for producing hypervelocity flows in aerodynamic test facilities
[AD-709210] N70-41152

GAS EXPANSION
Underexpanded carbon dioxide free jet expanding into vacuum from conical nozzles
A70-35246
Corrections for real gas effects in nitrogen gas expansion by isentropic processes and computer programs of hypervelocity wind tunnel nozzle design
[VKI-TN-58] N70-42586

GAS FLOW
Hypersonic gas flow around blown plane of segmentally blunted cones at large angle of attack, using two dimensional model
A70-36258
Soviet book on passenger aircraft aerodynamics covering motions of gases and immersed bodies, similarity laws, boundary layer theory, finite span wing, etc
A70-36507
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles
A70-37228
Interaction zone between gas flow and injected air jets, measuring turbulence characteristics by thermoanemometer
A70-41773
Spark tracing in gaseous flows in flames, wind tunnels, nozzles and pneumatic valves, using pulse transformer
[SMPTE PREPRINT 41] A70-43041
Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem
A70-43362

GAS GENERATORS
High temperature and pressure hot gas source for testing fluidic temperature sensor used in gas turbine engine inlet simulation
A70-35157
Optimum adaptation of propulsion gas generators to power jet driven rotors with blown flap control, considering jet engine, fanjet and engine driven compressor
A70-35661

GAS IONIZATION
Dissocited and ionized hypersonic flows of hydrogen heated by electric arc techniques, investigating flows in wind tunnel nozzles
A70-42759

GAS JETS
Sound vibrations resonant frequency relation to jet internal structure in gas jet stem radiator
A70-38658

GAS MIXTURES
Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model
[ICAS PAPER 70-52] A70-45500

GAS PIPES
Comparative load capacity of disk models of natural gas blowers of different designs under plastic strain
A70-43941

GAS TURBINE ENGINES
High strength Ti alloys for aircraft gas turbine engines, determining critical properties for compressor fan blades
A70-34436
Compressor erosion correlation with aerodynamic parameters in gas turbine engines
A70-34711
Aircraft gas turbine propulsion, discussing engine performance characteristics, thermodynamics, noise and installation
[AIAA PAPER 70-873] A70-34810
High temperature and pressure hot gas source for testing fluidic temperature sensor used in gas turbine engine inlet simulation
A70-35157
Aircraft design minimizing damage by bird strikes to gas turbine engine components, discussing service experience, airworthiness demonstration tests and research programs
A70-35994
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading
A70-35995
Flameout and ignition correlation for diffusion fuel burnup behind angled stabilizers in annular turbine combustion chamber
A70-36127
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
Gas turbine engine dynamic performance simulation, using analog and digital techniques
[ASME PAPER 70-GT-23] A70-36830
Ni superalloys for gas turbine engines, discussing chemical composition, microstructure, strength, solidification, etc
[ASME PAPER 70-GT-24] A70-36831
Helicopter gas turbine governor systems for engine and rotor speed control, minimizing pilot activity
[ASME PAPER 70-GT-37] A70-36835
Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests
[ASME PAPER 70-GT-38] A70-36836
Critical aviation gas turbine rotating component life limit determination, describing statistical, maintenance, inspection and life evaluation computer program /SMILE/
[ASME PAPER 70-GT-66] A70-36841
Helicopter gas turbine engines protection against salt spray, dust, sand, ice, cut grass, etc
[ASME PAPER 70-GT-96] A70-36843
Electronic gas turbine diagnostic systems, discussing engine parameters and analysis system
[ASME PAPER 70-GT-131] A70-36857
Control system considerations for small shaft-type aircraft gas turbines providing torque,

temperature, load sharing and overspeed limiting functions
[ASME PAPER 70-GT-132] A70-36858
Aerodynamic stability of branched diffuser systems used in annular combustors of gas turbine engines
[ASME PAPER 70-GT-27] A70-36868
Aero gas turbine engines digital computer control, discussing special properties, design and safety problems
[ASME PAPER 70-GT-40] A70-36870
Gas turbine emissions analysis for air pollutants, determining species distribution and concentration
[ASME PAPER 70-GT-81] A70-36883
Surface alterations by machining processes for gas turbine engine materials, emphasizing effects of milling on Ti and grinding on high strength steels
[ASME PAPER 70-GT-100] A70-36888
Ceramic materials for low cost high inlet temperature gas turbine engine components
[ASME PAPER 70-GT-105] A70-36889
Gas turbines, dust and air cleaners interrelationship in preventing failure due to air contaminants
[ASME PAPER 70-GT-104] A70-36890
Aircraft gas turbine engine development, considering gas dynamic and structural parameters
A70-37238
Gas turbine engine combustion chamber efficiency dependence on injector characteristics, temperature and fuel physicochemical properties
A70-37247
Air-mechanical fuel injection effect on gas turbine engine combustion chamber working process, investigating heat generation coefficient, temperature field nonuniformity and combustion efficiency
A70-37248
Model gas turbine engine blades fatigue strength under stress conditions, considering tensile stresses reproducibility from centrifugal loads
A70-38459
Failure and defect formation in gas turbine engine disks made of steel alloys, stressing fabrication methods effect on reliability
A70-38469
Aircraft gas turbine engine smoke emission measurement, discussing test equipment and procedure standardization
A70-39720
Angular contact bearing balls track position on aero gas turbine engines shaft measurement in test rig at high speeds
A70-40141
Gas turbine engine compressor rotor roller bearing operation conditions analysis by computer calculation of thermal regime
A70-41777
Helicopter gas turbine engine protection against sand and dust erosion using particle separators, screens and coatings
[SAE PAPER 700705] A70-42671
Sand and dust erosion reduction in gas turbine engines by coatings, sleeves and inserts
[SAE PAPER 700706] A70-42672
Fuel delivery and speed control systems for aircraft gas turbine engines, discussing control circuit transfers and block diagrams
A70-43116
Gas turbine combustion chamber convective and radiant heat transmission, examining steam film cooling of flame tube
A70-43199
Convection, transpiration and full coverage film cooling methods for various local turbine inlet temperatures, gas pressures and cooling air temperatures
A70-43275
Gas turbine engine combustion chamber starting, discussing effects of temperature, nozzle characteristics and fuel physicochemical properties
A70-43356
Two stage gas turbine engine optimal tuning for RPM, thrust, fuel rate and gas temperature, describing automated bench tests
A70-43361
Stepwise heat removal for increased continuous combustion gas turbine engine cycle efficiency, deriving equations describing cycles
A70-43372
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes
A70-43439
Aircraft flight propulsion systems performance improvement via materials technology for gas turbine engine components
A70-43573
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines
A70-43574
Statistical analysis of durability data of heat resistant alloys for gas turbine engines, using long term strength tests of melts in mass production
A70-43940
Gas turbine engines flow velocity fields, comparing various calculation methods
A70-44735
Heat transfer at air cooled gas turbine blade trailing edges at various wall temperatures and Reynolds numbers
A70-44737
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification
A70-44857
High temperature gas turbine aircraft engine control system requirements, noting stoichiometric fuel-air ratio
[SAE PAPER 700823] A70-45895
Turbofan, turbojet and turboprop engine development in aircraft gas turbine evolution, discussing VTOL propulsion, centrifugal and axial compressor engines
A70-46251
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts
[AD-705127] N70-32265
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts - annotated bibliography
[AD-705128] N70-32266
Combustion efficiency of natural gas turbojet combustor with inlet air deoxygenation
[NASA-TM-X-52711] N70-33746
Gas turbine engine response to blast wave overpressures
[DRES-267] N70-36951

GAS TURBINES
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
Transpiration cooling for high temperature gas turbines, investigating effects on aerodynamic and thermodynamic performance
[ASME PAPER 70-GT-56] A70-36839
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
Gas turbine propulsion systems design, performance and applications for industrial and military uses, discussing sensors for measurement and control of critical engine parameters
A70-37881
Heat transfer from gas to gas turbine buckets, determining angle of attack and rotation influences by extending transfer equation
A70-40345
Single stage gas turbines rational design based on minimum diametric dimensions
A70-41768
Finishing bench test adjustment of gas turbine assembly model
[AD-701986] N70-32420
Reynolds number effect on tip losses
[AD-700578] N70-36419

GAS-SOLID INTERFACES
Heat transfer from gas to gas turbine buckets,

determining angle of attack and rotation influences by extending transfer equation A70-40345
Gas-surface interactions and orbital aerodynamic calculations [NASA-CR-102827] N70-41375

GASEOUS DIFFUSION
Kr 85 tracer for gaseous diffusion determination in atmospheric wakes and meteorological wind tunnels [COO-2053-1] N70-40380
Three dimensional jet mixing analysis for combustion chamber design [NASA-CR-111782] N70-43101

GELLED PROPELLANTS
Compatibility of gelled and emulsified aircraft turbine fuels [NA-70-11] N70-32365
Economics of using gelled fuels in commercial jet transport [FAA-NA-70-45] N70-34002

GENERAL AVIATION AIRCRAFT
Corporate-executive market for helicopters related to fixed wing business air transportation problems [SAE PAPER 700285] A70-36814
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics A70-37388
Air conditioning in piston-powered light general aviation aircraft, comparing vapor cycle and cryogenic systems A70-38500
ATC and general aviation growth, considering airport capacity, radars, navigation, National Airspace System, etc A70-38631
Yak-40 business jet design and flight characteristics A70-42174
SN 600 Corvette business jet design and performance A70-42175
General aviation traffic control, discussing limitations of present system and improvements of position information and area navigation approach procedures A70-42385
General aviation aircraft influences on federal airways systems, considering area and Omega navigation examples [AIAA PAPER 70-1314] A70-45929
General aviation expansion and competitive position dependence on safety and utility improvements and simultaneous cost reductions [AIAA PAPER 70-1220] A70-45953
Evaluation of effect of yaw-rate damper on flying qualities of light twin-engine airplane [NASA-TN-D-5890] N70-32770
Corporate/executive aircraft accident briefs in US general aviation [PB-190409] N70-34525
Aircraft accident briefs involving alcohol as cause factor in 1967 US general aviation [PB-190413] N70-34576
Statistical summary of corporate/executive aircraft accidents in 1964-1968 US general aviation [PB-190408] N70-34643
Congressional hearings on general aviation role in social and economic systems, and future developments N70-36155
General aviation weather avoidance sensor study [NASA-CR-112774] N70-36981
Flight tests of spiral divergence and bank angle control of executive jet aircraft N70-40780
VFR and IFR training program and ice prevention and removal for general purpose aircraft N70-40781
General aviation data systems N70-41534

GEODETIC SATELLITES
Applicability of pulse compression radar to space geodesy altimetry [NASA-CR-1605] N70-34166

GEOIDS
Gravity measurement errors in high speed aircraft parallel to undulating geoid attributed to associated vertical accelerations A70-43662

GEOPHYSICAL OBSERVATORIES
Aircraft capabilities as scientific observation platform in astronomy and geophysics, including instrument adaptation and IR absorber problems A70-43146

GEORGIA
Graphic simulation study of two sites for second major airport in Atlanta area [FAA-RD-70-63] N70-41198

GERMANY
West German aircraft bird hazards problems, discussing research activities and recommendations for strike avoidance A70-35980
Hypersonic wind tunnel facility for hypersonic aircraft and recoverable booster systems development [DFVLR-SONDDR-19] A70-44799

GLASS
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience A70-41137
High strength glass for aircraft structures, discussing applications to passenger cabin windows A70-41891

GLASS FIBERS
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design A70-34702
Composite wing section design and fabrication utilizing unidirectional glass reinforcement [AIAA PAPER 70-919] A70-35813
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air A70-37370

GLIDE LANDINGS
Gliding parachute air cargo systems using nonproportional and proportional automatic manual control, estimating wind effects on ground track and impact computer simulation [AIAA PAPER 70-1193] A70-41823
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion [AIAA PAPER 70-1191] A70-41825
Glide and landing performance of twin-keel parawings, discussing wind tunnel, radio flight and simulator tests [AIAA PAPER 70-1186] A70-41829

GLIDE PATHS
ILS glide slope calibration using optically projected digital codes as reference A70-37912
Analog monitor design and tests to improve ILS localizer signal display in aircraft [EER-5-10] N70-36912

GLIDERS
Rotary piston engine for powered gliders and light aircraft power source by modifying industrial Wankel engine A70-34690
High lift flaps for sailplane cross country speed improvement by cruise-climb tradeoffs [AIAA PAPER 70-878] A70-34814
Wings flexural deformability influence on longitudinal stability of glider, using small perturbation theory A70-35190
Water ballast effect on glider loads, using concept of characteristic velocities A70-36253
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air A70-37370
Reefing systems for Parawings, Sailwings, Para-Flyers, Paraplanes and Volplanes, discussing performance tests [AIAA PAPER 70-1192] A70-41824

Optimum light construction design of glider wings, considering spar weight, aluminum honeycomb structure and repair A70-42961
Water ballast loadings on sailplane Cobra 17, considering wing, aileron, tailplane, fuselage and landing gear A70-42962
Aerodynamic measurements of radiated noise from sailplanes [AD-709689] N70-41268

GLIDING
Basket weave fabrics for gliding descent decelerators with polyurethane and nylon coatings for tearing strength and pressure packing [AIAA PAPER 70-1180] A70-41833

GOVERNMENTS
National Aviation System Plan - 1971-1980 N70-37026
Federal policy and services relative to privately owned, publicly used airports N70-41530

GRAPHIC ARTS
Presentation styles of passenger emergency evacuation briefing cards, noting preference for sequential action graphic displays with minimum keywording A70-44486

GRAPHITE
Graphite-polyimide composites development for high temperature environments, discussing mechanical properties A70-38425

GRAPHS (CHARTS)
Graphic simulation study of two sites for second major airport in Atlanta area [FAA-RD-70-63] N70-41198
Washington National and Dulles International Airport plans for fiscal years 1970 to 1981 [AD-705087] N70-41302
Aerodynamic characteristics of air cushion models at very low ground clearances and at free stream dynamic pressures exceeding cushion pressure [NASA-TN-D-6011] N70-42087

GRAVIMETERS
Stochastic processes for probabilistic error analysis in airborne gravimetry, using gravity sensing instruments A70-43666

GRAVIMETRY
Dynamic gravimetry - Conference, Fort Worth, March 1970 A70-43656
DR-S Raydist radio location system in fixed wing aircraft for dynamic gravimetry A70-43661
Gravity measurement errors in high speed aircraft parallel to undulating geoid attributed to associated vertical accelerations A70-43662
Integrated helicopter gravity measuring system for various terrains, describing instrumentation and recording monitors A70-43663
Stochastic processes for probabilistic error analysis in airborne gravimetry, using gravity sensing instruments A70-43666

GRAVITATIONAL EFFECTS
Vapor volume entrained in liquid bulk from boundary layer boiling on vertical plate in low gravity field A70-41055

GRAVITY ANOMALIES
Gravity measurement errors in high speed aircraft parallel to undulating geoid attributed to associated vertical accelerations A70-43662

GRAVITY GRADIOMETERS
Dynamic gravimetry - Conference, Fort Worth, March 1970 A70-43656

GREAT BRITAIN
RAF aircraft damage due to bird strikes in U.K., discussing preventive measures at airfields A70-35978

GRIDS
Plane diffuser grid profiles for subcritical velocities of oncoming flow, using wind tunnel test data A70-36129

GROUND BASED CONTROL
Upper Air Space Control Center Automatic Data Processing and Display System for air traffic control A70-46238
Control zone establishment for instrument approaches N70-41533

GROUND EFFECT
Planar wing with end plates in ground effect, calculating minimum induced drag by approximation theory A70-40919
Ground effects on longitudinal stability of slender wings with small span/height ratio [ARC-CP-1095] N70-37085
Ground effect visualization at low speeds around aircraft models in hydrodynamic tunnel [NASA-TT-F-13254] N70-39296
Ground effects investigation of STOL air-sea transport model with blowing over canard and wing flaps [NASA-TN-D-5988] N70-40690
Model for testing effect of variations of parameters governing ground effect on vertical takeoff aircraft [AD-709096] N70-41014
Flight evaluation of ground effect on low aspect ratio airplanes [NASA-TN-D-6053] N70-42738
Piloted simulator investigation of ground effect on landing maneuver of large, tailless, delta wing airplane [NASA-TN-D-6046] N70-42810

GROUND EFFECT MACHINES
External aerodynamics role in handling qualities of amphibious hovercraft, discussing tests of hull shape, air cushion efflux and hollow models A70-34919
Tracked air cushion vehicle dynamic heave response, examining flow characteristics, active lip control, guideway contact, acceleration response, etc A70-35178
Hydrofoil and hovering craft design by fiber technology, discussing composite materials, whisker mechanical properties, polycrystalline fibers, matrix materials, etc A70-38941
Hovercraft wind directional stability and control by cam operated fin-tab assembly A70-38942
Bearing force and moment produced by motion of inclined plate supported by compressed air in ground effect machines with small angle of attack A70-39140
Static and dynamic spring constants of peripheral jet air cushion vehicle in heaving motion, obtaining sinusoidal input response characteristics A70-42279
Nonlinear heaving motion of plenum-chamber air cushion vehicles induced by sinusoidal ground irregularity A70-42280
Peripheral jet ground effect machine model heaving motion, investigating static hover and forced and free vibration characteristics A70-42281
Ground Effect Takeoff and Landing /GETOL/ aircraft, evaluating energy absorption capability of air cushion landing gear in touch-down condition A70-42282
Horizontal flight speed effects on aerodynamic characteristics of air cushion vehicles with elliptical planform A70-42801
Hovercraft operational advantages and legal status A70-43499
Study of high speed ground transportation for use as public transportation system in Northeast Corridor [PB-190934] N70-34644

Annotated bibliography on ground effect machines
[AD-704800] N70-35309
Cost analysis of high speed ground transportation modes
[PB-190942] N70-35446
Integral equation for calculating oscillations of slender wing in subsonic flow near solid ground plane
[AD-703995] N70-36285
Aerodynamic characteristics of air cushion models at very low ground clearances and at free stream dynamic pressures exceeding cushion pressure
[NASA-TN-D-6011] N70-42087
Ground effect machine and recovery vehicle for materials handling
[ARC-CP-1092] N70-42770

GROUND HANDLING
Mobile lounges and airport productivity concepts for optimal handling of passengers at airport terminal
[AIAA PAPER 70-918] A70-35830
C-5 aircraft cargo loading system for terminals minimizing ground time
A70-35831
Airport terminal design, describing electromechanical baggage handling and sorting systems
[SAE PAPER 700261] A70-36822
Jet fuels ground handling at airfields, describing flow monitors, filters, fueling techniques, etc
A70-43093
Air cargo management problems, discussing economics, ground handling, Jumbo jets, terminal facilities, mechanization, document handling, information flow, data systems, etc
A70-43269
Centralized terminal air cargo handling capacity, discussing Jumbo aircraft, airside ramp system, container movement, computer control and automation
A70-43270
Automated air cargo and data flow system with on-line computers, discussing handling, document management, load planning, information transmission, storage and mechanized freight systems
A70-43271
Computerized air cargo clearing, discussing London Airport Cargo Electronic-data- processing Scheme
A70-43272

GROUND STATIONS
Navigation aids evolution and trends, noting ground stations, Intelsat 3 and navigation satellites
A70-35879
Communication satellites systems for civil application, considering ground stations design, regional communication, ATC and maritime communications and navigation
A70-39409
Small ground stations in communication satellite systems involving regional telecommunication, TV distribution, air traffic and maritime applications, data exchange, weather and education service
A70-40764
Transportable earth station for satellite communications system, describing antenna design and transportation modes
A70-41344

GROUND SUPPORT EQUIPMENT
Boeing 747 ground operations and airport services, discussing computerized check-in, baggage handling equipment, etc
[AIAA PAPER 70-892] A70-35808

GROUND TESTS
Ground test noise measurements accuracy and repeatability on JT8D turbojet engine
A70-35183
Ground vibration testing for aircraft and missile flutter prevention
[ONERA-TP-816] A70-36508
Flight simulation as aircraft design tool, discussing ground and inflight simulation techniques
[ICAS PAPER 70-41] A70-44139
Interdependence of built-in, onboard, and ground based test facilities
N70-32158
Interrelation of onboard and ground automatic test equipment in achieving effective overall support system
N70-32159

GROUND TRACKS
High speed track facility for V/STOL aircraft tests, discussing characteristics and design
A70-40581

*GROUND-AIR-GROUND COMMUNICATIONS
ATC data link communications system speeding information flow between controller and pilot
A70-41348

GUIDANCE (MOTION)
Advanced integrated landing system test and evaluation for all-weather landing
[FAA-RD-70-28] N70-41271

GUIDE VANES
Axial flow compressor off-design performance optimization by adjustable inlet guide vanes with variable trailing edge flaps
A70-36846

GUN LAUNCHERS
Optimum droque gun firing angle of stabilization times for MEW /Minimal Envelope and Weight/ ejection seat system, considering zero and high velocities
[AIAA PAPER 70-1208] A70-41810

GUST ALLEVIATORS
Free wing aircraft dynamic characteristics, discussing gust alleviation and handling qualities
[AIAA PAPER 70-947] A70-39580

GUST LOADS
Flat plate airfoil unsteady lift due to chordwise velocity perturbations, using Horlock frozen gust pattern theory
A70-42303
Similarity rules for sinusoidal gust loads on thin two dimensional wing in nonstationary subsonic flows
A70-43970
Review of methods used for simulating random load fatigue in laboratory testing
[UTIAS-29] N70-33724
Gust effects on dynamics of slender wing aircraft during landing approach
[NASA-TT-F-12751] N70-34017
Frequency functions and power spectra of XB-70 aircraft response to gusts
[NASA-CR-1621] N70-35659
Prediction of steady and unsteady airloads on space shuttles
N70-36607

GUSTS
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models and simulating effects on XV-5 V/STOL aircraft
A70-40784
Mathematical modeling of atmospheric gusts in stratosphere, mountain wave and thunderstorm conditions relevant to aircraft design
A70-45420
Gust and wind effects near thunderstorms and mountains and during aircraft takeoff and landing
[ARC-CP-1091] N70-37242
Gust response of slender wing aircraft model mounted on rocket propelled sled moving past low speed wind tunnel mouth
[ARC-CP-1113] N70-42529

GYRO HORIZONS
Independent integrals of perturbed motion equations of spatial gyrohorizon compass
A70-35344

GYROCOMPASSES
Independent integrals of perturbed motion equations of spatial gyrohorizon compass
A70-35344

GYROSCOPES
Aeronautic navigation equipment including gyroscopes. Inertial navigation systems, and self adaptive control systems - stability and accuracy determinations
[JPRS-51241] N70-37787
Systems of orientation and guidance of aircraft
[AD-696052] N70-38146

GYROSCOPIC STABILITY
Axial and centrifugal moments of inertia arising from static balancing of gyroscopes

N70-37788

H

HANDLING EQUIPMENT
Automated baggage handling and processing, requiring total aviation community participation
[AIAA PAPER 70-917] A70-35829
HARDENING (MATERIALS)
High strength Ti alloys depth hardenability, discussing mechanical properties and use in aircraft components
A70-34434
HARMONIC ANALYSIS
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836
Aerodynamic model for calculating airloads and blade motion of helicopter rotor blades
[AD-707939] N70-39885
HARMONIC EXCITATION
Aeroelastic test equipment for Concorde SST using harmonic method and electromagnetic shakers
A70-38548
Linear elastomechanical systems natural vibration parameters by harmonic excitation method
A70-43200
HARMONIC MOTION
Classical flutter problem possible solutions and comments
[RAE-LIB-TRANS-1296] N70-32148
HARMONIC OSCILLATION
Harmonically oscillating wing linearized motion in subsonic flow, calculating generalized aerodynamic forces
A70-43118
Aerodynamic interferences of lifting surfaces harmonically vibrating in subsonic flow
A70-44765
Pressure measurements on harmonically vibrating sweptback wing with two control surfaces in incompressible flow
A70-44768
Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects
A70-45592
HARRIER AIRCRAFT
Harrier aircraft in Marine Corps close air support role
[AIAA PAPER 70-885] A70-35804
Harrier flight testing in terms of V/STOL capability compared with conventional aircraft
A70-42975
Harrier aircraft development history, discussing V/STOL constraints on transonic flight properties
[ICAS PAPER 70-51] A70-44148
HAWAII
Climatological summaries of airfields in Alaska and Hawaii
[AD-704607] N70-36250
HEAT FLUX
Thermal flux surface distribution lifting bodies, discussing aerodynamic efficiency dependence on drag and zero angle of attack Mach number
A70-45019
HEAT MEASUREMENT
Measurement methods for forces, pressure and heat flow in hotshot hypersonic wind tunnels
A70-34773
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone
A70-37246
HEAT OF COMBUSTION
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone
A70-37246
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes
A70-43439
HEAT PIPES
Aircraft electronic equipment cooling techniques, discussing natural and forced convection, phase change and heat pipes
A70-36763
HEAT RESISTANT ALLOYS
Ni superalloys for gas turbine engines, discussing chemical composition, microstructure, strength, solidification, etc
[ASME PAPER 70-GT-24] A70-36831
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines
A70-43574
Statistical analysis of durability data of heat resistant alloys for gas turbine engines, using long term strength tests of melts in mass production
A70-43940
HEAT SHIELDING
Newtonian aerodynamic coefficients for predicting hypersonic stability characteristics of reentry bodies with various heat shield, afterbody angle and edge geometries
[NASA-TM-X-64332] N70-34532
HEAT SINKS
Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials
[ICAS PAPER 70-16] A70-44127
HEAT TRANSFER
Optimum nozzle geometry for minimum heat transfer to convergent-divergent nozzle wall from high enthalpy flow
A70-35238
Sonic boom minimization through airstream alteration by force or heat fields and aircraft body shaping
[AIAA PAPER 70-903] A70-35817
Heat transfer from gas to gas turbine buckets, determining angle of attack and rotation influences by extending transfer equation
A70-40345
Local heat transfer between heated circular cylinder and air in transverse slip flow at low Reynolds and Mach numbers
A70-41035
Stepwise heat removal for increased continuous combustion gas turbine engine cycle efficiency, deriving equations describing cycles
A70-43372
Heat transfer measurements compared in free flight and in hypersonic wind tunnel at similar Reynolds number and temperature ratios
[ICAS PAPER 70-06] A70-44115
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow
[ICAS PAPER 70-03] A70-44117
Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129
Heat transfer at air cooled gas turbine blade trailing edges at various wall temperatures and Reynolds numbers
A70-44737
Bodies of revolution optimal configuration, considering minimum head drag coefficient and low heat transfer at hypersonic speeds, using modified Newtonian and hypersonic flow theories
A70-45021
Heat transfer in turbulent boundary layer in wind tunnel with air flowing over partially heated aerodynamically smooth flat plate
N70-32346
Heat transfer measurements on flat plate with trailing edge flap in hypersonic flow
[NASA-TN-D-5899] N70-32828
Wall temperature and heat transfer characteristics of air cooled plug nozzle system for afterburning turbojet engine
[NASA-TM-X-52897] N70-42174
Methane or hydrogen fuel direct cooling of first stage stator of SST aircraft turbine - numerical heat transfer analysis
[NASA-TN-D-6042] N70-42326

HEAT TRANSFER COEFFICIENTS
Stagnation point heat transfer coefficient to elliptical model taking into account pressure, model blunting and diameter, Mach number, etc
A70-39699
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems
[NASA-TM-X-52876] N70-37826
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and fin-plate models
[RM-487] N70-42113
HEAVING
Tracked air cushion vehicle dynamic heave response, examining flow characteristics, active lip control, guideway contact, acceleration response, etc
A70-35178
Static and dynamic spring constants of peripheral jet air cushion vehicle in heaving motion, obtaining sinusoidal input response characteristics
A70-42279
Nonlinear heaving motion of plenum-chamber air cushion vehicles induced by sinusoidal ground irregularity
A70-42280
Peripheral jet ground effect machine model heaving motion, investigating static hover and forced and free vibration characteristics
A70-42281
HELICOPTER CONTROL
High powered high speed helicopters autorotation entry characteristics, noting capability of meeting control time delay requirement
A70-34715
Gallium arsenide laser ranging system for helicopters obstacle warning
A70-34720
Crane helicopter controllability, discussing load stabilization and precision hovering
A70-34723
Hingeless rotor helicopter airborne and ground resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping
A70-34733
Dynamic control model of lift helicopters with two cable sling loads using multiple part motion equations
[AIAA PAPER 70-929] A70-35839
Helicopter gas turbine governor systems for engine and rotor speed control, minimizing pilot activity
[ASME PAPER 70-GT-37] A70-36835
Helicopter radar approach aid for serving oil rigs
A70-38621
Helicopter stabilization systems design, synthesizing controllers by modal control theory
[AIAA PAPER 70-1036] A70-39501
Single and coaxial dual rotor helicopter piloting characteristics during turning flight, discussing operational problems in snow
A70-43530
Main rotor wake adverse effects on tail rotor directional control in low velocity wind
A70-44323
Tail rotor thrust increase for yaw control via increased blade area, higher tip speeds and cambered airfoils
A70-44324
Helicopter automatic approach and hover coupler systems, discussing cockpit display devices, handling qualities, pilot workload and fatigue and external load stabilization
A70-44464
Computerized simulation and statistical analysis of V/STOL tactical landing system for helicopters
[AD-704324] N70-34849
HELICOPTER DESIGN
Fatigue characteristics of Ti alloy forgings for rotary wing vehicles, discussing effects of welding, annealing, reduction, surface finish and shot peening
A70-34441
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals
A70-34686
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design
A70-34702
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests
[AHS PREPRINT 451] A70-34703
Pressure jet helicopter with tipjet propelled rotor system, discussing power available calculation, mission performance, power management, etc
A70-34707
VTOL aircraft power plants optimization for future helicopter missions without restrictions of limited off-shelf inventory
A70-34708
Vortex visualization applications in helicopter noise research, using smoke generator in rotor blade tip
A70-34712
Helicopter structural weight statistical prediction and evaluation, discussing comparable fixed wing experience
A70-34728
Heavy lift helicopters cockpit display problems, describing photographic flight research program for data acquisition
A70-34731
Helicopter vibration reduction techniques, considering antivibration devices design and comfort crossover speed increase
A70-34735
Swept tip rotor blade design, discussing wind tunnel-whirl stand correlations
A70-34736
Second generation helicopter design, considering compound, convertible and electrically powered configurations
A70-35549
Convertible helicopter rotor technology, discussing materials, blade configurations and variable diameter concept
A70-35550
H3-E Sprinter semicompound helicopter with pneumatic rotor drive and side mounted fans for forward flight
A70-35626
Cross section deformation effect on helicopter rotor blade torsional vibration, using differential equations of vibrating beam
A70-35959
Helicopter engine rotor matching for tip propulsion efficiency, comparing with conventional shaft drive propulsion
[ASME PAPER 70-GT-68] A70-36842
Soviet book on helicopter aerodynamics covering main rotor operation, types classification and various flight characteristics
A70-37390
Rotor drive systems for rotary wing aircraft, indicating mechanical hub drive advantages over reaction blade drive
A70-41850
Soviet helicopter development after World War II, discussing Mi-8, Mi-2, Ka-26 and MI-10K helicopters
A70-43895
Armor airframed helicopter for aerial armored reconnaissance vehicle, noting design, fabrication and weight
A70-44095
Fenestron shrouded tail rotor for SA 341 Gazelle helicopter eliminating ground contact during approach and landing
A70-44322
Tail rotor thrust increase for yaw control via increased blade area, higher tip speeds and cambered airfoils
A70-44324
NACA/NASA rotary wing aircraft research covering autogyro and helicopter development, noting flight safety
A70-44851
SA-341 Gazelle French military helicopter configuration, performance, flight characteristics, technological particulars and design

A70-44854
Helicopter personnel escape capsule system feasibility by UH-25B helicopter, discussing incorporation into CH-46 and UH-1
[SAE PAPER 700832] A70-45890
Military helicopter test program application to commercial VTOL operations, discussing military-civil design and development relationships
[AIAA PAPER 70-1242] A70-46327
Helicopter hazards elimination measures, considering crash resistant fuel systems, flotation devices, redesigned seats, in-flight escape, etc
A70-46383

HELICOPTER ENGINES
Pressure jet helicopter with tipjet propelled rotor system, discussing power available calculation, mission performance, power management, etc
A70-34707
VTOL aircraft power plants optimization for future helicopter missions without restrictions of limited off-shelf inventory
A70-34708
Helicopter gas turbine governor systems for engine and rotor speed control, minimizing pilot activity
[ASME PAPER 70-GT-37] A70-36835
Flight test program for helicopter gas turbine engines, considering engine-airframe-control systems integration and environmental tests
[ASME PAPER 70-GT-38] A70-36836
Helicopter engine rotor matching for tip propulsion efficiency, comparing with conventional shaft drive propulsion
[ASME PAPER 70-GT-68] A70-36842
Helicopter gas turbine engines protection against salt spray, dust, sand, ice, cut grass, etc
[ASME PAPER 70-GT-96] A70-36843
CH-54A helicopter gas turbine engine air particle separator /EAPS/ field service in Vietnam, noting time before engine removal for erosion
[ASME PAPER 70-GT-97] A70-36844
Helicopter gas turbine engine protection against sand and dust erosion using particle separators, screens and coatings
[SAE PAPER 700705] A70-42671

HELICOPTER PERFORMANCE
AH-1G helicopters combat flight loads from onboard oscillograph data recording, defining performance in terms of critical variables
A70-34706
Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs
A70-34713
AH-1G Hueycobra helicopter stability, control, performance, vibration and structural loads characteristics during controlled steady state maneuvers
A70-34716
UH-1C, AH-1G and UH-1H helicopters combat operational flight profiles, considering airspeed, altitude, rotor speed, load factor, etc
A70-34717
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects
A70-34729
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738
Helicopter rotor blade differential pressure and structural load characteristics in transient and steady state maneuvers
A70-34739
STOL takeoff trajectory optimization for heavily loaded helicopter, using optimal control theory
A70-35841
Aerodynamics theory for separated flow effects on helicopter lift-drag capability, taking into account three dimensional flow and blade aeroelasticity
A70-35956
Soviet book on helicopter aerodynamics covering main rotor operation, types classification and various flight characteristics
A70-37390
Model testing for helicopters, considering scaling, ditching and rotor performance
A70-38610
Structural reliability testing methods and loads prediction for rotary wing vehicle components, considering AH-56A compound helicopter
A70-38612
Flight characteristics and performance calculation of single rotor helicopters by digital computers, considering wobble plate steering margin, compressibility, ground effects, separation and autorotation
A70-39716
Helicopter parts and assemblies fatigue life estimation and testing, discussing loading spectra, service conditions, etc
A70-43119
Helicopter rotor tests in large wind tunnel for increased flight speed, noting pressure and noise measurements
[ICAS PAPER 70-44] A70-44142
SA-341 Gazelle French military helicopter configuration, performance, flight characteristics, technological particulars and design
A70-44854
Lift margin display for helicopter landing and takeoff operations
[AD-704601] N70-36384
Stability and control prediction method for helicopters and stoppable rotor aircraft
[AD-706919] N70-37916

HELICOPTER PROPELLER DRIVE
Helicopter mechanical power transmission design, describing gearing, shaft bending, bearings, lubrication, weight factors, etc
[SAWE PAPER 844] A70-40367

HELICOPTER WAKES
Rotor blade flutter in forward flight accounting for wake unsteady aerodynamic effect
A70-34727
Main rotor wake adverse effects on tail rotor directional control in low velocity wind
A70-44323

HELICOPTERS
Corporate-executive market for helicopters related to fixed wing business air transportation problems
[SAE PAPER 700285] A70-36814
Soviet book on helicopter aerodynamics covering main rotor operation, types classification and various flight characteristics
A70-37390
Helicopter operations integration into civil air traffic system, noting special requirements for mixed fixed and rotary wing terminal environments
A70-38230
Helicopter cost reduction by transmission overhaul frequency reduction, discussing savings with on-condition maintenance
A70-38824
Comparative demand forecasting for military helicopter spare parts, stressing exponential smoothing model
A70-39643
Helicopter vibration measurement techniques, discussing in-service fault diagnosis
A70-40582
Helicopter dynamic tests for aeroelastic and mechanical instabilities and forced vibration problems
A70-40583
Integrated helicopter gravity measuring system for various terrains, describing instrumentation and recording monitors
A70-43663
Computerized simulation of dewinding of hovering helicopter
[AD-704349] N70-32069
Wind tunnel testing of helicopters, and test program for Polish helicopter industry
N70-34028
Adaptive aircraft control concept modified for helicopters
[AD-703231] N70-34923
Comparison between experimental data and lifting surface theory calculation of vortex induced

loads on single-bladed rotary wings
[NASA-CR-112769] N70-36986
Computer program for predicting performance of helicopters
[AD-706918] N70-37696
Compressibility effects in helicopter rotor blade flutter
[AD-706243] N70-38173
Computer programming aids for determining performance characteristics of helicopters
[AD-706374] N70-38357
Moving graph instrument display evaluation for landing approaches with helicopter
[NASA-TN-D-6025] N70-41183
Helicopter tinted Plexiglas for heat reduction and effecting night visibility
[AD-709405] N70-41229

HELMETS
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals
A70-44488

HEMISPHERE CYLINDER BODIES
Wind tunnel measurements of hemisphere cylinder yawmeter sensitivity at transonic speeds and Reynolds numbers
[ARL/A-320] N70-39031

HETEROGENEITY
Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter
A70-42603

HIGH ALTITUDE BALLOONS
PCM command control system for high altitude ballooning operations, discussing component equipment
A70-40085
Ultrahigh frequency air traffic control satellite simulation experiment using high altitude balloons
[NASA-TM-X-65348] N70-41942

HIGH ALTITUDE ENVIRONMENTS
Parachutes for low density atmospheres, describing low and high altitude test results
[AIAA PAPER 70-1164] A70-41846

HIGH ASPECT RATIO
Aerospace configuration with low and high aspect ratio variability for high and low speed flight
[NASA-CASE-XLA-00142] N70-33286
Aerodynamic configuration for aircraft capable of high speed flight and low drag for low speed takeoff or landing upon presently existing airfields
[NASA-CASE-XLA-00806] N70-34858

HIGH SPEED
Angular contact bearing balls track position on aero gas turbine engines shaft measurement in test rig at high speeds
A70-40141
Stretch fabric materials for personnel high speed escape parachute systems
A70-44482

HIGH SPEED CAMERAS
Artificial rain erosion effects on missile and spacecraft recorded via high speed photography
A70-40531
Spark photography of models in free flight in hypersonic shock tunnel
[SMPTE PREPRINT 99] A70-43035
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels
[SMPTE PREPRINT 3] A70-43056

HIGH STRENGTH ALLOYS
High strength Ti alloys depth hardenability, discussing mechanical properties and use in aircraft components
A70-34434
High strength Ti alloys for aircraft gas turbine engines, determining critical properties for compressor fan blades
A70-34436

HIGH STRENGTH STEELS
Aircraft structural materials, considering high strength steels Al and Ti alloys
A70-34675
F-111 high strength steel design experience concerning wing, fuselage and empennage support structure
[AIAA PAPER 70-884] A70-35803

HIGH TEMPERATURE ENVIRONMENTS
Graphite-polyimide composites development for high temperature environments, discussing mechanical properties
A70-38425
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785

HIGH TEMPERATURE GASES
High temperature and pressure hot gas source for testing fluidic temperature sensor used in gas turbine engine inlet simulation
A70-35157
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
Conference on kinetics and thermodynamics of combustion and high temperature gases
[NASA-SP-239] N70-32106
Hot gas recirculation measurements on four different-size models of simple VTOL configuration
[NASA-TT-F-12604] N70-32535
Indirect method of determining air flow through inside channel and gas temperature in front of double flow turbine
[NASA-TT-F-12982] N70-34312

HIGH TEMPERATURE NUCLEAR REACTORS
High temperature liquid metal cooled nuclear reactor for military aircraft with long flight endurance and range
A70-43188

HIGH TEMPERATURE TESTS
Ceramic materials for low cost high inlet temperature gas turbine engine components
[ASME PAPER 70-GT-105] A70-36889
High temperature transducer for engine vibration measurement, discussing piezoelectric accelerometers mechanical design, jet engines material evaluation, crystallographic considerations, etc
A70-38527

HIGHWAYS
Transportation system status and plans for improving intercity transportation in Northeast Corridor
[PB-190931] N70-34741
Social costs and benefits from Northeast corridor transportation system
[PB-190944] N70-36515
Transportation requirements survey for Northeast Corridor
[PB-190930] N70-36810
Cost analysis for Northeast Corridor transportation system air and highway modes
[PB-190943] N70-36811

HILL DETERMINANT
Dynamic systems stability with periodically varying parameters analyzed by Hill type infinite determinant, exemplifying helicopter rotor aeroelastic stability in forward flight
A70-44556

HISTORIES
Historical survey of aeronautical research and development at Ames Research Center from 1936 to 1965
[NASA-SP-4302] N70-41479

HL-10 REENTRY VEHICLE
Auxiliary lift system providing transportation means for HL-10 reentry vehicle
[NASA-CASE-LAR-10574-1] N70-41958

HODOGRAPHS
Plane transonic flow around airfoils, using hodograph based methods for shock free flow and finite difference methods for flow with shock waves
[ICAS PAPER 70-12] A70-44123
Lifting quasi-elliptical airfoils with supercritical shock free flow, discussing Nieuwland hodograph theory to compute profile number
[ICAS PAPER 70-15] A70-44126

HOLOGRAPHY
Subsonic air flow around airfoil in wind tunnel, detecting density gradients by pulsed ruby laser holographic visualization

A70-40809
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels
[SMPTE PREPRINT 3] A70-43056
Holographic interferometry for study of transparent media, noting application to aerodynamic phenomena
[ONERA-TP-851] A70-43455
Turbine compressor blades vibration mode measurements by holographic interferometry
A70-45563
Holographic display device for aircraft landing approach to aircraft carrier
[AD-703683] N70-36298
Aerodynamic holography
[AD-709764] N70-42551

HOMING DEVICES
Location identification system for identifying particular ground location
[NASA-CASE-ERC-10324] N70-36078

HONEYCOMB CORES
Low weight, high strength, rigid honeycomb core structures with minimal surface tubule sections
[NASA-CASE-ERC-10363] N70-40071

HONEYCOMB STRUCTURES
IR NDT bond inspection system for helicopter rotor blade honeycomb box assemblies, using closed circuit slow scan video system to detect bondline voids
A70-35184
Honeycomb panels with fiber reinforced facings, obtaining acoustic fatigue design criteria
[AIAA PAPER 70-897] A70-35814
Optimum light construction design of glider wings, considering spar weight, aluminum honeycomb structure and repair
A70-42961
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel honeycomb construction
A70-43213
Bonded honeycomb sandwich structure fastening techniques in aerospace design, noting application to aircraft and spacecraft structures
[SAE PAPER 700850] A70-45882
Structural mechanics of bonded and honeycomb structures
N70-38124

HORIZONTAL FLIGHT
Concorde SST horizontal navigation, discussing data sources, equipment specifications, flight rules, man-machine interaction, etc
A70-42660
Horizontal flight speed effects on aerodynamic characteristics of air cushion vehicles with elliptical planform
A70-42801

HORIZONTAL SPACECRAFT LANDING
Guidance and control techniques for terminal energy management and automatic horizontal landings of unpowered space shuttle vehicles
N70-40962

HORIZONTAL TAIL SURFACES
Boeing 2707 SST horizontal tail multiple channel actuation system features
A70-35827

HOT WORKING
Ti hot forming, discussing sheet use as aircraft structural material
A70-34444

HOT-WIRE ANEMOMETERS
Turbulent flow phase velocity fluctuations measurement by hot-wire anemometers, obtaining cross-spectral density by Fourier analysis digital techniques
A70-38019
Hot-wire anemometer study of turbulent boundary layer flow characteristics over elastic sheets
N70-40556

HOTSHOT WIND TUNNELS
Measurement methods for forces, pressure and heat flow in hotshot hypersonic wind tunnels
A70-34773
Hotshot wind tunnel performance improvement by coating arc chamber with silastene to retard heat loss and metal pollution
A70-34774
Integrated double oblique shock scramjet for supersonic combustion tests and instrumentation development, discussing fuel injection through sonic orifices, combustion data, etc
[AIAA PAPER 69-827] A70-41752

HOVERING
Longitudinal dynamics of VTOL aircraft during hover-forward flight transition, using multiple time scale analysis
[AIAA PAPER 69-130] A70-36681
Helicopter automatic approach and hover coupler systems, discussing cockpit display devices, handling qualities, pilot workload and fatigue and external load stabilization
A70-44464
Propeller blade aerodynamic characteristics at zero advance ratio, reducing singular integral equation to nonsingular form for computer solution
A70-44993

HOVERING STABILITY
Crane helicopter controllability, discussing load stabilization and precision hovering
A70-34723
Hingeless rotor helicopter airborne and ground resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping
A70-34733

HP-115 AIRCRAFT
Low speed wind tunnel measurements of lateral stability derivatives for HP-115 aircraft
[ARC-CP-1097] N70-37241

HUMAN FACTORS ENGINEERING
Pilot influence on dynamic aircraft design, taking into account physiological state during various operational tasks
[ICAS PAPER 70-37] A70-44134
Computer program for evaluating cockpit configurations using articulated human model
[AD-703269] N70-32339
Mathematical model for positioning and moving articulated human model in crewstation environment
[AD-703270] N70-32340
Articulated variable link length human model for simulating operator performance in cockpits
[AD-703271] N70-32341
Interface of maintainability, reliability, human factors, and system safety in military aircraft design
N70-40718
Temporal and spectral combinations effects on human judgements of aircraft noisiness
[FAA-NO-69-3] N70-42217

HUMAN PERFORMANCE
Individual and system performance indices for air traffic control system
[NA-69-40] N70-37033
Measuring forecasting performance relative to previous performance and use of automated forecast verification as management tool
[AD-707498] N70-37703

HUMAN REACTIONS
Airborne electronic equipment, collision avoidance systems, displays, instrumentation, human response and ground based control in air traffic control
A70-39198
Human disturbance from SST overflight sonic booms, discussing overpressure, rise times and durations
A70-44016
Aircraft noise reduction, discussing generation sources in propulsion system, noise levels and subjective responses
A70-44395
Sonic boom, discussing characteristic flow phenomena, intensity, effects on buildings and animals, human reactions, etc
A70-45786

HUMAN TOLERANCES
Modified calculations for relative perceived noisiness of aircraft by human subjects
[NASA-CR-1636] N70-35898

HUMIDITY
Humidity resistance test method involving flight simulation for airborne equipment in tropical environment

A70-35159
Aircraft air conditioning, discussing temperature and humidity control, cooling systems, etc
A70-37975
HYBRID COMPUTERS
Guide for selection of avionic projects for simulation by hybrid computer facility
[AD-703843] N70-34805
Hybrid computer program for optimization of flight control systems and instrument landing system glide path automatic pilot mode for F-2 aircraft
[RAE-TR-70043] N70-42386
HYBRID NAVIGATION SYSTEMS
Air navigation aids and hybrid navigation systems for transport and Comet 4 aircraft
[RAE-TR-69220] N70-42346
HYBRID PROPULSION
Energy transfer methods for hybrid air breathing ramjet propulsion systems with rocket motor S qas source
[ICAS PAPER 70-61] A70-44156
HYBRID ROCKET ENGINES
Hybrid combustion ram rocket drives, discussing booster initial acceleration, exhaust gas use as fuel and payload gain
[ICAS PAPER 70-50] A70-44147
HYDRAULIC CONTROL
SST electrohydraulic primary and standby brake control systems, discussing design and advantages
[AIAA PAPER 70-913] A70-35825
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785
Flow difference sensor for aircraft hydraulic systems damage vulnerability reduction, discussing design, operation and flight tests results
A70-40786
Fluidics for aircraft high pressure hydraulic systems, discussing circuit breaker, feel computer and landing gear sequencing circuit
[SAE PAPER 700784] A70-45860
HYDRAULIC EQUIPMENT
Aircraft vertical gyro with hydraulic damping device, calculating ballistic deviations limitation conditions
A70-39733
Hydraulic load loops with random force signal for aircraft structures endurance testing
A70-39913
Evaluation tests on Boulton-Paul VC-10 aileron integrated flight control actuator
[AD-703471] N70-35080
Aircraft hydraulic system circuit breaker for protection against major system leakage
[AD-702172] N70-36652
HYDRAULIC FLUIDS
Hypersonic and supersonic aircraft fuels, lubricants, and hydraulic fluids, with bibliographies
[AGARDOGRAPH-108] N70-39638
Supersonic and hypersonic aircraft lubricants and hydraulic fluids
N70-39641
HYDROCARBON FUELS
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes
A70-43439
HYDRODYNAMICS
Hydrodynamics of accelerated turbulent boundary layer with and without mass injection
[NASA-CR-110650] N70-32466
Annotated bibliography on ground effect machines
[AD-704800] N70-35309
Engineering approximation of maximum accelerations experienced by planing craft in rough water
[AD-706098] N70-38390
HYDROELASTICITY
Hydroelastic analysis of circular cylinder/lift on bodies of revolution
[AD-708434] N70-40252
HYDROFOIL CRAFT
Hydrofoil and hovering craft design by fiber technology, discussing composite materials, whisker mechanical properties, polycrystalline fibers, matrix materials, etc
A70-38941
HYDROGEN
Supersonic combustion of vitiated air-hydrogen mixtures
[AD-705129] N70-32090
HYDROGEN PLASMA
Dissocited and ionized hypersonic flows of hydrogen heated by electric arc techniques, investigating flows in wind tunnel nozzles
A70-42759
HYDROPLANING
Tire-pavement friction coefficients
[AD-705987] N70-33636
HYPERBOLIC FUNCTIONS
Similarity transformations and boundary value problems of hyperbolic partial differential equations with wave solutions
[AD-710403] N70-42747
HYPERBOLIC NAVIGATION
Eurocontrol evaluation of navigational aid systems air traffic control, examining HARCO and VORDAC systems
A70-38641
HYPERSONIC AIRCRAFT
Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions
A70-38304
Hypersonic airbreathers aerodynamic, structural and propulsive system interactions, discussing hydrogen fuel heat sink, airframe and engine cooling and airframe materials
[ICAS PAPER 70-16] A70-44127
Hypersonic aircraft stability and control problems, discussing bulky engines and air intake and exhaust geometry
[ICAS PAPER 70-17] A70-44128
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957
Turbine-compressor system for active cooling of hypersonic aircraft
[NASA-CR-66930] N70-33268
Hypersonic and supersonic aircraft fuels, lubricants, and hydraulic fluids, with bibliographies
[AGARDOGRAPH-108] N70-39638
Supersonic and hypersonic aircraft lubricants and hydraulic fluids
N70-39641
Analysis of bending loads of hypersonic aircraft
[NASA-TM-X-2092] N70-40808
Longitudinal aerodynamic stability of three hypersonic aircraft at Mach numbers from 0.065 to 10.70
[NASA-TM-X-2113] N70-42574
Wing elevation, incidence, and chamber effects on aerodynamic characteristics of representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737
HYPERSONIC BOUNDARY LAYER
Displacement interacting boundary layer in symmetry plane region of flat hypersonic delta wing by control volume balances for mass, momentum and energy
A70-34975
Free stream disturbances influence on hypersonic boundary layer transition Reynolds number in heated and unheated flows
[AIAA PAPER 69-704] A70-41744
Inviscid and viscous hypersonic flows, boundary layer problems, separated flows, and hypervelocity wind tunnels - reviews
[AD-709216] N70-41586
HYPERSONIC FLIGHT
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind tunnel flow
A70-35962
Thermal protection system based on radiation cooling for high altitude cruising hypersonic flight, achieving zero net mass transfer
A70-41745

Newtonian hypersonic aerodynamic theory for arbitrary bodies, discussing computational difficulty for shadowed areas
A70-41866
Requirements posed by hypersonic and supersonic flight, including propulsion system performance
N70-39639

HYPERSONIC FLOW
Hypersonic flow field around yawed half angle cone from wind tunnel measurements including surface pressure distributions and flow visualization photographs
A70-34485
Yawed two dimensional wedges in hypersonic stream, including leading edge bluntness, viscous interaction and angle of attack effects
[AIAA PAPER 70-783] A70-34503
Two dimensional hypersonic viscous flow, analyzing viscosity and bluntness induced pressure effects
A70-35034
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies
A70-35035
Dihedra placed at angle of attack in hypersonic rarefied gas flow, investigating base flow and near wakes
A70-35047
Hypersonic gas flow around blown plane of segmentally blunted cones at large angle of attack, using two dimensional model
A70-36258
Hypersonic flow around delta wings of finite thickness with supersonic leading edges
A70-36260
Hypersonic test flow in arc heated wind tunnel, measuring freestream Pitot pressure, mass flux, stagnation point heat transfer rate and wall pressure
A70-40270
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock
A70-40288
Hypersonic flow pattern past windward side of triangular wing with supersonic leading edges, joining potential and vortex regions behind shock wave
A70-40609
Dust content effect on hypersonic wind tunnel flow test results, noting drag force on slender and blunt nosed models
A70-42224
Dissocited and ionized hypersonic flows of hydrogen heated by electric arc techniques, investigating flows in wind tunnel nozzles
A70-42759
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow
[ICAS PAPER 70-03] A70-44117
Inviscid hypersonic flow fields past lower /compression/ surface of delta wing calculated by one strip approximation of integral relations method
A70-46245
Aerodynamic interference effects on half-cone bodies with thin wings in hypersonic flow
[NASA-TN-D-5898] N70-32827
Angle of attack and bluntness effects on hypersonic flow over 15 deg semiapex cone in helium
[NASA-TN-D-5903] N70-34073
Pressure distribution of spherically-blunted 60 deg half-angle cone in hypersonic flow
[NASA-CR-109982] N70-35952
Inviscid and viscous hypersonic flows, boundary layer problems, separated flows, and hypervelocity wind tunnels - reviews
[AD-709216] N70-41586

HYPERSONIC HEAT TRANSFER
Hypersonic heat transfer rates on flat plates in helium and in corner flow region with air
[NASA-CR-114257] N70-42365

HYPERSONIC SHOCK
Spark photography of models in free flight in hypersonic shock tunnel
[SMPTE PREPRINT 99] A70-43035

HYPERSONIC SPEED
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution
A70-40918
Hypersonic aerodynamic deceleration devices for axisymmetrical bodies with cylindrical main sections and various front sections, using gun tunnel techniques
[AIAA PAPER 70-1174] A70-41839
Continuous surface of revolution parachute for supersonic/hypersonic speeds, performing wind tunnel tests
[AIAA PAPER 70-1173] A70-41840
European hypersonic aerodynamic research activities, describing Eurohyp program
A70-43507
Parameter determination of atmosphere in transition domain at 80 to 120 km on blunt bodies
N70-36963

HYPERSONIC VEHICLES
Hypersonic cruise vehicles viscous interactions areas, examining compression corners, shock interactions, laminar and turbulent flow, boundary layer separation, etc
[AIAA PAPER 70-781] A70-34475
Aerospace thermophysics considerations in spacecraft and hypervelocity vehicles systems thermal design, discussing thermal control and control coatings optical and radiative properties
[AIAA PAPER 70-812] A70-34509
Laminar heating in hypersonic vehicles interior corners, analyzing helium tunnel heat transfer data for various intersecting wedge corners
A70-39700
Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129
Aerodynamic characteristics of hypersonic transport configuration at Mach 6.86
[NASA-TN-D-5885] N70-34876
High velocity flight mechanics, hypersonic aerodynamic predictions, and optimization of hypersonic lifting bodies and cruise vehicles
[AD-708133] N70-39844

HYPERSONIC WAKES
Hypersonic wake studies, including two dimensional wakes, sphere wakes, and sharp and blunt cone wakes
[AD-708757] N70-40162

HYPERVELOCITY FLOW
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems
[NASA-TM-X-52876] N70-37826
Hypersonic heat transfer rates on flat plates in helium and in corner flow region with air
[NASA-CR-114257] N70-42365

HYPERVELOCITY IMPACT
Research in combustion, explosions and hypervelocity
N70-38119

HYPERVELOCITY PROJECTILES
Theory and capabilities of magnetically driven flyers
[AD-708449] N70-41131

HYPERVELOCITY WIND TUNNELS
Free flight wind tunnel test for feasibility of hypersonic drogue deployment into reentry vehicle wake
[AIAA PAPER 70-587] A70-35195
Low pressure measuring system for aerodynamic models tested in Mach 12-14 wind tunnel, discussing transducers and high speed digital recording and data processing system
A70-35493
Digital computer for high speed wind tunnel data acquisition, processing and operations control
A70-37923
Hypersonic test flow in arc heated wind tunnel, measuring freestream Pitot pressure, mass flux, stagnation point heat transfer rate and wall pressure
A70-40270
Time varying flow properties effects on hypersonic wind tunnel spectroscopic measurements,

considering direct emission and electron beam techniques A70-40271
Dust content effect on hypersonic wind tunnel flow test results, noting drag force on slender and blunt nosed models A70-42224
Spark photography of models in free flight in hypersonic shock tunnel [SMPTE PREPRINT 99] A70-43035
Heat transfer measurements compared in free flight and in hypersonic wind tunnel at similar Reynolds number and temperature ratios [ICAS PAPER 70-06] A70-44115
Hypersonic wind tunnel facility for hypersonic aircraft and recoverable booster systems development [DFVLR-SONDDR-19] A70-44799
Feasibility of uncooled nozzle throat for hypersonic wind tunnel facility [AD-705577] N70-33910
Pressure operated electrical switch for positioning protective cone in front of model in hypersonic wind tunnel [NASA-CASE-LAR-10137-1] N70-35597
Blowdown, supersonic, and hypervelocity wind tunnel apparatus at the Centre Ricerche Aerospaziali, Rome, Italy N70-37016
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities [NASA-TN-D-5908] N70-37168
ONERA hypersonic wind tunnels for flow studies related to space shuttles N70-37832
Inviscid and viscous hypersonic flows, boundary layer problems, separated flows, and hypervelocity wind tunnels - reviews [AD-709216] N70-41586
Corrections for real gas effects in nitrogen gas expansion by isentropic processes and computer programs of hypervelocity wind tunnel nozzle design [VKI-TN-58] N70-42586

HYSTERESIS
Dynamic unbalance effects in rigid body rotors, discussing lubricant temperature changes and instability hysteresis [ASME PAPER 69-LUB-14] A70-37606

I

ICE PREVENTION
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft N70-40776
VFR and IFR training program and ice prevention and removal for general purpose aircraft N70-40781

IDEAL FLUIDS
Sound field produced in uniform moving ideal fluid stream by nonuniform oscillating elastic wall A70-38657

IDEAL GAS
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics A70-37242
Perfect gas supersonic flow with constant velocity, pressure and density around finite nonaxisymmetric body at small angles of attack A70-43322
Perfect gas three dimensional boundary layer separation on circular cone at incidence, comparing numerical calculation and experimental results A70-44207
Lift and side force acting on bodies in transonic flow N70-37314

IGNITION
Flameout and ignition correlation for diffusion fuel burnup behind angled stabilizers in annular turbine combustion chamber A70-36127

IGNITION LIMITS
Full-scale annular ram-induction combustor tests for Mach 3 cruise turbojet engine [NASA-TN-D-6041] N70-41975
Effectiveness of various inerting agents for preventing ignition and flame propagation of hydrocarbon fuel-air systems N70-42756

IGNITION SYSTEMS
Ignition and sustaining of combustion by energy addition in turbulent supersonic flow [AD-710283] N70-42528

IMPACT DAMAGE
Flight loads data extraction and analysis from damaged magnetic tapes after aircraft crash A70-35518
Erosion by solid particles, discussing impacting velocity effects, natural sand quartz particle size distribution and composition, artificial industrial abrasives, etc A70-35600
Soviet monograph on collision hazards between aircraft and birds covering accidents, damage and preventive measures A70-44099

IMPACT LOADS
Simulation of bird impact during flight N70-33654

IMPACT PREDICTION
Birdproofing aircraft research program using pneumatic cannon firing real and simulated bird carcasses A70-46398

IMPACT RESISTANCE
Pressure distribution shock pattern and impact wave resistance in frictionless plane parallel and source shaped supersonic flow A70-36385

IMPACT TESTS
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading A70-35995
Birdproofing aircraft research program using pneumatic cannon firing real and simulated bird carcasses A70-46398
Experimental systems for impact protection using starch/brine dilatant suspensions [AD-708017] N70-40188

IMPELLERS
Pure impulse principle applied to axial compressor impellers with high solidity high camber blades A70-36647
Forced vortex impeller in axial flow fan without inlet vanes, presenting lift and drag coefficients of blade sections, loss of head, etc A70-38222
Velocity distribution in boundary layer on thin rotating turbine blade of impeller driven at wind tunnel outlet, solving turbulent and laminar flows momentum equations A70-38224
Basic elements for advanced design of radial flow compressors N70-39096

IMPULSE GENERATORS
Shakers and solid rocket propellant impulse generators for aeroelastic and vibration flight tests of Concorde aircraft structures [ONERA-TP-811] N70-37148

IN-FLIGHT MONITORING
In-flight evaluation of selected aircraft pilots controllers, noting role in design [AIAA PAPER 70-925] A70-35836
Avionics maintenance effectivness logistics, discussing symptom pattern observation technique /SPOT/ for in-flight data A70-38399
Aircraft landing maneuver optimization by in-flight monitoring of approach and landing phases, furnishing decision making display [AIAA PAPER 70-1000] A70-39531
Analog monitor design and tests to improve ILS localizer signal display in aircraft [EER-5-10] N70-36912

INCENDIARY AMMUNITION
Investigating sensitization of aliphatic

hydrocarbon fuels for weapons application
[AD-704509] N70-36487
INCIDENCE
Short static probe with good incidence characteristics at supersonic speed
[ARC-CP-1099] N70-37072
INCINERATORS
Aerodynamic holder stabilized smoke flames to avoid intermittent flaming and thick puffs for incinerator air pollution reduction
A70-40887
INCOMPRESSIBLE FLOW
Laminar incompressible separating and reattaching flows, correlating finite difference solutions with experimentation
[AIAA PAPER 70-763] A70-34488
German monograph on oscillations of tandem wing without outgoing wake in plane incompressible flow, using numerical computations
A70-35372
Two dimensional cascades for incompressible plane potential flows with given velocity distribution
[ASME PAPER 70-GT-87] A70-36880
Boundary layer transition region of flat plate in incompressible flow by subsonic wind tunnel tests, demonstrating harmonic wall perturbation effect
A70-41440
Optimum pressure distribution and airfoil profiles for maximum lift without separation in incompressible flow determined by second order theory
[AIAA PAPER 69-739] A70-42704
Method for calculating interaction of cylindrical wall with circular straight section with flow from doublet placed in wall
[NASA-TT-F-13155] N70-33808
Nonsteady axisymmetric flow of inviscid, incompressible fluid through heavily loaded actuator disk
[AD-708396] N70-39937
INCOMPRESSIBLE FLUIDS
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution
A70-38350
Lift determination of slender curved periodically recurring airfoils array in plane potential flow of inviscid incompressible fluid
A70-44158
INDEPENDENT VARIABLES
Previous history effect on parameters relation in similar turbulent boundary layers under pressure distributions
A70-36375
Aircraft stability design by parameter plane technique, using for YO-3A aircraft
[AIAA PAPER 70-983] A70-39546
Parameter determination of atmosphere in transition domain at 80 to 120 km on blunt bodies
N70-36963
INDEXES (RATIOS)
Equations for determining vortex hazard index
N70-40915
INDICATING INSTRUMENTS
CH-47 cruise guide indicator for displaying fatigue loading to pilots, discussing design and operation
A70-34705
Fluidic parallel flow low airspeed indicator for V/STOL instrumentation tested in wind tunnel
[AIAA PAPER 70-906] A70-35818
In-flight comparison of Kaiser FP-50 flight director with standard C-131 instruments
[AD-702748] N70-36264
INDUCTANCE
Lightning induced voltages in electrical circuits of aircraft fuel systems
N70-42759
INDUSTRIAL SAFETY
Basic requirements for system, industrial, aviation, and public safety
[NASA-TM-X-66319] N70-39716
INDUSTRIES
Pollution, air traffic control systems, airport locations, and advanced aircraft development effects on airline industry
N70-41439
INERTIA
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes
A70-41408
INERTIAL GUIDANCE
Systems of orientation and guidance of aircraft
[AD-696052] N70-38146
INERTIAL NAVIGATION
Commercial aircraft strapdown inertial navigation systems, examining initial self alignment techniques
A70-36442
STOL navigation systems, evaluating Vector Analog Computer, Decca Omnitrac IIB and inertial system
A70-36513
Inertial navigation platform system for long range flights, passing command through computer to automatic pilot
A70-36950
Avionics hardware operational effectiveness assessment method, considering inertial navigation system LN-12D
A70-38837
Radar inertial system flight evaluation, discussing V/STOL program for approach and landing by use of ground based radar for updating onboard inertial navigator
A70-42651
Inertial navigation system application to air transportation, discussing system mechanization and compatibility with ATC requirements
A70-42654
Use of inertial navigation in American air traffic environment
[AD-702090] N70-36651
Aeronautic navigation equipment including gyroscopes. Inertial navigation systems, and self adaptive control systems - stability and accuracy determinations
[JPRS-51241] N70-37787
Rapid initialization of inertial navigation systems through parameter estimation
[AD-706219] N70-37975
Flight evaluation of inertial/DME/DME system
[FAA-RD-70-24] N70-41325
INERTIAL PLATFORMS
Inertial navigation platform system for long range flights, passing command through computer to automatic pilot
A70-36950
Aircraft navigation control system by digital computer combined with inertial platform, considering emergency backup, slow drift and system malfunctions
A70-46092
INFLATABLE STRUCTURES
Ballistic trajectory, packageability, deployment and flight stability of attached ram air inflatable decelerator for high speed/low altitude store delivery
[AIAA PAPER 70-1199] A70-41817
Euler buckling of inflated toroidal drag bodies, including packaging and load deflection tests for Mylar, dacron-neoprene and stainless steel-silicone fabrics
[AIAA PAPER 70-1198] A70-41818
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects
A70-44456
INFLATING
Stress distribution and shape in arbitrarily shaped gore parachute under unsteady pressure distribution during inflation and descent
[AIAA PAPER 70-1197] A70-41819
Three body problem for parachute system dynamics during inflation
[AIAA PAPER 70-1170] A70-41843
Parachute trajectory and opening load prediction based on inflation process and added mass, determining drag area as function of distance
[AIAA PAPER 70-1168] A70-43993
INFLUENCE COEFFICIENT
Unsteady aerodynamics prediction of supersonic elastic aircraft, discussing aerodynamics influence coefficients /AIC/ method refinement
[AIAA PAPER 70-944] A70-39583

INFORMATION RETRIEVAL
Flight loads data extraction and analysis from damaged magnetic tapes after aircraft crash A70-35518
Integrated data systems for aircraft maintenance, noting information retrieval role in maintenance management for cost reduction and safety A70-39647

INFORMATION SYSTEMS
Airborne flight test data acquisition and ground based automatic bulk data processing system for helicopter test and development programs A70-34713
Data acquisition system applications philosophy, discussing data integrity, expansion facility, flight safety, etc A70-36339
Statistical properties of civil ATC system based on central processor, discussing system informational congestion A70-36394
Automated airline communications system for collecting, analyzing, storing, transmitting, receiving and presenting information required by ATC and advisory services A70-41347
Aircraft accident filing system data analysis using Fortran programs A70-42880
Satellite based navigation/air traffic control information systems for short range STOL air carrier aircraft
[AIAA PAPER 70-1338] A70-45930
Upper Air Space Control Center Automatic Data Processing and Display System for air traffic control A70-46238

INFRARED DETECTORS
Clear air turbulence detection by IR radiometry of thermal gradients, using staggered receivers for panoramic visualization A70-46093

INFRARED INSPECTION
IR NDT bond inspection system for helicopter rotor blade honeycomb box assemblies, using closed circuit slow scan video system to detect bondline voids A70-35184

INFRARED INSTRUMENTS
Test techniques used for state-of-the-art airborne infrared equipment N70-32176

INFRARED TRACKING
Computer systems for teaching, air traffic control, and space surveillance
[AD-704573] N70-36488

INGESTION (ENGINES)
Birdstrikes as aircraft hazard, discussing structural damage, engine ingestion and various countermeasures A70-36319
Exhaust gas ingestion suppression model tests for VTOL lift engines, measuring inlet thermal environment
[AIAA PAPER 70-905] A70-37396

INJECTORS
Optimum manifold and injector hole area of pulsed exhaust systems of two cycle engine with turbosupercharger A70-42809

INLET FLOW
Plane diffuser grid profiles for subcritical velocities of oncoming flow, using wind tunnel test data A70-36129
Axial flow compressor off-design performance optimization by adjustable inlet guide vanes with variable trailing edge flaps A70-36846
Axial flow compressor cascades, predicting total pressure losses for inlet relative Mach number greater than unity
[ASME PAPER 70-GT-57] A70-36872
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
Jet engine compressor noise analysis, noting inlet swirl role A70-42725
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency A70-46012
Basic elements for advanced design of radial flow compressors N70-39096

INLET NOZZLES
Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft
[NASA-TM-X-2034] N70-32047

INLET PRESSURE
Inlet pressure oscillation effects on turbofan engine compressor
[NASA-TM-X-2081] N70-39421

INSPECTION
Ultrasonic crack detection in fastener holes in C-5A wings A70-45571
Federal flight inspection of navigation systems and air traffic control facilities N70-41531
Inspection, evaluation, classification, and reuse criteria for used airfield landing mats
[AD-708891] N70-43200

INSTRUMENT APPROACH
Aircraft accident report for Allegheny Airlines CV-440 near Bradford, Pennsylvania, 6 Jan. 1969
[NTSB-AAR-70-10] N70-35760
Landing approach maneuvering using radio direction finder of 'Svod' system
[JPRS-51258] N70-36101
Aircraft accident report for Convair 580 near Bradford, Pennsylvania on Dec. 24, 1968
[PB-189649] N70-37196
Control zone establishment for instrument approaches N70-41533

INSTRUMENT COMPENSATION
Static weight tare compensation for V/STOL wind tunnel models, using accelerometer outputs A70-35500
Flight test instrumentation for V/STOL stability derivatives extraction, noting instrument errors and required compensation A70-35502

INSTRUMENT ERRORS
Air total temperature measurement for jet powered aircraft, discussing subsonic and supersonic wind tunnel data for sensor thermal recovery characteristics A70-37882
Gravity measurement errors in high speed aircraft parallel to undulating geoid attributed to associated vertical accelerations A70-43662
Stochastic processes for probabilistic error analysis in airborne gravimetry, using gravity sensing instruments A70-43666
VHF omnirange propagation and stability study
[AD-705079] N70-33644
Effects of meteorological parameters and instrument errors on vertical flight performance of supersonic transports
[NASA-CR-1570] N70-34253

INSTRUMENT FLIGHT RULES
Maximum throughput-rate capacity for runway and final approach path airspace involving multiple IFR landings A70-38235
ATC integration of SST, discussing en route and terminal projects of national airspace system, modular automation, instrument flight rules, etc A70-38633
VTOL aircraft instrument flight in terminal area, defining requirements and operating characteristics for vertical and low speed capabilities
[AIAA PAPER 70-1333] A70-45935
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft N70-40776

VFR and IFR training program and ice prevention and removal for general purpose aircraft N70-40781
Designing terminal area navigation, guidance, and control system suitable for landing space shuttle vehicles under Category 2 conditions N70-40961
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids [N-5390.3] N70-41076
Terminal navigation aids and IFR operations for STOL aircraft N70-41081
Reduced terminal IFR separation standards and runway spacings N70-41532

INSTRUMENT LANDING SYSTEMS
Air traffic control, discussing precision instrument landing, approach lighting, collision avoidance, navigation aids, etc A70-35185
Precision approach and landing guidance system selection by RTCA committee, discussing aircraft antennas, scan rates, international cooperation, etc [AIAA PAPER 70-937] A70-35846
ILS glide slope calibration using optically projected digital codes as reference A70-37912
Airport capacity and terminal area safety increase by scanning beam instrument landing system, discussing automatic guidance trajectory example A70-37913
ATC by scanning beam ILS and onboard control systems, increasing airport capacity and terminal area safety [AIAA PAPER 70-1033] A70-39504
Correlation detection methods providing information for ILS in terminal area congestion, discussing role in aircrew-ATC cooperation A70-42667
Aircraft accident investigation occasioned by improper application of automatic-coupled instrument landing systems [NTSB-AAR-70-2] N70-36043
Analog monitor design and tests to improve ILS localizer signal display in aircraft [EER-5-10] N70-36912
Aircraft accident investigation of De Havilland Heron 114-2 crash in mountains of Puerto Rico during ILS approach to San Juan airport [PB-191991] N70-37334
Comparison of instrument landing systems for space shuttle and aircraft N70-39607
Terminal area guidance techniques for space shuttle landing N70-40960
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids [N-5390.3] N70-41076
Lower ILS altitude and visibility minimums for light aircraft [AD-708294] N70-41156
National aviation system planning review conference, including air traffic control, airport planning, airspace capacity, and ILS development N70-41526
Implementation of 50 kHz frequency separation standard for ILS/VOR/DME frequency assignments N70-41529
Instrument landing system implementation and research and development N70-41541
Hybrid computer program for optimization of flight control systems and instrument landing system glide path automatic pilot mode for F-2 aircraft [RAE-TR-70043] N70-42386

INSTRUMENTS
Instrumentation in aerospace industry - Conference, Seattle, May 1970 A70-37873

INSULATION
Considering noise intensity levels in houses and buildings near airports [NLL-LIB-COMM-1527-/5196/] N70-42827

INTAKE SYSTEMS
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests A70-35996
Radial compressor diffusers design and technology [ASME PAPER 70-GT-116] A70-36850
M 3.5 two dimensional mixed compression inlet system with self restart using flexible variable ramp system [AIAA PAPER 69-447] A70-42707
Convection, transpiration and full coverage film cooling methods for various local turbine inlet temperatures, gas pressures and cooling air temperatures A70-43275
Model scale effect on inlet temperature rise of VTOL jet configurations [NASA-CR-66965] N70-34533
Deflector for preventing objects from entering nacelle inlets of jet aircraft [NASA-CASE-XLE-00388] N70-34788

INTEGRAL EQUATIONS
Subsonic wing theory calculation method, obtaining close solutions for integral expression constants for downward air currents A70-38164
Equations system for determining constants in Sedov integral for conformal mapping of polygonal airfoil lattice onto Riemann surface A70-39767
Unsteady aerodynamic loading of wings with control surfaces, discussing Kuessner integral equation of subsonic lifting theory A70-44761
Integral equation for calculating oscillations of slender wing in subsonic flow near solid ground plane [AD-703995] N70-36285

INTEGRATED CIRCUITS
Aircraft digital interior communication systems, combining multiplexing techniques with solid state integrated circuits technology and systems integration [SAE PAPER 700302] A70-36813
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules A70-44542
Design and procurement of hybrid microcircuit [AD-705974] N70-34087
Minimizing cost and schedule problems of integrating software of avionics system N70-40954
Multiplex data bus subsystem for improving reliability and reducing weight of space shuttle avionics system N70-40957

INTELSAT SATELLITES
Navigation aids evolution and trends, noting ground stations, Intelsat 3 and navigation satellites A70-35879

INTERCEPTION
Minimax study of aim angle for proportional navigation missile - planar case [AD-708167] N70-39778

INTERFACIAL TENSION
Negative g Drone aircraft surface tension fuel system preventing air inclusion in turbojet engine fuel by tank filters /screens/ [AIAA PAPER 70-910] A70-35822

INTERFERENCE
Wind tunnel wall interference effects for V/STOL aircraft with lift jets, using modified theoretical model for complex jet arrangements [ICAS PAPER 70-54] A70-44150
Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects A70-45592

INTERFERENCE DRAG
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference A70-36445
Transonic wind tunnel porous walls, investigating interference effects and aerodynamic

characteristics
A70-42337
Exhaust nozzle/airframe interference test evaluation for twin engine supersonic fighter
[AIAA PAPER 69-430] A70-42702
INTERFERENCE LIFT
Aerodynamic interferences of lifting surfaces harmonically vibrating in subsonic flow
A70-44765
Lift interference analysis on sweptback wing in rectangular wind tunnel test section with slotted side walls
[NASA-TR-R-344] N70-32610
INTERFEROMETRY
Holographic interferometry for study of transparent media, noting application to aerodynamic phenomena
[ONERA-TP-851] A70-43455
Turbine compressor blades vibration mode measurements by holographic interferometry
A70-45563
INTERMITTENCY
Intermittent, single jack, flexible nozzle supersonic wind tunnel calibration at Mach numbers 1.5 to 3.0
[TAE-110] N70-36965
INTERNAL COMBUSTION ENGINES
Temperature distribution in cylinders of aircraft internal combustion rotary piston engine under air cooling
A70-44742
INTERNATIONAL COOPERATION
Variable sweep high thrust-weight ratio multirole combat aircraft /MRCA/, discussing British-French cooperation, development programs and requirements
A70-34916
International Civil Aviation Organization /ICAO/ work on bird hazard reduction, including aircraft airworthiness specifications, bird data dissemination, etc
A70-35997
International civil aviation, discussing ICAO functions, airports and terminal facilities problems
A70-37748
IATA policy on future ATC development, discussing controlled airspace, communications and radar requirements
A70-38630
IFALPA views on ATC services, emphasizing aircraft approach spacing in North Atlantic airways
A70-38632
European avionics role in Post Apollo program, noting space shuttles, space tugs, space stations and modules
A70-43501
Management organization of European operational application satellite systems, concerning interurban telecommunication and air traffic control
A70-43502
Space systems supporting international air transportation growth, discussing UHF satellite R and D programs on beam antennas
[SAE PAPER 700760] A70-45870
Summary record of panel meetings on structures and materials used in aerospace research
N70-41741
INTERNATIONAL LAW
Liability for damages due to supersonic flight sonic booms, discussing pertinent provisions in Dutch and international law
A70-37561
Air freight carrier liabilities in passenger transportation international regulations, noting conflicting interpretations
A70-37562
INTERNATIONAL TRADE
Export market research for military aircraft
A70-38618
Airport planning for air transportation in underdeveloped nations, discussing economic, financial, technical and operational factors
[AIAA PAPER 70-1268] A70-45926
INTERROGATION
Computerized calculations of interrogation repetition frequency sets nonsynchronous for N interrogations
[AD-709553] N70-42008
INVARIANCE
Invariant systems structural synthesis for automatic control of plant motion, deriving control laws for thrust and angle of attack
A70-39844
Multidimensional control for turboramjet engine, relating system characteristics to invariance conditions during startup and ascent
A70-39847
INVENTORIES
VTOL aircraft power plants optimization for future helicopter missions without restrictions of limited off-shelf inventory
A70-34708
INVENTORY CONTROLS
Comparative demand forecasting for military helicopter spare parts, stressing exponential smoothing model
A70-39643
INVESTMENTS
Investment risks and technical impact on aircraft development, world aviation growth and airline costs
A70-34915
INVISCID FLOW
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies
A70-35035
Three dimensional inviscid small perturbation compressible flow past lifting axial compressor rotor at subsonic and transonic speeds
A70-36691
Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837
Lift determination of slender curved periodically recurring airfoils array in plane potential flow of inviscid incompressible fluid
A70-44158
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943
Inviscid hypersonic flow fields past lower /compression/ surface of delta wing calculated by one strip approximation of integral relations method
A70-46245
Inverse method solution for radiating, nonadiabatic, equilibrium inviscid flow over blunt body
[NASA-TN-D-5907] N70-34016
ISOTROPIC TURBULENCE
Aerodynamic theory of pressure field induced on lifting surface by isotropic atmospheric turbulence, considering transfer function of Concorde aircraft
[ICAS PAPER 70-30] A70-44104
ITALY
Italian automated ATC system /ATCAS/, discussing subsystem functions, display devices, data acquisition, information distribution, etc
A70-40911
ITERATIVE SOLUTION
Iterative solution for supersonic compressed flow around triangular wing surface
N70-35137

J

J-85 ENGINE
Scaling comparison of recirculation effects of VTOL YJ-85 lift engine pod with similar small-scale simulated engine pod
[NASA-CR-1625] N70-35846
JAGUAR AIRCRAFT
Jaguar flight test instrumentation methods, discussing Anglo-French participation
A70-38534
Airborne magnetic recording flight test instrumentation of Anglo-French Jaguar aircraft
A70-38535
Jaguar flight test data processing system, discussing airborne digital computer

A70-38536
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment
A70-38537

JET AIRCRAFT
Nonlinear balance mass solutions for tab-aileron flutter free operation of jet trainer for arbitrary store configuration
A70-34923
Air total temperature measurement for jet powered aircraft, discussing subsonic and supersonic wind tunnel data for sensor thermal recovery characteristics
A70-37882
Military Airlift Command jet aircraft computerized area navigation system operational procedures
A70-38232
Yak-40 business jet design and flight characteristics
A70-42174
SN 600 Corvette business jet design and performance
A70-42175
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Superjet airliners wiring connectors for power distribution, signal circuitry and self ejecting push buttons for passenger seats
A70-44545
Weather modification by jet aircraft contrails, discussing cloud seeding observations in Alaska
A70-45421
Highlift and blown wing types slow speed STOL aircraft, comparing pilot training requirements with jet airline flying
[AIAA PAPER 70-1282] A70-45971
Manual IFR formation flight display system requirements for advanced rotary wing and jet fighter aircraft
[AD-705133] N70-32317
Computation of total sound pressure field of jet aircraft on ground
[NASA-TT-F-13096] N70-32947
Deflector for preventing objects from entering nacelle inlets of jet aircraft
[NASA-CASE-XLE-00388] N70-34788
Evaluation tests on Boulton-Paul VC-10 aileron integrated flight control actuator
[AD-703471] N70-35080
Dynamic soaring - influence of airspeed, wind shear, lift drag ratio, and angle of inclination
[NASA-TT-F-13217] N70-36081
Air feed jet combustion chamber operations under unstable conditions
[AD-700801] N70-36450
Characteristics of severe turbulence encountered by civil jet transport aircraft
[ARC-CP-1098] N70-37086
Feasibility of high voltage dc electrical power in aircraft electrical systems
[AD-709079] N70-40339
Aircraft fuel system fire safety and prevention, and jet aircraft air pollution
N70-40779
Flight tests of spiral divergence and bank angle control of executive jet aircraft
N70-40780
Predicted wide bodied jet aircraft impact on air transportation system, including Boeing 747, DC 10, and L-1011
N70-41142
Air pollution from future giant jetports
[NASA-CR-110887] N70-42774

JET AIRCRAFT NOISE
Airport operations effects on total environment, considering jet aircraft noise pollution
[AIAA PAPER 70-887] A70-37391
Jet engine compressor noise analysis, noting inlet swirl role
A70-42725
Aircraft noise sources, examining compressors with dynamic pressure devices and jets with turbulence investigations
[ICAS PAPER 70-22] A70-44111
Jet aircraft noise reduction devices directed at turbulence fluctuation noise sources, noting effects on flight characteristics
[ICAS PAPER 70-21] A70-44112
High bypass model jet noise study, describing test setup and noise measurement results as function of secondary/primary flow velocity ratio
A70-44394
Noise suppression for high-bypass ratio CF6 turbofan engine in DC-10 airplane, considering effect on engine design
[SAE PAPER 700804] A70-45878
Quiet V/STOL transport aircraft from DC-9-10 modification, discussing flying qualities, propulsion and control system interfaces, configurations, etc
[AIAA PAPER 70-1409] A70-45916
SST sonic boom noise level reduction by thermal simulation of long body aircraft, considering thermal spike or keel
[AIAA PAPER 70-1323] A70-45942
Upper surface, external flow, jet-augmented flap configuration for high wing jet aircraft for noise reduction
[NASA-CASE-XLA-00087] N70-33332
Jet aircraft noise attenuation characteristics of wood-sided and brick-veneered frame houses
[NASA-CR-1637] N70-35694
Congressional hearings on supersonic aircraft and airport planning and development, air traffic control, and aircraft noise
N70-36161
Aircraft engine noise and sonic boom
[AGARD-AR-26-70] N70-38782
Fluctuating turbulent stresses in noise producing region of jet
[RR-10-PT-2] N70-40566
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft
N70-40776
Research and development programs for reduction of sonic boom and aircraft noise
N70-40787

JET BLAST EFFECTS
Low-speed fan used for noise reduction data on fan and exhaust jet noise
[NASA-TM-X-52871] N70-41963

JET BOUNDARIES
Multilayered and multiple supersonic jets, deriving dispersion equations for boundaries stability
A70-38663
Aerodynamic forces and torque on airfoil in potential jet from boundary asymptotes position, determining flow characteristics by electrical analogy
A70-45438

JET CONTROL
Aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors including dual jets and cyclic results
[AIAA PAPER 69-741] A70-42705

JET ENGINE FUELS
Field test for microbiological contamination of jet fuel, discussing phosphates detection
A70-36344
Turbojet aircraft engine fuels quality control, considering chemical composition, physical properties and handling problems
A70-36550
Water separation index modified /WSIM/ test for jet fuel surface active materials in relation to filter/separator performance
[SAE PAPER 700279] A70-36815
Jet fuel system deposits measurement, noting reliability of oxygen combustion and beta ray backscattering techniques
[SAE PAPER 700257] A70-36824
Jet A kerosene deposit accumulation problem and proposed SST fuel tank design
[SAE PAPER 700256] A70-36825
Jet fuels ground handling at airfields, describing flow monitors, filters, fueling techniques, etc
A70-43093
Jet engine air pollution in U.S., discussing fuel types, additives and burner design for smoke emission reduction

A70-44200
Compatibility of gelled and emulsified aircraft turbine fuels
[NA-70-11] N70-32365
Investigating sensitization of aliphatic hydrocarbon fuels for weapons application
[AD-704509] N70-36487
Jet engines and fuels
[AD-706167] N70-37640
Component and additives effects on storage stability of jet engine fuels
[AD-707524] N70-38458
Burning properties and effects of kerosene fuels used in jet aircraft engines
[AD-708352] N70-39926

JET ENGINES
Ti alloys use in jet engines design, considering weight, structural stability, useful temperature range, cost, etc
A70-34448
Close-spaced nozzles twin jet configuration, achieving low nozzle and total afterbody drag
[AIAA PAPER 70-934] A70-35844
High speed and long life bearings and dampers for future jet engines, considering design factors
[SAE PAPER 700318] A70-36800
Electrochemical machining /ECM/ effects on components surface integrity, discussing jet engine materials
[ASME PAPER 70-GT-111] A70-36849
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption
[ASME PAPER 70-GT-79] A70-36885
Liquid fuel jet engine thrust aftereffect momentum, investigating switching off transient process
A70-37249
Jet engine combustor design and efficiency, discussing heat transfer, cooling and engine materials
A70-39648
Electromagnetic interference in aircraft communication due to jet engine charging, considering various prevention measures
A70-39724
Subsonic jet engine intake duct radar cross section calculation using waveguide model
A70-43584
Aircraft propulsion system test facilities, discussing altitude simulation, large subsonic and supersonic engines and component development
[ICAS PAPER 70-45] A70-44143
Jet engine air pollution in U.S., discussing fuel types, additives and burner design for smoke emission reduction
A70-44200
German monograph on dynamic control behavior of jet engines covering computation for normal external actions and perturbation effects
A70-44396
Two shaft bypass jet engine analog simulation, determining angular acceleration dependence on angular velocity and fuel consumption
A70-45442
Jet engine combustion chamber pressure loss, flow velocity through flare tube holes and air supply calculation, noting adaptation for computer use
A70-45446
Concorde thrust control by employment of variable area nozzle and reheat system, discussing crew work load
[SAE PAPER 700817] A70-45900
Jet engine noise propagation near porous surface, predicting anomalous LF dip from direct and reflected waves interference with phase delay
A70-46068
Thrustmeter for direct output reading from jet engines based on stream and total port pressures
A70-46328
Reduced smoke combustion chambers for jet aircraft engines tested in full scale JT8D engine
A70-46387
Model scale effect on inlet temperature rise of VTOL jet configurations
[NASA-CR-66965] N70-34533
Jet engines and fuels
[AD-706167] N70-37640
Survey of jet engine exhaust and trailing vortex wakes
[AD-707118] N70-38206
Jet engine/airframe interface problems in fighter aircraft design
N70-40709

JET EXHAUST
Fog dissipation on aircraft runways, using aircraft jet engine exhaust heat and mixing properties
A70-35929
Probability theory of stresses during random vibrations of flat panel in acoustic field of jet engine exhaust
A70-36301
Wind tunnel tests measuring transverse jet plumes
[GSL-TR-70-4] N70-37120
Calibration of blowdown wind tunnel for Concorde aircraft jet exhaust nozzle studies
[ONERA-NT-160] N70-42475
Air pollution from future giant jetports
[NASA-CR-110887] N70-42774

JET FLAPS
Increased lift via hinge suction jet flaps on augmentor wings, using thin airfoil model and small disturbance theory
A70-43432
Free jet stream effect on thin jet-flapped airfoil with fully developed wake, using linear theory
A70-43737
Jet-ambient air mixing effect on flow characteristics around thin airfoil with jet flap
A70-45439
Determining unsteady aerodynamics of two dimensional jet flap wing
[AD-704722] N70-33274
Upper surface, external flow, jet-augmented flap configuration for high wing jet aircraft for noise reduction
[NASA-CASE-XLA-00087] N70-33332

JET FLOW
Noise spectra of two dimensional jet flowing from nozzle ejector, using dispersion equation
A70-38662
Sound generation by fluctuating subsonic jet flow, considering field directional characteristics and sound pressure variations with Mach number
A70-41422
Jet curtain flow recirculation model based on air-bubble flow visualization technique, determining minimum power for air cushion vehicle
A70-42278
Static and dynamic spring constants of peripheral jet air cushion vehicle in heaving motion, obtaining sinusoidal input response characteristics
A70-42279
Free jet stream effect on thin jet-flapped airfoil with fully developed wake, using linear theory
A70-43737
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584
Instability of two dimensional compressible jet
[AD-707257] N70-37667
Aerodynamics and gas jet calculations of gas flame theory
[AD-706646] N70-38635

JET IMPINGEMENT
Viscosity effect on turbulent supersonic underexpanded jet flow into submerged region
A70-36262
Two phase plume at various incidence angles on fla plate, determining impinging particle mass flux, forces and damage
A70-44566

JET LIFT
Ground simulations data of jet lift V/STOL compared with visual flight results, noting hover, lateral quick start and stop maneuver
A70-35954
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts
[SAE PAPER 700269] A70-36819

Lightweight lift jet engine design, testing and performance for V/STOL aircraft
[ASME PAPER 70-GT-32] A70-36833
Thrust deflector for VTOL aircraft fuselage mounted lift engines designed as isentropic plug nozzle, considering mass flow, pressure forces and Coanda effect
[SAWE PAPER 841] A70-40379
Wind tunnel wall interference effects for V/STOL aircraft with lift jets, using modified theoretical model for complex jet arrangements
[ICAS PAPER 70-54] A70-44150

JET MIXING FLOW
Jet-ambient air mixing effect on flow characteristics around thin airfoil with jet flap
A70-45439
Fluctuating turbulent stresses in noise producing region of jet
[RR-10-PT-2] N70-40566
Turbulent mixing of supersonic jets investigated for momentum and energy equations
[AD-708735] N70-40679
Three dimensional jet mixing analysis for combustion chamber design
[NASA-CR-111782] N70-43101

JET NOZZLES
Turbojet engines noise-suppressing nozzles flow rate and thrust characteristics calculation
A70-43371
Aerodynamic design and calibration of thermal acoustic jet facility-cold flow duct
[NASA-TM-X-53907] N70-37529

JET PROPULSION
Optimum adaptation of propulsion gas generators to power jet driven rotors with blown flap control, considering jet engine, fanjet and engine driven compressor
A70-35661

JET STREAMS (METEOROLOGY)
Forces and moments induced on VTOL aircraft wing by intake and jet stream effects of two lift fan configurations
[NASA-TT-F-13277] N70-39849

JET THRUST
Turbojet engines noise-suppressing nozzles flow rate and thrust characteristics calculation
A70-43371

JET VANES
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629

JETSTREAM AIRCRAFT
Hot gas recirculation measurements on four different-size models of simple VTOL configuration
[NASA-TT-F-12604] N70-32535

JOINTS (JUNCTIONS)
Joint strength of three layer fiberglass reinforced plastic panels with bilateral adhesive patches under linear axial force
A70-42812

JUDGMENTS
Perceived noisiness of various types of aircraft by subjects seated outdoors and inside houses
[NASA-CR-1635] N70-35881

K

KARMAN VORTEX STREET
Aeroelastic stability for circular cylindrical structures under periodic Karman vortex excitation
A70-44764

KEROSENE
Jet A kerosene deposit accumulation problem and proposed SST fuel tank design
[SAE PAPER 700256] A70-36825
Burning properties and effects of kerosene fuels used in jet aircraft engines
[AD-708352] N70-39926

KINEMATICS
Kinematically unsteady aerodynamic coefficients consistent with stiffness and inertia properties of lifting surface in supersonic flow by finite element method
A70-45154

KINETICS
Soviet papers on kinetics and aerodynamics of fuel combustion processes covering supersonic flow, flame stabilization, fluid atomization, nonequilibrium recombination, etc
A70-39265

KITS
Infrared radiation hot working for polystyrene aircraft maintenance tool kit tray manufacture
[A/AEE-NOTE-9001] N70-42525

KRYPTON 85
Kr 85 tracer for gaseous diffusion determination in atmospheric wakes and meteorological wind tunnels
[COO-2053-1] N70-40380

L

L-1011 AIRCRAFT
Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities
A70-38951
L-1011 onboard system for gross weight and center of gravity determination, describing transducers placement, computer design and display panel
[SAWE PAPER 837] A70-40359
L-1011 aircraft optimum minimum noise pod design, describing technology, restraints and system requirements
[SAE PAPER 700805] A70-45877
Predicted wide bodied jet aircraft impact on air transportation system, including Boeing 747, DC 10, and L-1011
N70-41142

LABORATORIES
Projects and facilities of Canadian Laboratories
N70-33655

LAMBERT SURFACE
Horizontal Situation Display /HSD/ map computer mechanization transforming earth location to X, Y coordinates for Lambert conformal projection
[AIAA PAPER 69-987] A70-42710

LAMINAR BOUNDARY LAYER
Laminar boundary layer transition on sharp cone at zero yaw in supersonic wind tunnels, correlating aerodynamic noise disturbances with transition Reynolds numbers
[AIAA PAPER 70-799] A70-34462
Velocity distribution in boundary layer on thin rotating turbine blade of impeller driven at wind tunnel outlet, solving turbulent and laminar flows momentum equations
A70-38224
Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations
A70-43323
Calculating laminar boundary layer flow on highly swept delta wing at high incidence
[ARC-CP-1096] N70-37138

LAMINAR FLOW
Transitional flow separation upstream of compression corner at trailing edge of sharp leading edge flat plate
[AIAA PAPER 70-764] A70-34487
Laminar incompressible separating and reattaching flows, correlating finite difference solutions with experimentation
[AIAA PAPER 70-763] A70-34488
Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate
A70-36194
Lift forces acting on spheres in cylindrical tube laminar flow
A70-37647

LAMINAR HEAT TRANSFER
Laminar heating in hypersonic vehicles interior corners, analyzing helium tunnel heat transfer data for various intersecting wedge corners
A70-39700

LAMINAR WAKES
Steady state laminar flow model for near wake of slender body in supersonic flow
A70-34467

LAMINATES
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience

A70-41137
LANDING AIDS
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721
Aircraft perspective display as independent landing monitor based on electronic runway lights, discussing simulator development and flight validation
[AIAA PAPER 70-924] A70-35835
Precision approach and landing guidance system selection by RTCA committee, discussing aircraft antennas, scan rates, international cooperation, etc
[AIAA PAPER 70-937] A70-35846
Helicopter radar approach aid for serving oil rigs
A70-38621
Airborne three dimensional area navigation equipment for reducing mid-air collision exposure and for raising landing safety in terminal areas
A70-42296
Simulation of continuous runway centerline marking
[FAA-RD-70-40] N70-37021
Moving graph instrument display evaluation for landing approaches with helicopter
[NASA-TN-D-6025] N70-41183
Runway marking patterns studied under limited visibility conditions
[FAA-RD-70-27] N70-41517
LANDING GEAR
C-5A aircraft six wheel main landing gear bogie pitching control, emphasizing braking torque compensating mechanism design
[AIAA PAPER 70-914] A70-35826
Large wheel and tire imperfection effects on nosegear parametric shimmy instability, using Mathieu equation
A70-36455
Landing gear weight analytical estimation, discussing ground loads, member cross sectional area, parametric variations, etc
[SAWE PAPER 829] A70-40366
Nose gear steering system for vehicles with main skids to provide directional stability after loss of aerodynamic control
[NASA-CASE-XLA-01804] N70-34160
Scandinavian aircraft accident investigation and subsequent recommendations
[NTSB-AAR-70-14] N70-36114
Aircraft wheel spray drag alleviator for dual tandem landing gear
[NASA-CASE-XLA-01583] N70-36825
Vertically descending flight vehicle landing gear for rough terrain
[NASA-CASE-XMF-01174] N70-41589
LANDING INSTRUMENTS
Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845
SATRAM, multiple trajectory landing system for aircraft position indication within large airspace
A70-36948
Airport capacity and terminal area safety increase by scanning beam instrument landing system, discussing automatic guidance trajectory example
A70-37913
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Compatibility factors affecting concept development of approach and landing guidance systems
[AD-707129] N70-37993
LANDING SIMULATION
Aircraft perspective display as independent landing monitor based on electronic runway lights, discussing simulator development and flight validation
[AIAA PAPER 70-924] A70-35835
Aircraft simulation of lunar excursion module landing approach trajectories
[NASA-TM-X-64433] N70-35662
Fixed-base visual simulation study for ability determination of onboard pilot during landing
[NASA-TN-D-5940] N70-35927
Display instrumentation for V/STOL aircraft in simulated landing with steep angle approaches or zero-zero visibility
[NASA-CR-112779] N70-37158
LANDING SITES
Graphic simulation study of two sites for second major airport in Atlanta area
[FAA-RD-70-63] N70-41198
LANDING SPEED
Calculating velocity distribution with altitude while braking bodies in atmosphere
[AD-706171] N70-38655
LASER OUTPUTS
Turbulent mixing in supersonic cone near wake, using laser planogram technique for flow visualization
A70-37529
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels
[SMPTE PREPRINT 3] A70-43056
Laser system for monitoring wingtip vortices on runways
[NASA-TM-X-64525] N70-42182
LASER RANGER/TRACKER
Gallium arsenide laser ranging system for helicopters obstacle warning
A70-34720
LASERS
Laser Doppler velocimeter for low speed V/STOL wind tunnel
[AD-708717] N70-40796
Aerodynamic holography
[AD-709764] N70-42551
LATERAL CONTROL
Turbulence effects on lateral directional flying qualities, examining pilot task performance, control workload and compensatory behavior
[AIAA PAPER 70-998] A70-39533
Automatic aircraft lateral motion stabilization during flight in perturbed atmosphere by HF invariant systems
A70-39839
Aircraft rolling motion /eigenmotion/ in flight at small angle of attack following initial disturbance, discussing response to control action
A70-42515
Wheel force and roll moment nonlinearities effect on light STOL aircraft handling qualities during approach
[ICAS PAPER 70-55] A70-44151
Free flight measurement of aerodynamic lateral force and moment coefficients on bombs with freely spinning cruciform and monoplane tails and fixed split skirts
[WRE-TN-HSA-162] N70-36045
Flight investigation of roll requirements for transport airplanes in cruising flight
[NASA-TN-D-5957] N70-38625
Flight simulator study of STOL transport lateral control characteristics
[FAA-RD-70-61] N70-42013
LATERAL STABILITY
Wind tunnel investigation of V/STOL transport model with four pod-mounted lift fans
[NASA-TN-D-5942] N70-34100
Low speed wind tunnel measurements of lateral stability derivatives for HP-115 aircraft
[ARC-CP-1097] N70-37241
LAUNCH VEHICLES
Research program and activities in aeronautics and space flight
[NASA-TM-X-65099] N70-36959
LAW (JURISPRUDENCE)
Hovercraft operational advantages and legal status
A70-43499
Legal guidance criteria for expert witnesses presentation of technical evidence before jury in products liability litigation
A70-43869
Air hijacking as aviation safety problem, discussing history, prevention and detection methods and equipment, law enforcement, etc
A70-44496

Commercial air service and miscellaneous air laws
N70-36198

LEADING EDGE SWEEP
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference
A70-36445

LEADING EDGES
Yawed two dimensional wedges in hypersonic stream, including leading edge bluntness, viscous interaction and angle of attack effects
[AIAA PAPER 70-783] A70-34503
Hypersonic flow around delta wings of finite thickness with supersonic leading edges
A70-36260
Flow field about leading edges of tapered wings set at incident angle of attack, using gas dynamic and Monge equations
A70-36376
High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications
[AIAA PAPER 70-904] A70-37392
Hypersonic flow pattern past windward side of triangular wing with supersonic leading edges, joining potential and vortex regions behind shock wave
A70-40609
Quasi-conical supersonic wings with curved subsonic leading edges, discussing perturbation potential, boundary conditions, homogeneous flow and gothic and ogee planforms
A70-42108
Boundary layer calculation on airfoil leading edge separation during stall
[AD-701771] N70-34290

LEGAL LIABILITY
Liability for damages due to supersonic flight sonic booms, discussing pertinent provisions in Dutch and international law
A70-37561
Air freight carrier liabilities in passenger transportation international regulations, noting conflicting interpretations
A70-37562
Legal guidance criteria for expert witnesses presentation of technical evidence before jury in products liability litigation
A70-43869

LIAPUNOV FUNCTIONS
Imperfect, reduced-state relay control application to model-reference controller design
[NASA-CR-1645] N70-36916

LIFE (DURABILITY)
Hybrid boost bearing with long life and free starting, stopping and oil system failure characteristics of rolling element bearing
[ASME PAPER 69-LUB-16] A70-37605

LIFE SUPPORT SYSTEMS
Continuous flow requirements in aircraft passenger oxygen systems using phased dilution principle, discussing breathing mask efficiencies
A70-44483
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals
A70-44488

LIFT
DC 8 Super 63 aircraft direct lift control flight evaluation
A70-35496
Lifting and side force distributions acting on body in transonic flow
A70-35696
Lift forces acting on spheres in cylindrical tube laminar flow
A70-37647
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results
[AIAA PAPER 70-971] A70-39558
Slender wings of low aspect ratio and sharp leading edges, predicting inviscid maximum lift
A70-40585
Flat plate airfoil unsteady lift due to chordwise velocity perturbations, using Horlock frozen gust pattern theory
A70-42303
Short wing lift investigated via lateral fluid jets fired in wind tunnel for various lengths
A70-42614
Optimum pressure distribution and airfoil profiles for maximum lift without separation in incompressible flow determined by second order theory
[AIAA PAPER 69-739] A70-42704
Continuous trailing vortex sheet rolling up into two discrete vortices, discussing wing lift limitations
A70-43890
Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments
[ICAS PAPER 70-08] A70-44119
Lifting quasi-elliptical airfoils with supercritical shock free flow, discussing Nieuwland hodograph theory to compute profile number
[ICAS PAPER 70-15] A70-44126
Lift determination of slender curved periodically recurring airfoils array in plane potential flow of inviscid incompressible fluid
A70-44158
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448

LIFT AUGMENTATION
High lift airfoils boundary layer separation suppression by blowing, describing wall jets streamwise development prediction methods
[AIAA PAPER 70-872] A70-34818
Increased lift via hinge suction jet flaps on augmentor wings, using thin airfoil model and small disturbance theory
A70-43432
Wing lift increase by spanwise blowing along upper surface, causing flow reattachment on wing and vortex induced effective aerodynamic camber increase
[ICAS PAPER 70-09] A70-44120

LIFT DEVICES
Lightweight lift jet engine design, testing and performance for V/STOL aircraft
[ASME PAPER 70-GT-32] A70-36833
Subsonic high lift cruise wing optimal design using kernel function method of planar lifting surface theory
A70-42709
Aerodynamic theory of pressure field induced on lifting surface by isotropic atmospheric turbulence, considering transfer function of Concorde aircraft
[ICAS PAPER 70-30] A70-44104
Aerodynamic interferences of lifting surfaces harmonically vibrating in subsonic flow
A70-44765
Kinematically unsteady aerodynamic coefficients consistent with stiffness and inertia properties of lifting surface in supersonic flow by finite element method
A70-45154
Lifting and control surface flutter on space shuttles
N70-36605
Comparison between experimental data and lifting surface theory calculation of vortex induced loads on single-bladed rotary wings
[NASA-CR-112769] N70-36986
Modified Multhopp lifting surface theory as programmed for NAL Sirius computer
[NAL-TN-17] N70-41883
Auxiliary lift system providing transportation means for HL-10 reentry vehicle
[NASA-CASE-LAR-10574-1] N70-41958

LIFT DRAG RATIO
Aerodynamics theory for separated flow effects on helicopter lift-drag capability, taking into account three dimensional flow and blade aeroelasticity
A70-35956
Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions
A70-38304
Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings, giving low lift-

dependent drag
A70-38615
Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129
Numerical technique for computing optimum spanwise load distribution on nonplanar wings of arbitrary shape minimum induced drag
[AD-704502] N70-36322
Lift and drag coefficient dependency on angle of attack for bisymmetric lifting vehicles
[AD-708022] N70-40037
High lift low drag airfoil investigation
[REPT-6802] N70-43048

LIFT FANS
Wind tunnel investigation of V/STOL transport model with four pod-mounted lift fans
[NASA-TN-D-5942] N70-34100
Forces and moments induced on VTOL aircraft wing by intake and jet stream effects of two lift fan configurations
[NASA-TT-F-13277] N70-39849

LIFTING BODIES
Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877
ONERA calculations in aeroelasticity including lifting surface optimization, control surface vibration, pressure fields, aircraft transfer functions and panel flutter
A70-44762
Thermal flux surface distribution lifting bodies, discussing aerodynamic efficiency dependence on drag and zero angle of attack Mach number
A70-45019
Using oscillatory aerodynamic theory for calculating dynamic stability derivatives with respect to unsteady lifting surface theory
N70-35873
High velocity flight mechanics, hypersonic aerodynamic predictions, and optimization of hypersonic lifting bodies and cruise vehicles
[AD-708133] N70-39844
Compression surface design for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993
Modified Multhopp lifting surface theory as programmed for NAL Sirius computer
[NAL-TN-17] N70-41883
Asymptotic study of perfect aerodynamic fluid flows around weakly lifting three-dimensional bodies in sonic regime
[NASA-TT-F-13319] N70-42020

LIFTING REENTRY VEHICLES
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow
[ICAS PAPER 70-03] A70-44117
Aeroelastic and aerothermoelastic development of winged interorbital space shuttle concerning panel flutter, stability and nonstationary lifting surface theory
A70-44760
Elevon design for lifting reentry vehicles to eliminate cross coupling and yaw at supersonic and hypersonic speeds
[NASA-CASE-XLA-89670] N70-36056
Boundary layer transition on lifting reentry vehicles at high angles of attack
N70-37843
Lift and drag coefficient dependency on angle of attack for bisymmetric lifting vehicles
[AD-708022] N70-40037
Wind tunnel model and flight tests of parawing lifting body landing system
[NASA-TN-D-5893] N70-40667

LIFTING ROTORS
Lifting rotor blade motions stability computation using Floquet transition matrix
A70-34726
Helicopter rotor blade stall flutter response prediction based on NACA 0012 airfoil aerodynamic data
A70-34734
Surface pressure and lift measurement on model lifting rotor blade as function of vortex interaction, using flush mounted pressure transducers
A70-34737
Three dimensional inviscid small perturbation compressible flow past lifting axial compressor rotor at subsonic and transonic speeds
A70-36691
Runway test vehicle for lifting rotor performance in simulated forward flight, comparing with wind tunnel tests
A70-38611

LIGHT AIRCRAFT
Rotary piston engine for powered gliders and light aircraft power source by modifying industrial Wankel engine
A70-34690
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
Four-seat two-engined STOL propeller passenger and sport aircraft design and performance
A70-37371
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics
A70-37388
Air conditioning in piston-powered light general aviation aircraft, comparing vapor cycle and cryogenic systems
A70-38500
Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703
Small airplane unsteady motion downwash angle at low speeds, comparing results from rectilinear steady flights
[ICAS PAPER 70-25] A70-44108
OV-10A forward air control and light attack aircraft design, specifications and performance
[SAE PAPER 700837] A70-45883
Wake turbulence dangers to light aircraft
N70-39350
Lower ILS altitude and visibility minimums for light aircraft
[AD-708294] N70-41156
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339

LIGHTING EQUIPMENT
Anticollision lights for supersonic transport
[FAA-AM-70-9] N70-42404

LIGHTNING
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within cloud
A70-42775
Heating estimation of aircraft wing from lightning bolt using Joule heating
[AD-705645] N70-33442
Lightning induced voltages in electrical circuits of aircraft fuel systems
N70-42759

LINEAR ENERGY TRANSFER (LET)
Measuring stratospheric radiation levels using recombination ionization chamber as multichannel LET spectrometer
N70-32393

LINEAR PROGRAMMING
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques
A70-37241
Linear programming approach to airport congestion using multitime period model
[AD-703621] N70-35049

LINEAR SYSTEMS
Soviet book on vibrations in flight vehicle engines covering linear and nonlinear systems, computer methods, etc
A70-37229
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes

A70-37403
Sensitivity optimization for linear optimal control systems design, describing aircraft lateral-directional control case study
[AIAA PAPER 70-962] A70-39567
Linear elastomechanical systems natural vibration parameters by harmonic excitation method
A70-43200

LINEAR VIBRATION
Harmonically oscillating wing linearized motion in subsonic flow, calculating generalized aerodynamic forces
A70-43118

LINEARIZATION
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836

LININGS
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530
Structural and environmental design criteria for acoustical duct-lining materials in turbofan noise suppression
A70-42531
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533

LIQUID COOLED REACTORS
High temperature liquid metal cooled nuclear reactor for military aircraft with long flight endurance and range
A70-43188

LIQUID METALS
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785

LIQUID NITROGEN
In-flight liquid nitrogen fire extinguishers for commercial aircraft
N70-42757
Feasibility of nitrogen fuel tank inerting systems for commercial aircraft
N70-42760

LIQUID SLOSHING
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161

LIQUID-VAPOR INTERFACES
Vapor volume entrained in liquid bulk from boundary layer boiling on vertical plate in low gravity field
A70-41055
Liquid droplet breakup by aerodynamic forces, obtaining solutions for fluid flow inside droplet and in coupled liquid-gaseous boundary layer
A70-43741

LISTS
Minimum Equipment List from aircraft manufacturer and airline operations viewpoint
[AIAA PAPER 70-900] A70-35816

LOAD DISTRIBUTION (FORCES)
Spacecraft parachute stress analysis, using finite elements with nonlinear elastic properties to obtain shape and load distribution
[AIAA PAPER 70-1195] A70-41821
Low disk loading rotors in high speed VTOL aircraft for economical vertical payload lift
[ICAS PAPER 70-57] A70-44153
Numerical technique for computing optimum spanwise load distribution on nonplanar wings of arbitrary shape minimum induced drag
[AD-704502] N70-36322

LOAD TESTING MACHINES
Hydraulic load loops with random force signal for aircraft structures endurance testing
A70-39913

LOAD TESTS
Crack propagation, fatigue damage and interaction effects in aircraft structures and materials under flight simulation loading
A70-34924
Aircraft design fatigue life and cumulation damage problems, discussing information value of programmed load and random tests
A70-39622
Comparative load capacity of disk models of natural gas blowers of different designs under plastic strain
A70-43941
Aircraft structure fatigue load monitoring, discussing strain gage installation in critical areas
[ICAS PAPER 70-31] A70-44102
Differential pressure cell insensitive to changes in ambient temperature and extreme overload
[NASA-CASE-XAC-00042] N70-34816

LOADING
Dynamic control model of lift helicopters with two cable sling loads using multiple part motion equations
[AIAA PAPER 70-929] A70-35839

LOADING OPERATIONS
C-5 aircraft cargo loading system for terminals minimizing ground time
A70-35831

LOADS (FORCES)
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data
[AIAA PAPER 70-948] A70-39579
Loads induced by terminal shock boundary layer interaction on cone-cylinder bodies, discussing angle of attack effect
A70-41863
Comparison of cord loads with aircraft tire on grooved and smooth runway surfaces
[NASA-CR-1627] N70-33150
Load transfer mechanics between elastic shell and airframe structure
[AD-703641] N70-35374
Forces and moments on prolate spheroid accelerating with constant angle of attack under free surface
[UCRL-50843] N70-36183
Load estimation and aeroelasticity in advanced fighter aircraft design initial stages
N70-40713
General aviation flying occupant load factors
[REPT-70-9] N70-40800
Soil strength evaluation of unsurfaced forward-area airfields by use of ground vehicles
[AD-709589] N70-41602

LOCKHEED AIRCRAFT
YF-12A interceptor aircraft development and testing, discussing titanium alloys application, aerodynamics and thermodynamics, escape systems for high speed and altitude tests
A70-36451

LOGISTICS
Avionics maintenance effectivness logistics, discussing symptom pattern observation technique /SPOT/ for in-flight data
A70-38399
Testbed development for evaluating tactical airlift capability
[AD-708722] N70-40276

LONGITUDINAL CONTROL
C-5A aircraft six wheel main landing gear bogie pitching control, emphasizing braking torque compensating mechanism design
[AIAA PAPER 70-914] A70-35826
Pilot/vehicle feedback systems with flight director computer for transport aircraft longitudinal control during landing, discussing design by manual control displays theory
[AIAA PAPER 70-1001] A70-39530
VTOL aircraft longitudinal motion automatic stabilization in presence of turbulence and internal disturbances, using rotors and jet engines
A70-39838
Fighter aircraft higher order control system dynamics effects on longitudinal handling qualities evaluated by in-flight simulator for role of pilot induced oscillations tendencies
[AIAA PAPER 69-768] A70-42711

Space shuttle transition trajectory optimization for cruising flight entry, considering longitudinal control, pitchup instability and angle of attack
A70-44623
Aircraft geometry effects on longitudinal flight characteristics calculations, noting wing aspect ratio and horizontal tail changes
A70-45437
Pitchdown control system for stabilization of space shuttle vehicles during reentry
N70-40963

LONGITUDINAL STABILITY
Wings flexural deformability influence on longitudinal stability of glider, using small perturbation theory
A70-35190
Longitudinal dynamics of VTOL aircraft during hover-forward flight transition, using multiple time scale analysis
[AIAA PAPER 69-130] A70-36681
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448
Ground effects on longitudinal stability of slender wings with small span/height ratio
[ARC-CP-1095] N70-37085
Low speed flight tests on longitudinal stability and control of Avro 707 delta wing aircraft
[ARC-CP-1105] N70-37164
Longitudinal aerodynamic characteristics of twin-turbofan supersonic transport with nacelles mounted under wings
[NASA-TN-D-5971] N70-40689
Longitudinal aerodynamic stability of three hypersonic aircraft at Mach numbers from 0.065 to 10.70
[NASA-TM-X-2113] N70-42574

LOSSES
Reynolds number effect on tip losses
[AD-700578] N70-36419
Secondary flow losses in axial compressors
N70-39095

LOUISIANA
Douglas DC-3 accident report - New Orleans International Airport
[PB-189376] N70-37607

LOW ASPECT RATIO
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
Vibration characteristics of low aspect ratio compressor blades, using thin shell theory and Rayleigh-Ritz method
[ASME PAPER 70-GT-94] A70-36876
Slender wings of low aspect ratio and sharp leading edges, predicting inviscid maximum lift
A70-40585
Low aspect ratio compressor blade cascade performance at blade span center, discussing pressure loss, angle of attack and staggering
A70-42272
Aerospace configuration with low and high aspect ratio variability for high and low speed flight
[NASA-CASE-XLA-00142] N70-33286
Aerodynamic configuration for aircraft capable of high speed flight and low drag for low speed takeoff or landing upon presently existing airfields
[NASA-CASE-XLA-00806] N70-34858
Performance prediction for turbocompressor blades with high deflection and low aspect ratio in transonic flow
[VKI-TN-59] N70-34929
Flight evaluation of ground effect on low aspect ratio airplanes
[NASA-TN-D-6053] N70-42738

LOW ASPECT RATIO WINGS
Low aspect ratio wings under conditions of creep, calculating stress by method of strains
A70-37244
Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276
Aircraft control surface aerodynamic characteristics, considering low aspect ratio wing elevons with variable sweep leading edge as longitudinal and lateral controls
[ICAS PAPER 70-26] A70-44107

LOW NOISE
Design and specifications for low-noise output turbofan engine for long-range subsonic transport aircraft
[NASA-TM-X-52640] N70-33773

LOW SPEED
STOL aircraft low speed handling characteristics described via approach and landing profiles, power requirements, wind effects, etc
[AIAA PAPER 70-1332] A70-45936
Ground effect visualization at low speeds around aircraft models in hydrodynamic tunnel
[NASA-TT-F-13254] N70-39296
Flight simulation of lateral directional handling qualities for V/STOL aircraft in low speed maneuvering flight
[AD-707831] N70-40002
Low speed inducers for rocket engine feed system
[NASA-CR-72716] N70-41058

LOW SPEED STABILITY
Small airplane unsteady motion downwash angle at low speeds, comparing results from rectilinear steady flights
[ICAS PAPER 70-25] A70-44108

LOW SPEED WIND TUNNELS
Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments
[ICAS PAPER 70-08] A70-44119
Low speed wind tunnel study of oscillatory rolling moments of slender wing with sharp leading edge and frequency and ground effects
[ARC-R/M-3617] N70-37162
Low speed wind tunnel tests of all-flexible twin-keel tension structure parawings
[NASA-TN-D-5965] N70-40688
Low speed wind tunnel tests on high aspect ratio unswept wings with boundary layer control by blowing over ailerons and trailing-edge flaps
[ARC-CP-1108] N70-43015

LOW TURBULENCE
Wind tunnel tests measuring transverse jet plumes
[GSL-TR-70-4] N70-37120

LOW VISIBILITY
Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845
Runway low visibility and ceilings frequency and duration at German airports, using 1949-1967 statistical data
A70-37925
Airport fog layers repetition frequency after low visibility periods
A70-43246
Display instrumentation for V/STOL aircraft in simulated landing with steep angle approaches or zero-zero visibility
[NASA-CR-112779] N70-37158
Numerical forecasting of low visibilities caused by suspended particles in atmosphere
[AD-708141] N70-39902
Runway marking patterns studied under limited visibility conditions
[FAA-RD-70-27] N70-41517
Simulator study of flight management task performance during low visibility approach and landing using baseline category 2 flight instrumentation
[NASA-CR-73478] N70-42037

LOWER ATMOSPHERE
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models and simulating effects on XV-5 V/STOL aircraft
A70-40784
Lower atmosphere electric field vertical distribution measurement by combined balloon and rocket soundings
A70-42797

LUBRICANTS
Hypersonic and supersonic aircraft fuels, lubricants, and hydraulic fluids, with bibliographies
[AGARDOGRAPH-108] N70-39638

Supersonic and hypersonic aircraft lubricants and hydraulic fluids
N70-39641
LUBRICATING OILS
Aircraft engine failures advanced detection by spectrometric lubricating oil analysis
A70-35481
Mathematical methods for calculating service life of aircraft engine lubricating oils
[AD-703999] N70-36225
LUNAR MODULE
Aircraft simulation of lunar excursion module landing approach trajectories
[NASA-TM-X-64433] N70-35662

M

MACH NUMBER
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
A70-35923
Axial flow compressor cascades, predicting total pressure losses for inlet relative Mach number greater than unity
[ASME PAPER 70-GT-57] A70-36872
Pressure distribution on thin nonlifting airfoils in steady two dimensional flow with freestream Mach number at or near unity
A70-44583
Pressure measurements and boundary layer separation studies on slender cone delta wing at different Mach and Reynolds numbers
[ARC-R/M-3626] N70-42500
MACH-ZEHNDER INTERFEROMETERS
Two dimensional turbine cascade air flow, examining boundary layer regime, thickness, velocity and pressure coefficient at any point by Mach-Zehnder interferometer
A70-42344
MACHINE ORIENTED LANGUAGES
Classification of software and hardware examples for automatic test equipment
N70-32171
Software and hardware specifications for automatic test equipment
N70-32173
MAGNETIC FIELDS
Theory and capabilities of magnetically driven flyers
[AD-708449] N70-41131
MAGNETIC RECORDING
Airborne magnetic recording flight test instrumentation of Anglo-French Jaguar aircraft
A70-38535
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests
A70-38547
MAGNETIC TAPES
Flight loads data extraction and analysis from damaged magnetic tapes after aircraft crash
A70-35518
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment
A70-38537
MAGNETOHYDRODYNAMIC FLOW
Thin airfoil theory in magnetoaerodynamics, considering steady two dimensional flow of compressible perfectly conducting inviscid fluid in presence of uniform magnetic field
A70-37597
Compressible fluids flow with conductivity tensor in presence of thin wing under orthogonal fields, reducing integral equation to Fredholm equation
A70-37599
Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces
A70-41444
Conducting fluid supersonic flow past slender body of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem
A70-42669
Magnetic fields and electrically conducting fluids interaction with emphasis on magnetodynamics equations, investigating rectilinear flows in pipes and nozzles, shock waves, etc
A70-44098
MAGNETOHYDRODYNAMIC GENERATORS
Large MHD generator channel aerodynamics, discussing pressure distributions to stall and stagnation pressure loss
A70-40002
MAGNETOHYDRODYNAMICS
Magnetohydrodynamics - JPL Conference, Padasena, March 1970
A70-40001
MAINTAINABILITY
Reliability and maintainability - Conference, Detroit, July 1970, Volume 9, Assurance technology spinoffs
A70-38815
Gaseous radioactive penetrant inspections for early low cycle fatigue in aircraft engine materials, discussing impact on maintainability
A70-38828
TSCP700 aircraft auxiliary power unit design, fuel consumption and maintainability
[SAE PAPER 700815] A70-45902
Aircraft electrical power systems optimization - maintainability tradeoff with equipment cost and weight
N70-32054
Technical and operational evaluation of Direct Altitude and Identity Readout /DAIR/ system /interrogator set AN/TPX-42/
[FAA-RD-70-29] N70-36950
Interface of maintainability, reliability, human factors, and system safety in military aircraft design
N70-40718
MAINTENANCE
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals
A70-34686
Versatile Avionic Shop Test maintenance system supporting avionic equipment aboard aircraft carriers
A70-40772
Mechanical and power equipment of airports
[AD-709693] N70-41055
Literature review and bibliography on altimetry
[FAA-RD-70-52] N70-41197
MALFUNCTIONS
Aircraft instrument for indicating malfunctions during takeoff
[NASA-CASE-XLA-00100] N70-36807
MAN MACHINE SYSTEMS
Concorde aircraft man machine simulation and handling using fixed cabin, variable stability and ground based simulators
[AIAA PAPER 70-923] A70-35834
Commercial aircraft flight deck systems controls and time sharing displays, emphasizing crew management
[AIAA PAPER 70-938] A70-35847
Computerized simulation of dynamic man model for evaluating cockpit geometry
[AD-703268] N70-32338
Computer program for evaluating cockpit configurations using articulated human model
[AD-703269] N70-32339
Mathematical model for positioning and moving articulated human model in crewstation environment
[AD-703270] N70-32340
Airborne/spaceborne computer systems engineering, including digital techniques, design tradeoffs, man machine interfaces, display devices, memory, microprogramming, packaging, and maintainability
[AGARDOGRAPH-127] N70-39489
MANAGEMENT PLANNING
Airline maintenance department assurance of air service regularity, stressing management role
A70-35855
Multiaircraft flight test program time compression by management techniques, discussing program length and costs
A70-38530
Cost and time optimization for complex aircraft development projects via network planning

A70-39644
Inlet data for engine stability analyses, developing technical management procedure patterns for pretest test and posttest results
[AIAA PAPER 70-1214] A70-41320
Air cargo management problems, discussing economics, ground handling, Jumbo jets, terminal facilities, mechanization, document handling, information flow, data systems, etc
A70-43269
Financing methods for airport redevelopment and expansion, discussing economic and political framework of operations
[AIAA PAPER 70-1267] A70-45920
Northeast Corridor transportation facts and data
[PB-190932] N70-34691
Cost analysis of high speed ground transportation modes
[PB-190942] N70-35446
Economic effectiveness of aircraft transportation systems
[AD-703162] N70-36309
Policies, requirements, goals, and criteria for national aviation system
N70-36967
General aviation airport system planning in Florida
[PB-191235] N70-37498
Military system development planning for operational capability needs
N70-40720
Research and development plan for increased airport and airspace capacity
[AD-707186] N70-40748
Minimizing cost and schedule problems of integrating software of avionics system
N70-40954
Planning for STOL air transportation system
N70-41086
Recommendations concerning Panamanian civil aeronautics directorate
[AC-70-3188] N70-41143
Changing patterns of commercial air service and airline economics
N70-41437
Pollution, air traffic control systems, airport locations, and advanced aircraft development effects on airline industry
N70-41439
National aviation system planning review conference, including air traffic control, airport planning, airspace capacity, and ILS development
N70-41526
National aviation system policy and plan
N70-41544
Panamanian civil aeronautics directorate departments of air safety, air traffic, airports, and air transport, with US technical assistance recommendations
[AC-70-3187] N70-41734

MANEUVERABILITY
AH-1G Hueycobra helicopter stability, control, performance, vibration and structural loads characteristics during controlled steady state maneuvers
A70-34716
Maneuver load alleviation /MLA/ configurations for wing bending load relief on transport aircraft, showing improved payload and span performance
[AIAA PAPER 70-877] A70-34813
Single and coaxial dual rotor helicopter piloting characteristics during turning flight, discussing operational problems in snow
A70-43530
Maneuver demand control using electric signalling feedback technique in Avro 707C and Hunter Mk 12 aircraft
A70-46203

MANEUVERS
Helicopter rotor blade differential pressure and structural load characteristics in transient and steady state maneuvers
A70-34739

MANIFOLDS
Optimum manifold and injector hole area of pulsed exhaust systems of two cycle engine with turbosupercharger
A70-42809

MANNED SPACE FLIGHT
Manned space flights, satellite observations, space sciences, and air traffic control - NASA report to Congress for 1 Jan. to 30 June 1969
[NASA-TM-X-64292] N70-33962

MANNED SPACECRAFT
Flame resistant nonmetallic materials for manned spacecraft and aircraft interiors, considering fibers, polymers, paper and composites
A70-42295

MANPOWER
Manpowered aircraft, considering possibility as future flying sport vehicles
[AIAA PAPER 70-879] A70-34809
Air cargo terminal operations analysis, discussing manpower cost reduction
A70-40127

MANUAL CONTROL
Flight check console tests using DC-6B aircraft N-114
[FAA-NA-70-57] N70-36849

MANUFACTURING
Soviet book on aircraft electrical and radio systems manufacturing, assembling and testing methods, considering effectiveness and standardization
A70-37405
Adhesive bonded aircraft structures, discussing methods and requirements for establishment and control of manufacturing procedures
A70-38594
Aircraft engine manufacturing technology, discussing metal cutting and forming, bonding, electrochemical machining and electron beam welding
A70-45298
Computer-aided production engineering involving numerically controlled machines for Rolls-Royce aircraft engines manufacture
A70-45299

MAPS
Ceiling and visibility atlas for Southeast Asia /1000 ft and 2 1/2 mi/
[AD-707496] N70-37708
Ceiling and visibility atlas for Southeast Asia /5000 ft and 5 mi/
[AD-707494] N70-37709

MARKETING
Export market research for military aircraft
A70-38618
European airbuses designs, considering potential market and financial problems
A70-38952

MARKING
Simulation of continuous runway centerline marking
[FAA-RD-70-40] N70-37021

MARKOV CHAINS
Markov chain analysis of aircraft repair using cannibalization
[AD-707041] N70-37824

MASS DISTRIBUTION
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes
A70-41408
Sweptback thin cantilever wing transonic flutter characteristics, investigating concentrated mass spanwise location effects
A70-42274

MASS FLOW
Mass flow ion drift anemometer applicable to aircraft speed measurement including V/STOL
A70-37885
Mass flow limitations in supersonic compressors
N70-39093

MASS TRANSFER
Thermal protection system based on radiation cooling for high altitude cruising hypersonic flight, achieving zero net mass transfer
A70-41745
Hydrodynamics of accelerated turbulent boundary layer with and without mass injection
[NASA-CR-110650] N70-32466

MATCHING
Helicopter engine rotor matching for tip propulsion efficiency, comparing with conventional shaft drive propulsion
[ASME PAPER 70-GT-68] A70-36842

MATERIALS HANDLING
Two-point suspension system with longitudinally displaced cargo hooks for handling helicopter loads, discussing wind tunnel and flight tests A70-34714
Static charge reducer for aircraft fuels handling safety, discussing performance factors [SAE PAPER 700277] A70-36808
Ground effect machine and recovery vehicle for materials handling [ARC-CP-1092] N70-42770
MATERIALS SCIENCE
Be production, development, potential uses and properties [ASM PAPER GG8-102] A70-39970
Aircraft flight propulsion systems performance improvement via materials technology for gas turbine engine components A70-43573
MATERIALS TESTS
Jet engine roller bearings retainer candidate cage materials and coatings evaluation on test rig simulating engine conditions [ASLE PREPRINT 70AM 2D-1] A70-38805
Papers on design and materials, discussing alloys for aircraft structures, stress-rupture life of Ni base alloy, single crystal structures, etc A70-39412
Turbocompressor disk materials selection by low cycle fatique tests, discussing stop and start repetition and cracks in stress concentration zones A70-41261
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc A70-43084
Materials for crash-fire resistant aircraft fuel tanks [NA-69-43] N70-34001
MATHEMATICAL MODELS
Analytical model for jet interaction induced separation of supersonic turbulent boundary layers, conducting flat plat tests at Mach 4 [AIAA PAPER 70-765] A70-34486
Closed compartment fire mathematical model to analyze combustion parameter effects, atmosphere pressure and temperature during fire A70-35646
Mathematical model of three dimensional separated flows with applications to small aspect ratio delta wing and flat plate A70-36438
Operational analysis and real time computer simulation models in ATC development A70-38637
V/STOL aircraft automatic flight control, guidance and navigation by onboard computer, discussing mathematical model and simulation results [AIAA PAPER 70-1035] A70-39502
Category II longitudinal approach system model taking into account inputs, gusts, ILS beam noise, man machine interaction, etc [AIAA PAPER 70-1034] A70-39503
Variable wing sweep aircraft angular motion mathematical model, analyzing inertial moments influence on control dynamics A70-40182
Spoiler theory based on mathematical model, using two dimensional potential theory in conjunction with experimental data on wake phenomena A70-42273
STOL system traffic analysis simulation model for interurban transportation system as tool for flight hardware evaluation A70-43731
Wind tunnel wall interference effects for V/STOL aircraft with lift jets, using modified theoretical model for complex jet arrangements [ICAS PAPER 70-54] A70-44150
Mathematical modeling of atmospheric gusts in stratosphere, mountain wave and thunderstorm conditions relevant to aircraft design A70-45420
Air traffic flow digital computer simulation model including departure, enroute and arrival phases for collision avoidance, weather effects and control constraints [AIAA PAPER 70-1316] A70-45945
Aircraft maintenance cost statistical analysis recursive regression model for aircraft failure and manhour cost data A70-46125
Computerized simulation of dynamic man model for evaluating cockpit geometry [AD-703268] N70-32338
Mathematical model for positioning and moving articulated human model in crewstation environment [AD-703270] N70-32340
Inverse method solution for radiating, nonadiabatic, equilibrium inviscid flow over blunt body [NASA-TN-D-5907] N70-34016
Linear programming approach to airport congestion using multitime period model [AD-703621] N70-35049
Mathematical models for Northeast Corridor transportation system [PB-190933] N70-36452
Imperfect, reduced-state relay control application to model-reference controller design [NASA-CR-1645] N70-36916
Mathematical theory of control of nonlinear processes emphasizing controller design techniques for systems with distributed parameters and time delays [AD-706908] N70-37666
Prediction performance of axial flow compressors using flow-through analysis N70-39092
Mathematical model of rotary wing aircraft for performance, stability, response, and rotor blade load characteristics determination [AD-707881] N70-39729
Aerodynamic model for calculating airloads and blade motion of helicopter rotor blades [AD-707939] N70-39885
Mathematical model for airfoil pressure distribution in two dimensional, uniformly sheared slipstreams [AD-709696] N70-41266
MATRICES (MATHEMATICS)
Lifting rotor blade motions stability computation using Floquet transition matrix A70-34726
Calculating frequencies and modes using inertia matrix [AE-276-S] N70-33607
MATRIX METHODS
Finite element stiffness matrix technique for composite structures, discussing airplane component design program A70-40040
Skew panels supersonic flutter and vibration calculated by matrix displacement method A70-40586
MEASUREMENT
Wall thickness measurement by supersonic testing method based on resonance A70-45681
MEASURING INSTRUMENTS
Wind tunnel response tests of cup, vane and propeller wind sensors, determining wind direction and speed parameters, damped and natural frequencies, etc A70-42914
Thrustmeter for direct output reading from jet engines based on stream and total port pressures A70-46328
Nonisentropic gas dynamics measurements and probe development [AD-705655] N70-36489
MECHANICAL DEVICES
Helicopter mechanical power transmission design, describing gearing, shaft bending, bearings, lubrication, weight factors, etc [SAWE PAPER 844] A70-40367
Mechanical and power equipment of airports [AD-709693] N70-41055
MECHANICAL DRIVES
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests [AHS PREPRINT 451] A70-34703
Helicopter cost reduction by transmission overhaul frequency reduction, discussing savings with on-

condition maintenance
A70-38824
Rotor drive systems for rotary wing aircraft, indicating mechanical hub drive advantages over reaction blade drive
A70-41850
Direct drive turbine engine control components and airframe accessories, noting weight and frontal area reduction
[SAE PAPER 700821] A70-45896
MECHANICAL ENGINEERING
Tension-torsion machine developed from aircraft carrier catapult principle, producing radial loading paths
A70-43453
Markov chain analysis of aircraft repair using cannibalization
[AD-707041] N70-37824
Bibliography on aeronautical engineering and aerospace and mechanical sciences
[AD-709351] N70-42151
MECHANICAL MEASUREMENT
Rumanian book on methods, equipment and facilities for aeromechanical measurements covering fluid flow, wind and shock tunnels, flow measurements, etc
A70-45000
MECHANICAL PROPERTIES
Forged alpha/beta Ti alloys, investigating relationship between mechanical properties and microstructures produced by heating
A70-34427
High strength Ti alloys depth hardenability, discussing mechanical properties and use in aircraft components
A70-34434
Ti alloys use in Olympus 593 engine for Concorde SST, discussing weight saving, mechanical properties and manipulation characteristics
A70-34449
Composite compression tubes for VTOL aircraft components, describing weight parameters and mechanical properties
[AIAA PAPER 70-898] A70-35809
Normalization of mechanical properties of aircraft engine components, increasing weight efficiency and reliability
A70-37254
Graphite-polyimide composites development for high temperature environments, discussing mechanical properties
A70-38425
Alloys for aircraft structures design, considering materials strength, corrosion resistance, producibility and cost
A70-39414
Beta III Ti alloy for aircraft fasteners, describing microstructure and mechanical properties
A70-39966
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc
A70-43084
Statistical analysis of durability data of heat resistant alloys for gas turbine engines, using long term strength tests of melts in mass production
A70-43940
Annotated bibliography of tests and applications of pressure vessels - Vol. 1
[AD-702600] N70-33795
MECHANICAL SHOCK
Digest of abstracts and literature reviews concerning shock and vibration
[AD-709734] N70-41450
MECHANICS (PHYSICS)
Applied mechanics - Conference, Bucharest, June 1969
A70-42601
Applied mechanics - Conference, Bucharest, June 1969
A70-42610
Applied mechanics - Conference, Bucharest, June 1969
A70-45586
MECHANIZATION
Inertial navigation system application to air transportation, discussing system mechanization and compatibility with ATC requirements
A70-42654
MEDITERRANEAN SEA
Highly localized clear air turbulence at aircraft flight level over Mediterranean, noting simultaneous temperature rise
A70-38948
METAL BONDING
Adhesive bonded aircraft structures, discussing methods and requirements for establishment and control of manufacturing procedures
A70-38594
Synthetic resin adhesives for aircraft components fabrication
A70-40532
Airframe skin panels adhesive bonding in wide-bodied jet transports, emphasizing fuselage fatigue and corrosion resistance
[SAE PAPER 700863] A70-45875
METAL FATIGUE
Ti-Al-Cr-Fe tensile, fatigue and creep properties at various temperatures, considering industrial applications
A70-34428
Fatigue characteristics of Ti alloy forgings for rotary wing vehicles, discussing effects of welding, annealing, reduction, surface finish and shot peening
A70-34441
Gaseous radioactive penetrant inspections for early low cycle fatigue in aircraft engine materials, discussing impact on maintainability
A70-38828
METAL FOILS
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration
A70-36345
METAL PLATES
Influence of surface melting or surface vaporization on temperature distribution in plate
[AD-705640] N70-33519
METAL SHEETS
Ti hot forming, discussing sheet use as aircraft structural material
A70-34444
Ti sheet welded construction for transport aircraft fuselages, assuming use of electron beam and plasma arc equipment
A70-34452
METAL STRIPS
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models
[AIAA PAPER 69-350] A70-35657
METALLURGY
Be production, development, potential uses and properties
[ASM PAPER GG8-102] A70-39970
Annotated bibliography of tests and applications of pressure vessels - Vol. 1
[AD-702600] N70-33795
Scientific research in materials science, general science, electronics, and oceanography
[AD-706718] N70-38374
METALS
Plastic strain in metals, including work hardening and recovery, atomic lattice distortions, and metallurgical transformations
N70-37804
METEOROLOGICAL PARAMETERS
Effects of meteorological parameters and instrument errors on vertical flight performance of supersonic transports
[NASA-CR-1570] N70-34253
Cloud and synoptic parameters associated with clear air turbulence
[NASA-CR-111778] N70-40766
METEOROLOGICAL RADAR
General aviation weather avoidance sensor study
[NASA-CR-112774] N70-36981
METHANE
Turbine aerodynamic and cooling requirements for turbojet powered Mach 3 transport using methane fuel
[NASA-TN-D-5928] N70-34015

METHOD OF CHARACTERISTICS
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles A70-37228
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics A70-37242
Method of characteristics analytical technique for flow predictions of supersonic cross flows over conical bodies [NASA-TN-D-5884] N70-32004
METHODOLOGY
Rumanian book on methods, equipment and facilities for aeromechanical measurements covering fluid flow, wind and shock tunnels, flow measurements, etc A70-45000
METROLOGY
Measurement methods for forces, pressure and heat flow in hotshot hypersonic wind tunnels A70-34773
Rumanian book on methods, equipment and facilities for aeromechanical measurements covering fluid flow, wind and shock tunnels, flow measurements, etc A70-45000
MICROBIOLOGY
Field test for microbiological contamination of jet fuel, discussing phosphates detection A70-36344
MICROMINIATURIZATION
Theory of functional electric networks and microminiaturization for avionics system [AD-705677] N70-34957
MICROPROGRAMMING
Airborne/spaceborne computer systems engineering, including digital techniques, design tradeoffs, man machine interfaces, display devices, memory, microprogramming, packaging, and maintainability [AGARDOGRAPH-127] N70-39489
MICROSTRUCTURE
Forged alpha/beta Ti alloys, investigating relationship between mechanical properties and microstructures produced by heating A70-34427
Beta III Ti alloy for aircraft fasteners, describing microstructure and mechanical properties A70-39966
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification A70-44857
MICROVISION LANDING AID
Electronic attitude director indicator /EADI/ for supersonic transport, employing CRT display, head down TV and microvision sensors A70-37911
MICROWAVE AMPLIFIERS
S band CW power amplifier and varactor doubler module for airborne phased arrays A70-36674
MICROWAVE RADIOMETERS
Microwave radiometry and applications as material composition and temperature sensors for aircraft navigation, landing aids, pollution surveillance, meteorology and oceanology A70-44648
Microwave radiometric airborne measurement of salinity of Mississippi River outflow, using P3A aircraft A70-45979
MICROWAVES
Earth/atmosphere system outgoing microwave radiation calculations, surveying aircraft/satellite measurements at various wavelengths A70-45192
MILITARY AIR FACILITIES
Value of static and trend persistance in one-hour prediction of ceiling and visibility [AD-703305] N70-35342
Measuring forecasting performance relative to previous performance and use of automated forecast verification as management tool [AD-707498] N70-37703
Occurrence of typhoons and tropical storms at selected locations for years 1949 to 1969 [AD-706408] N70-37861
Air facility establishment criteria N70-41528
MILITARY AIRCRAFT
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems A70-34672
Military aircraft avionics central digital computers, discussing memory capacity, computational speed requirements, cost and tradeoffs A70-34673
Avionics problems in future Army aviation, discussing communications, navigation, instrumentation, automatic flight control, electronic countermeasures, fire control, etc A70-34725
Variable sweep high thrust-weight ratio multirole combat aircraft /MRCA/, discussing British-French cooperation, development programs and requirements A70-34916
Airborne data acquisition and flight recorder systems, comparing civil and military aircraft requirements A70-35515
System engineering process for survival enhancement of military aircraft to meet stringent requirements of general nuclear war [AIAA PAPER 70-893] A70-35810
Air to air armament selection effect on aircraft configuration [AIAA PAPER 70-939] A70-35848
RAF aircraft damage due to bird strikes in U.K., discussing preventive measures at airfields A70-35978
German Air Force aircraft bird strikes statistics A70-35979
Military airlift command bird hazard minimization near airfields by environmental control, including uses of scare devices, chemicals, trapping, etc A70-35988
YF-12A interceptor aircraft development and testing, discussing titanium alloys application, aerodynamics and thermodynamics, escape systems for high speed and altitude tests A70-36451
Military aircraft engines performance increase and cost reduction [SAE PAPER 700272] A70-36817
Military and commercial transports turbofan propulsion systems impact on future aircraft design and development [SAE PAPER 700267] A70-36820
High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications [AIAA PAPER 70-904] A70-37392
USAF operations integration into ATC system A70-38229
Military Airlift Command jet aircraft computerized area navigation system operational procedures A70-38232
Export market research for military aircraft A70-38618
Comparative demand forecasting for military helicopter spare parts, stressing exponential smoothing model A70-39643
Military and commercial aircraft maintenance costs reduction, discussing labor/material ratio, spare parts use, diagnostic systems, etc A70-40750
Integrated communication, navigation and identification for worldwide needs of military aircraft A70-41132
High temperature liquid metal cooled nuclear reactor for military aircraft with long flight endurance and range A70-43188
Fluidics in naval avionics, discussing CH-46A helicopter stability augmentation and approach power compensator for carrier-based aircraft

A70-45428
Nondestructive testing technology impact on military aircraft maintenance, discussing training, applications and advantages
A70-45678
Fluidically augmented artificial feel system for fighter and attack aircraft control, discussing improved handling qualities
[SAE PAPER 700785] A70-45859
Tradeoffs between various configurations of onboard fault detection and fault isolation systems
N70-32166
Design possibilities for tactical aircraft in next decade
[AD-707042] N70-37730
Air Force aircraft structural integrity program with referenced specifications - airplane requirements
[AD-707884] N70-39664
Fatigue load monitoring of military aircraft in NATO countries
[AGARD-AR-28] N70-40069
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Development program stages in preliminary military aircraft design
N70-40702
Army aircraft development programs and Dassault prototypes
N70-40704
Airframe materials advances and influence on military aircraft design
N70-40714
Airframe systems design evaluation for military aircraft
N70-40715
Interface of maintainability, reliability, human factors, and system safety in military aircraft design
N70-40718
Avionics design problem in systems integration for terrain following capability in military transport aircraft
N70-40719

MILITARY AVIATION
Army aviation requirements in high intensity conflicts, discussing transportation, communications, intelligence acquisition, organization and suitable aircraft types
A70-44855
National aviation system policy and plan
N70-41544
Potential savings in military aircraft maintenance
N70-41985

MILITARY HELICOPTERS
AH-1G helicopters combat flight loads from onboard oscillograph data recording, defining performance in terms of critical variables
A70-34706
UH-1C, AH-1G and UH-1H helicopters combat operational flight profiles, considering airspeed, altitude, rotor speed, load factor, etc
A70-34717
Attack helicopter fire control system with day and night detection, recognition and kill capabilities, discussing system components, operation and reliability
A70-34732
Flight loads spectrum data for army CH-47A, UB-1B and CH-54A helicopters components compared with fatigue life spectra
A70-35955
U.S. Army rotary wing mishap experience for product assurance and accident prevention
A70-38825
U.S. Army UH-1/AH-1 helicopter maintainability and reliability field program, including statistical data
A70-38827
Armor airframed helicopter for aerial armored reconnaissance vehicle, noting design, fabrication and weight
A70-44095
SA-341 Gazelle French military helicopter configuration, performance, flight characteristics, technological particulars and design
A70-44854
Military helicopter test program application to commercial VTOL operations, discussing military-civil design and development relationships
[AIAA PAPER 70-1242] A70-46327

MILITARY TECHNOLOGY
Air superiority fighter design philosophy, including tradeoffs between armament, detection capability, thrust, speed and load factor
[AIAA PAPER 70-930] A70-35840
RAMMIT /reliability and maintainability management improvement techniques/ for processing maintenance data relevant to Army aircraft operations and support
A70-38826
General Purpose Automatic Test System using building block concept for avionic systems evaluation at military depot level
A70-40771
Disposable load drop effect on aircraft range, using Breguet equations for graphic determination of bombing range
A70-40868
Army aviation requirements in high intensity conflicts, discussing transportation, communications, intelligence acquisition, organization and suitable aircraft types
A70-44855
Military system development planning for operational capability needs
N70-40720

MILLIMETER WAVES
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721

MILLING (MACHINING)
Surface alterations by machining processes for gas turbine engine materials, emphasizing effects of milling on Ti and grinding on high strength steels
[ASME PAPER 70-GT-100] A70-36888

MILLING MACHINES
Digitally controlled milling machine for complex aerodynamic profiles and prismatic blades
A70-43117

MINIATURIZATION
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc
A70-38523
Helicopter rotors fatigue testing using small scale models of full scale components
[ICAS PAPER 70-34] A70-44131

MINIMAX TECHNIQUE
Minimax study of aim angle for proportional navigation missile - planar case
[AD-708167] N70-39778

MINIMUM DRAG
Planar wing with end plates in ground effect, calculating minimum induced drag by approximation theory
A70-40919

MISS DISTANCE
Minimax study of aim angle for proportional navigation missile - planar case
[AD-708167] N70-39778

MISSILE CONTROL
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules
A70-44542

MISSILE VIBRATION
Ground vibration testing for aircraft and missile flutter prevention
[ONERA-TP-816] A70-36508

MISSION PLANNING
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers
[AIAA PAPER 70-899] A70-35815

MIXING LENGTH FLOW THEORY
Turbulent near wake of symmetrical airfoil,

determining universal constant in mixing length formula for inner wake
A70-40276
MOBILE LOUNGES
Mobile lounges and airport productivity concepts for optimal handling of passengers at airport terminal
[AIAA PAPER 70-918] A70-35830
MODELS
Sonic boom modeling and topographic and atmospheric effects
[MDC-J0734/01] N70-36809
MODULES
F-111 crew escape module, describing main parachute and pyrotechnics severance improvements, parachute deployment and inflation, etc
[AIAA PAPER 70-1210] A70-41807
MOISTURE CONTENT
Water separation index modified /WSIM/ test for jet fuel surface active materials in relation to filter/separator performance
[SAE PAPER 700279] A70-36815
MOLECULAR BEAMS
Monoenergetic nitrogen free molecule beam impingement on solid surface, calculating satellite drag coefficients from momentum transfer measurements
A70-41743
MOLECULAR INTERACTIONS
Molecular reflection effects on aerodynamic characteristics of blunt bodies in rarefied gas flow
[NASA-TT-F-13250] N70-37535
Gas-surface interactions and orbital aerodynamic calculations
[NASA-CR-102827] N70-41375
MOLECULAR PHYSICS
Nonisentropic gas dynamics measurements and probe development
[AD-705655] N70-36489
MOLECULAR RELAXATION
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind tunnel flow
A70-35962
MOMENTS
Forces and moments on prolate spheroid accelerating with constant angle of attack under free surface
[UCRL-50843] N70-36183
MOMENTS OF INERTIA
Variable wing sweep aircraft angular motion mathematical model, analyzing inertial moments influence on control dynamics
A70-40182
Determination of inflated shape and inertial properties of all-flexible parawing
[NASA-TN-D-5900] N70-32259
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161
Axial and centrifugal moments of inertia arising from static balancing of gyroscopes
N70-37788
MOMENTUM
Liquid fuel jet engine thrust aftereffect momentum, investigating switching off transient process
A70-37249
MOMENTUM TRANSFER
Load transfer mechanics between elastic shell and airframe structure
[AD-703641] N70-35374
Turbulent mixing of supersonic jets investigated for momentum and energy equations
[AD-708735] N70-40679
MONITORS
Automatic sound monitoring system for measuring aircraft noise in airport vicinity
A70-37908
Computer controlled aircraft noise monitoring system at Stuttgart airport
A70-37909
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Laser system for monitoring wingtip vortices on runways
[NASA-TM-X-64525] N70-42182
MONOPLANES
MBB Bo-209 Monsun travel, commuter and acrobatics aircraft, discussing configurations, specifications, structure and handling characteristics
A70-37388
MOTION STABILITY
Lifting rotor blade motions stability computation using Floquet transition matrix
A70-34726
Longitudinal handling qualities of variable stability flight simulator
[AD-703225] N70-35288
MOUNTAINS
Gust and wind effects near thunderstorms and mountains and during aircraft takeoff and landing
[ARC-CP-1091] N70-37242
MOVING TARGET INDICATORS
Moving graph instrument display evaluation for landing approaches with helicopter
[NASA-TN-D-6025] N70-41183
MULTICHANNEL COMMUNICATION
Multichannel interior communication system using time multiplexing, applicable to modern aircraft
[AD-706723] N70-37740
MULTIPLEXING
Solid state multiplexed electrical power distribution system for future generation military and commercial airplanes
[SAE PAPER 700301] A70-36803
Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems
[SAE PAPER 700303] A70-36811
Aircraft digital interior communication systems, combining multiplexing techniques with solid state integrated circuits technology and systems integration
[SAE PAPER 700302] A70-36813
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques
A70-44543
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design
A70-44544
Multiplex data bus subsystem for improving reliability and reducing weight of space shuttle avionics system
N70-40957
MULTIVARIATE STATISTICAL ANALYSIS
Statistical analysis of aircraft engine oil spectrometric data
[AD-704522] N70-32783

N

NACELLES
NASA acoustically treated nacelle program reducing noise under commercial transport flight path near airports
A70-42529
Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades
[ICAS PAPER 70-14] A70-44125
L-1011 aircraft optimum minimum noise pod design, describing technology, restraints and system requirements
[SAE PAPER 700805] A70-45877
Deflector for preventing objects from entering nacelle inlets of jet aircraft
[NASA-CASE-XLE-00388] N70-34788
Nacelle induced flutter effects in elastodynamic scaled model of fan jet transport aircraft mounted in wind tunnel
[NASA-TN-D-6003] N70-39907
Longitudinal aerodynamic characteristics of twin-turbofan supersonic transport with nacelles mounted under wings

[NASA-TN-D-5971] N70-40689
NASA PROGRAMS
NASA research in turbojet aircraft propulsion noting inlet, compressor, combustor, turbine and nozzle component technology
[ICAS PAPER 70-46] A70-44144
Commercial transport aircraft fatigue loading data from NASA VGH /airspeed-acceleration-altitude/ program, discussing instrumentation, sample sizes, etc
A70-44548
NACA/NASA rotary wing aircraft research covering autogyro and helicopter development, noting flight safety
A70-44851
NACA/NASA rotating wing aircraft research history 1915-1970, Part 2, autogyro flight test experiences, rotor blade dynamics research, interest in helicopters, etc
A70-44852
NACA/NASA rotary wing aircraft research history 1915-1970, Part 3, covering rotor and helicopter theory, related flight and wind tunnel testing, etc
A70-44853
NACA/NASA rotating wing aircraft research history 1915-1970, Part 3, covering rotor dynamics and flying qualities, hovering tests, rotor flow, loads, etc
A70-44856
Manned space flights, satellite observations, space sciences, and air traffic control - NASA report to Congress for 1 Jan. to 30 June 1969
[NASA-TM-X-64292] N70-33962
NASA aeronautic research and development projects
N70-36782
NATIONAL AIRSPACE UTILIZATION SYSTEM
National airspace system /NAS/, describing en route stage A automated air traffic control
A70-36399
National Airspace System air traffic control automation program for en route and terminal facilities
A70-37914
Area navigation system charting, discussing effect on flight information publications
A70-38231
Airline area navigation in national airspace system, emphasizing moving map display for navigation charting
A70-38233
ATC and general aviation growth, considering airport capacity, radars, navigation, National Airspace System, etc
A70-38631
ATC integration of SST, discussing en route and terminal projects of national airspace system, modular automation, instrument flight rules, etc
A70-38633
Air traffic control, future national airspace system improvements in view of air transportation growth, computerized automation technology, etc
[AIAA PAPER 70-1263] A70-45969
NAVIGATION
Position finding and navigation in space, air and sea - Conference, Hamburg, October 1969, Volume 1
A70-41126
NAVIGATION AIDS
Air traffic control, discussing precision instrument landing, approach lighting, collision avoidance, navigation aids, etc
A70-35185
Navigation aids evolution and trends, noting ground stations, Intelsat 3 and navigation satellites
A70-35879
STOL navigation systems, evaluating Vector Analog Computer, Decca Omnitrac IIB and inertial system
A70-36513
SATRAM, multiple trajectory landing system for aircraft position indication within large airspace
A70-36948
Area navigation system charting, discussing effect on flight information publications
A70-38231
Pictorial display methods for pilot error reduction in area navigation via guidance control and capability beyond visual field
A70-38234
Eurocontrol evaluation of navigational aid systems air traffic control, examining HARCO and VORDAC systems
A70-38641
General aviation weather avoidance sensor study
[NASA-CR-112774] N70-36981
Aircraft accident report for DC-3 near Lone Pine, California on Feb. 18, 1969
[PB-189650] N70-37177
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
Terminal navigation aids and IFR operations for STOL aircraft
N70-41081
Air navigation aids and hybrid navigation systems for transport and Comet 4 aircraft
[RAE-TR-69220] N70-42346
NAVIGATION INSTRUMENTS
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems
A70-34672
Military Airlift Command jet aircraft computerized area navigation system operational procedures
A70-38232
Airborne navigation systems operational aspects in ATC, discussing sensors, digital computer, cockpit displays, etc
A70-38640
Navigation errors and time delays in prediction techniques for air traffic control
A70-38642
Aircraft navigation control system by digital computer combined with inertial platform, considering emergency backup, slow drift and system malfunctions
A70-46092
Aeronautic navigation equipment including gyroscopes. Inertial navigation systems, and self adaptive control systems - stability and accuracy determinations
[JPRS-51241] N70-37787
NAVIGATION SATELLITES
Navigation aids evolution and trends, noting ground stations, Intelsat 3 and navigation satellites
A70-35879
Ground and cockpit initiated collision avoidance commands system based on satellites surveillance of aircraft position and velocity data
A70-38242
Telecommunication, ATC and navigation satellite systems, examining economic bases for aeronautical and maritime space systems
A70-39407
Aeronautical satellite system for civil flight safety, discussing operational, technical and economic aspects
A70-41131
Dioscures project for ATC over Atlantic Ocean, describing distance measurement by simultaneous use of two geostationary satellites
A70-41258
Air traffic safety problems, discussing satellite radiobeacons applications to aerial navigation
A70-42652
Satellite technology applications to ATC, including communications, navigation, surveillance over water and data acquisition
[AIAA PAPER 70-1301] A70-45922
Satellite based navigation/air traffic control information systems for short range STOL air carrier aircraft
[AIAA PAPER 70-1338] A70-45930
Aeronautical satellite communication, navigation, and surveillance
N70-41527
NAVION AIRCRAFT
Wind tunnel test data for predicting aerodynamic loads on single engine light aircraft
N70-39253

NETWORK SYNTHESIS
Theory of functional electric networks and microminiaturization for avionics system
[AD-705677] N70-34957
NEWTON THEORY
Newtonian hypersonic aerodynamic theory for arbitrary bodies, discussing computational difficulty for shadowed areas
A70-41866
Digital computer program for Newtonian aerodynamics of body composed of flat plate segments
[NASA-TM-X-64431] N70-35621
NICKEL ALLOYS
Ni superalloys for gas turbine engines, discussing chemical composition, microstructure, strength, solidification, etc
[ASME PAPER 70-GT-24] A70-36831
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification
A70-44857
NIGHT
Aircraft nighttime and daytime accident rate comparision, considering darkness, flight phase, etc
A70-41489
NIGHT VISION
Helicopter tinted Plexiglas for heat reduction and effecting night visibility
[AD-709405] N70-41229
NITROGEN
Corrections for real gas effects in nitrogen gas expansion by isentropic processes and computer programs of hypervelocity wind tunnel nozzle design
[VKI-TN-58] N70-42586
Summary of C-141 and C-135 aircraft fuel tank nitrogen inerting tests
N70-42755
NODES (STANDING WAVES)
Nodal patterns on thin elastic circular plate vibrating in flexure, considering natural and compounded modes
A70-38245
NOISE INTENSITY
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects
A70-34729
Aircraft noise reduction, discussing generation sources in propulsion system, noise levels and subjective responses
A70-44395
Cockpit noise exposures associated with operation of fixed and rotary wing aircraft
[AD-705964] N70-33974
Noise and sound propagation and nonlinear signal distortion in circular tubes
[NPL-AERO-AC-43] N70-35068
Perceived noisiness of various types of aircraft by subjects seated outdoors and inside houses
[NASA-CR-1635] N70-35881
Temporal and spectral combinations effects on human judgements of aircraft noisiness
[FAA-NO-69-3] N70-42217
Aircraft noise exposure forecasting procedures and applications
[FAA-NO-70-9] N70-42218
Noise exposure forecast contours for 1967, 1970, and 1975 at 28 airports
[FAA-NO-70-8] N70-42219
Considering noise intensity levels in houses and buildings near airports
[NLL-LIB-COMM-1527-/5196/] N70-42827
NOISE PROPAGATION
Collection of papers on aerodynamic noise covering noise generation, solid boundaries effect, strength distribution, jet noise, perturbation theory, etc
A70-35448
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Jet engine noise propagation near porous surface, predicting anomalous LF dip from direct and reflected waves interference with phase delay
A70-46068
Axial flow compressor fan discrete tone noise radiation directivity pattern measurement and theoretical explanation for cut-off effect, power and harmonics
A70-46069
NOISE REDUCTION
Sound transmission and suppression in turbomachinery fans and compressor ducts, using three dimensional wave equation
[ASME PAPER 70-GT-58] A70-36873
NASA acoustically treated nacelle program reducing noise under commercial transport flight path near airports
A70-42529
Structural and environmental design criteria for acoustical duct-lining materials in turbofan noise suppression
A70-42531
Duct lining parameters effects on engine inlet and fan discharge noise reduction during fan jet landing
A70-42532
Test rig vehicle design for noise research on single stage high bypass ratio fans for quieter turbofan power plants
[AIAA PAPER 69-492] A70-42708
Turbojet engines noise-suppressing nozzles flow rate and thrust characteristics calculation
A70-43371
Jet aircraft noise reduction devices directed at turbulence fluctuation noise sources, noting effects on flight characteristics
[ICAS PAPER 70-21] A70-44112
Aircraft noise reduction, discussing generation sources in propulsion system, noise levels and subjective responses
A70-44395
Noise reduction regulations effects on subsonic transport design and configuration
[SAE PAPER 700806] A70-45876
L-1011 aircraft optimum minimum noise pod design, describing technology, restraints and system requirements
[SAE PAPER 700805] A70-45877
Noise suppression for high-bypass ratio CF6 turbofan engine in DC-10 airplane, considering effect on engine design
[SAE PAPER 700804] A70-45878
STOL aircraft augmentor wing concept, examining noise suppression, flight research vehicle program and application to turbofan production aircraft
[SAE PAPER 700812] A70-45903
Boeing 2707 SST design for low community noise, discussing engine-airframe matching effect
[SAE PAPER 700808] A70-45906
Noise reduction design for subsonic transport turbofan engines
[SAE PAPER 700807] A70-45907
SST sonic boom noise level reduction by thermal simulation of long body aircraft, considering thermal spike or keel
[AIAA PAPER 70-1323] A70-45942
Upper surface, external flow, jet-augmented flap configuration for high wing jet aircraft for noise reduction
[NASA-CASE-XLA-00087] N70-33332
Noise exposure forecasts for John F. Kennedy, O Hare International, and Los Angeles International airports, including effects of changes in aircraft hardware and procedures
[FAA-NO-70-7] N70-36942
Aircraft noise study of Logan International Airport to determine effects on surrounding community
[PB-190118] N70-37337
Aircraft engine noise and sonic boom
[AGARD-AR-26-70] N70-38782
Research and development programs for reduction of sonic boom and aircraft noise
N70-40787
Low-speed fan used for noise reduction data on fan and exhaust jet noise
[NASA-TM-X-52871] N70-41963
NOISE SPECTRA
Flow noise mechanisms, considering discharge, propeller, ventilator, jet engine, boundary layer, water pipe and supersonic aircraft

sources
A70-38474
Discrete components formation in noise spectra of axial turbocompressor intake, considering relationship between blades and rotor disk
A70-38652
Rod surface roughness effect on eddying sound frequency and intensity and on aerodynamic resistance
A70-38654
Supersonic air jet noise spectrum analysis at various pressures
A70-38659
Supersonic jets noise spectra, using linear equations of moving medium acoustics
A70-38660
Discrete components of noise frequency spectrum of free supersonic jet
A70-38661
Noise spectra of two dimensional jet flowing from nozzle ejector, using dispersion equation
A70-38662
Acoustic lining technology and materials for turbofan engine ducts, considering environmental factors and noise spectra
A70-42530
Aircraft noise sources, examining compressors with dynamic pressure devices and jets with turbulence investigations
[ICAS PAPER 70-22] A70-44111

NOISE THRESHOLD
Modified calculations for relative perceived noisiness of aircraft by human subjects
[NASA-CR-1636] N70-35898

NONDESTRUCTIVE TESTS
IR NDT bond inspection system for helicopter rotor blade honeycomb box assemblies, using closed circuit slow scan video system to detect bondline voids
A70-35184
Gaseous radioactive penetrant inspections for early low cycle fatigue in aircraft engine materials, discussing impact on maintainability
A70-38828
Condition Monitored Maintenance program for turbine engines eliminating total overhauls at specified time, using NDT
A70-38830
Aircraft engine diagnostics and defectoscopy, considering radioactive isotopes testing for component wear and performance
A70-43083
Nondestructive testing - Conference, Hanover, June 1970, General problems
A70-45676
Nondestructive testing for aircraft maintenance, considering economics
A70-45677
Nondestructive testing technology impact on military aircraft maintenance, discussing training, applications and advantages
A70-45678
Nondestructive testing - Conference, Hanover, June 1970, Material properties determination
A70-45717
NDT for aircraft service life extension, discussing fatigue tests and crack detection
A70-45719

NONEQUILIBRIUM FLOW
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind tunnel flow
A70-35962
Research on surface catalysis in nonequilibrium flow
[AD-704814] N70-33275

NONFLAMMABLE MATERIALS
Flame resistant nonmetallic materials for manned spacecraft and aircraft interiors, considering fibers, polymers, paper and composites
A70-42295
Fireproof nonmetallic materials for spacecraft and aircraft, discussing functional utility, durability and aesthetic requirements relative to environmental conditions
A70-44610

NONISENTROPICITY
Nonisentropic gas dynamics measurements and probe development
[AD-705655] N70-36489

NONLINEAR EQUATIONS
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515

NONLINEAR SYSTEMS
Soviet book on vibrations in flight vehicle engines covering linear and nonlinear systems, computer methods, etc
A70-37229
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes
A70-37403
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836
Mathematical theory of control of nonlinear processes emphasizing controller design techniques for systems with distributed parameters and time delays
[AD-706908] N70-37666

NONLINEARITY
Nonlinear heaving motion of plenum-chamber air cushion vehicles induced by sinusoidal ground irregularity
A70-42280
Wheel force and roll moment nonlinearities effect on light STOL aircraft handling qualities during approach
[ICAS PAPER 70-55] A70-44151

NONUNIFORM FLOW
Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837
Actuator disk theory and flow field calculations for propeller induced flow with nonuniform circulation distribution
[NASA-CR-1672] N70-38435

NORMALIZING (STATISTICS)
Normalization of mechanical properties of aircraft engine components, increasing weight efficiency and reliability
A70-37254

NORTH ATLANTIC TREATY ORGANIZATION (NATO)
Fatigue load monitoring of military aircraft in NATO countries
[AGARD-AR-28] N70-40069

NOSE CONES
Effects of pointed nose on spin characteristics of fighter aircraft model and correlation of free flight test results with theoretical data
[NASA-TN-D-5291] N70-37395

NOSE WHEELS
Boeing 737 aircraft nose gear gravel deflector and engine vortex dissipator
[AIAA PAPER 70-912] A70-35824
Large wheel and tire imperfection effects on nosegear parametric shimmy instability, using Mathieu equation
A70-36455
Nose gear steering system for vehicles with main skids to provide directional stability after loss of aerodynamic control
[NASA-CASE-XLA-01804] N70-34160

NOTCH STRENGTH
Static strength of notched or cracked structural components, including fatigue crack initiation and elastic stress distribution in thin sheets
N70-37806

NOZZLE DESIGN
Close-spaced nozzles twin jet configuration, achieving low nozzle and total afterbody drag
[AIAA PAPER 70-934] A70-35844
Supersonic air intake unsteady buzz phenomenon, examining shear layer under cowl and boundary layer detachment at shock wave base for design improvement
A70-41262
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel honeycomb construction
A70-43213

Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics A70-44991
Supersonic combustion of vitiated air-hydrogen mixtures [AD-705129] N70-32090
Intermittent, single jack, flexible nozzle supersonic wind tunnel calibration at Mach numbers 1.5 to 3.0 [TAE-110] N70-36965
Penshaped, supersonic exhaust nozzle design [NASA-CASE-XLE-00057] N70-38711
Telescoping-spike supersonic nozzle for turbojet or ramjet engines [NASA-CASE-XLE-00005] N70-39899

NOZZLE EFFICIENCY
Low angle conical plug nozzle with stowed thrust reverser performance at Mach 0 to 2.0 [NASA-TM-X-2116] N70-42437
Boattail and plug area variation effect on convergent and plug nozzle efficiency at Mach 0 to 1.97 [NASA-TM-X-2112] N70-42438

NOZZLE FLOW
Optimum nozzle geometry for minimum heat transfer to convergent-divergent nozzle wall from high enthalpy flow A70-35238
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles A70-37228
Noise spectra of two dimensional jet flowing from nozzle ejector, using dispersion equation A70-38662

NOZZLE GEOMETRY
Optimum nozzle geometry for minimum heat transfer to convergent-divergent nozzle wall from high enthalpy flow A70-35238
Two stream ejector type propelling nozzles for supersonic aircraft, investigating various configuration effects over range of secondary/primary air flow ratios [ICAS PAPER 70-48] A70-44145
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency A70-46012

NOZZLE THRUST COEFFICIENTS
Performance analysis of rotary nozzle utilizing 30 deg spin angle rotor [AD-705057] N70-32246

NOZZLE WALLS
Feasibility of uncooled nozzle throat for hypersonic wind tunnel facility [AD-705577] N70-33910

NUCLEAR PROPELLED AIRCRAFT
High temperature liquid metal cooled nuclear reactor for military aircraft with long flight endurance and range A70-43188

NUCLEAR PROPULSION
Criticality study of meltdown configurations for nuclear aircraft reactors [NASA-TM-X-2068] N70-36660

NUCLEAR REACTOR CONTROL
Criticality study of meltdown configurations for nuclear aircraft reactors [NASA-TM-X-2068] N70-36660

NUCLEAR WARFARE
System engineering process for survival enhancement of military aircraft to meet stringent requirements of general nuclear war [AIAA PAPER 70-893] A70-35810

NUMERICAL ANALYSIS
Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model [ICAS PAPER 70-52] A70-45500
Numerical technique for computing optimum spanwise load distribution on nonplanar wings of arbitrary shape minimum induced drag [AD-704502] N70-36322
Methane or hydrogen fuel direct cooling of first stage stator of SST aircraft turbine - numerical heat transfer analysis [NASA-TN-D-6042] N70-42326
Numerical methods for determining whirl characteristics of rotors running on shafts supported by ball bearings N70-43036

NUMERICAL CONTROL
Digitally controlled milling machine for complex aerodynamic profiles and prismatic blades A70-43117
Computerized air cargo clearing, discussing London Airport Cargo Electronic-data- processing Scheme A70-43272
Computer-aided production engineering involving numerically controlled machines for Rolls-Royce aircraft engines manufacture A70-45299

NUMERICAL INTEGRATION
Aircraft and rocket guidance systems navigation error analysis, discussing numerical integration techniques and computer program [AIAA PAPER 70-1004] A70-39527

NUMERICAL WEATHER FORECASTING
Numerical fog forecasting method for airport in Yugoslavia [NLL-M-9052-/5828.4F/] N70-36479
Numerical forecasting of low visibilities caused by suspended particles in atmosphere [AD-708141] N70-39902

NYLON (TRADEMARK)
Packable near weightless nylon cloth wings without rigid members for improved aeronautical efficiency in cargo delivery, powered flight and rocket and spacecraft recovery [AIAA PAPER 70-880] A70-34815

O

OCEANOGRAPHY
Scientific research in materials science, general science, electronics, and oceanography [AD-706718] N70-38374

OCULOMETERS
System design of optimal remote oculometer for use in operational aircraft [NASA-CR-1562] N70-33103

OGIVES
Supersonic flow field over aeroelastic ogive cylinder model with boundary layer control [AD-708485] N70-40297

OILS
Statistical analysis of aircraft engine oil spectrometric data [AD-704522] N70-32783
High altitude flow visualization of boundary layer transition and shock waves using oil coatings [ARC-CP-1090] N70-37173

OMEGA NAVIGATION SYSTEM
General aviation aircraft influences on federal airways systems, considering area and Omega navigation examples [AIAA PAPER 70-1314] A70-45929
Reduction of precipitation effects on Omega aircraft receivers [AD-707710] N70-40129

OMNIDIRECTIONAL ANTENNAS
Vertically polarized stacked array of independently fed omnidirectional antennas for use in radar collision warning on commercial aircraft [NASA-CASE-LAR-10545-1] N70-35524

OMNIDIRECTIONAL RADIO RANGES
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system A70-46240

ON-LINE PROGRAMMING
On-line final V/STOL Wind Tunnel Data Encoding and Evaluation System /WINDEE/ for complex powered models, using computer monitoring A70-35494
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers [AIAA PAPER 70-899] A70-35815
Discussion on feasibility of real-time on-line optimal flight control [AD-709714] N70-41664

ONBOARD EQUIPMENT
Aircraft onboard maintenance recording system,

discussing design and effectiveness
A70-35516
Engine vibration monitoring system for Boeing 747 aircraft, including piezoelectric transducer, transmission assembly and differential charge converter
A70-37898
ATC by scanning beam ILS and onboard control systems, increasing airport capacity and terminal area safety
[AIAA PAPER 70-1033] A70-39504
Onboard velocity sensors for VOR/DME navigation systems positional accuracy improvement, describing optimal and suboptimal data filtering
[AIAA PAPER 70-1024] A70-39511
C5 Malfunction Detection Analysis and Recording /MADAR/ subsystem for onboard fault isolation including engines
[SAE PAPER 700820] A70-45898
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Interdependence of built-in, onboard, and ground based test facilities
N70-32158
Interrelation of onboard and ground automatic test equipment in achieving effective overall support system
N70-32159
Tradeoffs between various configurations of onboard fault detection and fault isolation systems
N70-32166
Onboard checkout systems approach to avionic systems self-test
N70-32167
Analysis of onboard equipment testing methods
N70-32169

ONE DIMENSIONAL FLOW
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results
[AIAA PAPER 70-971] A70-39558
Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces
A70-41444

OPERATING TEMPERATURE
Model scale effect on inlet temperature rise of VTOL jet configurations
[NASA-CR-66965] N70-34533

OPERATIONAL HAZARDS
Using polyurethane foam as inerting material in fuel tanks of combat aircraft
N70-42754

OPERATIONAL PROBLEMS
Gas turbine engine compressor rotor roller bearing operation conditions analysis by computer calculation of thermal regime
A70-41777
STOL aircraft operational constraints, considering economics, short haul market characteristics, community acceptance, speed, propulsion system, takeoff/landing performance and maneuverability
[AIAA PAPER 70-1283] A70-45972

OPERATIONS RESEARCH
Operational analysis and real time computer simulation models in ATC development
A70-38637
Management operations research, and design of present air traffic control system and future research
[NASA-CR-109980] N70-35713

OPERATOR PERFORMANCE
Articulated variable link length human model for simulating operator performance in cockpits
[AD-703271] N70-32341

OPERATORS (PERSONNEL)
Statistical data tables on commuter air carrier operators
N70-41172

OPTICAL COMMUNICATION
Optical communications in space, considering multiple access low earth orbit-to-synchronous and synchronous-to-synchronous links
A70-37878

OPTICAL MEASUREMENT
Approach guidance method using single onboard optical measurement
[NASA-TN-D-5963] N70-40743

OPTICAL MEASURING INSTRUMENTS
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339

OPTICAL TRACKING
ILS glide slope calibration using optically projected digital codes as reference
A70-37912

OPTIMAL CONTROL
Aircraft optimal operating procedure development by integral-variational performance analysis methods, discussing flight paths, fuel consumption, mission requirements, etc
[AIAA PAPER 70-876] A70-34812
STOL takeoff trajectory optimization for heavily loaded helicopter, using optimal control theory
A70-35841
Stochastic processes with linear dynamics and quadratic control cost, considering application to aircraft landing approach path optimization
A70-35973
Necessary and sufficient conditions for optimal control law existence for model following system, discussing applications to aircraft control
A70-36443
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques
A70-37241
Satellite-based air traffic control system for North Atlantic, applying stochastic optimal control theory
[AIAA PAPER 70-966] A70-39563
Sensitivity optimization for linear optimal control systems design, describing aircraft lateral-directional control case study
[AIAA PAPER 70-962] A70-39567
Stochastic processes control optimization, selecting elastic aircraft stabilizer planform
A70-43352
Two stage gas turbine engine optimal tuning for RPM, thrust, fuel rate and gas temperature, describing automated bench tests
A70-43361
Operational air traffic control considering several optimality criteria
[NASA-TT-F-13276] N70-41884

OPTIMIZATION
VTOL aircraft power plants optimization for future helicopter missions without restrictions of limited off-shelf inventory
A70-34708
V/STOL 5000 hp engine design optimization, considering component arrangements, rotor design, blade cooling method and fuel control
A70-34709
Turbofan engine performance optimization by closed form solution of operating cycle parameter functions
[ASME PAPER 70-GT-65] A70-36840
Boundary layer optimization for high turning axial flow compressor blades, using flow theory and conformal mapping
[ASME PAPER 70-GT-88] A70-36879
Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions
A70-38304
Cost and time optimization for complex aircraft development projects via network planning
A70-39644
Aircraft engine design combining turbojet and ramjet features to ensure optimum performance
A70-40148
Fuselage frames minimum weight analysis by automatic iterative method
[SAWE PAPER 826] A70-40370
Optimum pressure distribution and airfoil profiles for maximum lift without separation in incompressible flow determined by second order theory
[AIAA PAPER 69-739] A70-42704
Air transport system technical and operational functions optimization

A70-43532
Planning criteria for optimum metropolitan airport system considering operational, physical, social and economic factors
[AIAA PAPER 70-1266] A70-45921
Discussion on feasibility of real-time on-line optimal flight control
[AD-709714] N70-41664
ORBITAL MECHANICS
Gas-surface interactions and orbital aerodynamic calculations
[NASA-CR-102827] N70-41375
ORDNANCE
Air to air armament selection effect on aircraft configuration
[AIAA PAPER 70-939] A70-35848
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515
ORGANIZATIONS
Management organization of European operational application satellite systems, concerning interurban telecommunication and air traffic control
A70-43502
Recommendations concerning Panamanian civil aeronautics directorate
[AC-70-3188] N70-41143
ORTHOGONALITY
Orthogonality of eigenmodes of aircraft vibrations based on F-104G ground measurements
A70-44766
OSCILLATING FLOW
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations
A70-36382
Sound field produced in uniform moving ideal fluid stream by nonuniform oscillating elastic wall
A70-38657
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock
A70-40288
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory
A70-41407
OSCILLATION DAMPERS
High speed and long life bearings and dampers for future jet engines, considering design factors
[SAE PAPER 700318] A70-36800
Aircraft vertical gyro with hydraulic damping device, calculating ballistic deviations limitation conditions
A70-39733
OV-10 AIRCRAFT
OV-10A forward air control and light attack aircraft design, specifications and performance
[SAE PAPER 700837] A70-45883
Spin tunnel investigation of 1/20 scale model of modified straight-wing, twin boom, counter insurgency airplane
[NASA-TM-X-2053] N70-40657
OVERPRESSURE
Lower bounds for sonic boom, considering negative overpressure region in configuration tailoring
A70-36456
Gas turbine engine response to blast wave overpressures
[DRES-267] N70-36951
OXIDATION RESISTANCE
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines
A70-43574
OXYGEN MASKS
Continuous flow requirements in aircraft passenger oxygen systems using phased dilution principle, discussing breathing mask efficiencies
A70-44483

P

PACIFIC ISLANDS
Climatological tables for Tontouta Airfield, New Caledonia - 1951 to 1966
N70-38299
PACKAGING
Polymers industrial applications in textiles, building materials, furniture, aviation, automobile industry and packaging
A70-38700
Procedural analysis of parachute packing
[AD-706159] N70-38140
PAINTS
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and fin-plate models
[RM-487] N70-42113
PANAMA
Recommendations concerning Panamanian civil aeronautics directorate
[AC-70-3188] N70-41143
Panamanian civil aeronautics directorate departments of air safety, air traffic, airports, and air transport, with US technical assistance recommendations
[AC-70-3187] N70-41734
PANEL FLUTTER
Probability theory of stresses during random vibrations of flat panel in acoustic field of jet engine exhaust
A70-36301
Flutter design charts for isotropic panels stressed to verge of buckling for tropical values of structural damping
A70-36446
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter
A70-38342
Skew panels supersonic flutter and vibration calculated by matrix displacement method
A70-40586
Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter
A70-42603
Aeroelastic and aerothermoelastic development of winged interorbital space shuttle concerning panel flutter, stability and nonstationary lifting surface theory
A70-44760
ONERA calculations in aeroelasticity including lifting surface optimization, control surface vibration, pressure fields, aircraft transfer functions and panel flutter
A70-44762
Aerodynamic nonlinearity and turbulent boundary layer effects on hypersonic panel flutter
[NASA-CR-112668] N70-36902
PANELS
Response of acoustically loaded panel excited by supersonically convected turbulence
[NASA-CR-113879] N70-41029
PARACHUTE DESCENT
Significant terms in equations of motion for parachutes inflating in free air and in wind tunnel experiments
[AIAA PAPER 68-924] A70-36449
Aircraft-borne and descent systems performance and weight optimized for midair retrieval
[AIAA PAPER 70-1201] A70-41805
Optimum droque gun firing angle of stabilization times for MEW /Minimal Envelope and Weight/ ejection seat system, considering zero and high velocities
[AIAA PAPER 70-1208] A70-41810
Pilot airborne recovery device /PARD/ midair rescue system, discussing buoyance, midair pickup, seat ejection energy absorber, homing avionics and human factors
[AIAA PAPER 70-1206] A70-41812
Extraction parachute deployment for airdropping multiple loads from C-5A aircraft
[AIAA PAPER 70-1203] A70-41814
Attached inflated BALLUTE /balloon-parachute/ for stabilization and retardation of aircraft stores, high altitude descent devices and planetary entry vehicles

[AIAA PAPER 70-1200] A70-41816
Ballistic trajectory, packageability, deployment and flight stability of attached ram air inflatable decelerator for high speed/low altitude store delivery
[AIAA PAPER 70-1199] A70-41817
Stress distribution and shape in arbitrarily shaped gore parachute under unsteady pressure distribution during inflation and descent
[AIAA PAPER 70-1197] A70-41819
Gliding parachute air cargo systems using nonproportional and proportional automatic manual control, estimating wind effects on ground track and impact computer simulation
[AIAA PAPER 70-1193] A70-41823
Reefing systems for Parawings, Sailwings, Para-Flyers, Paraplanes and Volplanes, discussing performance tests
[AIAA PAPER 70-1192] A70-41824
All-flexible parawing as primary descent system for large spacecraft landing, discussing configuration, structural arrangement, multistage reefing and L/D performance tests
[AIAA PAPER 70-1187] A70-41828
Basket weave fabrics for gliding descent decelerators with polyurethane and nylon coatings for tearing strength and pressure packing
[AIAA PAPER 70-1180] A70-41833
Solid cloth personnel parachutes opening forces, discussing loading conditions, flight path shock parameters, mass ratio variations and elasticity of system
[AIAA PAPER 70-1167] A70-43992
Parachute trajectory and opening load prediction based on inflation process and added mass, determining drag area as function of distance
[AIAA PAPER 70-1168] A70-43993
Results of MK 45 parachute flare flight tests
[AD-702752] N70-36265
Multiple parachute system for landing control of Apollo type spacecraft
[NASA-CASE-XLA-00898] N70-36804

PARACHUTE FABRICS
Euler buckling of inflated toroidal drag bodies, including packaging and load deflection tests for Mylar, dacron-neoprene and stainless steel-silicone fabrics
[AIAA PAPER 70-1198] A70-41818
Stretch fabric materials for personnel high speed escape parachute systems
A70-44482

PARACHUTES
Spacecraft parachute stress analysis, using finite elements with nonlinear elastic properties to obtain shape and load distribution
[AIAA PAPER 70-1195] A70-41821
Drag prediction for Ballute and parachute trailing decelerators at supersonic speed and zero angle of attack, using flow field computations
[AIAA PAPER 70-1177] A70-41836
Parachute canopy surfaces transient aerodynamic pressures during unsteady processes, using piston theory
[AIAA PAPER 70-1175] A70-41838
Continuous surface of revolution parachute for supersonic/hypersonic speeds, performing wind tunnel tests
[AIAA PAPER 70-1173] A70-41840
Reefed and unreefed disk gap band parachutes tested in supersonic and subsonic wind tunnels to determine stability and performance
[AIAA PAPER 70-1172] A70-41841
Three body problem for parachute system dynamics during inflation
[AIAA PAPER 70-1170] A70-41843
Tethered parachutes vibration modes, determining fundamental frequencies from canopy/lines mass ratio and materials elastic properties
[AIAA PAPER 70-1169] A70-41844
Parachute flexibility as performance parameter, discussing stiffness-weight index, inflation process, squidding, etc
[AIAA PAPER 70-1166] A70-41845
Parachutes for low density atmospheres, describing low and high altitude test results
[AIAA PAPER 70-1164] A70-41846
Para-foil application programs and test results, discussing flight and glide performance, turn control, deployment inflation, etc
A70-42706
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals
A70-44488
Parachute opening load amplification due to suspension line elasticity, using two-body spring- mass model
A70-44531
Prototype cargo-recovery parachute assembly for airdropping heavy unit loads - design study
[AD-701004] N70-33952
Procedural analysis of parachute packing
[AD-706159] N70-38140
Outstanding problems and possible methods of solution for parachute technology in western Europe and the United States
[RAE-LIB-TRANS-1447] N70-39271

PARAGLIDERS
Hi-glide personnel canopy /Para-Foil, Parawing, Sailwing, Volplane/ technology capability requirements identification from performance parameters tradeoffs
[AIAA PAPER 70-1194] A70-41822
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion
[AIAA PAPER 70-1191] A70-41825
Parafoil flight performance predictions and test results based on wind tunnel data and manned free flight
[AIAA PAPER 70-1190] A70-41826
Para-foil application programs and test results, discussing flight and glide performance, turn control, deployment inflation, etc
A70-42706
Multiple parachute system for landing control of Apollo type spacecraft
[NASA-CASE-XLA-00898] N70-36804

PARALLEL PLATES
Critical height phenomenon for vertical jet exhausting into horizontal parallel plates channel simulating aircraft surfaces
A70-36709

PARAMETERIZATION
Turbofan engine performance optimization by closed form solution of operating cycle parameter functions
[ASME PAPER 70-GT-65] A70-36840

PARAWINGS
Parawing canopy behavior during deployment in free flight at specific altitudes and dynamic pressures
[AIAA PAPER 70-1189] A70-41804
AERCAB /Aircrew Escape/Rescue Capability/ flying ejection seat, considering rotary wings, fixed wings and parawings
[AIAA PAPER 70-1213] A70-41806
Finite element analysis of critical stress distribution in canopy of deployed twin keel parawing, predicting failure stress levels
[AIAA PAPER 70-1196] A70-41820
Hi-glide personnel canopy /Para-Foil, Parawing, Sailwing, Volplane/ technology capability requirements identification from performance parameters tradeoffs
[AIAA PAPER 70-1194] A70-41822
Reefing systems for Parawings, Sailwings, Para-Flyers, Paraplanes and Volplanes, discussing performance tests
[AIAA PAPER 70-1192] A70-41824
All-flexible parawings aerodynamic performance prediction based on slender wing theory and circular arc approximations for canopy shape
[AIAA PAPER 70-1188] A70-41827
All-flexible parawing as primary descent system for large spacecraft landing, discussing configuration, structural arrangement, multistage reefing and L/D performance tests
[AIAA PAPER 70-1187] A70-41828
Glide and landing performance of twin-keel parawings, discussing wind tunnel, radio flight and simulator tests
[AIAA PAPER 70-1186] A70-41829
Determination of inflated shape and inertial properties of all-flexible parawing
[NASA-TN-D-5900] N70-32259

Performance and characteristics of single keel personnel parawings
[NASA-TN-D-5911] N70-32844
Wind tunnel model and flight tests of parawing lifting body landing system
[NASA-TN-D-5893] N70-40667
Low speed wind tunnel tests of all-flexible twin-keel tension structure parawings
[NASA-TN-D-5965] N70-40688
Wind tunnel test of canopy construction methods, design details, and canopy slots effects on aerodynamic characteristics of small scale all flexible parawings
[NASA-TN-D-5974] N70-40751
Method for deployment of flexible wing glider from space vehicle with minimum impact and loading
[NASA-CASE-XMS-00907] N70-41630

PARTIAL DIFFERENTIAL EQUATIONS
Ducted propeller subsonic rotational flow with free boundaries, presenting second-order partial differential equation solution without linearizing assumptions
A70-45269
Similarity transformations and boundary value problems of hyperbolic partial differential equations with wave solutions
[AD-710403] N70-42747

PARTICLE INTERACTIONS
Monoenergetic nitrogen free molecule beam impingement on solid surface, calculating satellite drag coefficients from momentum transfer measurements
A70-41743

PARTICLE SIZE DISTRIBUTION
Erosion by solid particles, discussing impacting velocity effects, natural sand quartz particle size distribution and composition, artificial industrial abrasives, etc
A70-35600
Numerical forecasting of low visibilities caused by suspended particles in atmosphere
[AD-708141] N70-39902

PASSENGER AIRCRAFT
Mobile lounges and airport productivity concepts for optimal handling of passengers at airport terminal
[AIAA PAPER 70-918] A70-35830
Central passenger traffic schedule role in air traffic control, discussing computer solutions, aircraft optimal use, etc
A70-36397
Soviet book on passenger aircraft aerodynamics covering motions of gases and immersed bodies, similarity laws, boundary layer theory, finite span wing, etc
A70-36507
Mass air transportation, discussing aircraft characteristics, traffic growth, scheduling, passenger and cargo handling, etc
A70-36656
Passenger seaplanes virtues and drawbacks, discussing bases, servicing, refueling, passenger conveyance, prospects, etc
A70-43887
Continuous flow requirements in aircraft passenger oxygen systems using phased dilution principle, discussing breathing mask efficiencies
A70-44483
Superjet airliners wiring connectors for power distribution, signal circuitry and self ejecting push buttons for passenger seats
A70-44545
Corporate/executive aircraft accident briefs in US general aviation
[PB-190409] N70-34525
Statistical summary of corporate/executive aircraft accidents in 1964-1968 US general aviation
[PB-190408] N70-34643

PASSENGERS
Air freight carrier liabilities in passenger transportation international regulations, noting conflicting interpretations
A70-37562
Preliminary report on Cleveland Before and After Study to reduce conjestion of highway facilities at airport by rapid rail extension
[PB-184060] N70-41400

PAVEMENTS
Aircraft dynamic wheel load effects on airport pavements
[FAA-RD-70-19] N70-32560
Tire-pavement friction coefficients
[AD-705987] N70-33636
Inspection, evaluation, classification, and reuse criteria for used airfield landing mats
[AD-708891] N70-43200

PAYLOAD MASS RATIO
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957

PAYLOADS
Commercial air transport mission payload and range capability analysis, noting on-line flight planning computers
[AIAA PAPER 70-899] A70-35815
Weight growth factor in aircraft design, discussing fixed and variable weight, payload, performance, flight quality, structural criteria and life expectancy
[SAWE PAPER 839] A70-40363
Aircraft loadability design by computerized loading program using graphic plotter
[SAWE PAPER 836] A70-40364
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369
Disposable load drop effect on aircraft range, using Breguet equations for graphic determination of bombing range
A70-40868
Low disk loading rotors in high speed VTOL aircraft for economical vertical payload lift
[ICAS PAPER 70-57] A70-44153

PCM TELEMETRY
PCM command control system for high altitude ballooning operations, discussing component equipment
A70-40085

PENNSYLVANIA
Aircraft accident report for Convair 580 near Bradford, Pennsylvania on Dec. 24, 1968
[PB-189649] N70-37196

PERFORMANCE PREDICTION
Helicopter rotor blades flapwise bending moments prediction by transfer function/superposition techniques
A70-34704
Aircraft optimal operating procedure development by integral-variational performance analysis methods, discussing flight paths, fuel consumption, mission requirements, etc
[AIAA PAPER 70-876] A70-34812
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
End wall boundary layers effect included in performance prediction method for multistage axial compressors
[ASME PAPER 70-GT-80] A70-36884
Computer program for assessment and modification of mechanical component life predictions by discrete formulation of Bayes theorem
A70-38816
Slender wings of low aspect ratio and sharp leading edges, predicting inviscid maximum lift
A70-40585
All-flexible parawings aerodynamic performance prediction based on slender wing theory and circular arc approximations for canopy shape
[AIAA PAPER 70-1188] A70-41827
Newtonian aerodynamic coefficients for predicting hypersonic stability characteristics of reentry bodies with various heat shield, afterbody angle and edge geometries
[NASA-TM-X-64332] N70-34532
Performance prediction for turbocompressor blades with high deflection and low aspect ratio in transonic flow
[VKI-TN-59] N70-34929
Wind tunnel tests and flight performance of different models of VTOL aircraft
[NASA-TT-F-13181] N70-37542

Computer program for predicting performance of helicopters
[AD-706918] N70-37696
Stability and control prediction method for helicopters and stoppable rotor aircraft
[AD-706919] N70-37916
Computer programming aids for determining performance characteristics of helicopters
[AD-706374] N70-38357
Prediction performance of axial flow compressors using flow-through analysis
N70-39092
Wind tunnel test data for predicting aerodynamic loads on single engine light aircraft
N70-39253
Mathematical model of rotary wing aircraft for performance, stability, response, and rotor blade load characteristics determination
[AD-707881] N70-39729
High velocity flight mechanics, hypersonic aerodynamic predictions, and optimization of hypersonic lifting bodies and cruise vehicles
[AD-708133] N70-39844
Performance results of operating full annulus swirl-can primary combustor near stoichiometric temperature
[NASA-TM-X-52902] N70-40624
Pilot-vehicle analysis method for specification and evaluation of flying qualities with application to vertical takeoff aircraft
[AD-710590] N70-43030

PERFORMANCE TESTS
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests
A70-35996
High bypass ratio aircraft turbofan engines, discussing program of factory, flight and operational suitability testing
[SAE PAPER 700290] A70-36806
Static charge reducer for aircraft fuels handling safety, discussing performance factors
[SAE PAPER 700277] A70-36808
Two dimensional compressor cascades of double circular arc and wedge shape blades testing performance in transonic and supersonic wind tunnels
[ASME PAPER 70-GT-7] A70-36829
Supersonic cascade wind tunnel performance evaluation, using compressor blades of simple geometric shapes
[ASME PAPER 70-GT-110] A70-36848
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
Runway test vehicle for lifting rotor performance in simulated forward flight, comparing with wind tunnel tests
A70-38611
Jet engine roller bearings retainer candidate cage materials and coatings evaluation on test rig simulating engine conditions
[ASLE PREPRINT 70AM 2D-1] A70-38805
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109
Concorde aircraft flight test program for verifying design features of wing vortices, fuel transfer, longitudinal stability, etc
A70-40580
Helicopter vibration measurement techniques, discussing in-service fault diagnosis
A70-40582
Helicopter dynamic tests for aeroelastic and mechanical instabilities and forced vibration problems
A70-40583
Parafoil flight performance predictions and test results based on wind tunnel data and manned free flight
[AIAA PAPER 70-1190] A70-41826
Reefed and unreefed disk gap band parachutes tested in supersonic and subsonic wind tunnels to determine stability and performance
[AIAA PAPER 70-1172] A70-41841
Low aspect ratio compressor blade cascade performance at blade span center, discussing pressure loss, angle of attack and staggering
A70-42272
Hypersonic wind tunnel facility for hypersonic aircraft and recoverable booster systems development
[DFVLR-SONDDR-19] A70-44799
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system
A70-46240
Interdependence of built-in, onboard, and ground based test facilities
N70-32158
Finishing bench test adjustment of gas turbine assembly model
[AD-701986] N70-32420
Evaluation tests on Boulton-Paul VC-10 aileron integrated flight control actuator
[AD-703471] N70-35080
Design and performance of ringsail parachute
[NASA-TN-D-5968] N70-35910
Results of MK 45 parachute flare flight tests
[AD-702752] N70-36265
Propeller static performance test data for V/STOL aircraft
[AD-708742] N70-40594

PERIODIC VARIATIONS
Theorem proving and interference reduction between two sequences of periodic events
[AD-702734] N70-34878

PERIPHERAL JET FLOW
Static and dynamic spring constants of peripheral jet air cushion vehicle in heaving motion, obtaining sinusoidal input response characteristics
A70-42279
Peripheral jet ground effect machine model heaving motion, investigating static hover and forced and free vibration characteristics
A70-42281

PERSONNEL SELECTION
UK organization of ATC services, considering responsibilities, facilities and personnel recruitment
A70-38634

PERTURBATION
Independent integrals of perturbed motion equations of spatial gyrohorizon compass
A70-35344

PERTURBATION THEORY
Quasi-conical supersonic wings with curved subsonic leading edges, discussing perturbation potential, boundary conditions, homogeneous flow and gothic and ogee planforms
A70-42108
Perturbation scheme for unknown disturbances in orbit affecting sea-surface altimetry accuracy
[AD-705268] N70-36237

PHASE SHIFT CIRCUITS
Ferrite phase shifter for array antennas, discussing design trends, production, performance characteristics and future developments
A70-37864

PHASE TRANSFORMATIONS
Plastic strain in metals, including work hardening and recovery, atomic lattice distortions, and metallurgical transformations
N70-37804

PHASE VELOCITY
Turbulent flow phase velocity fluctuations measurement by hot-wire anemometers, obtaining cross-spectral density by Fourier analysis digital techniques
A70-38019

PHASED ARRAYS
S band CW power amplifier and varactor doubler module for airborne phased arrays
A70-36674

PHOTOGRAPHIC RECORDING
Artificial rain erosion effects on missile and spacecraft recorded via high speed photography
A70-40531
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels
[SMPTE PREPRINT 3] A70-43056

PHYSICAL PROPERTIES
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc A70-43084

PHYSIOLOGICAL RESPONSES
Pilot influence on dynamic aircraft design, taking into account physiological state during various operational tasks
[ICAS PAPER 70-37] A70-44134

PILOT ERROR
Pictorial display methods for pilot error reduction in area navigation via guidance control and capability beyond visual field A70-38234
Aircraft accident report for Allegheny Airlines CV-440 near Bradford, Pennsylvania, 6 Jan. 1969
[NTSB-AAR-70-10] N70-35760
Aircraft accident investigation of Convair 880 on takeoff from Moses Lake, Washington
[NTSB-AAR-70-11] N70-36031
Investigating aircraft accident during incorrect approach maneuver by pilot in mountainous terrain
[NTSB-AAR-70-12] N70-38644

PILOT PERFORMANCE
Safety in airline operations, discussing roles of aircraft designer and pilot
[AIAA PAPER 70-907] A70-35819
Integrated flight management system for commercial aircraft pilot using computer
[AIAA PAPER 70-908] A70-35820
Bobweights effects on pilot induced oscillations, noting role in flying qualities and control system design
[AIAA PAPER 70-1002] A70-39529
Turbulence effects on lateral directional flying qualities, examining pilot task performance, control workload and compensatory behavior
[AIAA PAPER 70-998] A70-39533
Aircraft handling qualities specifications and definitions evolution based on test pilot rating correlation with engineering data and piloting ease evaluation with transfer functions
[ICAS PAPER 70-19] A70-44114
Pilot influence on dynamic aircraft design, taking into account physiological state during various operational tasks
[ICAS PAPER 70-37] A70-44134
Aircraft crew and pilot in-flight work load measurement and simulator
[ICAS PAPER 70-43] A70-44141
Flight simulator for evaluating pilot performance
[AD-703638] N70-32650
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339
Display research for aircraft collision warning systems
[NASA-CR-113886] N70-41493
Simulator study of flight management task performance during low visibility approach and landing using baseline category 2 flight instrumentation
[NASA-CR-73478] N70-42037
Pilot-vehicle analysis method for specification and evaluation of flying qualities with application to vertical takeoff aircraft
[AD-710590] N70-43030

PILOT PLANTS
Finishing bench test adjustment of gas turbine assembly model
[AD-701986] N70-32420

PILOT TRAINING
Boeing 747 pilot transition training, discussing takeoff, landing, eyelevel, flareout taxi speeds, inertial navigation and electrical, fuel and hydraulic systems A70-40083
Highlift and blown wing types slow speed STOL aircraft, comparing pilot training requirements with jet airline flying
[AIAA PAPER 70-1282] A70-45971
Evaluation of low cost visual approach slope indicator as pilot training aid
[FAA-DS-70-4] N70-32530
Aircraft accident investigation occasioned by improper application of automatic-coupled instrument landing systems
[NTSB-AAR-70-2] N70-36043
VFR and IFR training program and ice prevention and removal for general purpose aircraft N70-40781

PILOTS (PERSONNEL)
Concorde research pilot simulator
[NLL-M-9223-/5828.4F/] N70-36216
Collision prevention conference, including pilot warning indicators, air traffic control systems, and collision avoidance systems N70-40927
Simulation study of optical pilot warning indicator in terminal area traffic N70-40928
Symposium on geographic orientation of pilots during air operations
[AD-709124] N70-41056

PIPE FLOW
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
Lift forces acting on spheres in cylindrical tube laminar flow A70-37647

PIPER AIRCRAFT
Accident investigations of Beechcraft and Piper aircraft
[PB-192067] N70-37551
Accident investigations of Aero Commander, Beechcraft, Cessna, and Piper aircraft
[PB-192069] N70-37553

PIPES (TUBES)
Static tests of aluminum and steel frangible tube energy absorbers for nuclear aircraft reactors
[NASA-TM-X-52847] N70-34152
Attitude sensing head using short protuding tubes in transonic wind tunnel at Mach numbers 0.5 to 1.1
[ARL/A-321] N70-39023
Foldable conduit capable of springing back as self erecting structural member
[NASA-CASE-XLE-00620] N70-41579

PISTON ENGINES
Temperature distribution in cylinders of aircraft internal combustion rotary piston engine under air cooling A70-44742

PITCH
Axial flow compressor fan discrete tone noise radiation directivity pattern measurement and theoretical explanation for cut-off effect, power and harmonics A70-46069

PITCHING MOMENTS
Bearing force and moment produced by motion of inclined plate supported by compressed air in ground effect machines with small angle of attack A70-39140
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion
[AIAA PAPER 70-1191] A70-41825
Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments
[ICAS PAPER 70-08] A70-44119
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161

PITOT TUBES
Wind tunnel and flight evaluation Rosemount shielded pitot static tube model 850N
[AD-708859] N70-40514

PLAN POSITION INDICATORS
Air traffic control CRT plan position indicators, considering alphanumeric symbols strokes design A70-38645

PLANAR STRUCTURES
Drag optimal stern section of plane body at supersonic flow, allowing for friction forces A70-36261

PLANETARY LANDING
Multiple parachute system for landing control of Apollo type spacecraft
[NASA-CASE-XLA-00898] N70-36804

PLANFORMS
Horizontal flight speed effects on aerodynamic characteristics of air cushion vehicles with elliptical planform
A70-42801

PLANNING
National Aviation System Plan - 1971-1980
N70-37026

PLASMA GENERATORS
Techniques for producing hypervelocity flows in aerodynamic test facilities
[AD-709210] N70-41152

PLASMA PHYSICS
Scientific research in materials science, general science, electronics, and oceanography
[AD-706718] N70-38374

PLASTIC AIRCRAFT STRUCTURES
Tungsten filled urethane in aircraft areas as balancing agent
A70-35418
Composite compression tubes for VTOL aircraft components, describing weight parameters and mechanical properties
[AIAA PAPER 70-898] A70-35809
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air
A70-37370
Reinforced plastic for aircraft parts, investigating low viscosity polyester resins of styrene crosslinking type
A70-40028
High thermal stability glass fibers alternatives improving stiffness-to-weight ratio of resin and Al-based composites used in F-111 boron epoxy wings
A70-42480

PLASTIC COATINGS
Basket weave fabrics for gliding descent decelerators with polyurethane and nylon coatings for tearing strength and pressure packing
[AIAA PAPER 70-1180] A70-41833

PLASTIC DEFORMATION
Comparative load capacity of disk models of natural gas blowers of different designs under plastic strain
A70-43941
Structural fatigue manual, including plastic strain, static tests, and notched or cracked component strength, for aircraft applicability and with bibliographies
[AGARD-MAN-8-70-VOL-1] N70-37802
Plastic strain in metals, including work hardening and recovery, atomic lattice distortions, and metallurgical transformations
N70-37804
Static testing and creep, including tensile tests, plastic deformation, and buckling
N70-37805
Physical changes and damage during fatigue, including plastic processes and crack propagation
N70-37807

PLASTIC PROPERTIES
Pliability calculation of elastic bearings for turbomachines
[AD-700690] N70-35204

PLASTICS
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience
A70-41137
Plastic balloon platforms for atmospheric research and engineering applications, discussing design and use of unreinforced polyethylene and reinforced Mylar types
A70-43650

PLATES (STRUCTURAL MEMBERS)
Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209
Aerodynamic noise scattering by semiinfinite compliant plate in turbulent flow, using Lighthill theory and Wiener-Hopf technique
A70-43968

PLENUM CHAMBERS
Nonlinear heaving motion of plenum-chamber air cushion vehicles induced by sinusoidal ground irregularity
A70-42280

PLOTTING
Computer code for plotting wind tunnel aerodynamic data
[SC-DR-69-690] N70-39164
Digital computer program for aircraft configuration plotting
[NASA-TM-X-2074] N70-39376

PLUG NOZZLES
Thrust deflector for VTOL aircraft fuselage mounted lift engines designed as isentropic plug nozzle, considering mass flow, pressure forces and Coanda effect
[SAWE PAPER 841] A70-40379
Low angle conical plug nozzle with stowed thrust reverser performance at Mach 0 to 2.0
[NASA-TM-X-2116] N70-42437
Boattail and plug area variation effect on convergent and plug nozzle efficiency at Mach 0 to 1.97
[NASA-TM-X-2112] N70-42438

PLUMES
Two phase plume at various incidence angles on fla plate, determining impinging particle mass flux, forces and damage
A70-44566
Wind tunnel tests measuring transverse jet plumes
[GSL-TR-70-4] N70-37120

PNEUMATIC CONTROL
Fluidically controlled aircraft fuel transfer system three-tank model construction, noting maintenance and fail safe operation
[SAE PAPER 700786] A70-45858

PNEUMATIC EQUIPMENT
Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053
Mechanical and power equipment of airports
[AD-709693] N70-41055

POLAND
Wind tunnel testing of helicopters, and test program for Polish helicopter industry
N70-34028

POLICIES
Policies, requirements, goals, and criteria for national aviation system
N70-36967
Federal policy and services relative to privately owned, publicly used airports
N70-41530
National aviation system policy and plan
N70-41544

POLYESTER RESINS
Reinforced plastic for aircraft parts, investigating low viscosity polyester resins of styrene crosslinking type
A70-40028

POLYIMIDE RESINS
Graphite-polyimide composites development for high temperature environments, discussing mechanical properties
A70-38425

POLYMERS
Polymers industrial applications in textiles, building materials, furniture, aviation, automobile industry and packaging
A70-38700

POLYMETHYL METHACRYLATE
Helicopter tinted Plexiglas for heat reduction and effecting night visibility
[AD-709405] N70-41229

POLYSTYRENE
Infrared radiation hot working for polystyrene aircraft maintenance tool kit tray manufacture
[A/AEE-NOTE-9001] N70-42525

POLYTETRAFLUOROETHYLENE
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration
A70-36345

POLYURETHANE FOAM
Using polyurethane foam as inerting material in fuel tanks of combat aircraft

N70-42754

POROUS BOUNDARY LAYER CONTROL
Steady incompressible turbulent boundary layer form on permeable curvilinear surface with uniform suction, assuming small pressure gradients
A70-42803

POROUS MATERIALS
Jet engine noise propagation near porous surface, predicting anomalous LF dip from direct and reflected waves interference with phase delay
A70-46068

POROUS WALLS
Transonic wind tunnel porous walls, investigating interference effects and aerodynamic characteristics
A70-42337

PORTABLE EQUIPMENT
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities
A70-38533
Transportable earth station for satellite communications system, describing antenna design and transportation modes
A70-41344
Portable recording instrument for measuring and surveying noise and vibration
[AD-707826] N70-40026

POSITION (LOCATION)
Position finding and navigation in space, air and sea - Conference, Hamburg, October 1969, Volume 1
A70-41126
General aviation airport system planning in Florida
[PB-191235] N70-37498

POSITION ERRORS
Onboard velocity sensors for VOR/DME navigation systems positional accuracy improvement, describing optimal and suboptimal data filtering
[AIAA PAPER 70-1024] A70-39511

POSITION INDICATORS
SATRAM, multiple trajectory landing system for aircraft position indication within large airspace
A70-36948
DR-S Raydist radio location system in fixed wing aircraft for dynamic gravimetry
A70-43661
Molding model crash position indicators for use in supersonic wind tunnel tests
N70-33653
Flight evaluation of inertial/DME/DME system
[FAA-RD-70-24] N70-41325

POSITRON ANNIHILATION
Positron annihilation in quenched Cd metal from radar backscatter intensities in aircraft model compared with anechoic chamber measurements
A70-46257

POSTFLIGHT ANALYSIS
Flight evaluation of inertial/DME/DME system
[FAA-RD-70-24] N70-41325

POTENTIAL FLOW
Two dimensional cascades for incompressible plane potential flows with given velocity distribution
[ASME PAPER 70-GT-87] A70-36880
Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem
A70-43362
Lift determination of slender curved periodically recurring airfoils array in plane potential flow of inviscid incompressible fluid
A70-44158
Aerodynamic forces and torque on airfoil in potential jet from boundary asymptotes position, determining flow characteristics by electrical analogy
A70-45438

POTENTIAL THEORY
Spoiler theory based on mathematical model, using two dimensional potential theory in conjunction with experimental data on wake phenomena
A70-42273

POWDER METALLURGY
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc
A70-43084

POWDERED ALUMINUM
Scorched aluminum powder /SAP/ materials, discussing fabrication, physical and mechanical properties, applications in aircraft structural components, etc
A70-43084

POWER AMPLIFIERS
S band CW power amplifier and varactor doubler module for airborne phased arrays
A70-36674

POWER EFFICIENCY
Internal efficiency of turbine stages with long twist-varying blades
A70-37250
Allison/Rolls-Royce TF41 turbofan engine improved power and reduced weight versions, comparing afterburning Model 912-B23 to nonafterburning TF41-A-2
A70-44596

POWER PLANTS
Rotary piston engine for powered gliders and light aircraft power source by modifying industrial Wankel engine
A70-34690

POWER SPECTRA
Simulated neutral atmospheric boundary layer measurements in wind tunnel, extending power spectral and correlation determinations
A70-40139
Frequency functions and power spectra of XB-70 aircraft response to gusts
[NASA-CR-1621] N70-35659

POWER SUPPLIES
Propulsion control integration for aircraft power management
[SAE PAPER 700818] A70-45899

POWER SUPPLY CIRCUITS
Solid state multiplexed electrical power distribution system for future generation military and commercial airplanes
[SAE PAPER 700301] A70-36803
Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems
[SAE PAPER 700303] A70-36811
Aircraft electrical power systems optimization
[NASA-CR-86410] N70-32051
Aircraft electrical power systems optimization - electric power load supply equipment
N70-32052
Aircraft electrical power systems optimization - comparison of hydraulic, pneumatic, and electric power for actuation systems
N70-32053
Aircraft electrical power systems optimization - maintainability tradeoff with equipment cost and weight
N70-32054
Aircraft electrical power systems optimization - weighted factors for systems effectiveness
N70-32055
Aircraft electrical power systems optimization - failure prediction, detection, and compensation
N70-32056

POWER TRANSMISSION
Helicopter mechanical power transmission design, describing gearing, shaft bending, bearings, lubrication, weight factors, etc
[SAWE PAPER 844] A70-40367

PRECIPITATION (METEOROLOGY)
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc
A70-38800
Reduction of precipitation effects on Omega aircraft receivers
[AD-707710] N70-40129

PRESENTATION
Presentation styles of passenger emergency evacuation briefing cards, noting preference for sequential action graphic displays with minimum keywording
A70-44486

PRESSING (FORMING)
Ti alloy aircraft parts heavy press forging, considering mechanical properties, temperature effects, cost factors, etc
A70-34360

PRESSURE DISTRIBUTION
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
A70-35923
Previous history effect on parameters relation in similar turbulent boundary layers under pressure distributions
A70-36375
Pressure distribution shock pattern and impact wave resistance in frictionless plane parallel and source shaped supersonic flow
A70-36385
Pressure balanced rotor flow path design for mixed flow centrifugal compressors, calculating losses in rotor and diffuser section
[ASME PAPER 70-GT-12] A70-36863
Conical convergent nozzles discharge coefficient for varying pressure ratios
A70-38243
Modified linearized transonic flow theory application to pressure coefficient distribution on circular arc bodies of revolution
A70-39614
Large MHD generator channel aerodynamics, discussing pressure distributions to stall and stagnation pressure loss
A70-40002
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution
A70-40918
Subcritical viscous flow around arbitrary airfoils, calculating boundary layer effect on pressure distribution from inviscid flow approximation
A70-40924
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory
A70-41407
Stress distribution and shape in arbitrarily shaped gore parachute under unsteady pressure distribution during inflation and descent
[AIAA PAPER 70-1197] A70-41819
Unsteady supersonic flow around oscillating cross-shaped wing-fuselage system, determining perturbation velocities and pressure distributions
A70-42609
Optimum pressure distribution and airfoil profiles for maximum lift without separation in incompressible flow determined by second order theory
[AIAA PAPER 69-739] A70-42704
Aerodynamic theory of pressure field induced on lifting surface by isotropic atmospheric turbulence, considering transfer function of Concorde aircraft
[ICAS PAPER 70-30] A70-44104
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow
[ICAS PAPER 70-03] A70-44117
Pressure distribution on thin nonlifting airfoils in steady two dimensional flow with freestream Mach number at or near unity
A70-44583
Two dimensional shock theory for predicting pressures on elliptic cones at supersonic speeds
[NASA-TN-D-5952] N70-35926
Pressure distribution of spherically-blunted 60 deg half-angle cone in hypersonic flow
[NASA-CR-109982] N70-35952
Computer program for pressure distribution on thin wing in supersonic flow
[NLR-TR-G-50] N70-37079
Mathematical model for airfoil pressure distribution in two dimensional, uniformly sheared slipstreams
[AD-709696] N70-41266
Local pressure field in turbulent shear flow and its relation to aerodynamic noise
[NASA-CR-113881] N70-41283
Wing root shapes and pressure distribution of swept wing aircraft configurations at supersonic speeds
[ARC-CP-1109] N70-43087

PRESSURE DROP
Axial flow compressor cascades, predicting total pressure losses for inlet relative Mach number greater than unity
[ASME PAPER 70-GT-57] A70-36872
Jet engine combustion chamber pressure loss, flow velocity through flare tube holes and air supply calculation, noting adaptation for computer use
A70-45446

PRESSURE EFFECTS
Two dimensional hypersonic viscous flow, analyzing viscosity and bluntness induced pressure effects
A70-35034
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Performance analysis of rotary nozzle utilizing 30 deg spin angle rotor
[AD-705057] N70-32246

PRESSURE GAGES
Differential pressure cell insensitive to changes in ambient temperature and extreme overload
[NASA-CASE-XAC-00042] N70-34816

PRESSURE GRADIENTS
Boundary layer momentum thickness growth in channels with adverse pressure gradients by stepwise integration of Truckenbrodt equation and extending Gruschwitz-Schmidbauer separation criterion
[ASME PAPER 70-GT-12] A70-36864
Stress distribution and shape in arbitrarily shaped gore parachute under unsteady pressure distribution during inflation and descent
[AIAA PAPER 70-1197] A70-41819
Atmospheric pressure surface sharp slopes at SST altitudes producing vertical acceleration based on temperature gradients inspection
A70-46050
Wind tunnel investigation of Mach 2.2 turbulent boundary layers in nominally zero pressure gradient
[BL/TN/3] N70-36814
Turbulent boundary layer in adverse pressure gradient regions and distributed suction for higher aerodynamic lift coefficients
[ARC-R/M-3621] N70-37073
Investigating pressure fields from sonic booms transmitted into rooms through open windows
[NASA-CR-111787] N70-42168

PRESSURE MEASUREMENTS
Surface pressure and lift measurement on model lifting rotor blade as function of vortex interaction, using flush mounted pressure transducers
A70-34737
Measurement methods for forces, pressure and heat flow in hotshot hypersonic wind tunnels
A70-34773
Low pressure measuring system for aerodynamic models tested in Mach 12-14 wind tunnel, discussing transducers and high speed digital recording and data processing system
A70-35493
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
A70-35923
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory
A70-41407
Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions
[AVA-FB-7029] A70-44668
Pressure measurements on harmonically vibrating sweptback wing with two control surfaces in incompressible flow

A70-44768
German monograph on three dimensional flow and blade pressure measurements at axial flow compressor casing wall, discussing test control and digital data processing
A70-45093
Thrustmeter for direct output reading from jet engines based on stream and total port pressures
A70-46328
Wind pressure measurements on wind tunnel models of closely-spaced cylindrical silos
[NPL-AERO-NOTE-1088] N70-34941
Surface pressure measurements of wing immersed in propeller slipstream
[NAE-LR-525] N70-35551
Pressure and supersonic heat transfer measurements on delta wing at incidence and sweepbacks using free flight test apparatus
[ARC-R/M-3625] N70-37071
Pressure measurements and boundary layer separation studies on slender cone delta wing at different Mach and Reynolds numbers
[ARC-R/M-3626] N70-42500
Unsteady pressure distribution measurements on oscillating wing at subsonic and transonic speeds
[NASA-TT-F-13337] N70-42576

PRESSURE OSCILLATIONS
Turbine blades aerodynamic forces theoretical and experimental investigation, noting cascade series interaction induced pressure pulsations
A70-45504
Inlet pressure oscillation effects on turbofan engine compressor
[NASA-TM-X-2081] N70-39421

PRESSURE REDUCTION
Off-design pressure losses in single stage axial flow compressor, using test rotor in annular duct
[ASME PAPER 70-GT-78] A70-36886
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients
A70-45444

PRESSURE SENSORS
Fast response transducer for measuring transient pressures due to shock interaction
A70-35484
Low pressure measuring system for aerodynamic models tested in Mach 12-14 wind tunnel, discussing transducers and high speed digital recording and data processing system
A70-35493
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc
A70-38523
Pressure probe for sensing ambient static air pressures
[NASA-CASE-XLA-00481] N70-36824
Short static probe with good incidence characteristics at supersonic speed
[ARC-CP-1099] N70-37072
Instrument for measuring wind velocity and direction in wind tunnels using pressure sensors
[NASA-TM-X-66391] N70-42824

PRESSURE SWITCHES
Pressure operated electrical switch for positioning protective cone in front of model in hypersonic wind tunnel
[NASA-CASE-LAR-10137-1] N70-35597

PRESSURE VESSELS
Annotated bibliography of tests and applications of pressure vessels - Vol. 1
[AD-702600] N70-33795

PRINTED CIRCUITS
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules
A70-44542

PROBLEM SOLVING
Classical flutter problem possible solutions and comments
[RAE-LIB-TRANS-1296] N70-32148
Quasiconformal mappings in space
N70-39251

PROCUREMENT
Design and procurement of hybrid microcircuit
[AD-705974] N70-34087

PRODUCT DEVELOPMENT
Cost and time optimization for complex aircraft development projects via network planning
A70-39644

PRODUCTION ENGINEERING
Aircraft engine production cost estimating techniques, discussing physical, thermodynamic and metallurgical characteristics
[SAE PAPER 700271] A70-36818
Boeing 747 wing panels shot peening process, discussing machine, control technique and operational requirements
A70-38498
Adhesive bonded aircraft structures, discussing methods and requirements for establishment and control of manufacturing procedures
A70-38594
Computer-aided production engineering involving numerically controlled machines for Rolls-Royce aircraft engines manufacture
A70-45299

PRODUCTIVITY
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369
Price and productivity change estimates in aircraft industry
[AD-706885] N70-37723

PROFILES
Pulling force during motion of sinusoidally deformable flat profile, taking into account trailing edge vortices
A70-36280

PROGRAMS
Development program stages in preliminary military aircraft design
N70-40702

PROJECT MANAGEMENT
Impact of management of automatic test equipment in avionic repair organization
N70-32154
Project design of fighter aircraft
N70-40703

PROJECTILES
Applying Nishiwaki theory of penetration to projectile shapes against aluminum alloy targets
[AD-707837] N70-40024

PROLATE SPHEROIDS
Three dimensional boundary layer on lee- and windside of prolate spheroid, emphasizing separation and embedded streamwise vortices
A70-39359
Forces and moments on prolate spheroid accelerating with constant angle of attack under free surface
[UCRL-50843] N70-36183

PROPANE
Performance and economics of supercooled propane fog dispersion system at Orly airport
[FAA-RD-70-16] N70-32366

PROPELLANT ACTUATED DEVICES
Aerospace pyrotechnics applications, considering pressure controlled propellant actuated device for escape systems
[SAE PAPER 700831] A70-45889

PROPELLANT ADDITIVES
Component and additives effects on storage stability of jet engine fuels
[AD-707524] N70-38458

PROPELLANT COMBUSTION
Integrated double oblique shock scramjet for supersonic combustion tests and instrumentation development, discussing fuel injection through sonic orifices, combustion data, etc
[AIAA PAPER 69-827] A70-41752

PROPELLANT TESTS
Field test for microbiological contamination of jet fuel, discussing phosphates detection
A70-36344
Integrated double oblique shock scramjet for supersonic combustion tests and instrumentation development, discussing fuel injection through sonic orifices, combustion data, etc
[AIAA PAPER 69-827] A70-41752

PROPELLER BLADES
Blade flexibility effects on static stability

derivatives of prop/rotors in propeller flight mode A70-34701
Propeller blade aerodynamic characteristics at zero advance ratio, reducing singular integral equation to nonsingular form for computer solution A70-44993
Directed fluid stream for propeller blade loading control [NASA-CASE-XAC-00139] N70-34856
Propeller static performance test data for V/STOL aircraft [AD-708742] N70-40594
Propeller static performance tests for V/STOL aircraft [AD-708501] N70-40939

PROPELLER DRIVE
Four-seat two-engined STOL propeller passenger and sport aircraft design and performance A70-37371

PROPELLER EFFICIENCY
Actuator disk theory and flow field calculations for propeller induced flow with nonuniform circulation distribution [NASA-CR-1672] N70-38435

PROPELLER FANS
H3-E Sprinter semicompound helicopter with pneumatic rotor drive and side mounted fans for forward flight A70-35626

PROPELLER SLIPSTREAMS
Surface pressure measurements of wing immersed in propeller slipstream [NAE-LR-525] N70-35551
Theoretical analysis of wing lift in wide and circular stripstreams, and engineering method for predicting practical V/STOL configuration characteristics [NASA-CR-1632] N70-36851
Wind tunnel measurements of flow field behind model of twin-propeller deflected slipstream STOL aircraft [NAL-TR-197T] N70-40562
Mathematical model for airfoil pressure distribution in two dimensional, uniformly sheared slipstreams [AD-709696] N70-41266

PROPELLERS
German book on propeller theory covering airfoil theory, propeller flow and pressure fields, propeller vibrations, shrouded and tilted propellers, helicopter rotors, etc A70-44097
Optimal propeller selection for given aircraft and engine designs, considering aerodynamic and acoustic characteristics A70-45441
Propeller and airframe integration in supersonic fighter aircraft design N70-40711

PROPORTIONAL COUNTERS
Measuring stratospheric radiation levels using recombination ionization chamber as multichannel LET spectrometer N70-32393

PROPULSION SYSTEM CONFIGURATIONS
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts [SAE PAPER 700269] A70-36819
V/STOL attitude control system as integral propulsion system part, analyzing design and weight tradeoffs [ASME PAPER 70-GT-31] A70-36832
Aircraft propulsion system test facilities, discussing altitude simulation, large subsonic and supersonic engines and component development [ICAS PAPER 70-45] A70-44143
Two stream ejector type propelling nozzles for supersonic aircraft, investigating various configuration effects over range of secondary/primary air flow ratios [ICAS PAPER 70-48] A70-44145
Energy transfer methods for hybrid air breathing ramjet propulsion systems with rocket motor S gas source [ICAS PAPER 70-61] A70-44156
Entrainment theory for incompressible turbulent boundary layer velocity and drag on bodies of revolution employed in fuselage, submersible and cowlings for propulsion design A70-44400
Commercial STOL aircraft propulsion systems from airline viewpoint, emphasizing subsystem design, engine selection, thrust deterioration and maintainability [SAE PAPER 700810] A70-45904

PROPULSION SYSTEM PERFORMANCE
Convertible fan-shaft engine for V/STOL tactical and transport aircraft, discussing design and performance A70-34710
Aircraft gas turbine propulsion, discussing engine performance characteristics, thermodynamics, noise and installation [AIAA PAPER 70-873] A70-34810
Power plant efficiency, size, maintenance and operating economics of propulsion systems for air transport A70-34917
C-5A propulsion system onboard monitoring for malfunction detection, analysis and subsystem recording A70-35497
JT9D engine design and performance, describing operational problems [SAE PAPER 700288] A70-36807
Military aircraft engines performance increase and cost reduction [SAE PAPER 700272] A70-36817
Gas turbine engine dynamic performance simulation, using analog and digital techniques [ASME PAPER 70-GT-23] A70-36830
Turbofan engine performance optimization by closed form solution of operating cycle parameter functions [ASME PAPER 70-GT-65] A70-36840
Gas turbine propulsion systems design, performance and applications for industrial and military uses, discussing sensors for measurement and control of critical engine parameters A70-37881
Aircraft flight propulsion systems performance improvement via materials technology for gas turbine engine components A70-43573
Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft [NASA-TM-X-2034] N70-32047
Propulsive evaluation of ramjet installed under wing and up to Mach 7 [NASA-TT-F-12951] N70-33230
Engine performance design considerations for large subsonic transport with high by-pass ratio N70-37761
Requirements posed by hypersonic and supersonic flight, including propulsion system performance N70-39639

PROPULSIVE EFFICIENCY
Helicopter engine rotor matching for tip propulsion efficiency, comparing with conventional shaft drive propulsion [ASME PAPER 70-GT-68] A70-36842
Optimal propeller selection for given aircraft and engine designs, considering aerodynamic and acoustic characteristics A70-45441
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency A70-46012

PROTECTIVE COATINGS
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration A70-36345
Helicopter gas turbine engine protection against sand and dust erosion using particle separators, screens and coatings [SAE PAPER 700705] A70-42671
Sand and dust erosion reduction in gas turbine engines by coatings, sleeves and inserts [SAE PAPER 700706] A70-42672

PROTOTYPES
Army aircraft development programs and Dassault prototypes
N70-40704
PSYCHOACOUSTICS
Jet aircraft noise attenuation characteristics of wood-sided and brick-veneered frame houses
[NASA-CR-1637] N70-35694
PULLING
Pulling force during motion of sinusoidally deformable flat profile, taking into account trailing edge vortices
A70-36280
PULSE CODE MODULATION
DC-10 airborne flight test PCM data system, discussing capability, onboard operating characteristics and test results
A70-35498
PULSE COMPRESSION
Applicability of pulse compression radar to space geodesy altimetry
[NASA-CR-1605] N70-34166
PYROTECHNICS
Aircraft auxiliary systems and spacecraft power supplies, considering fly-by-wire control actuators, pyrotechnics and stowable solar array
A70-39669
Aerospace pyrotechnics applications, considering pressure controlled propellant actuated device for escape systems
[SAE PAPER 700831] A70-45889

Q

QUALITY CONTROL
Turbojet aircraft engine fuels quality control, considering chemical composition, physical properties and handling problems
A70-36550
QUEUEING THEORY
Queueing requirements in automatic radar target detection system operating with narrow bandwidth data link
A70-43489

R

RADAR
Applicability of pulse compression radar to space geodesy altimetry
[NASA-CR-1605] N70-34166
RADAR APPROACH CONTROL
Helicopter radar approach aid for serving oil rigs
A70-38621
Aircraft onboard radar system with landing monitor perspective display of runway operating independently of ground based electronic equipment
[AIAA PAPER 70-1336] A70-45932
Landing approach maneuvering using radio direction finder of 'Svod' system
[JPRS-51258] N70-36101
Live tests of tower cab radar approach control / procedures
[FAA-NA-70-38] N70-36848
RADAR BEACONS
Technical and operational evaluation of Direct Altitude and Identity Readout /DAIR/ system /interrogator set AN/TPX-42/
[FAA-RD-70-29] N70-36950
RADAR CROSS SECTIONS
Subsonic jet engine intake duct radar cross section calculation using waveguide model
A70-43584
RADAR DATA
Digital extraction of primary and secondary radar data for air traffic control
A70-38644
ATC radar data processing and display systems equipment and operation, emphasizing economy
A70-45044
RADAR DETECTION
Airport bird detection equipment /ABDE/ radar to display airfield map for presence and magnitude of bird groups and vegetation on runway
A70-35998
Queueing requirements in automatic radar target detection system operating with narrow bandwidth data link
A70-43489
RADAR EQUIPMENT
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721
Nationwide air traffic control, using radar network and real time computer flight information centers for air safety
A70-35880
Compatibility factors affecting concept development of approach and landing guidance systems
[AD-707129] N70-37993
Engineering survey and analysis of en route ATC radar/display system errors
[FAA-NA-70-14] N70-41207
RADAR NAVIGATION
IATA policy on future ATC development, discussing controlled airspace, communications and radar requirements
A70-38630
ATC and general aviation growth, considering airport capacity, radars, navigation, National Airspace System, etc
A70-38631
Radar inertial system flight evaluation, discussing V/STOL program for approach and landing by use of ground based radar for updating onboard inertial navigator
A70-42651
Accident of private aircraft near Upland, California - investigations and subsequent recommendations
[NTSB-AAR-70-13] N70-36116
RADAR SCATTERING
Millimeter wave radar for high resolution aircraft landing aid, describing experiments to obtain backscatter data from airborne platform
A70-34721
Positron annihilation in quenched Cd metal from radar backscatter intensities in aircraft model compared with anechoic chamber measurements
A70-46257
Analog monitor design and tests to improve ILS localizer signal display in aircraft
[EER-5-10] N70-36912
RADAR TARGETS
Queueing requirements in automatic radar target detection system operating with narrow bandwidth data link
A70-43489
RADAR TRACKING
Automated radar terminal system, ARTS-III Beacon Tracking Level for continuous aircraft identity on controllers radar display
A70-36393
Individually built-in self test techniques as applied to terrain following radar systems
N70-32162
Computerized calculations of interrogation repetition frequency sets nonsynchronous for N interrogations
[AD-709553] N70-42008
RADAR TRANSMISSION
Airport and air route radar surveillance, beacon systems, microwave links and instrument landing systems, discussing transmission and reception problems
A70-43486
RADARSCOPES
Live tests of tower cab radar approach control / procedures
[FAA-NA-70-38] N70-36848
RADIAL FLOW
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency
A70-46012
Three-dimensional stress concentration in rotating anisotropic disks with radial compressor blades using finite element method
[DLR-FB-70-16] N70-38484
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry
[AGARD-LS-39-70] N70-39091

Basic elements for advanced design of radial flow compressors
N70-39096
Supersonic radial diffusers for centrifugal compressors
N70-39097

RADIANT COOLING
Thermal protection system based on radiation cooling for high altitude cruising hypersonic flight, achieving zero net mass transfer
A70-41745

RADIATION DISTRIBUTION
Axial flow compressor fan discrete tone noise radiation directivity pattern measurement and theoretical explanation for cut-off effect, power and harmonics
A70-46069

RADIATION DOSAGE
Supersonic transport radiation hazards to flight crew, passengers and population, discussing dosages, probabilities, solar cosmic ray encounters, warning systems, etc
A70-39923

RADIATION EFFECTS
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air
A70-37370

RADIATION HAZARDS
Supersonic transport radiation hazards to flight crew, passengers and population, discussing dosages, probabilities, solar cosmic ray encounters, warning systems, etc
A70-39923
Supersonic transport radiation hazards and St. Lawrence River tides
[DME/NAE-1970/1/] N70-37215

RADIATION MEASUREMENT
Contrail effects on atmospheric thermal radiation budget in heavy jet traffic regions from airborne IR and solar radiometric observations
A70-44033

RADIATIVE HEAT TRANSFER
Gas turbine combustion chamber convective and radiant heat transmission, examining steam film cooling of flame tube
A70-43199

RADIO BEACONS
Air traffic safety problems, discussing satellite radiobeacons applications to aerial navigation
A70-42652

RADIO DIRECTION FINDERS
Landing approach maneuvering using radio direction finder of 'Svod' system
[JPRS-51258] N70-36101

RADIO EQUIPMENT
Soviet book on aircraft electrical and radio systems manufacturing, assembling and testing methods, considering effectiveness and standardization
A70-37405

RADIO FREQUENCY INTERFERENCE
Aircraft streamer /spark/ discharges formation, waveforms and RF noise levels, using mathematical model for electric field strength
A70-38179
Computerized calculations of interrogation repetition frequency sets nonsynchronous for N interrogations
[AD-709553] N70-42008

RADIO NAVIGATION
Area navigation for aircraft guidance with radio aids, discussing advantages, airborne equipment, Dynamic Map Displays, etc
A70-42658
DR-S Raydist radio location system in fixed wing aircraft for dynamic gravimetry
A70-43661
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system
A70-46240
Using communication satellites for onboard navigation and air traffic control over North Atlantic
N70-32235
Radio navigation of aircraft
[AD-704025] N70-32575
Aircraft accident report for DC-3 near Lone Pine, California on Feb. 18, 1969
[PB-189650] N70-37177

RADIO RECEIVERS
VHF omnirange propagation and stability study
[AD-705079] N70-33644
Reduction of precipitation effects on Omega aircraft receivers
[AD-707710] N70-40129

RADIOACTIVE ISOTOPES
Aircraft engine diagnostics and defectoscopy, considering radioactive isotopes testing for component wear and performance
A70-43083

RADIOACTIVE MATERIALS
Gaseous radioactive penetrant inspections for early low cycle fatigue in aircraft engine materials, discussing impact on maintainability
A70-38828

RADIOGRAPHY
Aircraft structures service life estimation, using Ir-192 and Tm-170 gamma ray radiography
A70-45725

RAIL TRANSPORTATION
TRANSOP computer program for determination of transportation equilibrium supply and demand levels
[PB-190936] N70-34622
Study of high speed ground transportation for use as public transportation system in Northeast Corridor
[PB-190934] N70-34644
Determining intercity transportation requirements for Northeast Corridor
[PB-190929] N70-34648
Northeast Corridor transportation facts and data
[PB-190932] N70-34691
Transportation system status and plans for improving intercity transportation in Northeast Corridor
[PB-190931] N70-34741
Mathematical models for Northeast Corridor transportation system
[PB-190933] N70-36452
Social costs and benefits from Northeast corridor transportation system
[PB-190944] N70-36515
Transportation requirements survey for Northeast Corridor
[PB-190930] N70-36810
Activities of National Transportation Safety Board for 1969
N70-41227

RAIN
Artificial rain erosion effects on missile and spacecraft recorded via high speed photography
A70-40531

RAMJET ENGINES
Aircraft engine design combining turbojet and ramjet features to ensure optimum performance
A70-40148
Hybrid combustion ram rocket drives, discussing booster initial acceleration, exhaust gas use as fuel and payload gain
[ICAS PAPER 70-50] A70-44147
Energy transfer methods for hybrid air breathing ramjet propulsion systems with rocket motor S gas source
[ICAS PAPER 70-61] A70-44156
Telescoping-spike supersonic nozzle for turbojet or ramjet engines
[NASA-CASE-XLE-00005] N70-39899

RAMPS (STRUCTURES)
M 3.5 two dimensional mixed compression inlet system with self restart using flexible variable ramp system
[AIAA PAPER 69-447] A70-42707

RANDOM LOADS
Hydraulic load loops with random force signal for aircraft structures endurance testing
A70-39913
Fatigue testing device applying random discrete load levels to test specimen and applicable to aircraft structures
[NASA-CASE-XLA-02131] N70-42003

RANDOM PROCESSES
Review of methods used for simulating random load fatigue in laboratory testing
[UTIAS-29] N70-33724

RANDOM SAMPLING
Aircraft design fatigue life and cumulation damage problems, discussing information value of programmed load and random tests A70-39622
RANDOM VIBRATION
Probability theory of stresses during random vibrations of flat panel in acoustic field of jet engine exhaust A70-36301
RANGE
Disposable load drop effect on aircraft range, using Breguet equations for graphic determination of bombing range A70-40868
RANGEFINDING
Airborne computerized time frequency systems for aircraft range and velocity determination, using stable clocks with ambiguity resolution A70-42659
Visibility measurements for aircraft landings and takeoffs N70-40785
RAPID TRANSIT SYSTEMS
Transportation system status and plans for improving intercity transportation in Northeast Corridor [PB-190931] N70-34741
Transportation requirements survey for Northeast Corridor [PB-190930] N70-36810
Cost analysis for Northeast Corridor transportation system air and highway modes [PB-190943] N70-36811
Preliminary report on Cleveland Before and After Study to reduce conjestion of highway facilities at airport by rapid rail extension [PB-184060] N70-41400
RAREFIED GAS DYNAMICS
Dihedra placed at angle of attack in hypersonic rarefied gas flow, investigating base flow and near wakes A70-35047
ONERA low pressure wind tunnel equipped with electron beam probing device to visualize flows too rarefied for optical methods A70-37208
Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions [AVA-FB-7029] A70-44668
Molecular reflection effects on aerodynamic characteristics of blunt bodies in rarefied gas flow [NASA-TT-F-13250] N70-37535
REACTION KINETICS
Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model [ICAS PAPER 70-52] A70-45500
Conference on kinetics and thermodynamics of combustion and high temperature gases [NASA-SP-239] N70-32106
REACTOR MATERIALS
Static tests of aluminum and steel frangible tube energy absorbers for nuclear aircraft reactors [NASA-TM-X-52847] N70-34152
REAL GASES
Corrections for real gas effects in nitrogen gas expansion by isentropic processes and computer programs of hypervelocity wind tunnel nozzle design [VKI-TN-58] N70-42586
REAL TIME OPERATION
Real time computers design tradeoffs in avionics systems A70-35510
Nationwide air traffic control, using radar network and real time computer flight information centers for air safety A70-35880
Real time narrow band vibration spectrum analysis techniques, discussing application to failure prediction and flight and wind tunnel tests A70-38528
Operational analysis and real time computer simulation models in ATC development A70-38637
Signal automatic air traffic control system /SATCO/ for flight plan processing, using multi-processing real time computer, electronic displays and software facilities A70-38646
Discussion on feasibility of real-time on-line optimal flight control [AD-709714] N70-41664
Real time simulation of aircraft in free flight using digital computers [DLR-FB-70-21] N70-42430
REATTACHED FLOW
Laminar incompressible separating and reattaching flows, correlating finite difference solutions with experimentation [AIAA PAPER 70-763] A70-34488
Wing lift increase by spanwise blowing along upper surface, causing flow reattachment on wing and vortex induced effective aerodynamic camber increase [ICAS PAPER 70-09] A70-44120
RECIRCULATIVE FLUID FLOW
Jet curtain flow recirculation model based on air-bubble flow visualization technique, determining minimum power for air cushion vehicle A70-42278
RECOMBINATION REACTIONS
Conference on kinetics and thermodynamics of combustion and high temperature gases [NASA-SP-239] N70-32106
RECONNAISSANCE AIRCRAFT
VAK 191 B VTOL aircraft fitting NATO Basic Military Requirements for low level reconnaissance-fighter operations developed from Fiat G-91 A70-34992
Armor airframed helicopter for aerial armored reconnaissance vehicle, noting design, fabrication and weight A70-44095
RECORDING INSTRUMENTS
Aircraft onboard maintenance recording system, discussing design and effectiveness A70-35516
European requirements for aircraft accident and maintenance recording systems A70-35517
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels [SMPTE PREPRINT 3] A70-43056
Portable recording instrument for measuring and surveying noise and vibration [AD-707826] N70-40026
RECOVERABLE LAUNCH VEHICLES
Suborbital space transports problem solution by recoverable jet orbital or jet assisted aircraft, discussing implications of Concorde supersonic flight A70-36663
RECOVERY PARACHUTES
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device [AIAA PAPER 70-1209] A70-41809
Design and performance of ringsail parachute [NASA-TN-D-5968] N70-35910
RECOVERY VEHICLES
Ground effect machine and recovery vehicle for materials handling [ARC-CP-1092] N70-42770
RECTANGULAR WINGS
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory A70-41407
Aerodynamic lift, drag and momentum coefficients in supersonic regime for rectangular and trapezoidal wings with spanwise variable profile A70-42615
RECURSIVE FUNCTIONS
Aircraft maintenance cost statistical analysis recursive regression model for aircraft failure and manhour cost data A70-46125
REDUCED GRAVITY
Negative g Drone aircraft surface tension fuel

system preventing air inclusion in turbojet engine fuel by tank filters /screens/
[AIAA PAPER 70-910] A70-35822
REDUNDANT COMPONENTS
Computerized metropolitan air transit system, discussing system redundancy for safety level maintainance and all-weather dependability
A70-34730
Automatic landing system assurance of DH 121 aircraft schedule all-weather regularity through high safety level via redundancy
A70-35856
All-weather Autoland control system using inertial smoothing, discussing required redundancy, fault detection, ground beam anomalies compensation, etc
A70-38821
Characteristics of adaptive aircraft control system in self-organizing configuration
[AD-703656] N70-32921
REENTRY PHYSICS
Thermal load of aerodynamic reentry body and resulting optimization and design criteria
[SC-T-70-4015] N70-33249
REENTRY TRAJECTORIES
Pitchdown control system for stabilization of space shuttle vehicles during reentry
N70-40963
REENTRY VEHICLES
Free flight wind tunnel test for feasibility of hypersonic drogue deployment into reentry vehicle wake
[AIAA PAPER 70-587] A70-35195
Liquid jets aerodynamic atomization at orifice exit in reentry vehicle into gaseous crossflow, investigating critical Weber number variation with Knudsen number
A70-39701
Reentry bodies of revolution subsonic and supersonic aerodynamic characteristics
A70-39704
Aerodynamic characteristics associated with aircraft flight and reentry vehicles
[AD-705584] N70-33694
Newtonian aerodynamic coefficients for predicting hypersonic stability characteristics of reentry bodies with various heat shield, afterbody angle and edge geometries
[NASA-TM-X-64332] N70-34532
Theory and capabilities of magnetically driven flyers
[AD-708449] N70-41131
REFLECTED WAVES
Reflection and focusing of sonic booms by two dimensional curved surfaces
[NASA-CR-110727] N70-32893
REFRACTORY MATERIALS
Composite technology effects on engineering design, emphasizing carbon-carbon materials for aircraft structural weight reduction, performance improvement and high temperature applications
A70-39202
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification
A70-44857
REFUELING
Boeing 747 aircraft pressure fueling system, describing tanks, feed system, refueling and electrostatic charge minimization
[SAE PAPER 700276] A70-36816
Jet fuels ground handling at airfields, describing flow monitors, filters, fueling techniques, etc
A70-43093
REGRESSION ANALYSIS
Pilot induced oscillation rating regression analysis, examining time delay, slope after and time to first peak and stick force per g
A70-36444
REGULATIONS
Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845
Air transport regulatory system, considering operational, technological and economic factors
A70-40579
REINFORCED PLASTICS
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air
A70-37370
Graphite-polyimide composites development for high temperature environments, discussing mechanical properties
A70-38425
Reinforced plastic for aircraft parts, investigating low viscosity polyester resins of styrene crosslinking type
A70-40028
Fiber reinforced plastics /FRP/ composites applications in Japanese aircraft production and aerospace industries
A70-40057
Joint strength of three layer fiberglass reinforced plastic panels with bilateral adhesive patches under linear axial force
A70-42812
REINFORCED PLATES
Fatigue strength of stiffened aircraft panels subjected to repeated buckling by compression loads
[ICAS PAPER 70-35] A70-44132
REINFORCING FIBERS
Composite wing section design and fabrication utilizing unidirectional glass reinforcement
[AIAA PAPER 70-919] A70-35813
Honeycomb panels with fiber reinforced facings, obtaining acoustic fatigue design criteria
[AIAA PAPER 70-897] A70-35814
Boron composites development for aircraft structures compared with titanium
[ASME PAPER 70-GT-120] A70-36851
Hydrofoil and hovering craft design by fiber technology, discussing composite materials, whisker mechanical properties, polycrystalline fibers, matrix materials, etc
A70-38941
Fiber reinforced plastics /FRP/ composites applications in Japanese aircraft production and aerospace industries
A70-40057
High thermal stability glass fibers alternatives improving stiffness-to-weight ratio of resin and Al-based composites used in F-111 boron epoxy wings
A70-42480
RELIABILITY
Flat conductor feeder tests and evaluation
[AD-705969] N70-34072
Technical and operational evaluation of Direct Altitude and Identity Readout /DAIR/ system /interrogator set AN/TPX-42/
[FAA-RD-70-29] N70-36950
Literature review and bibliography on altimetry
[FAA-RD-70-52] N70-41197
RELIABILITY ANALYSIS
Computer program for system reliability
[AD-706827] N70-37871
RELIABILITY ENGINEERING
Reliability and maintainability - Conference, Detroit, July 1970, Volume 9, Assurance technology spinoffs
A70-38815
Condition Monitored Maintenance program for turbine engines eliminating total overhauls at specified time, using NDT
A70-38830
Weapon systems effective reliability analysis, using degraded mode evaluation and deterministic computer program
A70-38833
Avionics hardware operational effectiveness assessment method, considering inertial navigation system LN-12D
A70-38837
Interface of maintainability, reliability, human factors, and system safety in military aircraft design
N70-40718
REMOTE CONTROL
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems
A70-34672

REMOTE SENSORS
Ultrasonic sensor for detecting altitude and vertical velocity of aircraft near ground, applying to helicopter hovering flight or conventional airplane takeoff and landing
[AIAA PAPER 70-1031] A70-39506
Thermistor and dew cell as remote air temperature and dewpoint measurement at airports
A70-40760
Microwave radiometry and applications as material composition and temperature sensors for aircraft navigation, landing aids, pollution surveillance, meteorology and oceanology
A70-44648
REPORTS
United States of America accident briefs on civil aviation
[PB-188859] N70-37606
REQUIREMENTS
Policies, requirements, goals, and criteria for national aviation system
N70-36967
RESCUE OPERATIONS
Aircraft-borne and descent systems performance and weight optimized for midair retrieval
[AIAA PAPER 70-1201] A70-41805
Pilot airborne recovery device /PARD/ midair rescue system, discussing buoyance, midair pickup, seat ejection energy absorber, homing avionics and human factors
[AIAA PAPER 70-1206] A70-41812
Helicopter automatic approach and hover coupler systems, discussing cockpit display devices, handling qualities, pilot workload and fatigue and external load stabilization
A70-44464
Technology review on suppression and rescue systems for aircraft fires on ground
[AD-703393] N70-35487
STOL port arresting gear, fire fighting, and rescue equipment
N70-41084
RESEARCH
Scientific research in materials science, general science, electronics, and oceanography
[AD-706718] N70-38374
RESEARCH AND DEVELOPMENT
European hypersonic aerodynamic research activities, describing Eurohyp program
A70-43507
Research and development in air traffic control systems for civil aviation
[AD-704475] N70-34255
Congressional hearings on aeronautical research and development
[REPT-91-932] N70-36160
NASA aeronautic research and development projects
N70-36782
Canadian research in science and technology
N70-38116
Research in combustion, explosions and hypervelocity
N70-38119
Summaries of research in aerodynamic noise
N70-38121
Military system development planning for operational capability needs
N70-40720
Research and development plan for increased airport and airspace capacity
[AD-707186] N70-40748
FAA research and development work on runway friction measurement and aircraft safety on slick runways
N70-40778
Research and development programs for reduction of sonic boom and aircraft noise
N70-40787
Research and development of STOL port criteria, airworthiness and operational criteria, and flight test procedures
N70-41085
Historical survey of aeronautical research and development at Ames Research Center from 1936 to 1965
[NASA-SP-4302] N70-41479
Instrument landing system implementation and research and development
N70-41541
Research and development in airport/airway capacity, national airspace system, aircraft safety, and aerospace medicine
N70-41543
RESEARCH FACILITIES
Hypersonic wind tunnel facility for hypersonic aircraft and recoverable booster systems development
[DFVLR-SONDDR-19] A70-44799
Projects and facilities of Canadian Laboratories
N70-33655
RESEARCH PROJECTS
FAA research activities on eliminating birds at airports and improving aircraft components resistance to impact, including interagency committee functions on hazard problems
A70-35982
NACA/NASA rotating wing aircraft research history 1915-1970, Part 2, autogyro flight test experiences, rotor blade dynamics research, interest in helicopters, etc
A70-44852
NACA/NASA rotary wing aircraft research history 1915-1970, Part 3, covering rotor and helicopter theory, related flight and wind tunnel testing, etc
A70-44853
NACA/NASA rotating wing aircraft research history 1915-1970, Part 3, covering rotor dynamics and flying qualities, hovering tests, rotor flow, loads, etc
A70-44856
Research program and activities in aeronautics and space flight
[NASA-TM-X-65099] N70-36959
RESONANCE TESTING
Wall thickness measurement by supersonic testing method based on resonance
A70-45681
RESONANT FREQUENCIES
Sound vibrations resonant frequency relation to jet internal structure in gas jet stem radiator
A70-38658
Tethered parachutes vibration modes, determining fundamental frequencies from canopy/lines mass ratio and materials elastic properties
[AIAA PAPER 70-1169] A70-41844
Linear elastomechanical systems natural vibration parameters by harmonic excitation method
A70-43200
RESONANT VIBRATION
Hingeless rotor helicopter airborne and ground resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping
A70-34733
RESPIRATORY SYSTEM
Continuous flow requirements in aircraft passenger oxygen systems using phased dilution principle, discussing breathing mask efficiencies
A70-44483
RETROFIRING
Device for use in descending spacecraft as altitude sensor for actuating deceleration retrorockets
[NASA-CASE-XMS-03792] N70-41812
REUSE
Inspection, evaluation, classification, and reuse criteria for used airfield landing mats
[AD-708891] N70-43200
REVERSED FLOW
Multistage multiple reentry axial flow reaction turbine with reverse flow reentry ducting
[NASA-CASE-XLE-00170] N70-36412
REVIEWING
Bibliography on ducted propeller studies
[AD-705524] N70-33670
REYNOLDS NUMBER
Laminar boundary layer transition on sharp cone at zero yaw in supersonic wind tunnels, correlating aerodynamic noise disturbances with transition Reynolds numbers
[AIAA PAPER 70-799] A70-34462
Steady viscous flow past oblique flat plate at high Reynolds number, using Oseen linearized approximation
A70-41714
Free stream disturbances influence on hypersonic boundary layer transition Reynolds number in

heated and unheated flows
[AIAA PAPER 69-704] A70-41744
Wave rider aerodynamic properties at small Reynolds numbers, using non-Weiler wing for flow field, pressure and force measurements at rarefied flow conditions
[AVA-FB-7029] A70-44668
Test section for use in short duration wind tunnel for simulating high Reynolds numbers over transonic speed range
[NASA-CASE-MFS-20509] N70-35676
Reynolds number effect on tip losses
[AD-700578] N70-36419
Aircraft and engine design problems for high Reynolds number, high speed, large subsonic aircraft - conference
[AGARD-LS-37-70] N70-37753
High Reynolds number, near sonic aircraft design N70-37758
ONERA hypersonic wind tunnels for flow studies related to space shuttles N70-37832
Airfoil measurements that show behavior of wing sections in low-turbulence stream in Reynolds number range from 20,000 to 170,000
[NASA-TM-X-60976] N70-39001
Wind tunnel measurements of hemisphere cylinder yawmeter sensitivity at transonic speeds and Reynolds numbers
[ARL/A-320] N70-39031
Pressure measurements and boundary layer separation studies on slender cone delta wing at different Mach and Reynolds numbers
[ARC-R/M-3626] N70-42500

RIGID ROTORS
Hingeless rotor helicopter airborne and ground resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping A70-34733
Dynamic unbalance effects in rigid body rotors, discussing lubricant temperature changes and instability hysteresis
[ASME PAPER 69-LUB-14] A70-37606

RIGID STRUCTURES
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes A70-41408
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion
[AIAA PAPER 70-1191] A70-41825
Light rigid civil aircraft response to continuous atmospheric turbulence estimated using two rigid body degrees of freedom method for vertical and lateral gusts
[AIAA PAPER 69-766] A70-42703
Low weight, high strength, rigid honeycomb core structures with minimal surface tubule sections
[NASA-CASE-ERC-10363] N70-40071

RIGID WINGS
Calculations on thin profile oscillations in subsonic flow near rigid boundary
[NASA-TT-F-12966] N70-34182
Wind tunnel characteristics of ejection seat scale model with rigid wing recovery system
[NASA-TN-D-5922] N70-34399
Deployment system for flexible wing with rigid superstructure
[NASA-CASE-XLA-01220] N70-41863

RING STRUCTURES
Euler buckling of inflated toroidal drag bodies, including packaging and load deflection tests for Mylar, dacron-neoprene and stainless steel-silicone fabrics
[AIAA PAPER 70-1198] A70-41818

RIOMETERS
Three-frequency riometer system operation on NASA 711 aircraft during 1969 auroral absorption
[NASA-CR-112356] N70-36632

RIVERS
Microwave radiometric airborne measurement of salinity of Mississippi River outflow, using P3A aircraft A70-45979
Supersonic transport radiation hazards and St. Lawrence River tides
[DME/NAE-1970/1/] N70-37215

ROADS
Mathematical models for Northeast Corridor transportation system
[PB-190933] N70-36452

ROCKET ENGINE DESIGN
Hybrid combustion ram rocket drives, discussing booster initial acceleration, exhaust gas use as fuel and payload gain
[ICAS PAPER 70-50] A70-44147

ROCKET ENGINES
Energy transfer methods for hybrid air breathing ramjet propulsion systems with rocket motor S gas source
[ICAS PAPER 70-61] A70-44156

ROCKET EXHAUST
Jet-plume-induced flow separation on asymmetric bodies at 3.00, 4.50, and 6.00 Mach numbers
[NASA-TM-X-2059] N70-34350

ROCKET FLIGHT
Aircraft and rocket guidance systems navigation error analysis, discussing numerical integration techniques and computer program
[AIAA PAPER 70-1004] A70-39527

ROCKET PLANES
Flight dynamics and trajectory calculations for winged rocket aircraft
[AD-706663] N70-38629

ROCKET PROPELLED SLEDS
Gust response of slender wing aircraft model mounted on rocket propelled sled moving past low speed wind tunnel mouth
[ARC-CP-1113] N70-42529

ROCKET VEHICLES
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals A70-34686

RODS
Rod surface roughness effect on eddying sound frequency and intensity and on aerodynamic resistance A70-38654

ROLL
Aircraft rolling motion /eigenmotion/ in flight at small angle of attack following initial disturbance, discussing response to control action A70-42515
Flight investigation of roll requirements for transport airplanes in cruising flight
[NASA-TN-D-5957] N70-38625

ROLLER BEARINGS
Hybrid boost bearing with long life and free starting, stopping and oil system failure characteristics of rolling element bearing
[ASME PAPER 69-LUB-16] A70-37605
Jet engine roller bearings retainer candidate cage materials and coatings evaluation on test rig simulating engine conditions
[ASLE PREPRINT 70AM 2D-1] A70-38805
Gas turbine engine compressor rotor roller bearing operation conditions analysis by computer calculation of thermal regime A70-41777

ROLLING MOMENTS
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161
Low speed wind tunnel study of oscillatory rolling moments of slender wing with sharp leading edge and frequency and ground effects
[ARC-R/M-3617] N70-37162

ROOMS
Investigating pressure fields from sonic booms transmitted into rooms through open windows
[NASA-CR-111787] N70-42168

ROOT-MEAN-SQUARE ERRORS
RMS spectrum analysis system for wideband acoustic data processing, using analog method with digital output A70-37910

ROTARY STABILITY
Rotor blade flutter in forward flight accounting for wake unsteady aerodynamic effect A70-34727
Sliding friction effects of nonlinear asymmetric supports on turbine engine rotor-shaft stability

[SAE PAPER 700320] A70-36799
Prevention and elimination of vibration of rotary machines
[AD-703063] N70-35499

ROTARY WING AIRCRAFT
NACA/NASA rotating wing aircraft research history 1915-1970, Part 2, autogyro flight test experiences, rotor blade dynamics research, interest in helicopters, etc A70-44852
NACA/NASA rotary wing aircraft research history 1915-1970, Part 3, covering rotor and helicopter theory, related flight and wind tunnel testing, etc A70-44853
NACA/NASA rotating wing aircraft research history 1915-1970, Part 3, covering rotor dynamics and flying qualities, hovering tests, rotor flow, loads, etc A70-44856
Manual IFR formation flight display system requirements for advanced rotary wing and jet fighter aircraft
[AD-705133] N70-32317
Mathematical model of rotary wing aircraft for performance, stability, response, and rotor blade load characteristics determination
[AD-707881] N70-39729
Rotary wing and vertical takeoff aircraft displays for steep angle approaches
[AD-709475] N70-41477

ROTARY WINGS
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design A70-34702
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests
[AHS PREPRINT 451] A70-34703
Helicopter rotor blades flapwise bending moments prediction by transfer function/superposition techniques A70-34704
Helicopter blade sections dynamic stall characteristics, considering accelerated flow generation by nonzero pitch rate A70-34718
Rotor blade flutter in forward flight accounting for wake unsteady aerodynamic effect A70-34727
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects A70-34729
Helicopter rotor blade stall flutter response prediction based on NACA 0012 airfoil aerodynamic data A70-34734
Swept tip rotor blade design, discussing wind tunnel-whirl stand correlations A70-34736
Helicopter rotor blade differential pressure and structural load characteristics in transient and steady state maneuvers A70-34739
IR NDT bond inspection system for helicopter rotor blade honeycomb box assemblies, using closed circuit slow scan video system to detect bondline voids A70-35184
Convertible helicopter rotor technology, discussing materials, blade configurations and variable diameter concept A70-35550
Optimum adaptation of propulsion gas generators to power jet driven rotors with blown flap control, considering jet engine, fanjet and engine driven compressor A70-35661
Aerodynamics theory for separated flow effects on helicopter lift-drag capability, taking into account three dimensional flow and blade aeroelasticity A70-35956
Cross section deformation effect on helicopter rotor blade torsional vibration, using differential equations of vibrating beam A70-35959
Model testing for helicopters, considering scaling, ditching and rotor performance A70-38610
AERCAB /Aircrew Escape/Rescue Capability/ flying ejection seat, considering rotary wings, fixed wings and parawings
[AIAA PAPER 70-1213] A70-41806
Rotor drive systems for rotary wing aircraft, indicating mechanical hub drive advantages over reaction blade drive A70-41850
Aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors including dual jets and cyclic results
[AIAA PAPER 69-741] A70-42705
Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades
[ICAS PAPER 70-14] A70-44125
Helicopter rotors fatigue testing using small scale models of full scale components
[ICAS PAPER 70-34] A70-44131
Helicopter rotor tests in large wind tunnel for increased flight speed, noting pressure and noise measurements
[ICAS PAPER 70-44] A70-44142
Low disk loading rotors in high speed VTOL aircraft for economical vertical payload lift
[ICAS PAPER 70-57] A70-44153
Main rotor wake adverse effects on tail rotor directional control in low velocity wind A70-44323
Dynamic systems stability with periodically varying parameters analyzed by Hill type infinite determinant, exemplifying helicopter rotor aeroelastic stability in forward flight A70-44556
Reducing aerodynamic noise and blade-vortex interaction by modifying tip vortex of helicopter rotors
[AD-704804] N70-32556
Cockpit noise exposures associated with operation of fixed and rotary wing aircraft
[AD-705964] N70-33974
Aircraft control system with four command channels suited to rotary wing aircraft
[NASA-CASE-ERC-10439] N70-36052
Lift margin display for helicopter landing and takeoff operations
[AD-704601] N70-36384
Comparison between experimental data and lifting surface theory calculation of vortex induced loads on single-bladed rotary wings
[NASA-CR-112769] N70-36986
Compressibility effects in helicopter rotor blade flutter
[AD-706243] N70-38173
Accident investigation for Sikorsky S-61L in Paramount, California, 22 May 1968
[PB-189143] N70-38226
Aerodynamic model for calculating airloads and blade motion of helicopter rotor blades
[AD-707939] N70-39885
Rotor/wing concept of stopped-rotor helicopter configuration
[AD-710425] N70-43132

ROTATING BODIES
Heat transfer from gas to gas turbine buckets, determining angle of attack and rotation influences by extending transfer equation A70-40345
Asymmetric rotating bodies mass properties measurement on Dynamic Balancing Machine, taking into account aerodynamic forces
[SAWE PAPER 818] A70-40351

ROTATING CYLINDERS
Experimental windage losses for close clearance rotating cylinders in turbulent flow
[NASA-TM-X-52851] N70-33066

ROTATING DISKS
Three-dimensional stress concentration in rotating anisotropic disks with radial compressor blades using finite element method
[DLR-FB-70-16] N70-38484

ROTATING FLUIDS
Ducted propeller subsonic rotational flow with free boundaries, presenting second-order partial differential equation solution without linearizing assumptions

A70-45269
ROTATING STALLS
Rotating stall in axial compressors, using finite difference method
A70-35450
Rotating stall study in turbine engine compressors
[AD-708484] N70-40756
ROTOR AERODYNAMICS
Helicopter rotor blades flapwise bending moments prediction by transfer function/superposition techniques
A70-34704
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A70-37237
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A70-44856
ROTOR BLADES
CH-47C helicopter fiberglass main rotor blade, discussing composite materials impact on design
A70-34702
Helicopter rotor blade stall flutter response prediction based on NACA 0012 airfoil aerodynamic data
A70-34734
Shock wave radiation from supersonic ducted rotor, determining sound power at blade passing harmonic frequency
A70-38614
NACA/NASA rotating wing aircraft research history 1915-1970, Part 2, autogyro flight test experiences, rotor blade dynamics research, interest in helicopters, etc
A70-44852
ROTOR BLADES (TURBOMACHINERY)
Gas turbine aero engines damage due to bird strikes, emphasizing rig testing and simulation at first stage rotor blading
A70-35995
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor
[ASME PAPER 70-GT-39] A70-36869
Discrete components formation in noise spectra of axial turbocompressor intake, considering relationship between blades and rotor disk
A70-38652
Compressibility effects in helicopter rotor blade flutter
[AD-706243] N70-38173
ROTOR SPEED
High powered high speed helicopters autorotation entry characteristics, noting capability of meeting control time delay requirement
A70-34715
Basic elements for advanced design of radial flow compressors
N70-39096
ROTORS
Three dimensional flow through rotor of axial vortex flow fan, using airfoil method for design
A70-38248
Tail rotor thrust increase for yaw control via increased blade area, higher tip speeds and cambered airfoils
A70-44324
Performance analysis of rotary nozzle utilizing 30 deg spin angle rotor
[AD-705057] N70-32246
Magnesium aluminum alloy as filler material in steel welds for rotor construction
[M70-111-ROM/VDT/NAT] N70-35540
Dynamic balancing of rotors
N70-37790
Multistage, multiple reentry, single rotor, axial flow turbine
[NASA-CASE-XLE-00085] N70-39895
Endurance test on two phase flow rotor bearing system for turbomachinery
[MTI-70-TR-33] N70-40214
Numerical methods for determining whirl characteristics of rotors running on shafts supported by ball bearings
N70-43036
ROUTES
Long range air transport routes, predicting equipment and expenditures modifications
A70-43533
RUBBER COATINGS
Hotshot wind tunnel performance improvement by coating arc chamber with silastene to retard heat loss and metal pollution
A70-34774
RUNWAY CONDITIONS
Aircraft landing and takeoff difficulties and dangers due to mud and water on runways, discussing coping methods
A70-34692
Fog dissipation on aircraft runways, using aircraft jet engine exhaust heat and mixing properties
A70-35929
Airport bird detection equipment /ABDE/ radar to display airfield map for presence and magnitude of bird groups and vegetation on runway
A70-35998
Runway low visibility and ceilings frequency and duration at German airports, using 1949-1967 statistical data
A70-37925
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
FAA research and development work on runway friction measurement and aircraft safety on slick runways
N70-40778
RUNWAY LIGHTS
Runway lights and markings for STOL ports
N70-41083
RUNWAYS
Commercial aircraft launching and arresting systems for airport runway length reduction, discussing safety factors
[SAE PAPER 700264] A70-36821
ATC systems safety, capacity and delay, discussing terminal operations, runway capacity and aircraft spacing
A70-38228
Maximum throughput-rate capacity for runway and final approach path airspace involving multiple IFR landings
A70-38235
Airport capacity analysis for terminal areas, using simulation for alternatives to parallel runway operation
A70-38236
ATC airborne surveillance, communication and control system functioning as CAS after error or failure, discussing minimum parallel runway separation
A70-38241
Comparison of cord loads with aircraft tire on grooved and smooth runway surfaces
[NASA-CR-1627] N70-33150
Rapid assessment of soil strength at aircraft landing sites
[AD-705572] N70-33677
Arresting gear concepts for runway use
[AD-701331] N70-34263
Simulation of continuous runway centerline marking
[FAA-RD-70-40] N70-37021
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft
N70-40776
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids
[N-5390.3] N70-41076
Determination of runway length for STOL ports
N70-41080

Runway marking patterns studied under limited visibility conditions
[FAA-RD-70-27] N70-41517
Reduced terminal IFR separation standards and runway spacings N70-41532
Classifying standard runway lengths and distance requirements during takeoffs and landings N70-41595
Soil strength evaluation of unsurfaced forward-area airfields by use of ground vehicles
[AD-709589] N70-41602
Laser system for monitoring wingtip vortices on runways
[NASA-TM-X-64525] N70-42182
Inspection, evaluation, classification, and reuse criteria for used airfield landing mats
[AD-708891] N70-43200

S

S-61 HELICOPTER
Accident investigation for Sikorsky S-61L in Paramount, California, 22 May 1968
[PB-189143] N70-38226
SAAB 37 AIRCRAFT
Flight simulation in SAAB AJ37 aircraft development, describing analog and digital computers, cockpit simulators, automatic pilots, control and display devices
[ICAS PAPER 70-42] A70-44140
Viggen aircraft testing for flight properties, discussing measuring instruments, analog and digital recording, preprogrammed control, etc A70-46228
Sapuc-Salut system for evaluating test data measured onboard Viggen aircraft A70-46229
SAFETY DEVICES
Static charge reducer for aircraft fuels handling safety, discussing performance factors
[SAE PAPER 700277] A70-36808
Tractor rocket powered escape system of 600 knot extraction capability using drogue parachute and barometric time delay device
[AIAA PAPER 70-1209] A70-41809
Pilot airborne recovery device /PARD/ midair rescue system, discussing buoyance, midair pickup, seat ejection energy absorber, homing avionics and human factors
[AIAA PAPER 70-1206] A70-41812
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects A70-44456
Emergency life saving instant exits for transport aircraft, using electromechanical confined transfer shaped explosive device A70-44487
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals A70-44488
Modularized multiple use SIIIS-3 ejection seat escape system, discussing weight, envelope and low cost A70-44499
SAFETY FACTORS
Aircraft accident prevention and investigation, noting economic factors as deterrent to safety measures implementation A70-35860
Interface of maintainability, reliability, human factors, and system safety in military aircraft design N70-40718
SAILWINGS
Hi-glide personnel canopy /Para-Foil, Parawing, Sailwing, Volplane/ technology capability requirements identification from performance parameters tradeoffs
[AIAA PAPER 70-1194] A70-41822
Water ballast loadings on sailplane Cobra 17, considering wing, aileron, tailplane, fuselage and landing gear A70-42962
SALINITY
Microwave radiometric airborne measurement of salinity of Mississippi River outflow, using P3A aircraft A70-45979
SAMPLING
Wind tunnel tests measuring transverse jet plumes
[GSL-TR-70-4] N70-37120
Metropolitan area airport capacity analysis for 1980 - Atlanta, Georgia N70-41195
SANDS
Erosion by solid particles, discussing impacting velocity effects, natural sand quartz particle size distribution and composition, artificial industrial abrasives, etc A70-35600
SANDWICH STRUCTURES
Joint strength of three layer fiberglass reinforced plastic panels with bilateral adhesive patches under linear axial force A70-42812
Bonded honeycomb sandwich structure fastening techniques in aerospace design, noting application to aircraft and spacecraft structures
[SAE PAPER 700850] A70-45882
Weight optimization in structural sandwich panel design
[AD-709656] N70-42286
SATELLITE ATTITUDE CONTROL
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants A70-39667
SATELLITE DRAG
Monoenergetic nitrogen free molecule beam impingement on solid surface, calculating satellite drag coefficients from momentum transfer measurements A70-41743
SATELLITE NAVIGATION SYSTEMS
Dioscures project for ATC over Atlantic Ocean, describing distance measurement by simultaneous use of two geostationary satellites A70-41258
Air traffic safety problems, discussing satellite radiobeacons applications to aerial navigation A70-42652
Dioscures satellite navigation system for aircraft and ships, discussing coverage, radio links, project costs, etc A70-42657
SATELLITE NETWORKS
Telecommunication, ATC and navigation satellite systems, examining economic bases for aeronautical and maritime space systems A70-39407
Communication satellites systems for civil application, considering ground stations design, regional communication, ATC and maritime communications and navigation A70-39409
Satellite-based air traffic control system for North Atlantic, applying stochastic optimal control theory
[AIAA PAPER 70-966] A70-39563
Aeronautical satellite system for civil flight safety, discussing operational, technical and economic aspects A70-41131
SATELLITE OBSERVATION
Satellite based systems for aircraft surveillance, discussing satellite power and bandwidth conservation, pulse techniques and interrogators A70-36391
Manned space flights, satellite observations, space sciences, and air traffic control - NASA report to Congress for 1 Jan. to 30 June 1969
[NASA-TM-X-64292] N70-33962
SATELLITE ROTATION
Dynamic systems stability with periodically varying parameters analyzed by Hill type infinite determinant, exemplifying helicopter rotor aeroelastic stability in forward flight A70-44556
SATURN S-4B STAGE
Aerodynamic and gravity gradient torque effects on attitude control of Apollo/S-4B configuration in circular earth orbit
[NASA-TM-X-64300] N70-34218

SCALE (CORROSION)
Turbine blade corrosion and thickening effects on turbine efficiency
N70-39449
SCALE EFFECT
Scale effects on oscillatory control surface stability derivatives and three dimensional wind tunnel model tests without boundary layer transition
[NPL-AERO-1283] N70-34928
Scaling effects on shock-induced separation in high speed subsonic flow
N70-37756
Scaling and Reynolds number effects on predicting drag from tests on wind tunnel models
N70-37757
SCALE MODELS
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738
Wind tunnel balance for measuring small aerodynamic loads on scale models, describing three component construction
A70-35490
Model testing for helicopters, considering scaling, ditching and rotor performance
A70-38610
Helicopter rotors fatigue testing using small scale models of full scale components
[ICAS PAPER 70-34] A70-44131
High bypass model jet noise study, describing test setup and noise measurement results as function of secondary/primary flow velocity ratio
A70-44394
Model scale effect on inlet temperature rise of VTOL jet configurations
[NASA-CR-66965] N70-34533
Scaling comparison of recirculation effects of VTOL YJ-85 lift engine pod with similar small-scale simulated engine pod
[NASA-CR-1625] N70-35846
Nacelle induced flutter effects in elastodynamic scaled model of fan jet transport aircraft mounted in wind tunnel
[NASA-TN-D-6003] N70-39907
Spin tunnel investigation of 1/20 scale model of modified straight-wing, twin boom, counter insurgency airplane
[NASA-TM-X-2053] N70-40657
SCALING LAWS
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738
SCHEDULES
Automatic landing system assurance of DH 121 aircraft schedule all-weather regularity through high safety level via redundancy
A70-35856
Central passenger traffic schedule role in air traffic control, discussing computer solutions, aircraft optimal use, etc
A70-36397
SEALS (STOPPERS)
Computerized design of gas turbine mainshaft seals for operation to 500 ft/sec
[NASA-TM-X-52886] N70-40807
SEAPLANES
Passenger seaplanes virtues and drawbacks, discussing bases, servicing, refueling, passenger conveyance, prospects, etc
A70-43887
Engineering approximation of maximum accelerations experienced by planing craft in rough water
[AD-706098] N70-38390
Ground effects investigation of STOL air-sea transport model with blowing over canard and wing flaps
[NASA-TN-D-5988] N70-40690
SEAT BELTS
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects
A70-44456
SECONDARY FLOW
Secondary flow losses in axial compressors
N70-39095
SECONDARY INJECTION
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone
A70-37246
SECTORS
Increased enroute air traffic capacity through increased control sectorization
N70-41536
SELF ADAPTIVE CONTROL SYSTEMS
High performance aircraft self adaptive feedback control system, using airborne digital computer with inputs of elevator deflection and pitch rate for effectiveness identification
A70-40119
SELF ALIGNMENT
Commercial aircraft strapdown inertial navigation systems, examining initial self alignment techniques
A70-36442
SELF ERECTING DEVICES
Foldable conduit capable of springing back as self erecting structural member
[NASA-CASE-XLE-00620] N70-41579
SELF OSCILLATION
Harmonic linearization method for nonlinear automatic control systems with finite automata, discussing self oscillating modes of operation
A70-42836
SENSITIVITY
Sensitivity optimization for linear optimal control systems design, describing aircraft lateral-directional control case study
[AIAA PAPER 70-962] A70-39567
SENSITIZING
Investigating sensitization of aliphatic hydrocarbon fuels for weapons application
[AD-704509] N70-36487
SENSORS
Flow difference sensor for aircraft hydraulic systems damage vulnerability reduction, discussing design, operation and flight tests results
A70-40786
SENSORY FEEDBACK
Fluidically augmented artificial feel system for fighter and attack aircraft control, discussing improved handling qualities
[SAE PAPER 700785] A70-45859
SEPARATED FLOW
Transitional flow separation upstream of compression corner at trailing edge of sharp leading edge flat plate
[AIAA PAPER 70-764] A70-34487
Laminar incompressible separating and reattaching flows, correlating finite difference solutions with experimentation
[AIAA PAPER 70-763] A70-34488
Aerodynamics theory for separated flow effects on helicopter lift-drag capability, taking into account three dimensional flow and blade aeroelasticity
A70-35956
Mathematical model of three dimensional separated flows with applications to small aspect ratio delta wing and flat plate
A70-36438
Axial flow compressor stage efficiency under rotary separation conditions, investigating dependence on flow rate
A70-37252
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack
A70-42284
Jet-plume-induced flow separation on asymmetric bodies at 3.00, 4.50, and 6.00 Mach numbers
[NASA-TM-X-2059] N70-34350
Separated flow regime of two phase flow
[PB-189804] N70-37342
Scaling effects on shock-induced separation in high speed subsonic flow
N70-37756
Filtration methods for aircraft fuel systems presenting vortex separation principle
[AD-707058] N70-38574

Double hinged flap for boundary layer control over trailing edges of wings
[NASA-CASE-XLA-01290] N70-42016
SEPARATORS
Water separation index modified /WSIM/ test for jet fuel surface active materials in relation to filter/separator performance
[SAE PAPER 700279] A70-36815
SERVICE LIFE
Aircraft, helicopters and rockets aviation systems design and components service life problems, emphasizing maintenance intervals
A70-34686
Boeing 747 aircraft JT9D engine deflections and removals during early service experience and maintenance
[AIAA PAPER 70-890] A70-35807
Computer program for assessment and modification of mechanical component life predictions by discrete formulation of Bayes theorem
A70-38816
Helicopter parts and assemblies fatigue life estimation and testing, discussing loading spectra, service conditions, etc
A70-43119
Aircraft turbine engines durability estimated from rotor blade minimum tip clearance measurements
A70-43529
NDT for aircraft service life extension, discussing fatigue tests and crack detection
A70-45719
Aircraft structures service life estimation, using Ir-192 and Tm-170 gamma ray radiography
A70-45725
Mathematical methods for calculating service life of aircraft engine lubricating oils
[AD-703999] N70-36225
SERVICES
Computerized air transportation service including passenger name record, fare quotation, ticketing, etc
A70-34688
Federal policy and services relative to privately owned, publicly used airports
N70-41530
SERVOMOTORS
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
Liquid metal hydraulic servoactuation packages for flight control in high temperature environments without coolant systems
A70-40785
Automated aircraft flight safety, concerning probabilities and onboard elimination of servomotor failures in hydraulic system due to fuel contamination
A70-42804
SHADOWGRAPH PHOTOGRAPHY
Spark photography of models in free flight in hypersonic shock tunnel
[SMPTE PREPRINT 99] A70-43035
Spark tracing in gaseous flows in flames, wind tunnels, nozzles and pneumatic valves, using pulse transformer
[SMPTE PREPRINT 41] A70-43041
SHAFTS (MACHINE ELEMENTS)
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests
[AHS PREPRINT 451] A70-34703
Numerical methods for determining whirl characteristics of rotors running on shafts supported by ball bearings
N70-43036
SHAKERS
Digital electrodynamic vibration exciter control for sinusoidal, random and shock spectrum testing of aircraft, missiles and satellites
A70-37920
Aeroelastic test equipment for Concorde SST using harmonic method and electromagnetic shakers
A70-38548
Shakers and solid rocket propellant impulse generators for aeroelastic and vibration flight tests of Concorde aircraft structures
[ONERA-TP-811] N70-37148
SHARP LEADING EDGES
Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings, giving low lift-dependent drag
A70-38615
Slender wings of low aspect ratio and sharp leading edges, predicting inviscid maximum lift
A70-40585
SHEAR FLOW
Aerofoil section characteristics in shear flows of arbitrary velocity profile calculated by Glauert image method
A70-35957
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution
A70-38350
Conference on aerodynamics of atmospheric shear flows
[AGARD-AR-24-70] N70-40736
Local pressure field in turbulent shear flow and its relation to aerodynamic noise
[NASA-CR-113881] N70-41283
SHELLS (STRUCTURAL FORMS)
Report including finite element analysis of shells, pressure molding foam, and flight impact simulator
[DME/NAE-1969/4/] N70-33651
SHOCK ABSORBERS
Energy dissipating shock absorbing system for land payload recovery or vehicle braking
[NASA-CASE-XLA-00754] N70-34850
SHOCK LAYERS
Shock layer and combustion in supersonic flows about conical bodies at various angles of attack
A70-35894
SHOCK LOADS
Solid cloth personnel parachutes opening forces, discussing loading conditions, flight path shock parameters, mass ratio variations and elasticity of system
[AIAA PAPER 70-1167] A70-43992
SHOCK RESISTANCE
Experimental systems for impact protection using starch/brine dilatant suspensions
[AD-708017] N70-40188
SHOCK TUBES
Forcing time functions prediction for structures under shock tube test, relating aerodynamic parameters to mechanics terminology
A70-35180
Condensation in contoured nozzle shock tunnel
[AD-708475] N70-40655
Techniques for producing hypervelocity flows in aerodynamic test facilities
[AD-709210] N70-41152
SHOCK WAVE INTERACTION
Hypersonic cruise vehicles viscous interactions areas, examining compression corners, shock interactions, laminar and turbulent flow, boundary layer separation, etc
[AIAA PAPER 70-781] A70-34475
Fast response transducer for measuring transient pressures due to shock interaction
A70-35484
Shock wave diffraction by moving thin wing over flat terrains, discussing aircraft blast encounter
A70-36195
Loads induced by terminal shock boundary layer interaction on cone-cylinder bodies, discussing angle of attack effect
A70-41863
SHOCK WAVE PROFILES
Pressure distribution shock pattern and impact wave resistance in frictionless plane parallel and source shaped supersonic flow
A70-36385
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution
A70-40918
SHOCK WAVE PROPAGATION
Intersecting shock waves propagation, deriving equations for aircraft sonic boom intensity
A70-38484
Shock wave radiation from supersonic ducted rotor, determining sound power at blade passing harmonic frequency

A70-38614
SHOCK WAVES
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock
A70-40288
Hypersonic flow pattern past windward side of triangular wing with supersonic leading edges, joining potential and vortex regions behind shock wave
A70-40609
Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209
Plane transonic flow around airfoils, using hodograph based methods for shock free flow and finite difference methods for flow with shock waves
[ICAS PAPER 70-12] A70-44123
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943
Calculation of supersonic flow around blunted bodies with detached shock wave
[NASA-TT-F-13026] N70-32533
High altitude flow visualization of boundary layer transition and shock waves using oil coatings
[ARC-CP-1090] N70-37173
Mass flow limitations in supersonic compressors
N70-39093
Annotated bibliography of shock and vibration publications
[AD-700811] N70-40359
SHORT CIRCUITS
High current short circuit testing facilities for aircraft control and protection devices
[AD-705504] N70-36423
SHORT HAUL AIRCRAFT
V/STOL aircraft for short haul transportation, discussing speed, noise, reliability, economy, etc
[SAE PAPER 700333] A70-36797
V/STOL short haul air transportation program in western U.S., assessing public acceptance and economic viability
[AIAA PAPER 70-888] A70-37394
Yak-40 business jet design and flight characteristics
A70-42174
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Short haul intercity center facilities air transportation traffic alleviation by VTOL aircraft, emphasizing performance, ground facilities, system operation and economics
[AIAA PAPER 70-1243] A70-45914
U.S. western region short haul air transportation, discussing demand, modal split, STOL and VTOL aircraft, avionics and ground systems
[AIAA PAPER 70-1284] A70-45915
Short haul metropolitan air transportation, considering systems engineering as unifying technology
[AIAA PAPER 70-1281] A70-45927
ATC, air navigation facilities and airport design requirements for short haul transportation system
[AIAA PAPER 70-1288] A70-45973
Short haul STOL and VTOL air transportation systems study
N70-41032
SHORT TAKEOFF AIRCRAFT
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
STOL takeoff trajectory optimization for heavily loaded helicopter, using optimal control theory
A70-35841
STOL navigation systems, evaluating Vector Analog Computer, Decca Omnitrac IIB and inertial system
A70-36513
STOL systems 1975 technical and economic characteristics in terms of passenger market, aircraft design, terminal facilities and ATC capability
[SAE PAPER 700311] A70-36812
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts
[SAE PAPER 700269] A70-36819
Four-seat two-engined STOL propeller passenger and sport aircraft design and performance
A70-37371
Avionics role in STOL air transportation operational capabilities in congested air traffic environment
A70-38238
STOL system traffic analysis simulation model for interurban transportation system as tool for flight hardware evaluation
A70-43731
Wheel force and roll moment nonlinearities effect on light STOL aircraft handling qualities during approach
[ICAS PAPER 70-55] A70-44151
STOL operations from city centers, discussing safety requirements, navigation and guidance systems, airport criteria, etc
A70-44174
STOL aircraft augmentor wing concept, examining noise suppression, flight research vehicle program and application to turbofan production aircraft
[SAE PAPER 700812] A70-45903
Commercial STOL aircraft propulsion systems from airline viewpoint, emphasizing subsystem design, engine selection, thrust deterioration and maintainability
[SAE PAPER 700810] A70-45904
Satellite based navigation/air traffic control information systems for short range STOL air carrier aircraft
[AIAA PAPER 70-1338] A70-45930
STOL aircraft guidance and control, discussing area navigation utilization, multiple airways, data links and ground ATC computers
[AIAA PAPER 70-1334] A70-45934
STOL aircraft low speed handling characteristics described via approach and landing profiles, power requirements, wind effects, etc
[AIAA PAPER 70-1332] A70-45936
STOL aircraft FAA airworthiness standards and certification rules, examining noise, control systems, all weather operation, fire protection, handling qualities and performance
[AIAA PAPER 70-1331] A70-45937
Commercial STOL aircraft takeoff and landing physical parameters relationships based on wind tunnel and flight tests
[AIAA PAPER 70-1238] A70-45959
STOL aircraft field length, terminal area performance and minimum handling qualities requirements for safe and efficient operations
[AIAA PAPER 70-1240] A70-45960
Highlift and blown wing types slow speed STOL aircraft, comparing pilot training requirements with jet airline flying
[AIAA PAPER 70-1282] A70-45971
STOL aircraft operational constraints, considering economics, short haul market characteristics, community acceptance, speed, propulsion system, takeoff/landing performance and maneuverability
[AIAA PAPER 70-1283] A70-45972
Wind tunnel measurements of flow field behind model of twin-propeller deflected slipstream STOL aircraft
[NAL-TR-197T] N70-40562
Ground effects investigation of STOL air-sea transport model with blowing over canard and wing flaps
[NASA-TN-D-5988] N70-40690
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft
N70-40776
FAA operational tests of STOL aircraft landing and control characteristics
N70-40777

Short haul STOL and VTOL air transportation systems study N70-41032
Airport planning, STOL aircraft, runways, instrument landing systems, aircraft safety, air transportation system, IFR, navigation aids [N-5390.3] N70-41076
Conference on STOL port planning and transportation system N70-41077
Formulation of design and construction standards for STOL ports N70-41078
Flight tests of STOL aircraft operational and performance parameters N70-41079
Determination of runway length for STOL ports N70-41080
Terminal navigation aids and IFR operations for STOL aircraft N70-41081
Determination and control of airspace construction creating hazards to STOL flight paths N70-41082
Runway lights and markings for STOL ports N70-41083
STOL port arresting gear, fire fighting, and rescue equipment N70-41084
Research and development of STOL port criteria, airworthiness and operational criteria, and flight test procedures N70-41085
Planning for STOL air transportation system N70-41086
Federal assistance in funding STOL port development N70-41087
Evolution of STOL/VTOL city center transportation system N70-41539
Flight simulator study of STOL transport lateral control characteristics [FAA-RD-70-61] N70-42013

SHOT PEENING
Boeing 747 wing panels shot peening process, discussing machine, control technique and operational requirements A70-38498

SHROUDED PROPELLERS
Fenestron shrouded tail rotor for SA 341 Gazelle helicopter eliminating ground contact during approach and landing A70-44322
Ducted propeller subsonic rotational flow with free boundaries, presenting second-order partial differential equation solution without linearizing assumptions A70-45269
Bibliography on ducted propeller studies [AD-705524] N70-33670

SIGNAL DISTORTION
Noise and sound propagation and nonlinear signal distortion in circular tubes [NPL-AERO-AC-43] N70-35068

SIGNAL PROCESSING
High performance military aircraft missile command and control signal data processor microelectronics packaging, using integrated and printed circuit modules A70-44542

SIGNS AND SYMPTOMS
Avionics maintenance effectivness logistics, discussing symptom pattern observation technique /SPOT/ for in-flight data A70-38399

SILICONES
Hotshot wind tunnel performance improvement by coating arc chamber with silastene to retard heat loss and metal pollution A70-34774

SIMILARITY THEOREM
Similarity rules for sinusoidal gust loads on thin two dimensional wing in nonstationary subsonic flows A70-43970
Similarity transformations and boundary value problems of hyperbolic partial differential equations with wave solutions [AD-710403] N70-42747

SIMULATORS
Airfreighters maintenance and reliability simulation, modeling specific aircraft designs via input data selection A70-38835
Simulation study of three instrument displays to assist airplane thrust management [NASA-TN-D-5982] N70-41193

SINE WAVES
Pulling force during motion of sinusoidally deformable flat profile, taking into account trailing edge vortices A70-36280

SINGLE CRYSTALS
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification A70-44857

SINGULAR INTEGRAL EQUATIONS
Propeller blade aerodynamic characteristics at zero advance ratio, reducing singular integral equation to nonsingular form for computer solution A70-44993

SINGULARITY (MATHEMATICS)
Stress concentration on axisymmetric annular wings calculated using method of singularities A70-36377
German monograph on airfoil and wings aerodynamic coefficients calculations, showing advantages of analog computers based on singularity theory and distance functions A70-45097

SITES
Evaluation of proposed airport sites in Chicago area [FAA-RD-70-25] N70-32546

SKID LANDINGS
Nose gear steering system for vehicles with main skids to provide directional stability after loss of aerodynamic control [NASA-CASE-XLA-01804] N70-34160

SKIDDING
Tire-pavement friction coefficients [AD-705987] N70-33636

SKIN (STRUCTURAL MEMBER)
Moving skin boundary layer control on airfoil achieved by moving wetted surface in streamwise direction [AIAA PAPER 70-881] A70-34808
Airframe skin panels adhesive bonding in wide-bodied jet transports, emphasizing fuselage fatigue and corrosion resistance [SAE PAPER 700863] A70-45875

SLENDER BODIES
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers A70-34465
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone A70-34466
Steady state laminar flow model for near wake of slender body in supersonic flow A70-34467
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies A70-35035
Flow field on suction side of slender body of revolution with/without wings, investigating by directional probe in wind tunnel A70-35924
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations A70-36382
Slender hypersonic airfoil shape optimization for maximum lift to drag ratio for given profile area, chord and free stream conditions A70-38304
Supersonic flow past slender bodies in presence of strong blowing, extending solution by expansion at leading edge of thin plate A70-39771

Aerodynamics of steady, inviscid transonic flows around slender bodies and wing-body combinations at free stream Mach number one
[AIAA PAPER 70-798] A70-39900
Conducting fluid supersonic flow past slender body of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem
A70-42669
Integral equation for calculating oscillations of slender wing in subsonic flow near solid ground plane
[AD-703995] N70-36285

SLENDER CONES
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584
Pressure measurements and boundary layer separation studies on slender cone delta wing at different Mach and Reynolds numbers
[ARC-R/M-3626] N70-42500

SLENDER WINGS
Slender wings of low aspect ratio and sharp leading edges, predicting inviscid maximum lift
A70-40585
Gust effects on dynamics of slender wing aircraft during landing approach
[NASA-TT-F-12751] N70-34017
Force and moment impulses experienced by slender wings in unsteady flow
[NASA-TT-F-13066] N70-34048
Flight tests of low speed controllability of BAC slender variable sweep wing research aircraft
[ARC-CP-1102] N70-37062
Ground effects on longitudinal stability of slender wings with small span/height ratio
[ARC-CP-1095] N70-37085
Low speed wind tunnel study of oscillatory rolling moments of slender wing with sharp leading edge and frequency and ground effects
[ARC-R/M-3617] N70-37162
Gust response of slender wing aircraft model mounted on rocket propelled sled moving past low speed wind tunnel mouth
[ARC-CP-1113] N70-42529

SLIDING FRICTION
Sliding friction effects of nonlinear asymmetric supports on turbine engine rotor-shaft stability
[SAE PAPER 700320] A70-36799

SLIP FLOW
Local heat transfer between heated circular cylinder and air in transverse slip flow at low Reynolds and Mach numbers
A70-41035

SLOTTED WIND TUNNELS
V/STOL testing wind tunnel section with solid vertical and slotted horizontal zero interference walls
A70-36461
Calibration tests in transonic wind tunnel with two and four sided perforation section
A70-38475
Low speed airfoil two dimensional testing in wind tunnel with slotted wall, examining lift, drag and pitching moments
[ICAS PAPER 70-08] A70-44119
Lift interference analysis on sweptback wing in rectangular wind tunnel test section with slotted side walls
[NASA-TR-R-344] N70-32610

SMALL PERTURBATION FLOW
Three dimensional inviscid small perturbation compressible flow past lifting axial compressor rotor at subsonic and transonic speeds
A70-36691

SMOKE
Aircraft gas turbine engine smoke emission measurement, discussing test equipment and procedure standardization
A70-39720
Aerodynamic holder stabilized smoke flames to avoid intermittent flaming and thick puffs for incinerator air pollution reduction
A70-40887

SMOKE ABATEMENT
Reduced smoke combustion chambers for jet aircraft engines tested in full scale JT8D engine
A70-46387

SNOW
Forecasting methods for snowshowers at military air facility in Japan
[AD-705567] N70-33804
Cost effectiveness analysis of airport snow removal and ice control
[FAA-RD-70-39] N70-36909

SOARING
Dynamic soaring - influence of airspeed, wind shear, lift drag ratio, and angle of inclination
[NASA-TT-F-13217] N70-36081

SOCIAL FACTORS
Wide-bodied and SST aircraft impact on airport design based on economic, social and environmental considerations
[AIAA PAPER 70-1269] A70-45970

SOIL MECHANICS
Rapid assessment of soil strength at aircraft landing sites
[AD-705572] N70-33677
Soil strength evaluation of unsurfaced forward-area airfields by use of ground vehicles
[AD-709589] N70-41602

SOLAR CELLS
Aircraft auxiliary systems and spacecraft power supplies, considering fly-by-wire control actuators, pyrotechnics and stowable solar array
A70-39669

SOLAR COSMIC RAYS
Supersonic transport radiation hazards to flight crew, passengers and population, discussing dosages, probabilities, solar cosmic ray encounters, warning systems, etc
A70-39923

SOLAR SPECTRA
Integration, testing, and performance analysis of solar pointing control and telemetry system with flight experiment aboard Aerobee sounding rocket
[AD-709102] N70-40992

SOLID PROPELLANTS
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants
A70-39667

SOLID STATE DEVICES
Solid state multiplexed electrical power distribution system for future generation military and commercial airplanes
[SAE PAPER 700301] A70-36803
Computer systems for teaching, air traffic control, and space surveillance
[AD-704573] N70-36488

SOLIDIFICATION
Columnar grain and Ni alloy single crystal gas turbine engine components resistant to high temperatures produced by precision casting, using directional solidification
A70-44857

SONIC BOOMS
Sonic boom minimization through airstream alteration by force or heat fields and aircraft body shaping
[AIAA PAPER 70-903] A70-35817
Supersonic boom intensity calculation on ground, assuming isobaric inhomogeneous atmosphere and weak shock wave
A70-36380
Lower bounds for sonic boom, considering negative overpressure region in configuration tailoring
A70-36456
Liability for damages due to supersonic flight sonic booms, discussing pertinent provisions in Dutch and international law
A70-37561
Intersecting shock waves propagation, deriving equations for aircraft sonic boom intensity
A70-38484
Atmospheric inhomogeneity and temperature gradient effects on sonic booms, discussing displacement, growth rate and shock wave radii refraction
A70-42311
Two dimensional flow about supersonic airfoil, considering trailing Taylor columns behavior like sonic booms
A70-42629
Human disturbance from SST overflight sonic booms, discussing overpressure, rise times and durations

A70-44016
SST configurations minimizing sonic booms obtainable for given length and weight
[ICAS PAPER 70-23] A70-44110
Near field flow effects on sonic boom for incident triangular wing with constant lift distribution
[ICAS PAPER 70-20] A70-44113
Sonic boom effects on building structures, using Concorde measurements and explosion simulation studies
A70-45151
Sonic boom waves diffraction and reflection, developing analytical method for pressure-time history in vicinity of walls and corners
A70-45266
Sonic boom, discussing characteristic flow phenomena, intensity, effects on buildings and animals, human reactions, etc
A70-45786
SST sonic boom noise level reduction by thermal simulation of long body aircraft, considering thermal spike or keel
[AIAA PAPER 70-1323] A70-45942
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957
Reflection and focusing of sonic booms by two dimensional curved surfaces
[NASA-CR-110727] N70-32893
Sonic boom simulation by low pressure sources
[NASA-CR-66969] N70-33864
Sonic boom modeling and topographic and atmospheric effects
[MDC-J0734/01] N70-36809
Aircraft engine noise and sonic boom
[AGARD-AR-26-70] N70-38782
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft
N70-40776
Research and development programs for reduction of sonic boom and aircraft noise
N70-40787
Investigating pressure fields from sonic booms transmitted into rooms through open windows
[NASA-CR-111787] N70-42168

SOUND FIELDS
Sound field produced in uniform moving ideal fluid stream by nonuniform oscillating elastic wall
A70-38657
Sound generation by fluctuating subsonic jet flow, considering field directional characteristics and sound pressure variations with Mach number
A70-41422
Lighthill aerodynamic noise theory fundamental equation for acoustic field density distribution, determining flow fields for surfaces in uniform translational motion
A70-45268

SOUND GENERATORS
Sound vibrations resonant frequency relation to jet internal structure in gas jet stem radiator
A70-38658
Sound generation by fluctuating subsonic jet flow, considering field directional characteristics and sound pressure variations with Mach number
A70-41422

SOUND INTENSITY
Shock wave radiation from supersonic ducted rotor, determining sound power at blade passing harmonic frequency
A70-38614
Rod surface roughness effect on eddying sound frequency and intensity and on aerodynamic resistance
A70-38654

SOUND PRESSURE
Probability theory of stresses during random vibrations of flat panel in acoustic field of jet engine exhaust
A70-36301
Sound generation by fluctuating subsonic jet flow, considering field directional characteristics and sound pressure variations with Mach number
A70-41422
Computation of total sound pressure field of jet aircraft on ground
[NASA-TT-F-13096] N70-32947

SOUND PROPAGATION
Axial compressor air intake wall design influence on sound propagation
A70-38653
Noise and sound propagation and nonlinear signal distortion in circular tubes
[NPL-AERO-AC-43] N70-35068

SOUND TRANSMISSION
Sound transmission and suppression in turbomachinery fans and compressor ducts, using three dimensional wave equation
[ASME PAPER 70-GT-58] A70-36873
Acoustic pulse transmission through plane vortex sheet, examining zone of silence, geometrical acoustics and sound radiation
A70-41243

SOUND WAVES
Sound wave radiation and excitation in plane infinite plate by vortices
A70-38722
Reflection and focusing of sonic booms by two dimensional curved surfaces
[NASA-CR-110727] N70-32893

SOUTHEAST ASIA
Ceiling and visibility atlas for Southeast Asia /1000 ft and 2 1/2 mi/
[AD-707496] N70-37708
Ceiling and visibility atlas for Southeast Asia /5000 ft and 5 mi/
[AD-707494] N70-37709
Occurrence of typhoons and tropical storms at selected locations for years 1949 to 1969
[AD-706408] N70-37861
Climatological summaries for selected airfields in Southeast Asia
[AD-705355] N70-38207

SPACE COMMUNICATION
Optical communications in space, considering multiple access low earth orbit-to-synchronous and synchronous-to-synchronous links
A70-37878
Crossed slot antenna array for very high frequency aircraft communication with satellites
[AD-705170] N70-32481

SPACE ENVIRONMENT SIMULATION
Use of fighter aircraft to provide zero gravity environment in support of space manufacturing experiments
[NASA-TM-X-53896] N70-37570

SPACE ERECTABLE STRUCTURES
Deployment system for flexible wing with rigid superstructure
[NASA-CASE-XLA-01220] N70-41863

SPACE LAW
Legal aspects of suborbital space transports based on air transportation concepts
A70-36661

SPACE NAVIGATION
Aeronautic navigation equipment including gyroscopes. Inertial navigation systems, and self adaptive control systems - stability and accuracy determinations
[JPRS-51241] N70-37787
Approach guidance method using single onboard optical measurement
[NASA-TN-D-5963] N70-40743

SPACE SHUTTLES
Space shuttle transition trajectory optimization for cruising flight entry, considering longitudinal control, pitchup instability and angle of attack
A70-44623
Aeroelastic and aerothermoelastic development of winged interorbital space shuttle concerning panel flutter, stability and nonstationary lifting surface theory
A70-44760
Dynamics and aeroelasticity for space shuttles
[NASA-TM-X-52876-VOL-2] N70-36595
Lifting and control surface flutter on space shuttles
N70-36605
Prediction of steady and unsteady airloads on space shuttles
N70-36607

Space shuttle buffeting and aerodynamic noise N70-36608
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems [NASA-TM-X-52876] N70-37826
ONERA hypersonic wind tunnels for flow studies related to space shuttles N70-37832
Review of commercial aircraft technology and potential application to space shuttle N70-39604
X-15 aircraft maintenance schedule and transfer to space shuttle requirements N70-39605
Comparison of instrument landing systems for space shuttle and aircraft N70-39607
Design consideration for air breathing gas turbine engine as third propulsion system of space shuttle N70-39637
Minimizing cost and schedule problems of integrating software of avionics system N70-40954
Multiplex data bus subsystem for improving reliability and reducing weight of space shuttle avionics system N70-40957
Terminal area guidance techniques for space shuttle landing N70-40960
Designing terminal area navigation, guidance, and control system suitable for landing space shuttle vehicles under Category 2 conditions N70-40961
Guidance and control techniques for terminal energy management and automatic horizontal landings of unpowered space shuttle vehicles N70-40962
Pitchdown control system for stabilization of space shuttle vehicles during reentry N70-40963

SPACE SURVEILLANCE
Satellite based systems for aircraft surveillance, discussing satellite power and bandwidth conservation, pulse techniques and interrogators A70-36391

SPACE SURVEILLANCE (SPACEBORNE)
Ground and cockpit initiated collision avoidance commands system based on satellites surveillance of aircraft position and velocity data A70-38242

SPACE TRANSPORTATION
Legal aspects of suborbital space transports based on air transportation concepts A70-36661
Suborbital space transports problem solution by recoverable jet orbital or jet assisted aircraft, discussing implications of Concorde supersonic flight A70-36663

SPACECRAFT CABINS
Closed compartment fire mathematical model to analyze combustion parameter effects, atmosphere pressure and temperature during fire A70-35646
Flame resistant nonmetallic materials for manned spacecraft and aircraft interiors, considering fibers, polymers, paper and composites A70-42295

SPACECRAFT COMMUNICATION
Transportable earth station for satellite communications system, describing antenna design and transportation modes A70-41344
ATS-1 VHF communications experimentation [FAA-RD-70-12] N70-36949

SPACECRAFT CONFIGURATIONS
Pressure distribution, force and heat transfer measurements on varied-configurations of lifting reentry vehicles in hypersonic flow [ICAS PAPER 70-03] A70-44117
Aerodynamics and configurations, atmospheric performance, and aerodynamic heating of space shuttle systems [NASA-TM-X-52876] N70-37826

SPACECRAFT CONSTRUCTION MATERIALS
Fireproof nonmetallic materials for spacecraft and aircraft, discussing functional utility, durability and aesthetic requirements relative to environmental conditions A70-44610

SPACECRAFT CONTROL
Multiple parachute system for landing control of Apollo type spacecraft [NASA-CASE-XLA-00898] N70-36804

SPACECRAFT DESIGN
Aerospace thermophysics considerations in spacecraft and hypervelocity vehicles systems thermal design, discussing thermal control and control coatings optical and radiative properties [AIAA PAPER 70-812] A70-34509

SPACECRAFT ELECTRONIC EQUIPMENT
Aerospace electronics covering fly-by-wire aircraft flight control, ATC, star trackers for spacecraft attitude control, etc A70-39668

SPACECRAFT ENVIRONMENTS
Artificial rain erosion effects on missile and spacecraft recorded via high speed photography A70-40531

SPACECRAFT INSTRUMENTS
Aerospace instrumentation - Conference, Cranfield Institute of Technology, England, March 1970 A70-38514

SPACECRAFT LANDING
All-flexible parawing as primary descent system for large spacecraft landing, discussing configuration, structural arrangement, multistage reefing and L/D performance tests [AIAA PAPER 70-1187] A70-41828
Fixed-base visual simulation study for ability determination of onboard pilot during landing [NASA-TN-D-5940] N70-35927
Device for use in descending spacecraft as altitude sensor for actuating deceleration retrorockets [NASA-CASE-XMS-03792] N70-41812

SPACECRAFT LAUNCHING
Dynamics and aeroelasticity for space shuttles [NASA-TM-X-52876-VOL-2] N70-36595

SPACECRAFT POWER SUPPLIES
Aircraft auxiliary systems and spacecraft power supplies, considering fly-by-wire control actuators, pyrotechnics and stowable solar array A70-39669
Brayton engine electrical subsystem design and computerized technique used to document wiring [NASA-TM-X-2079] N70-39388

SPACECRAFT RECOVERY
Method for deployment of flexible wing glider from space vehicle with minimum impact and loading [NASA-CASE-XMS-00907] N70-41630

SPACECRAFT STABILITY
Space shuttle transition trajectory optimization for cruising flight entry, considering longitudinal control, pitchup instability and angle of attack A70-44623
Pitchdown control system for stabilization of space shuttle vehicles during reentry N70-40963

SPACECRAFT STRUCTURES
Aircraft, rocket or other rigid or flexible structure, computing inertial constants based on measurements of generalized masses of natural modes A70-41408
All-flexible parawing as primary descent system for large spacecraft landing, discussing configuration, structural arrangement, multistage reefing and L/D performance tests [AIAA PAPER 70-1187] A70-41828

SPACING
Close-spaced nozzles twin jet configuration, achieving low nozzle and total afterbody drag [AIAA PAPER 70-934] A70-35844

SPARE PARTS
Comparative demand forecasting for military helicopter spare parts, stressing exponential smoothing model A70-39643
Markov chain analysis of aircraft repair using cannibalization [AD-707041] N70-37824

SPARKS
Spark tracing in gaseous flows in flames, wind tunnels, nozzles and pneumatic valves, using pulse transformer
[SMPTE PREPRINT 41] A70-43041
SPECIFIC HEAT
Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877
SPECTRAL EMISSION
Time varying flow properties effects on hypersonic wind tunnel spectroscopic measurements, considering direct emission and electron beam techniques
A70-40271
SPECTRAL LINE WIDTH
Real time narrow band vibration spectrum analysis techniques, discussing application to failure prediction and flight and wind tunnel tests
A70-38528
SPECTROMETERS
Aircraft engine failures advanced detection by spectrometric lubricating oil analysis
A70-35481
SPECTROSCOPIC ANALYSIS
Time varying flow properties effects on hypersonic wind tunnel spectroscopic measurements, considering direct emission and electron beam techniques
A70-40271
Statistical analysis of aircraft engine oil spectrometric data
[AD-704522] N70-32783
Analysis of oil sample data obtained from aircraft engines by spectrometry
[AD-706697] N70-38036
SPECTRUM ANALYSIS
RMS spectrum analysis system for wideband acoustic data processing, using analog method with digital output
A70-37910
Real time narrow band vibration spectrum analysis techniques, discussing application to failure prediction and flight and wind tunnel tests
A70-38528
SPEED INDICATORS
Wind tunnel and flight evaluation Rosemount shielded pitot static tube model 850N
[AD-708859] N70-40514
Laser Doppler velocimeter for low speed V/STOL wind tunnel
[AD-708717] N70-40796
SPEED REGULATORS
Helicopter gas turbine governor systems for engine and rotor speed control, minimizing pilot activity
[ASME PAPER 70-GT-37] A70-36835
SPHERES
Lift forces acting on spheres in cylindrical tube laminar flow
A70-37647
Hypersonic wake studies, including two dimensional wakes, sphere wakes, and sharp and blunt cone wakes
[AD-708757] N70-40162
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and fin-plate models
[RM-487] N70-42113
SPIKES (AERODYNAMIC CONFIGURATIONS)
Spike effect on nose drag and static stability of blunt bodies, estimating optimum length for drag reduction at zero angle of attack
A70-39702
SPIN DYNAMICS
Full scale aircraft spinning motion, computing static, damping, cross and acceleration aerodynamic characteristics for antispin devices
[AIAA PAPER 70-946] A70-39581
Spinning behavior and recovery from developed 60 degree spin of delta wing aircraft configuration using high speed digital computer
[WRE-TN-HSA-137] N70-36966
SPIN REDUCTION
Fighter aircraft design for spin resistance and recovery using analytical approach, wind tunnel and flight tests
[AIAA PAPER 70-928] A70-35838
SPIN STABILIZATION
Effects of pointed nose on spin characteristics of fighter aircraft model and correlation of free flight test results with theoretical data
[NASA-TN-D-5291] N70-37395
Spin tunnel investigation of 1/20 scale model of modified straight-wing, twin boom, counter insurgency airplane
[NASA-TM-X-2053] N70-40657
SPLINE FUNCTIONS
Spline approximation as applied to aeronautical problems
[NAL-TN-20] N70-41882
SPOILERS
Spoiler theory based on mathematical model, using two dimensional potential theory in conjunction with experimental data on wake phenomena
A70-42273
Estimating aerodynamic properties of airfoil with hinged flap and spoiler
[NASA-TT-F-13131] N70-34693
SPRAYING
Aircraft wheel spray drag alleviator for dual tandem landing gear
[NASA-CASE-XLA-01583] N70-36825
SPRINGS (ELASTIC)
Static and dynamic spring constants of peripheral jet air cushion vehicle in heaving motion, obtaining sinusoidal input response characteristics
A70-42279
STABILITY
Air feed jet combustion chamber operations under unstable conditions
[AD-700801] N70-36450
STABILITY DERIVATIVES
Blade flexibility effects on static stability derivatives of prop/rotors in propeller flight mode
A70-34701
Parameter model of VTOL airplane in transition, considering aerodynamic forces and moments and digital simulation
A70-34724
Flight test instrumentation for V/STOL stability derivatives extraction, noting instrument errors and required compensation
A70-35502
Force and moment impulses experienced by slender wings in unsteady flow
[NASA-TT-F-13066] N70-34048
Low speed wind tunnel measurements of lateral stability derivatives for HP-115 aircraft
[ARC-CP-1097] N70-37241
STABILITY TESTS
Modeling techniques based on Froude scaling laws for helicopter ditching and flotation stability characteristics
A70-34738
Helicopter dynamic tests for aeroelastic and mechanical instabilities and forced vibration problems
A70-40583
Stability of motion of wing near interface of two media
[AD-702836] N70-35650
STABILIZATION
Stability augmentation in aircraft design for handling and operation benefits, discussing control techniques, autopilot modes and load limitations
[ICAS PAPER 70-24] A70-44109
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft
[SAE PAPER 700794] A70-45853
Hydrofluidics flight controls for aircraft stability augmentation systems, noting component performance, transfer functions and operation
[SAE PAPER 700793] A70-45854
Flight evaluation of pilot-assist stability augmentation system for light aircraft
[FAA-DS-70-14] N70-41339
STABILIZED PLATFORMS
Rapid initialization of inertial navigation systems through parameter estimation
[AD-706219] N70-37975
Systems of orientation and guidance of aircraft
[AD-696052] N70-38146

STABILIZERS
Flameout and ignition correlation for diffusion fuel burnup behind angled stabilizers in annular turbine combustion chamber
A70-36127
STAGNATION POINT
Stagnation point heat transfer coefficient to elliptical model taking into account pressure, model blunting and diameter, Mach number, etc
A70-39699
STAGNATION PRESSURE
Large MHD generator channel aerodynamics, discussing pressure distributions to stall and stagnation pressure loss
A70-40002
STAINLESS STEELS
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration
A70-36345
STANDARDIZATION
Fastener standardization for airline maintenance requirements
[AIAA PAPER 70-894] A70-35811
STANDARDS
STOL aircraft FAA airworthiness standards and certification rules, examining noise, control systems, all weather operation, fire protection, handling qualities and performance
[AIAA PAPER 70-1331] A70-45937
Classifying standard runway lengths and distance requirements during takeoffs and landings
N70-41595
STAR TRACKERS
Aerospace electronics covering fly-by-wire aircraft flight control, ATC, star trackers for spacecraft attitude control, etc
A70-39668
STARTING
Low drag supersonic compressors for aircraft engines, calculating start and cruise conditions of quasi-isentropic flow cascades
A70-41405
Gas turbine engine combustion chamber starting, discussing effects of temperature, nozzle characteristics and fuel physicochemical properties
A70-43356
STATIC AERODYNAMIC CHARACTERISTICS
Full scale aircraft spinning motion, computing static, damping, cross and acceleration aerodynamic characteristics for antispin devices
[AIAA PAPER 70-946] A70-39581
Low speed wind tunnel tests of all-flexible twin-keel tension structure parawings
[NASA-TN-D-5965] N70-40688
STATIC DISCHARGERS
Static charge reducer for aircraft fuels handling safety, discussing performance factors
[SAE PAPER 700277] A70-36808
STATIC ELECTRICITY
Soviet book on aircraft electrification in clouds and precipitation during subsonic flight covering atmospheric electrical properties, flight dynamics modification, communications interference, etc
A70-38800
STATIC LOADS
Analysis of bending loads of hypersonic aircraft
[NASA-TM-X-2092] N70-40808
STATIC PRESSURE
Pressure probe for sensing ambient static air pressures
[NASA-CASE-XLA-00481] N70-36824
Short static probe with good incidence characteristics at supersonic speed
[ARC-CP-1099] N70-37072
Transonic compressor cascades - influence of compressibility and static pressure
N70-39094
STATIC STABILITY
Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls comfigured vehicle /CCV/ design concepts
A70-37395
Spike effect on nose drag and static stability of blunt bodies, estimating optimum length for drag reduction at zero angle of attack
A70-39702
Static and dynamic longitudinal stability of semirigid parafoil gliding descent system in pitching motion
[AIAA PAPER 70-1191] A70-41825
STATIC TESTS
Static tests of aluminum and steel frangible tube energy absorbers for nuclear aircraft reactors
[NASA-TM-X-52847] N70-34152
Structural fatigue manual, including plastic strain, static tests, and notched or cracked component strength, for aircraft applicability and with bibliographies
[AGARD-MAN-8-70-VOL-1] N70-37802
Static testing and creep, including tensile tests, plastic deformation, and buckling
N70-37805
Static strength of notched or cracked structural components, including fatigue crack initiation and elastic stress distribution in thin sheets
N70-37806
STATIC THRUST
Propeller static performance test data for V/STOL aircraft
[AD-708742] N70-40594
STATISTICAL ANALYSIS
Helicopter structural weight statistical prediction and evaluation, discussing comparable fixed wing experience
A70-34728
German Air Force aircraft bird strikes statistics
A70-35979
Statistical measurement of bird hazards to aircraft in terms of strike rates at airports, considering international strike rate standard
A70-35981
Statistical properties of civil ATC system based on central processor, discussing system informational congestion
A70-36394
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes
A70-37403
Statistical analysis of durability data of heat resistant alloys for gas turbine engines, using long term strength tests of melts in mass production
A70-43940
Aircraft maintenance cost statistical analysis recursive regression model for aircraft failure and manhour cost data
A70-46125
Briefs of aircraft accidents involving missing aircraft for 1967
[PB-190412] N70-34571
Aircraft accident briefs involving alcohol as cause factor in 1967 US general aviation
[PB-190413] N70-34576
Briefs of accidents involving amateur/home built aircraft occurring in 1967
[PB-190410] N70-34630
Statistical summary of corporate/executive aircraft accidents in 1964-1968 US general aviation
[PB-190408] N70-34643
Statistical analysis of United States of America civil aviation accidents - 1969
[PB-189247] N70-37608
Statistical analysis of peak day instrument flight rules departures from FAA operated terminals
[AD-710762] N70-40765
General aviation flying occupant load factors
[REPT-70-9] N70-40800
Flight test data of turbulent wakes for jet transport aircraft
N70-40911
Results of flight test investigation of vortex wake turbulence generated by large jet transport aircraft
N70-40913
Flight test data for vortex wake characteristics of transport aircraft
N70-40914
Statistical data tables on commuter air carrier operators
N70-41172

Near midair collision report of 1968
N70-41290
STATISTICAL WEATHER FORECASTING
Airport fog layers repetition frequency after low visibility periods
A70-43246
STATOR BLADES
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor
[ASME PAPER 70-GT-39] A70-36869
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
STATORS
Methane or hydrogen fuel direct cooling of first stage stator of SST aircraft turbine - numerical heat transfer analysis
[NASA-TN-D-6042] N70-42326
STEADY FLOW
Steady supersonic flow past conical bodies at yaw, adapting Telenin numerical method
A70-35889
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations
A70-36382
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution
A70-38350
Aerodynamics of steady, inviscid transonic flows around slender bodies and wing-body combinations at free stream Mach number one
[AIAA PAPER 70-798] A70-39900
Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces
A70-41444
Steady viscous flow past oblique flat plate at high Reynolds number, using Oseen linearized approximation
A70-41714
Pressure distribution on thin nonlifting airfoils in steady two dimensional flow with freestream Mach number at or near unity
A70-44583
STEADY STATE
Glauert equations applied to trailing wire shape for steady state aerodynamic forces on aircraft and trailing antennas, discussing computer solutions
A70-43893
STEAM
Subsonic flow visualization, using steam and cold nitrogen gas mixture and normal tunnel lighting
A70-36460
STEEL STRUCTURES
F-111 high strength steel design experience concerning wing, fuselage and empennage support structure
[AIAA PAPER 70-884] A70-35803
STEELS
Failure and defect formation in gas turbine engine disks made of steel alloys, stressing fabrication methods effect on reliability
A70-38469
Magnesium aluminum alloy as filler material in steel welds for rotor construction
[M70-111-ROM/VDT/NAT] N70-35540
Performance of aircraft arresting gear with steel cable energy absorbers
[AD-708760] N70-40298
STEEPEST DESCENT METHOD
Application of steepest descent method to trajectory optimization and aircraft performance problems
[NASA-CR-73366] N70-32760
STIFFNESS
Finite element stiffness matrix technique for composite structures, discussing airplane component design program
A70-40040
Parachute flexibility as performance parameter, discussing stiffness-weight index, inflation process, squidding, etc
[AIAA PAPER 70-1166] A70-41845
High thermal stability glass fibers alternatives improving stiffness-to-weight ratio of resin and Al-based composites used in F-111 boron epoxy wings
A70-42480
STOCHASTIC PROCESSES
Stochastic processes with linear dynamics and quadratic control cost, considering application to aircraft landing approach path optimization
A70-35973
Satellite-based air traffic control system for North Atlantic, applying stochastic optimal control theory
[AIAA PAPER 70-966] A70-39563
Stochastic processes control optimization, selecting elastic aircraft stabilizer planform
A70-43352
STORAGE STABILITY
Component and additives effects on storage stability of jet engine fuels
[AD-707524] N70-38458
STORMS (METEOROLOGY)
Soviet meteorology abstracts, including storm development, aerological sounding, and atmospheric diffusion studies
N70-37882
STRAIN ENERGY METHODS
Low aspect ratio wings under conditions of creep, calculating stress by method of strains
A70-37244
STRAIN GAGES
Aircraft structure fatigue load monitoring, discussing strain gage installation in critical areas
[ICAS PAPER 70-31] A70-44102
Electronic strain level counter for aircraft structural members
[NASA-TN-D-5944] N70-39377
STRAPDOWN INERTIAL GUIDANCE
Commercial aircraft strapdown inertial navigation systems, examining initial self alignment techniques
A70-36442
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - hardware and program summary
[NASA-CR-110822] N70-42428
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - test data
[NASA-CR-110821] N70-42429
STRATOSPHERE RADIATION
Measuring stratospheric radiation levels using recombination ionization chamber as multichannel LET spectrometer
N70-32393
STREAM FUNCTIONS (FLUIDS)
Theoretical scheme for calculating effect of transverse stream contraction in compressor or turbine cascade on supersonic flow across cascade
[NASA-TT-F-13260] N70-39939
STREAMLINING
Three dimensional boundary layer and flow resistance of flat plate with slip
N70-32335
STRESS ANALYSIS
Low aspect ratio wings under conditions of creep, calculating stress by method of strains
A70-37244
Swing tail cargo aircraft fuselage section stress analysis by finite element method, discussing displacement models, deformation modes and economics
A70-41260
Spacecraft parachute stress analysis, using finite elements with nonlinear elastic properties to obtain shape and load distribution
[AIAA PAPER 70-1195] A70-41821
STRESS CONCENTRATION
Probability theory of stresses during random vibrations of flat panel in acoustic field of jet engine exhaust
A70-36301
Stress concentration on axisymmetric annular wings calculated using method of singularities

A70-36377
Blade root design for axial flow compressors and turbines, avoiding tensile stress concentration
A70-38616
Stress distribution and shape in arbitrarily shaped gore parachute under unsteady pressure distribution during inflation and descent
[AIAA PAPER 70-1197] A70-41819
Finite element analysis of critical stress distribution in canopy of deployed twin keel parawing, predicting failure stress levels
[AIAA PAPER 70-1196] A70-41820
General principles of structural strength and fatigue, including airframes, fractures, and stress concentrations
N70-37803
Static strength of notched or cracked structural components, including fatigue crack initiation and elastic stress distribution in thin sheets
N70-37806
Physical changes and damage during fatigue, including plastic processes and crack propagation
N70-37807
Three-dimensional stress concentration in rotating anisotropic disks with radial compressor blades using finite element method
[DLR-FB-70-16] N70-38484

STRESS WAVES
Fluctuating turbulent stresses in noise producing region of jet
[RR-10-PT-2] N70-40566

STRETCHING
Snatch force during lines-first deployment of aerodynamic decelerator, including effects of canopy skirt acceleration and suspension wave propagation characteristics
[AIAA PAPER 70-1171] A70-41842
Stretch fabric materials for personnel high speed escape parachute systems
A70-44482

STRUCTURAL ANALYSIS
High temperature radial turbine design for small gas turbine engines, discussing aerodynamic, structure and thermal analyses
A70-36450
Finite element stiffness matrix technique for composite structures, discussing airplane component design program
A70-40040
Structural and environmental design criteria for acoustical duct-lining materials in turbofan noise suppression
A70-42531
Aircraft structures acoustic fatigue testing, discussing test facilities, environment simulation, etc
A70-44329
Structural mechanics of bonded and honeycomb structures
N70-38124

STRUCTURAL DESIGN
Aerodynamic and structural considerations in prop/rotor design for tilt-rotor aircraft, discussing blade twist effect on cruise efficiency and figure of merit
A70-34719
Wide body commercial jet transport structural design considerations applied to DC 10 aircraft
[AIAA PAPER 70-895] A70-35812
Extensible wing flap system for cargo aircraft, discussing structural design details and advantages
[AIAA PAPER 70-911] A70-35823
Flutter design charts for isotropic panels stressed to verge of buckling for tropical values of structural damping
A70-36446
Soviet book on wing structures analytical design methods covering thin supersonic wings, mass distribution, aerodynamic characteristics, etc
A70-37025
Papers on design and materials, discussing alloys for aircraft structures, stress-rupture life of Ni base alloy, single crystal structures, etc
A70-39412
Structural fatigue design loads computation for fighter aircraft using multivariable load environment model from oscillograph recorded multichannel aircraft response data
[AIAA PAPER 70-948] A70-39579
Helicopter mechanical power transmission design, describing gearing, shaft bending, bearings, lubrication, weight factors, etc
[SAWE PAPER 844] A70-40367
Canadair CL-84 V/STOL aircraft flight characteristics and structural design
A70-44017
V/STOL aircraft landing performance, discussing relationships between approach speeds, rates of descent, structural criteria and weight penalties
[ICAS PAPER 70-53] A70-44149
Bonded honeycomb sandwich structure fastening techniques in aerospace design, noting application to aircraft and spacecraft structures
[SAE PAPER 700850] A70-45882
Design and procurement of hybrid microcircuit
[AD-705974] N70-34087
Design calculations for interblade channels in centrifugal compressors
[NLL-RTS-5564] N70-34769
Design and performance of ringsail parachute
[NASA-TN-D-5968] N70-35910
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Structural problems in fighter aircraft design
N70-40712
Weight optimization in structural sandwich panel design
[AD-709656] N70-42286

STRUCTURAL ENGINEERING
Low weight, high strength, rigid honeycomb core structures with minimal surface tubule sections
[NASA-CASE-ERC-10363] N70-40071
Wind tunnel test of canopy construction methods, design details, and canopy slots effects on aerodynamic characteristics of small scale all flexible parawings
[NASA-TN-D-5974] N70-40751

STRUCTURAL FAILURE
Aircraft wing box beams bending tests to failure loads, considering crushing pressure, bulkhead flexural deformations, structure initial imperfections and instability phenomena
[ICAS PAPER 70-33] A70-44103
Aircraft design for low weight, discussing structural failures
[AIAA PAPER 70-1232] A70-45917
Failure analysis on adhesive bonds of aircraft honeycomb sandwich composites
[AD-710352] N70-43053

STRUCTURAL MEMBERS
Summary record of panel meetings on structures and materials used in aerospace research
N70-41741

STRUCTURAL RELIABILITY
Structural reliability testing methods and loads prediction for rotary wing vehicle components, considering AH-56A compound helicopter
A70-38612
Air Force aircraft structural integrity program with referenced specifications - airplane requirements
[AD-707884] N70-39664

STRUCTURAL STABILITY
Large wheel and tire imperfection effects on nosegear parametric shimmy instability, using Mathieu equation
A70-36455
High strength glass for aircraft structures, discussing applications to passenger cabin windows
A70-41891
General principles of structural strength and fatigue, including airframes, fractures, and stress concentrations
N70-37803

STRUCTURAL STRAIN
Electronic strain level counter for aircraft structural members
[NASA-TN-D-5944] N70-39377

STRUCTURAL VIBRATION
Hingeless rotor helicopter airborne and ground

resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping A70-34733
Helicopter vibration reduction techniques, considering antivibration devices design and comfort crossover speed increase A70-34735
Vibration characteristics of low aspect ratio compressor blades, using thin shell theory and Rayleigh-Ritz method [ASME PAPER 70-GT-94] A70-36876
Soviet book on vibration and balancing of aircraft engine rotors covering structural deformation and dynamics of turbine engines and compressors A70-37237
Linear elastomechanical systems natural vibration parameters by harmonic excitation method A70-43200
Orthogonality of eigenmodes of aircraft vibrations based on F-104G ground measurements A70-44766

STRUCTURAL WEIGHT
Ti alloy forgings for aircraft industry, utilizing high strength/weight ratio A70-34357
Ti alloys use in Olympus 593 engine for Concorde SST, discussing weight saving, mechanical properties and manipulation characteristics A70-34449
Helicopter structural weight statistical prediction and evaluation, discussing comparable fixed wing experience A70-34728
Packable near weightless nylon cloth wings without rigid members for improved aeronautical efficiency in cargo delivery, powered flight and rocket and spacecraft recovery [AIAA PAPER 70-880] A70-34815
Structural weight reduction and increased aerodynamic efficiency in aircraft design by including flight control technology early in configuration development phase [AIAA PAPER 70-874] A70-34817
Static weight tare compensation for V/STOL wind tunnel models, using accelerometer outputs A70-35500
Subsonic aircraft size effect in conventional design, discussing increased weight increments and economic gain rate [AIAA PAPER 70-940] A70-35849
Composite technology effects on engineering design, emphasizing carbon-carbon materials for aircraft structural weight reduction, performance improvement and high temperature applications A70-39202
Landing gear weight analytical estimation, discussing ground loads, member cross sectional area, parametric variations, etc [SAWE PAPER 829] A70-40366
Fuselage frames minimum weight analysis by automatic iterative method [SAWE PAPER 826] A70-40370
Fighter aircraft configuration design balancing, comparing weight penalties [SAWE PAPER 840] A70-40380
Parachute flexibility as performance parameter, discussing stiffness-weight index, inflation process, squidding, etc [AIAA PAPER 70-1166] A70-41845
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel honeycomb construction A70-43213
V/STOL aircraft landing performance, discussing relationships between approach speeds, rates of descent, structural criteria and weight penalties [ICAS PAPER 70-53] A70-44149
Aircraft design for low weight, discussing structural failures [AIAA PAPER 70-1232] A70-45917
Weight optimization in structural sandwich panel design [AD-709656] N70-42286

SUBCRITICAL FLOW
Plane diffuser grid profiles for subcritical velocities of oncoming flow, using wind tunnel test data A70-36129
Subcritical viscous flow around arbitrary airfoils, calculating boundary layer effect on pressure distribution from inviscid flow approximation A70-40924
Stationary elliptic cylinders in subcritical flow, determining Strouhal number, pressure fluctuations and wake geometry as functions of angle of attack [AIAA PAPER 69-745] A70-44564
Mechanism for avoiding supersonic air intake instability and approaches for eliminating drag [ARL/ME-313] N70-39012

SUBORBITAL FLIGHT
Legal aspects of suborbital space transports based on air transportation concepts A70-36661
Suborbital space transports problem solution by recoverable jet orbital or jet assisted aircraft, discussing implications of Concorde supersonic flight A70-36663

SUBROUTINES
Testing of airborne avionics systems using computer subroutines N70-32175
Stability and control prediction method for helicopters and stoppable rotor aircraft [AD-706919] N70-37916

SUBSONIC AIRCRAFT
Subsonic and supersonic aircraft dynamic loads under conditions of variable atmospheric density A70-34685
Subsonic aircraft size effect in conventional design, discussing increased weight increments and economic gain rate [AIAA PAPER 70-940] A70-35849
Subsonic and supersonic transport aircraft design, discussing supercritical wing concept, fuel consumption reduction, composite aircraft structures, short haul transports, etc A70-35854
Noise reduction regulations effects on subsonic transport design and configuration [SAE PAPER 700806] A70-45876
Design and specifications for low-noise output turbofan engine for long-range subsonic transport aircraft [NASA-TM-X-52640] N70-33773
Aircraft and engine design problems for high Reynolds number, high speed, large subsonic aircraft - conference [AGARD-LS-37-70] N70-37753
Economy of large high speed subsonic aircraft and design problems N70-37754
Unsteady aeromechanics and problems with large aircraft at near sonic speed N70-37755
High Reynolds number, near sonic aircraft design N70-37758
Engine performance design considerations for large subsonic transport with high by-pass ratio N70-37761
Aerodynamics of engine component design problems for large subsonic aircraft N70-37762

SUBSONIC FLOW
Aerodynamic and acoustic characteristics of subsonic and supersonic jets from convergent nozzles with room temperature air supply A70-34460
Blunt based right circular cylindrical body at subsonic speed, investigating turbulent near wake in wind tunnel A70-34463
Subsonic flow visualization, using steam and cold nitrogen gas mixture and normal tunnel lighting A70-36460
Subsonic air flow around airfoil in wind tunnel, detecting density gradients by pulsed ruby laser holographic visualization A70-40809
Harmonically oscillating wing linearized motion in subsonic flow, calculating generalized aerodynamic forces A70-43118

Subsonic jet engine intake duct radar cross section calculation using waveguide model A70-43584
Similarity rules for sinusoidal gust loads on thin two dimensional wing in nonstationary subsonic flows A70-43970
Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades [ICAS PAPER 70-14] A70-44125
High subsonic and transonic effects on pressure distributions for swept wing with oscillating control surface A70-44763
Aerodynamic interferences of lifting surfaces harmonically vibrating in subsonic flow A70-44765
Ducted propeller subsonic rotational flow with free boundaries, presenting second-order partial differential equation solution without linearizing assumptions A70-45269
Stationary aeroelastic cases studied in subsonic flow range, providing criteria for aircraft design with required flight characteristics A70-45443
Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft [NASA-TM-X-2034] N70-32047
Calculations on thin profile oscillations in subsonic flow near rigid boundary [NASA-TT-F-12966] N70-34182
Turbulent near-wake of blunt based, right circular cylinder immersed in uniform subsonic flow [AD-705687] N70-34978
Integral equation for calculating oscillations of slender wing in subsonic flow near solid ground plane [AD-703995] N70-36285
Scaling effects on shock-induced separation in high speed subsonic flow N70-37756

SUBSONIC SPEED
Subsonic wing theory calculation method, obtaining close solutions for integral expression constants for downward air currents A70-38164
Reentry bodies of revolution subsonic and supersonic aerodynamic characteristics A70-39704
Streamers /drag devices/ tests at subsonic speeds, measuring drag dependence on size, weight, shape and velocity A70-40282
Subsonic high lift cruise wing optimal design using kernel function method of planar lifting surface theory A70-42709
Downwash angle behind straight wing for unsteady aperiodic flight at subsonic speeds, using vorticity model A70-42802
Drag coefficients from modified X-15-2 aircraft configurations at speeds up to Mach 6.7 [NASA-TM-X-2056] N70-35693
Research in subsonic aerodynamics N70-38122
Aerodynamic testing at subsonic speed on conical configurations using magnetic system [AD-709197] N70-41721
Unsteady pressure distribution measurements on oscillating wing at subsonic and transonic speeds [NASA-TT-F-13337] N70-42576

SUBSONIC WIND TUNNELS
Variable geometry wind tunnel for testing aircraft models at subsonic speeds [NASA-CASE-XLA-7430] N70-35678
Longitudinal aerodynamic characteristics of twin-turbofan supersonic transport with nacelles mounted under wings [NASA-TN-D-5971] N70-40689

SUCTION
Steady incompressible turbulent boundary layer form on permeable curvilinear surface with uniform suction, assuming small pressure gradients A70-42803
Three dimensional boundary layer and flow resistance of flat plate with slip N70-32335
Turbulent boundary layer in adverse pressure gradient regions and distributed suction for higher aerodynamic lift coefficients [ARC-R/M-3621] N70-37073

SUPERCHARGERS
Optimum manifold and injector hole area of pulsed exhaust systems of two cycle engine with turbosupercharger A70-42809

SUPERCOOLING
Performance and economics of supercooled propane fog dispersion system at Orly airport [FAA-RD-70-16] N70-32366

SUPERCRITICAL FLOW
Lifting quasi-elliptical airfoils with supercritical shock free flow, discussing Nieuwland hodograph theory to compute profile number [ICAS PAPER 70-15] A70-44126

SUPERSONIC AIRCRAFT
Subsonic and supersonic aircraft dynamic loads under conditions of variable atmospheric density A70-34685
Airframe-inlet integration for supersonic tactical fighters, testing wind tunnel models [AIAA PAPER 70-933] A70-35843
Subsonic and supersonic transport aircraft design, discussing supercritical wing concept, fuel consumption reduction, composite aircraft structures, short haul transports, etc A70-35854
Unsteady aerodynamics prediction of supersonic elastic aircraft, discussing aerodynamics influence coefficients /AIC/ method refinement [AIAA PAPER 70-944] A70-39583
Supersonic aerodynamic design tools, discussing technological application of high speed computer and limitations [AIAA PAPER 68-1018] A70-42701
Exhaust nozzle/airframe interference test evaluation for twin engine supersonic fighter [AIAA PAPER 69-430] A70-42702
Two stream ejector type propelling nozzles for supersonic aircraft, investigating various configuration effects over range of secondary/primary air flow ratios [ICAS PAPER 70-48] A70-44145
Variable sweep wing configuration for supersonic aircraft [NASA-CASE-XLA-00230] N70-33255
Congressional hearings on supersonic aircraft and airport planning and development, air traffic control, and aircraft noise N70-36161
Supersonic aircraft variable sweep wing planform for varying aspect ratio [NASA-CASE-XLA-00350] N70-38011
Hypersonic and supersonic aircraft fuels, lubricants, and hydraulic fluids, with bibliographies [AGARDOGRAPH-108] N70-39638
Supersonic aircraft fuel technical requirements N70-39640
Supersonic and hypersonic aircraft lubricants and hydraulic fluids N70-39641
Preliminary design considerations and aeroelastic constraints for large supersonic aircraft with canard control N70-40706
Propeller and airframe integration in supersonic fighter aircraft design N70-40711
Aeromedical factors affecting airworthiness standards for SST aircraft N70-40782
Response of acoustically loaded panel excited by supersonically convected turbulence [NASA-CR-113879] N70-41029
System of positioning aircraft by Doppler effect for air traffic control [NASA-CASE-GSC-10087-4] N70-41978
Anticollision lights for supersonic transport [FAA-AM-70-9] N70-42404

SUPERSONIC AIRFOILS
Quasi-conical supersonic wings with curved subsonic leading edges, discussing perturbation potential, boundary conditions, homogeneous flow and gothic and ogee planforms A70-42108
Two dimensional flow about supersonic airfoil, considering trailing Taylor columns behavior like sonic booms A70-42629
Axial compressor airfoils for supersonic Mach numbers [AD-707144] N70-37673
SUPERSONIC BOUNDARY LAYERS
Analytical model for jet interaction induced separation of supersonic turbulent boundary layers, conducting flat plat tests at Mach 4 [AIAA PAPER 70-765] A70-34486
SUPERSONIC COMBUSTION
Ignition and sustaining of combustion by energy addition in turbulent supersonic flow [AD-710283] N70-42528
SUPERSONIC COMBUSTION RAMJET ENGINES
Integrated double oblique shock scramjet for supersonic combustion tests and instrumentation development, discussing fuel injection through sonic orifices, combustion data, etc [AIAA PAPER 69-827] A70-41752
Supersonic combustion of vitiated air-hydrogen mixtures [AD-705129] N70-32090
Propulsive evaluation of ramjet installed under wing and up to Mach 7 [NASA-TT-F-12951] N70-33230
Turbulent mixing of supersonic jets investigated for momentum and energy equations [AD-708735] N70-40679
Full-scale annular ram-induction combustor tests for Mach 3 cruise turbojet engine [NASA-TN-D-6041] N70-41975
SUPERSONIC COMMERCIAL AIR TRANSPORT
Measuring stratospheric radiation levels using recombination ionization chamber as multichannel LET spectrometer N70-32393
SUPERSONIC COMPRESSORS
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor [ASME PAPER 70-GT-39] A70-36869
Cascade tunnel testing role in designing supersonic compressor rotor blading for lower jet engine weight and fuel consumption [ASME PAPER 70-GT-79] A70-36885
Low drag supersonic compressors for aircraft engines, calculating start and cruise conditions of quasi-isentropic flow cascades A70-41405
Mass flow limitations in supersonic compressors N70-39093
SUPERSONIC DIFFUSERS
Short length combustor and diffuser configuration for supersonic cruise turbofan engine [NASA-CR-72734] N70-33771
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry [AGARD-LS-39-70] N70-39091
Supersonic radial diffusers for centrifugal compressors N70-39097
Theoretical scheme for calculating effect of transverse stream contraction in compressor or turbine cascade on supersonic flow across cascade [NASA-TT-F-13260] N70-39939
SUPERSONIC DRAG
Drag prediction for Ballute and parachute trailing decelerators at supersonic speed and zero angle of attack, using flow field computations [AIAA PAPER 70-1177] A70-41836
Cylindrical afterbodies base pressure drag under powered supersonic flight, modifying Korst flow model recompression criterion A70-42713
Minimum-drag boattail configurations optimization for supersonic flow, determining wave drag coefficients A70-42714
Mechanism for avoiding supersonic air intake instability and approaches for eliminating drag [ARL/ME-313] N70-39012
SUPERSONIC FLIGHT
Suborbital space transports problem solution by recoverable jet orbital or jet assisted aircraft, discussing implications of Concorde supersonic flight A70-36663
Liability for damages due to supersonic flight sonic booms, discussing pertinent provisions in Dutch and international law A70-37561
Reentry bodies of revolution subsonic and supersonic aerodynamic characteristics A70-39704
Supersonic flight altitude stability, studying effects of velocity, lift-drag ratio, thrust law, wind direction, engine unstarts, etc [AIAA PAPER 69-813] A70-42712
Airframe installation effects at transonic speeds on underwing supersonic cruise exhaust nozzles, using flight and wind tunnel tests A70-43274
Elastic fuselage flight vehicle dynamic stability at supersonic speeds, using automatic pilot stabilization A70-44157
Variable aspect ratio and variable sweep delta wing planforms for supersonic aircraft [NASA-CASE-XLA-00221] N70-33266
Requirements posed by hypersonic and supersonic flight, including propulsion system performance N70-39639
SUPERSONIC FLOW
Supersonic air flow control by electrostatic discharges tested by Mach 3 wind tunnels, using schlieren system for bow shock wave [AIAA PAPER 70-759] A70-34492
Steady supersonic flow past conical bodies at yaw, adapting Telenin numerical method A70-35889
Shock layer and combustion in supersonic flows about conical bodies at various angles of attack A70-35894
Drag optimal stern section of plane body at supersonic flow, allowing for friction forces A70-36261
Flow velocity and pressure on thin wing of small span width near sonic speed, using parabolic type linear equation A70-36374
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations A70-36382
Pressure distribution shock pattern and impact wave resistance in frictionless plane parallel and source shaped supersonic flow A70-36385
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles A70-37228
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics A70-37242
Shock wave radiation from supersonic ducted rotor, determining sound power at blade passing harmonic frequency A70-38614
Supersonic flow past slender bodies in presence of strong blowing, extending solution by expansion at leading edge of thin plate A70-39771
Turbulent boundary layer on cone in supersonic flow in presence of inflowing foreign substance, considering local surface friction coefficient A70-39814
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock A70-40288

Aerodynamic parameters of ionized Ar supersonic steady one dimensional nonviscous flow in thermodynamic equilibrium and subjected to Laplace accelerating forces
A70-41444

Nonuniform free stream supersonic flow past aerodynamic decelerators, calculating inviscid flow fields by method of characteristics
[AIAA PAPER 70-1176] A70-41837

Surface pressure coefficient dependence on specific heat ratio for yawed conical lifting bodies in supersonic streams
A70-41877

Unsteady supersonic flow around oscillating cross-shaped wing-fuselage system, determining perturbation velocities and pressure distributions
A70-42609

Two dimensional flow about supersonic airfoil, considering trailing Taylor columns behavior like sonic booms
A70-42629

Conducting fluid supersonic flow past slender body of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem
A70-42669

Perfect gas supersonic flow with constant velocity, pressure and density around finite nonaxisymmetric body at small angles of attack
A70-43322

Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations
A70-43323

Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem
A70-43362

Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades
[ICAS PAPER 70-14] A70-44125

German monograph on supersonic strongly deflecting retardation cascades covering flow geometry and application to axial flow compressor stage
A70-45095

Kinematically unsteady aerodynamic coefficients consistent with stiffness and inertia properties of lifting surface in supersonic flow by finite element method
A70-45154

Numerical analysis of fuel combustion in supersonic stationary flows of hydrogen air mixture past bodies by two-component reaction kinetics model
[ICAS PAPER 70-52] A70-45500

Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects
A70-45592

Method of characteristics analytical technique for flow predictions of supersonic cross flows over conical bodies
[NASA-TN-D-5884] N70-32004

Calculation of supersonic flow around blunted bodies with detached shock wave
[NASA-TT-F-13026] N70-32533

Design of parachutes and ballutes for decelerating atmospheric entries at supersonic velocities
[NASA-CR-66909] N70-32884

Computer program for pressure distribution on thin wing in supersonic flow
[NLR-TR-G-50] N70-37079

Supersonic flow field over aeroelastic ogive cylinder model with boundary layer control
[AD-708485] N70-40297

Schemes of location method in computing supersonic flows around blunt bodies
[NASA-TT-F-13230] N70-42136

SUPERSONIC FLUTTER

Skew panels supersonic flutter and vibration calculated by matrix displacement method
A70-40586

Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276

Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter
A70-42603

SUPERSONIC HEAT TRANSFER

Pressure and supersonic heat transfer measurements on delta wing at incidence and sweepbacks using free flight test apparatus
[ARC-R/M-3625] N70-37071

SUPERSONIC INLETS

Supersonic air intake unsteady buzz phenomenon, examining shear layer under cowl and boundary layer detachment at shock wave base for design improvement
A70-41262

M 3.5 two dimensional mixed compression inlet system with self restart using flexible variable ramp system
[AIAA PAPER 69-447] A70-42707

Mechanism for avoiding supersonic air intake instability and approaches for eliminating drag
[ARL/ME-313] N70-39012

SUPERSONIC JET FLOW

Aerodynamic and acoustic characteristics of subsonic and supersonic jets from convergent nozzles with room temperature air supply
A70-34460

Viscosity effect on turbulent supersonic underexpanded jet flow into submerged region
A70-36262

Supersonic air jet noise spectrum analysis at various pressures
A70-38659

Supersonic jets noise spectra, using linear equations of moving medium acoustics
A70-38660

Discrete components of noise frequency spectrum of free supersonic jet
A70-38661

Multilayered and multiple supersonic jets, deriving dispersion equations for boundaries stability
A70-38663

Supersonic jet force acting on target investigated for air and argon using dimensional analysis
A70-40515

SUPERSONIC NOZZLES

Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft
[NASA-TM-X-2034] N70-32047

Penshaped, supersonic exhaust nozzle design
[NASA-CASE-XLE-00057] N70-38711

Telescoping-spike supersonic nozzle for turbojet or ramjet engines
[NASA-CASE-XLE-00005] N70-39899

Condensation in contoured nozzle shock tunnel
[AD-708475] N70-40655

SUPERSONIC SPEEDS

Aerodynamic characteristics of transonic and supersonic blunt vehicles, reviewing numerical methods
A70-35895

Supersonic boom intensity calculation on ground, assuming isobaric inhomogeneous atmosphere and weak shock wave
A70-36380

Continuous surface of revolution parachute for supersonic/hypersonic speeds, performing wind tunnel tests
[AIAA PAPER 70-1173] A70-41840

Accelerated supersonic motion of plate with attached shock wave at finite angle of attack in ideal gas, using perturbed nonstationary motion equations
A70-42209

Aerodynamic lift, drag and momentum coefficients in supersonic regime for rectangular and trapezoidal wings with spanwise variable profile
A70-42615

Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129

Drag coefficients from modified X-15-2 aircraft configurations at speeds up to Mach 6.7
[NASA-TM-X-2056] N70-35693

Two dimensional shock theory for predicting pressures on elliptic cones at supersonic speeds
[NASA-TN-D-5952] N70-35926
Short static probe with good incidence characteristics at supersonic speed
[ARC-CP-1099] N70-37072
Compression surface design for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993
Effects of variable turbine area on subsonic cruise performance of turbojets designed for supersonic application
[NASA-TN-D-5962] N70-42010

SUPERSONIC TEST APPARATUS
Wall thickness measurement by supersonic testing method based on resonance
A70-45681

SUPERSONIC TRANSPORTS
Alloy applications to Boeing supersonic transport airframe and components, discussing materials characteristics and manufacturing processes
A70-34451
SST flight efficiency trends, discussing breakthrough and development method and Concorde aerodynamic, propulsion and structural history
[AIAA PAPER 70-871] A70-34811
SST electrohydraulic primary and standby brake control systems, discussing design and advantages
[AIAA PAPER 70-913] A70-35825
Boeing 2707 SST horizontal tail multiple channel actuation system features
A70-35827
Jet A kerosene deposit accumulation problem and proposed SST fuel tank design
[SAE PAPER 700256] A70-36825
Electronic attitude director indicator /EADI/ for supersonic transport, employing CRT display, head down TV and microvision sensors
A70-37911
ATC integration of SST, discussing en route and terminal projects of national airspace system, modular automation, instrument flight rules, etc
A70-38633
Supersonic transport radiation hazards to flight crew, passengers and population, discussing dosages, probabilities, solar cosmic ray encounters, warning systems, etc
A70-39923
Human disturbance from SST overflight sonic booms, discussing overpressure, rise times and durations
A70-44016
SST configurations minimizing sonic booms obtainable for given length and weight
[ICAS PAPER 70-23] A70-44110
U.S. SST flight deck instrumentation and cockpit displays during flight, discussing economic analysis of operations
[ICAS PAPER 70-59] A70-44155
Boeing 2707 SST design for low community noise, discussing engine-airframe matching effect
[SAE PAPER 700808] A70-45906
Atmospheric pressure surface sharp slopes at SST altitudes producing vertical acceleration based on temperature gradients inspection
A70-46050
Automatic control system for Boeing SST engine air intakes, optimizing engine performance and controlling noise propagation
A70-46214
Effects of meteorological parameters and instrument errors on vertical flight performance of supersonic transports
[NASA-CR-1570] N70-34253
Supersonic transport radiation hazards and St. Lawrence River tides
[DME/NAE-1970/1/] N70-37215
Congressional report on supersonic transports
N70-41782
Piloted simulator investigation of ground effect on landing maneuver of large, tailless, delta wing airplane
[NASA-TN-D-6046] N70-42810

SUPERSONIC TURBINES
Blade efficiency in producing vortex flow within two dimensional supersonic rotor blade sections
[NASA-TM-X-2095] N70-39419

SUPERSONIC WAKES
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers
A70-34465
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone
A70-34466
Steady state laminar flow model for near wake of slender body in supersonic flow
A70-34467
Turbulent mixing in supersonic cone near wake, using laser planogram technique for flow visualization
A70-37529

SUPERSONIC WIND TUNNELS
Laminar boundary layer transition on sharp cone at zero yaw in supersonic wind tunnels, correlating aerodynamic noise disturbances with transition Reynolds numbers
[AIAA PAPER 70-799] A70-34462
Supersonic air flow control by electrostatic discharges tested by Mach 3 wind tunnels, using schlieren system for bow shock wave
[AIAA PAPER 70-759] A70-34492
Supersonic cascade wind tunnel performance evaluation, using compressor blades of simple geometric shapes
[ASME PAPER 70-GT-110] A70-36848
Molding model crash position indicators for use in supersonic wind tunnel tests
N70-33653
Wind tunnel investigation of Mach 2.2 turbulent boundary layers in nominally zero pressure gradient
[BL/TN/3] N70-36814
Intermittent, single jack, flexible nozzle supersonic wind tunnel calibration at Mach numbers 1.5 to 3.0
[TAE-110] N70-36965
Blowdown, supersonic, and hypervelocity wind tunnel apparatus at the Centre Ricerche Aerospaziali, Rome, Italy
N70-37016

SUPPORT SYSTEMS
Interrelation of onboard and ground automatic test equipment in achieving effective overall support system
N70-32159

SUPPORTS
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models
[AIAA PAPER 69-350] A70-35657
Sliding friction effects of nonlinear asymmetric supports on turbine engine rotor-shaft stability
[SAE PAPER 700320] A70-36799

SURFACE DEFECTS
Electrochemical machining /ECM/ effects on components surface integrity, discussing jet engine materials
[ASME PAPER 70-GT-111] A70-36849

SURFACE GEOMETRY
Supersonic cascade wind tunnel performance evaluation, using compressor blades of simple geometric shapes
[ASME PAPER 70-GT-110] A70-36848

SURFACE NAVIGATION
Dioscures satellite navigation system for aircraft and ships, discussing coverage, radio links, project costs, etc
A70-42657
Aeronautic navigation equipment including gyroscopes. Inertial navigation systems, and self adaptive control systems - stability and accuracy determinations
[JPRS-51241] N70-37787

SURFACE PROPERTIES
Surface alterations by machining processes for gas turbine engine materials, emphasizing effects of milling on Ti and grinding on high strength steels
[ASME PAPER 70-GT-100] A70-36888
Steady incompressible turbulent boundary layer form on permeable curvilinear surface with uniform suction, assuming small pressure gradients
A70-42803

Reflection and focusing of sonic booms by two dimensional curved surfaces
[NASA-CR-110727] N70-32893
Forces and moments on prolate spheroid accelerating with constant angle of attack under free surface
[UCRL-50843] N70-36183
Compression surface design for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993

SURFACE REACTIONS
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines
A70-43574

SURFACE ROUGHNESS EFFECTS
Rod surface roughness effect on eddying sound frequency and intensity and on aerodynamic resistance
A70-38654

SURFACE VEHICLES
Aerodynamic characteristics of vehicle bodies at crosswind conditions in ground proximity
[NASA-TN-D-5935] N70-37030
Bibliography on air travel demand, airport configurations, flow patterns, and ground transportation systems
[AD-708023] N70-40109
Soil strength evaluation of unsurfaced forward-area airfields by use of ground vehicles
[AD-709589] N70-41602

SURFACES
Subsonic high lift cruise wing optimal design using kernel function method of planar lifting surface theory
A70-42709
Modified Multhopp lifting surface theory as programmed for NAL Sirius computer
[NAL-TN-17] N70-41883

SURVEILLANCE
Satellite technology applications to ATC, including communications, navigation, surveillance over water and data acquisition
[AIAA PAPER 70-1301] A70-45922

SURVIVAL
Escape and survivability rates in various aircraft flight envelope regimes, using existing escape statistics and mission profiles
A70-44492

SURVIVAL EQUIPMENT
F-111 crew escape module, describing main parachute and pyrotechnics severance improvements, parachute deployment and inflation, etc
[AIAA PAPER 70-1210] A70-41807
SIIIS-3 ejection seat escape system design, considering minimum weight, cost and maximum performance
[AIAA PAPER 70-1211] A70-41808
Aircraft crash protection with preinflated air bag added to conventional seat/lap belt tested with human sled subjects
A70-44456
In-flight escape systems and survival equipment reliability in U.S. Navy ejections
A70-44460
High energy emergency exit systems for passenger survival in aircraft accidents
A70-44466
F-111 aircraft crew cockpit escape module design for maximum efficiency, including survival equipment after ejection
A70-44491

SUSPENDING (HANGING)
Parachute opening load amplification due to suspension line elasticity, using two-body spring- mass model
A70-44531

SUSPENDING (MIXING)
Experimental systems for impact protection using starch/brine dilatant suspensions
[AD-708017] N70-40188

SUSPENSION SYSTEMS (VEHICLES)
Two-point suspension system with longitudinally displaced cargo hooks for handling helicopter loads, discussing wind tunnel and flight tests
A70-34714
Systems of orientation and guidance of aircraft
[AD-696052] N70-38146

SWEAT COOLING
Transpiration cooling for high temperature gas turbines, investigating effects on aerodynamic and thermodynamic performance
[ASME PAPER 70-GT-56] A70-36839

SWEPT WINGS
Swept tip rotor blade design, discussing wind tunnel-whirl stand correlations
A70-34736
Flow field about leading edges of tapered wings set at incident angle of attack, using gas dynamic and Monge equations
A70-36376
High angle of attack aerodynamic characteristics of swept wing navy aircraft designs improved via leading edge modifications
[AIAA PAPER 70-904] A70-37392
Aerodynamic problems due to /mixed subsonic and supersonic/ transonic flows on swept wings, nacelle lips and helicopter rotor blades
[ICAS PAPER 70-14] A70-44125
High subsonic and transonic effects on pressure distributions for swept wing with oscillating control surface
A70-44763
Wing root shapes and pressure distribution of swept wing aircraft configurations at supersonic speeds
[ARC-CP-1109] N70-43087

SWEPTBACK WINGS
Sweptback thin cantilever wing transonic flutter characteristics, investigating concentrated mass spanwise location effects
A70-42274
Pressure measurements on harmonically vibrating sweptback wing with two control surfaces in incompressible flow
A70-44768
Lift interference analysis on sweptback wing in rectangular wind tunnel test section with slotted side walls
[NASA-TR-R-344] N70-32610

SWING TAIL ASSEMBLIES
Swing tail cargo aircraft fuselage section stress analysis by finite element method, discussing displacement models, deformation modes and economics
A70-41260

SWIRLING
Jet engine compressor noise analysis, noting inlet swirl role
A70-42725

SYNCHRONISM
Time-synchronized approach control, combining aircraft precision navigation and guidance with ATC equipment
A70-38237

SYNCHRONOUS SATELLITES
Dioscures project for ATC over Atlantic Ocean, describing distance measurement by simultaneous use of two geostationary satellites
A70-41258

SYNOPTIC METEOROLOGY
Cloud and synoptic parameters associated with clear air turbulence
[NASA-CR-111778] N70-40766

SYNTHETIC RESINS
Synthetic resin adhesives for aircraft components fabrication
A70-40532

SYSTEM EFFECTIVENESS
Aircraft stretch efficiency factor as function of productivity and payload growth
[SAWE PAPER 838] A70-40369

SYSTEM FAILURES
ATC lag due to air transport growth and associated aircraft design and operations advances, discussing automation, noise abatement effects, etc
A70-35857
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448

SYSTEMS ANALYSIS
Statistical properties of civil ATC system based on central processor, discussing system informational congestion
A70-36394

Weapon systems effective reliability analysis, using degraded mode evaluation and deterministic computer program A70-38833
Avionics hardware operational effectiveness assessment method, considering inertial navigation system LN-12D A70-38837
Multidimensional control for turboramjet engine, relating system characteristics to invariance conditions during startup and ascent A70-39847
In-flight escape systems and survival equipment reliability in U.S. Navy ejections A70-44460
Aircraft electrical power systems optimization - weighted factors for systems effectiveness N70-32055
Determining intercity transportation requirements for Northeast Corridor [PB-190929] N70-34648
Individual and system performance indices for air traffic control system [NA-69-40] N70-37033
Advanced integrated landing system test and evaluation for all-weather landing [FAA-RD-70-28] N70-41271

SYSTEMS ENGINEERING
Computerized metropolitan air transit system, discussing system redundancy for safety level maintainance and all-weather dependability A70-34730
SST flight efficiency trends, discussing breakthrough and development method and Concorde aerodynamic, propulsion and structural history [AIAA PAPER 70-871] A70-34811
Airplane performance improvement by flight control system design, discussing ride quality, flutter margin, maneuver load, etc [AIAA PAPER 70-875] A70-34816
Structural weight reduction and increased aerodynamic efficiency in aircraft design by including flight control technology early in configuration development phase [AIAA PAPER 70-874] A70-34817
Digital computer technology impact on advanced aircraft design, discussing airborne computers, distributed and lumped computer systems, outer loop control, engine control and system integrity A70-34993
System engineering process for survival enhancement of military aircraft to meet stringent requirements of general nuclear war [AIAA PAPER 70-893] A70-35810
SST electrohydraulic primary and standby brake control systems, discussing design and advantages [AIAA PAPER 70-913] A70-35825
Flying qualities criterion for fighter flight control systems design [AIAA PAPER 70-927] A70-35837
Flight data recorders and system integration, discussing data replay system backing flight recording A70-36340
Flight data recording systems for accident investigation and operational purposes, discussing U.S., British and French regulations A70-36341
Underwater recovery requirements for flight data recorders, suggesting compressed air instead of explosive charges for ejection force A70-36343
National air transportation systems approach, emphasizing data acquisition, methodology, planning and policy making [SAE PAPER 700337] A70-36796
Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems [SAE PAPER 700303] A70-36811
V/STOL attitude control system as integral propulsion system part, analyzing design and weight tradeoffs [ASME PAPER 70-GT-31] A70-36832
Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors [ASME PAPER 70-GT-106] A70-36845
Radial compressor diffusers design and technology [ASME PAPER 70-GT-116] A70-36850
Control system considerations for small shaft-type aircraft gas turbines providing torque, temperature, load sharing and overspeed limiting functions [ASME PAPER 70-GT-132] A70-36858
Fire and overheat detection system design for turbine powered vehicles [ASME PAPER 70-GT-125] A70-36891
Soviet book on statistical calculation methods for linear and nonlinear automatic aircraft control systems design, using correlation theory of stochastic processes A70-37403
ATC systems safety, capacity and delay, discussing terminal operations, runway capacity and aircraft spacing A70-38228
System design and development of EUROCONTROL Center for optimum upper airspace in Benelux-FRG region A70-38639
Helicopter stabilization systems design, synthesizing controllers by modal control theory [AIAA PAPER 70-1036] A70-39501
Sensitivity optimization for linear optimal control systems design, describing aircraft lateral-directional control case study [AIAA PAPER 70-962] A70-39567
Invariant systems structural synthesis for automatic control of plant motion, deriving control laws for thrust and angle of attack A70-39844
Italian automated ATC system /ATCAS/, discussing subsystem functions, display devices, data acquisition, information distribution, etc A70-40911
SIIIS-3 ejection seat escape system design, considering minimum weight, cost and maximum performance [AIAA PAPER 70-1211] A70-41808
Test rig vehicle design for noise research on single stage high bypass ratio fans for quieter turbofan power plants [AIAA PAPER 69-492] A70-42708
Avionics system for fighter aircraft, discussing weapons design, navigation-attack systems integration, etc A70-44413
Short haul metropolitan air transportation, considering systems engineering as unifying technology [AIAA PAPER 70-1281] A70-45927
Development of effort expended on automatic test equipment for avionics systems [AGARD-CP-51] N70-32151
Role of built-in test equipment in performance monitoring and fault detection N70-32163
Hardware and software approach techniques for achieving high level of built-in test equipment N70-32164
Constraints placed on circuits and system design by various testing situations encountered during life of avionics equipment N70-32165
Design study for advanced automatic test equipment N70-32178
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts [AD-705127] N70-32265
Technology review on high speed rolling element bearing design for gas turbine engine mainshafts - annotated bibliography [AD-705128] N70-32266
Designing transonic compressors for investigating distortion tolerance of high tip speed fan stages [NASA-CR-72720] N70-32895
System design of optimal remote oculometer for use in operational aircraft [NASA-CR-1562] N70-33103
Design and specifications for low-noise output turbofan engine for long-range subsonic transport aircraft [NASA-TM-X-52640] N70-33773

Turbojet engine RD-3 M-500 data and operating conditions
[AD-700477] N70-36415
Design possibilities for tactical aircraft in next decade
[AD-707042] N70-37730
Computer program for system reliability
[AD-706827] N70-37871
Airborne/spaceborne computer systems engineering, including digital techniques, design tradeoffs, man machine interfaces, display devices, memory, microprogramming, packaging, and maintainability
[AGARDOGRAPH-127] N70-39489
Modular computer systems architecture for avionic and aerospace applications
N70-39496
Basic requirements for system, industrial, aviation, and public safety
[NASA-TM-X-66319] N70-39716
Capstan analysis computer program and aircraft recovery system, arresting gear capstan drive design
[AD-708759] N70-40257
Military aircraft preliminary design conference, including project design, aerodynamics, engines, structures, airframe systems, and systems integration for fighter and transport aircraft
[AGARD-CP-62] N70-40701
Multimission fighter aircraft engine design process, with weapon system design approach
N70-40710
Airframe systems design evaluation for military aircraft
N70-40715
Fighter aircraft flight control system design
N70-40717
Avionics design problem in systems integration for terrain following capability in military transport aircraft
N70-40719
Military system development planning for operational capability needs
N70-40720
Air traffic collision avoidance systems engineering
N70-40930
Air traffic control/collision avoidance systems design analysis
N70-40931
Minimizing cost and schedule problems of integrating software of avionics system
N70-40954
Low speed inducers for rocket engine feed system
[NASA-CR-72716] N70-41058
Formulation of design and construction standards for STOL ports
N70-41078

SYSTEMS STABILITY
Flutter analysis of n degrees of freedom system, basing stability criteria on energy balance considerations
A70-38244

T

TABLES (DATA)
Be production, development, potential uses and properties
[ASM PAPER GG8-102] A70-39970
Air traffic activity data for United States of America, 1969
N70-32361
Accident briefs on midair collisions of United States general aviation - 1967
[PB-190411] N70-34684
Occurrence of typhoons and tropical storms at selected locations for years 1949 to 1969
[AD-706408] N70-37861
Climatological tables for Tontouta Airfield, New Caledonia - 1951 to 1966
N70-38299
Statistical data tables on commuter air carrier operators
N70-41172
Aviation activity at air carrier airports in large and medium air traffic hubs - forecast tables for fiscal years 1971, 1976, 1981
N70-41291
Washington National and Dulles International Airport plans for fiscal years 1970 to 1981
[AD-705087] N70-41302

TABS (CONTROL SURFACES)
Nonlinear balance mass solutions for tab-aileron flutter free operation of jet trainer for arbitrary store configuration
A70-34923
Hovercraft wind directional stability and control by cam operated fin-tab assembly
A70-38942
Aerodynamic coefficients for control surface-tab coupling in subsonic, bidimensional, unsteady flow
[NASA-TT-F-12829] N70-32571

TAIL ASSEMBLIES
Composite tail rotor driveshaft for next generation helicopter, discussing materials, fabrication and tests
[AHS PREPRINT 451] A70-34703
Boeing 2707 SST horizontal tail multiple channel actuation system features
A70-35827
Aft tail and canard configurations trim drag considerations for maneuvering aircraft
[AIAA PAPER 70-932] A70-35842
Fenestron shrouded tail rotor for SA 341 Gazelle helicopter eliminating ground contact during approach and landing
A70-44322
Main rotor wake adverse effects on tail rotor directional control in low velocity wind
A70-44323
Tail rotor thrust increase for yaw control via increased blade area, higher tip speeds and cambered airfoils
A70-44324

TAKEOFF
Boeing 747 pilot transition training, discussing takeoff, landing, eyelevel, flareout taxi speeds, inertial navigation and electrical, fuel and hydraulic systems
A70-40083
Ground Effect Takeoff and Landing /GETOL/ aircraft, evaluating energy absorption capability of air cushion landing gear in touch-down condition
A70-42282
Aircraft longitudinal motion during takeoff and landing due to loss of lift after boundary layer control system failure
A70-45448
Aircraft instrument for indicating malfunctions during takeoff
[NASA-CASE-XLA-00100] N70-36807
Gust and wind effects near thunderstorms and mountains and during aircraft takeoff and landing
[ARC-CP-1091] N70-37242
Aircraft indicator for pilot control of takeoff roll, climbout path and verticle flight path in poor visibility conditions
[NASA-CASE-XLA-00487] N70-40157
Visibility measurements for aircraft landings and takeoffs
N70-40785

TAKEOFF RUNS
Aircraft landing and takeoff difficulties and dangers due to mud and water on runways, discussing coping methods
A70-34692
Optimal longitudinal takeoff trajectories, formulating obstacle clearance criterion function based on aircraft design parameters effects
[AIAA PAPER 70-963] A70-39566
Commercial STOL aircraft takeoff and landing physical parameters relationships based on wind tunnel and flight tests
[AIAA PAPER 70-1238] A70-45959
Classifying standard runway lengths and distance requirements during takeoffs and landings
N70-41595

TANDEM WING AIRCRAFT
German monograph on oscillations of tandem wing without outgoing wake in plane incompressible flow, using numerical computations
A70-35372

TAPE RECORDERS
Airborne data acquisition on high density computer tape for aircraft handling and flight dynamics research
A70-35499
TARGET RECOGNITION
Attack helicopter fire control system with day and night detection, recognition and kill capabilities, discussing system components, operation and reliability
A70-34732
TARGETS
Supersonic jet force acting on target investigated for air and argon using dimensional analysis
A70-40515
TARS
Aircraft braking friction measurements on wet tar and asphalt runways
[RAE-TR-69123] N70-37172
TASK COMPLEXITY
Avionics digital computer system using associative memory for executive control functions implementation to mechanize task assignment algorithm
A70-43105
TAXIING
Visual display and automatic taxi guidance system testing for improved aircraft docking accuracy
[AIAA PAPER 70-916] A70-35828
Boeing 747 pilot transition training, discussing takeoff, landing, eyelevel, flareout taxi speeds, inertial navigation and electrical, fuel and hydraulic systems
A70-40083
TEACHING MACHINES
Computer systems for teaching, air traffic control, and space surveillance
[AD-704573] N70-36488
TECHNOLOGIES
Space technology and science - Conference, Tokyo, August 1969
A70-35201
TECHNOLOGY TRANSFER
Tension-torsion machine developed from aircraft carrier catapult principle, producing radial loading paths
A70-43453
Technology transfer of human factors data for tactical utility helicopter instrumentation
[AD-705594] N70-34499
Review of commercial aircraft technology and potential application to space shuttle
N70-39604
X-15 aircraft maintenance schedule and transfer to space shuttle requirements
N70-39605
TECHNOLOGY UTILIZATION
Digital computer technology impact on advanced aircraft design, discussing airborne computers, distributed and lumped computer systems, outer loop control, engine control and system integrity
A70-34993
Aerospace technology applications to air pollution problems, including turbojet aircraft sources, rocket emissions, etc
[AIAA PAPER 70-815] A70-35194
Hydrofoil and hovering craft design by fiber technology, discussing composite materials, whisker mechanical properties, polycrystalline fibers, matrix materials, etc
A70-38941
Small ground stations in communication satellite systems involving regional telecommunication, TV distribution, air traffic and maritime applications, data exchange, weather and education service
A70-40764
Supersonic aerodynamic design tools, discussing technological application of high speed computer and limitations
[AIAA PAPER 68-1018] A70-42701
Satellite technology applications to ATC, including communications, navigation, surveillance over water and data acquisition
[AIAA PAPER 70-1301] A70-45922
Air traffic control, future national airspace system improvements in view of air transportation growth, computerized automation technology, etc
[AIAA PAPER 70-1263] A70-45969
TELECOMMUNICATION
Method for designing and incorporating automatic built-in test equipment into avionic communications equipment
N70-32161
Data acquisition and communications task in air traffic control
[AD-707137] N70-38709
TELEMETRY
Integration, testing, and performance analysis of solar pointing control and telemetry system with flight experiment aboard Aerobee sounding rocket
[AD-709102] N70-40992
TEMPERATURE CONTROL
Aerospace thermophysics considerations in spacecraft and hypervelocity vehicles systems thermal design, discussing thermal control and control coatings optical and radiative properties
[AIAA PAPER 70-812] A70-34509
Aircraft air conditioning, discussing temperature and humidity control, cooling systems, etc
A70-37975
TEMPERATURE DISTRIBUTION
Air-mechanical fuel injection effect on gas turbine engine combustion chamber working process, investigating heat generation coefficient, temperature field nonuniformity and combustion efficiency
A70-37248
Dynamic unbalance effects in rigid body rotors, discussing lubricant temperature changes and instability hysteresis
[ASME PAPER 69-LUB-14] A70-37606
Temperature distribution in cylinders of aircraft internal combustion rotary piston engine under air cooling
A70-44742
Thermal flux surface distribution lifting bodies, discussing aerodynamic efficiency dependence on drag and zero angle of attack Mach number
A70-45019
Influence of surface melting or surface vaporization on temperature distribution in plate
[AD-705640] N70-33519
TEMPERATURE EFFECTS
Forged alpha/beta Ti alloys, investigating relationship between mechanical properties and microstructures produced by heating
A70-34427
Ti-Al-Cr-Fe tensile, fatigue and creep properties at various temperatures, considering industrial applications
A70-34428
Thermal effects on aircraft elastic vibration mode shapes, recommending investigation to develop analysis and design tools
A70-36459
Atmospheric inhomogeneity and temperature gradient effects on sonic booms, discussing displacement, growth rate and shock wave radii refraction
A70-42311
Gas turbine engine combustion chamber starting, discussing effects of temperature, nozzle characteristics and fuel physicochemical properties
A70-43356
Surface degradation by oxidation, temperature fluctuations and hot corrosion of Ni- and Co-base superalloys in gas turbine engines
A70-43574
Differential pressure cell insensitive to changes in ambient temperature and extreme overload
[NASA-CASE-XAC-00042] N70-34816
TEMPERATURE GRADIENTS
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients
A70-45444
Atmospheric pressure surface sharp slopes at SST altitudes producing vertical acceleration based on temperature gradients inspection
A70-46050
Clear air turbulence detection by IR radiometry of thermal gradients, using staggered receivers for panoramic visualization

A70-46093
TEMPERATURE MEASURING INSTRUMENTS
High temperature transducer for engine vibration measurement, discussing piezoelectric accelerometers mechanical design, jet engines material evaluation, crystallographic considerations, etc
A70-38527
TEMPERATURE SENSORS
High temperature and pressure hot gas source for testing fluidic temperature sensor used in gas turbine engine inlet simulation
A70-35157
Air total temperature measurement for jet powered aircraft, discussing subsonic and supersonic wind tunnel data for sensor thermal recovery characteristics
A70-37882
High temperature transducer for engine vibration measurement, discussing piezoelectric accelerometers mechanical design, jet engines material evaluation, crystallographic considerations, etc
A70-38527
Microwave radiometry and applications as material composition and temperature sensors for aircraft navigation, landing aids, pollution surveillance, meteorology and oceanology
A70-44648
TENSILE PROPERTIES
Ti-Al-Cr-Fe tensile, fatigue and creep properties at various temperatures, considering industrial applications
A70-34428
TENSILE STRESS
Model gas turbine engine blades fatigue strength under stress conditions, considering tensile stresses reproducibility from centrifugal loads
A70-38459
Blade root design for axial flow compressors and turbines, avoiding tensile stress concentration
A70-38616
TENSILE TESTS
Tension-torsion machine developed from aircraft carrier catapult principle, producing radial loading paths
A70-43453
Static testing and creep, including tensile tests, plastic deformation, and buckling
N70-37805
TERMINAL BALLISTICS
Applying Nishiwaki theory of penetration to projectile shapes against aluminum alloy targets
[AD-707837] N70-40024
TERMINAL FACILITIES
Boeing 747 ground operations and airport services, discussing computerized check-in, baggage handling equipment, etc
[AIAA PAPER 70-892] A70-35808
Automated baggage handling and processing, requiring total aviation community participation
[AIAA PAPER 70-917] A70-35829
Mobile lounges and airport productivity concepts for optimal handling of passengers at airport terminal
[AIAA PAPER 70-918] A70-35830
Large capacity transports influence on air cargo operations, and joint use cargo terminal planning
[AIAA PAPER 70-920] A70-35832
Terminal airspace utilization from ATC viewpoint, discussing airport capacity, data acquisition, weather, etc
[SAE PAPER 700281] A70-36809
STOL systems 1975 technical and economic characteristics in terms of passenger market, aircraft design, terminal facilities and ATC capability
[SAE PAPER 700311] A70-36812
Airport terminal design, describing electromechanical baggage handling and sorting systems
[SAE PAPER 700261] A70-36822
International civil aviation, discussing ICAO functions, airports and terminal facilities problems
A70-37748
Hamburg airport terminal design including circular planets system for large aircraft, efficient intermodal transfer facilities, etc
A70-37750
National Airspace System air traffic control automation program for en route and terminal facilities
A70-37914
Air traffic control third generation system upgrading programs increasing airport, en route and terminal airspace capacities
A70-38227
ATC systems safety, capacity and delay, discussing terminal operations, runway capacity and aircraft spacing
A70-38228
Helicopter operations integration into civil air traffic system, noting special requirements for mixed fixed and rotary wing terminal environments
A70-38230
ATC integration of SST, discussing en route and terminal projects of national airspace system, modular automation, instrument flight rules, etc
A70-38633
UK organization of ATC services, considering responsibilities, facilities and personnel recruitment
A70-38634
Boeing 747, L-1011 and DC-10 introduction costs, profits and terminal facilities
A70-38951
International transportation regional hub airport planning with spin-off parking, circular terminal facilities and high speed interterminal passenger and baggage controls
A70-39673
Air cargo terminal operations analysis, discussing manpower cost reduction
A70-40127
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
Air cargo traffic problems, discussing mechanized terminals, automatic handling equipment, direct container delivery, mass traffic and large freighter aircraft
A70-43268
Centralized terminal air cargo handling capacity, discussing Jumbo aircraft, airside ramp system, container movement, computer control and automation
A70-43270
Passenger seaplanes virtues and drawbacks, discussing bases, servicing, refueling, passenger conveyance, prospects, etc
A70-43887
Airport accessibility role in planning V/STOL aircraft landing facilities
[AIAA PAPER 70-1311] A70-45947
Simulation study of optical pilot warning indicator in terminal area traffic
N70-40928
Terminal navigation aids and IFR operations for STOL aircraft
N70-41081
TERMINAL GUIDANCE
Automated radar terminal system, ARTS-III Beacon Tracking Level for continuous aircraft identity on controllers radar display
A70-36393
Terminal area guidance techniques for space shuttle landing
N70-40960
Designing terminal area navigation, guidance, and control system suitable for landing space shuttle vehicles under Category 2 conditions
N70-40961
Guidance and control techniques for terminal energy management and automatic horizontal landings of unpowered space shuttle vehicles
N70-40962
TERMINOLOGY
Trim changes definition, discussing exact meaning
A70-45436
TERRAIN
Vertically descending flight vehicle landing gear for rough terrain
[NASA-CASE-XMF-01174] N70-41589

TERRAIN FOLLOWING AIRCRAFT
Individually built-in self test techniques as applied to terrain following radar systems N70-32162
Avionics design problem in systems integration for terrain following capability in military transport aircraft N70-40719
TERRESTRIAL RADIATION
Earth/atmosphere system outgoing microwave radiation calculations, surveying aircraft/satellite measurements at various wavelengths A70-45192
TEST EQUIPMENT
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc A70-38523
Portable catapult and arresting gear analog instrumentation data acquistion system testing aboard aircraft carriers and at land-based facilities A70-38533
Digital computer magnetic tape recording system for flight tests of Jaguar aircraft, discussing data treatment A70-38537
Automatic test technology for avionics systems, discussing equipment and cost reduction A70-38543
Avionic systems automatic test equipment, discussing maintenance, reliability, cost and time reduction A70-38544
Emmanual magnetic recording system used with airborne digital computers for aircraft in-flight tests A70-38547
Aeroelastic test equipment for Concorde SST using harmonic method and electromagnetic shakers A70-38548
Aircraft gas turbine engine smoke emission measurement, discussing test equipment and procedure standardization A70-39720
Versatile Avionic Shop Test maintenance system supporting avionic equipment aboard aircraft carriers A70-40772
Avionics hardware design guidelines to meet automated testing constraints including malfunction isolation, block requirements, packaging, etc A70-44538
Development of effort expended on automatic test equipment for avionics systems [AGARD-CP-51] N70-32151
Operational requirements for airborne automatic test equipment N70-32152
Impact of management of automatic test equipment in avionic repair organization N70-32154
Application of automated testing and troubleshooting in electronic manufacturing plant N70-32155
Built-in test equipment for advanced flight guidance systems N70-32160
Method for designing and incorporating automatic built-in test equipment into avionic communications equipment N70-32161
Role of built-in test equipment in performance monitoring and fault detection N70-32163
Hardware and software approach techniques for achieving high level of built-in test equipment N70-32164
Onboard checkout systems approach to avionic systems self-test N70-32167
Analysis of onboard equipment testing methods N70-32169
Feasibility of automatically testing avionic systems N70-32170
Classification of software and hardware examples for automatic test equipment N70-32171
Automatic test equipment implementation techniques to realize cost effectiveness support N70-32172
Software and hardware specifications for automatic test equipment N70-32173
Application of programmer-comparator to avionics systems off-line testing N70-32174
Testing of airborne avionics systems using computer subroutines N70-32175
Test techniques used for state-of-the-art airborne infrared equipment N70-32176
Automatic testing of landing aid for VTOL aircraft N70-32177
Design study for advanced automatic test equipment N70-32178
Test equipment for airborne identification friend/foe interrogators and transponders N70-32179
TEST FACILITIES
Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors [ASME PAPER 70-GT-106] A70-36845
High speed track facility for V/STOL aircraft tests, discussing characteristics and design A70-40581
Polish Institute of Aviation, describing facilities and current test programs A70-40799
High bypass model jet noise study, describing test setup and noise measurement results as function of secondary/primary flow velocity ratio A70-44394
Testing laboratory for safety, survival and life support equipment concerning parachutes, aircrew protective helmets and maintenance manuals A70-44488
Rumanian book on methods, equipment and facilities for aeromechanical measurements covering fluid flow, wind and shock tunnels, flow measurements, etc A70-45000
Application of automated testing and troubleshooting in electronic manufacturing plant N70-32155
Interdependence of built-in, onboard, and ground based test facilities N70-32158
Design of test facility and prototype fan for turbofan acoustic research [NASA-TN-D-5877] N70-32721
Slingshot method of mechanically setting fluids into motion with respect to models [AD-702052] N70-32870
Sonic boom simulation by low pressure sources [NASA-CR-66969] N70-33864
Congressional testimony on falsification of data from laboratory tests of brakes for A-7D aircraft N70-36152
High current short circuit testing facilities for aircraft control and protection devices [AD-705504] N70-36423
Outstanding problems and possible methods of solution for parachute technology in western Europe and the United States [RAE-LIB-TRANS-1447] N70-39271
Theory and capabilities of magnetically driven flyers [AD-708449] N70-41131
Techniques for producing hypervelocity flows in aerodynamic test facilities [AD-709210] N70-41152
TEST VEHICLES
Runway test vehicle for lifting rotor performance in simulated forward flight, comparing with wind tunnel tests A70-38611
Test rig vehicle design for noise research on single stage high bypass ratio fans for quieter turbofan power plants

[AIAA PAPER 69-492] A70-42708
TESTING TIME
Continuous variation measurements of wind tunnel parameters minimizing testing time, discussing flow characteristics measurements during angle of attack variation A70-34775
THEOREM PROVING
Theorem proving and interference reduction between two sequences of periodic events
[AD-702734] N70-34878
THERMAL CYCLING TESTS
Avionic components reliability, determining nonsteady cooling air environment effects A70-44744
THERMAL DIFFUSION
Thermal method of measuring turbulence in wind tunnels
[AD-704773] N70-32641
THERMAL INSULATION
Concorde engine bay thermal insulation combining stainless steel foil and polytetrafluorethylene film, considering noise level, engine fire conditions and molten Ti globules penetration A70-36345
Aircraft passengers and crew fire protection in crashes via insulating air-carrying foam ejected into compartment from fuselage A70-44465
THERMAL PROTECTION
Thermal protection system based on radiation cooling for high altitude cruising hypersonic flight, achieving zero net mass transfer A70-41745
THERMAL RADIATION
Contrail effects on atmospheric thermal radiation budget in heavy jet traffic regions from airborne IR and solar radiometric observations A70-44033
THERMAL RESISTANCE
Fire test criteria for aircraft flight data and cockpit voice recorders
[FAA-NA-70-25] N70-33798
THERMAL SIMULATION
SST sonic boom noise level reduction by thermal simulation of long body aircraft, considering thermal spike or keel
[AIAA PAPER 70-1323] A70-45942
THERMAL STABILITY
High thermal stability glass fibers alternatives improving stiffness-to-weight ratio of resin and Al-based composites used in F-111 boron epoxy wings A70-42480
THERMAL STRESSES
Thermal effects on aircraft elastic vibration mode shapes, recommending investigation to develop analysis and design tools A70-36459
Gliders made of glass fiber reinforced plastics, investigating thermostatic properties under solar irradiation and surrounding warm air A70-37370
THERMISTORS
Thermistor and dew cell as remote air temperature and dewpoint measurement at airports A70-40760
THERMODYNAMIC CYCLES
Turbofan engine performance optimization by closed form solution of operating cycle parameter functions
[ASME PAPER 70-GT-65] A70-36840
Stepwise heat removal for increased continuous combustion gas turbine engine cycle efficiency, deriving equations describing cycles A70-43372
THERMODYNAMIC EFFICIENCY
Transpiration cooling for high temperature gas turbines, investigating effects on aerodynamic and thermodynamic performance
[ASME PAPER 70-GT-56] A70-36839
Stepwise heat removal for increased continuous combustion gas turbine engine cycle efficiency, deriving equations describing cycles A70-43372
Computerized calculation of gas turbine cycles thermal efficiency, using hydrocarbon fuel, considering fuel composition and heat of combustion changes A70-43439
THERMODYNAMIC PROPERTIES
Aerodynamic design and calibration of thermal acoustic jet facility-cold flow duct
[NASA-TM-X-53907] N70-37529
THERMODYNAMICS
German book on aircraft thermal propulsion systems calculation, design and evaluation, covering thermodynamic principles and atmospheric composition and properties A70-46150
Turbine aerodynamic and cooling requirements for turbojet powered Mach 3 transport using methane fuel
[NASA-TN-D-5928] N70-34015
THICKNESS
Wall thickness measurement by supersonic testing method based on resonance A70-45681
THIN AIRFOILS
Unsteady aerodynamic forces at stall flutter, applying vortex sheet theory to separated flow field around thin airfoil at high angle of attack A70-42284
Free jet stream effect on thin jet-flapped airfoil with fully developed wake, using linear theory A70-43737
Pressure distribution on thin nonlifting airfoils in steady two dimensional flow with freestream Mach number at or near unity A70-44583
Jet-ambient air mixing effect on flow characteristics around thin airfoil with jet flap A70-45439
THIN PLATES
Nodal patterns on thin elastic circular plate vibrating in flexure, considering natural and compounded modes A70-38245
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter A70-38342
Supersonic flow past slender bodies in presence of strong blowing, extending solution by expansion at leading edge of thin plate A70-39771
THIN WALLED SHELLS
Thin plates and thin walled cylinders aeroelastic stability in fluid flow, analyzing panel flutter A70-38342
Thin circular cylindrical panels in supersonic gas current parallel to generatrices, calculating heterogeneity effect on flutter A70-42603
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc A70-45147
THIN WINGS
Shock wave diffraction by moving thin wing over flat terrains, discussing aircraft blast encounter A70-36195
Flow velocity and pressure on thin wing of small span width near sonic speed, using parabolic type linear equation A70-36374
Soviet book on wing structures analytical design methods covering thin supersonic wings, mass distribution, aerodynamic characteristics, etc A70-37025
Compressible fluids flow with conductivity tensor in presence of thin wing under orthogonal fields, reducing integral equation to Fredholm equation A70-37599
Sweptback thin cantilever wing transonic flutter characteristics, investigating concentrated mass spanwise location effects A70-42274
Similarity rules for sinusoidal gust loads on thin two dimensional wing in nonstationary subsonic flows A70-43970
Aerodynamic interference effects on half-cone bodies with thin wings in hypersonic flow

[NASA-TN-D-5898] N70-32827
Calculations on thin profile oscillations in subsonic flow near rigid boundary
[NASA-TT-F-12966] N70-34182
Estimating aerodynamic properties of airfoil with hinged flap and spoiler
[NASA-TT-F-13131] N70-34693
Computer program for pressure distribution on thin wing in supersonic flow
[NLR-TR-G-50] N70-37079

THREE BODY PROBLEM
Three body problem for parachute system dynamics during inflation
[AIAA PAPER 70-1170] A70-41843

THREE DIMENSIONAL BOUNDARY LAYER
Three dimensional boundary layer on lee- and windside of prolate spheroid, emphasizing separation and embedded streamwise vortices
A70-39359
Three dimensional laminar boundary layer equations for body of revolution at angle of attack in supersonic gas flow derived for equations
A70-43323
Perfect gas three dimensional boundary layer separation on circular cone at incidence, comparing numerical calculation and experimental results
A70-44207
Three dimensional boundary layer and flow resistance of flat plate with slip
N70-32335

THREE DIMENSIONAL FLOW
Hypersonic flow past slender bodies, discussing inviscid flows, outer edge singularity of boundary layer and three dimensional interaction on needle- like bodies
A70-35035
Mathematical model of three dimensional separated flows with applications to small aspect ratio delta wing and flat plate
A70-36438
Three dimensional inviscid small perturbation compressible flow past lifting axial compressor rotor at subsonic and transonic speeds
A70-36691
Three dimensional flow through rotor of axial vortex flow fan, using airfoil method for design
A70-38248
German monograph on three dimensional flow and blade pressure measurements at axial flow compressor casing wall, discussing test control and digital data processing
A70-45093
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible working fluids
A70-45096
Iterative solution for supersonic compressed flow around trianqular wing surface
N70-35137
Three dimensional jet mixing analysis for combustion chamber design
[NASA-CR-111782] N70-43101

THRUST AUGMENTATION
VTOL aircraft ejector thrust augmentors, discussing configurations in wing root section
[ICAS PAPER 70-56] A70-44152
Tail rotor thrust increase for yaw control via increased blade area, higher tip speeds and cambered airfoils
A70-44324
STOL aircraft augmentor wing concept, examining noise suppression, flight research vehicle program and application to turbofan production aircraft
[SAE PAPER 700812] A70-45903
Performance analysis of rotary nozzle utilizing 30 deq spin angle rotor
[AD-705057] N70-32246
Propulsive evaluation of ramjet installed under wing and up to Mach 7
[NASA-TT-F-12951] N70-33230

THRUST CONTROL
Concorde thrust control by employment of variable area nozzle and reheat system, discussing crew work load
[SAE PAPER 700817] A70-45900
Simulation study of three instrument displays to assist airplane thrust management
[NASA-TN-D-5982] N70-41193
Turbofan engine thrust control simulation
[AD-709411] N70-41750

THRUST MEASUREMENT
Thrustmeter for direct output reading from jet engines based on stream and total port pressures
A70-46328
Effects of variable turbine area on subsonic cruise performance of turbojets designed for supersonic application
[NASA-TN-D-5962] N70-42010

THRUST REVERSAL
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel honeycomb construction
A70-43213
Low angle conical plug nozzle with stowed thrust reverser performance at Mach 0 to 2.0
[NASA-TM-X-2116] N70-42437

THRUST TERMINATION
Liquid fuel jet engine thrust aftereffect momentum, investigating switching off transient process
A70-37249

THRUST VECTOR CONTROL
Thrust deflector for VTOL aircraft fuselage mounted lift engines designed as isentropic plug nozzle, considering mass flow, pressure forces and Coanda effect
[SAWE PAPER 841] A70-40379

THRUST-WEIGHT RATIO
Variable sweep high thrust-weight ratio multirole combat aircraft /MRCA/, discussing British-French cooperation, development programs and requirements
A70-34916

THUNDERSTORMS
Thunderstorm development processes investigated by aircraft measurements of electrical structure in cumulonimbus clouds, noting lightning probability dependence on turbulence within cloud
A70-42775
Gust and wind effects near thunderstorms and mountains and during aircraft takeoff and landing
[ARC-CP-1091] N70-37242

TIDES
Supersonic transport radiation hazards and St. Lawrence River tides
[DME/NAE-1970/1/] N70-37215

TILTING ROTORS
Blade flexibility effects on static stability derivatives of prop/rotors in propeller flight mode
A70-34701
Aerodynamic and structural considerations in prop/rotor design for tilt-rotor aircraft, discussing blade twist effect on cruise efficiency and figure of merit
A70-34719
Tilt-fold-proprotor VTOL aircraft characteristics, stability and control, emphasizing flying qualities
A70-34722

TIME DEPENDENCE
Two dimensional time dependent solution for impulsive motion of circular cylinder involving viscous cross flow at moderate angles of attack
A70-36454
Multiaircraft flight test program time compression by management techniques, discussing program length and costs
A70-38530
Cost and time optimization for complex aircraft development projects via network planning
A70-39644
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943

TIME DIVISION MULTIPLEXING
Multichannel interior communication system using time multiplexing, applicable to modern aircraft
[AD-706723] N70-37740

TIME FUNCTIONS
Forcing time functions prediction for structures under shock tube test, relating aerodynamic parameters to mechanics terminology
A70-35180

TIME LAG
High powered high speed helicopters autorotation entry characteristics, noting capability of meeting control time delay requirement
A70-34715
Pilot induced oscillation rating regression analysis, examining time delay, slope after and time to first peak and stick force per g
A70-36444
Navigation errors and time delays in prediction techniques for air traffic control
A70-38642

TIME MEASUREMENT
Airborne computerized time frequency systems for aircraft range and velocity determination, using stable clocks with ambiguity resolution
A70-42659

TIME OPTIMAL CONTROL
ATA Collision Avoidance System based on time and frequency synchronization via ground stations or other aircraft
A70-38239

TIP DRIVEN ROTORS
Pressure jet helicopter with tipjet propelled rotor system, discussing power available calculation, mission performance, power management, etc
A70-34707
Helicopter engine rotor matching for tip propulsion efficiency, comparing with conventional shaft drive propulsion
[ASME PAPER 70-GT-68] A70-36842

TIP SPEED
Helicopter rotors noise intensity prediction for high tip Mach number, including compressibility and thickness effects
A70-34729
Designing transonic compressors for investigating distortion tolerance of high tip speed fan stages
[NASA-CR-72720] N70-32895

TITANIUM
Titanium science, technology and applications - Conference, London, May 1968
A70-34351
Ti hot forming, discussing sheet use as aircraft structural material
A70-34444
Ti sheet welded construction for transport aircraft fuselages, assuming use of electron beam and plasma arc equipment
A70-34452

TITANIUM ALLOYS
Ti alloy forgings for aircraft industry, utilizing high strength/weight ratio
A70-34357
Ti alloy aircraft parts heavy press forging, considering mechanical properties, temperature effects, cost factors, etc
A70-34360
Forged alpha/beta Ti alloys, investigating relationship between mechanical properties and microstructures produced by heating
A70-34427
Ti-Al-Cr-Fe tensile, fatigue and creep properties at various temperatures, considering industrial applications
A70-34428
High strength Ti alloys depth hardenability, discussing mechanical properties and use in aircraft components
A70-34434
High strength Ti alloys for aircraft gas turbine engines, determining critical properties for compressor fan blades
A70-34436
Fatigue characteristics of Ti alloy forgings for rotary wing vehicles, discussing effects of welding, annealing, reduction, surface finish and shot peening
A70-34441
Ti alloys use in jet engines design, considering weight, structural stability, useful temperature range, cost, etc
A70-34448
Ti alloys use in Olympus 593 engine for Concorde SST, discussing weight saving, mechanical properties and manipulation characteristics
A70-34449
Ti fabrications in aircraft engines, discussing alloys properties, sheet deformation, fusion welding, porosity, etc
A70-34450
Alloy applications to Boeing supersonic transport airframe and components, discussing materials characteristics and manufacturing processes
A70-34451
Aircraft structural materials, considering high strength steels Al and Ti alloys
A70-34675
Beta III Ti alloy for aircraft fasteners, describing microstructure and mechanical properties
A70-39966
Short-term creep and erosion resistance testing of Ti alloy in high speed air flows under aerodynamic vibrations
A70-45826

TOOLS
Infrared radiation hot working for polystyrene aircraft maintenance tool kit tray manufacture
[A/AEE-NOTE-9001] N70-42525

TOPOGRAPHY
Sonic boom modeling and topographic and atmospheric effects
[MDC-J0734/01] N70-36809

TORQUE
Aerodynamic forces and torque on airfoil in potential jet from boundary asymptotes position, determining flow characteristics by electrical analogy
A70-45438
Experimental windage losses for close clearance rotating cylinders in turbulent flow
[NASA-TM-X-52851] N70-33066
Aerodynamic and gravity gradient torque effects on attitude control of Apollo/S-4B configuration in circular earth orbit
[NASA-TM-X-64300] N70-34218

TORSION
Tension-torsion machine developed from aircraft carrier catapult principle, producing radial loading paths
A70-43453
Rumanian book on torsion in thin walled elastic structures of various cross sections covering calculation methods for box beams, cylindrical and conical shells, aircraft wings, etc
A70-45147

TORSIONAL VIBRATION
Cross section deformation effect on helicopter rotor blade torsional vibration, using differential equations of vibrating beam
A70-35959
Low aspect ratio cantilever plate wings supersonic bending torsion flutter speed calculation, using spanwise and chordwise variables and potential energy principle
A70-42276

TOWED BODIES
Free flight wind tunnel test for feasibility of hypersonic drogue deployment into reentry vehicle wake
[AIAA PAPER 70-587] A70-35195

TRACKS
Angular contact bearing balls track position on aero gas turbine engines shaft measurement in test rig at high speeds
A70-40141

TRADEOFFS
Air superiority fighter design philosophy, including tradeoffs between armament, detection capability, thrust, speed and load factor
[AIAA PAPER 70-930] A70-35840
Tradeoffs between various configurations of onboard fault detection and fault isolation systems
N70-32166
Tradeoff studies in preliminary fighter aircraft design
N70-40705

TRAFFIC CONTROL
Operational reliability of flight control systems

and automatic piloting of aircraft
[NASA-TT-F-610] N70-35169
TRAILING EDGES
Airfoil trailing edge stall in laminar flow, investigating circulation around flat plate A70-36194
Pulling force during motion of sinusoidally deformable flat profile, taking into account trailing edge vortices A70-36280
Flow field model for large surface blowing problem accounting for upstream and downstream effects with large rate normal injection near trailing edge A70-40110
Heat transfer at air cooled gas turbine blade trailing edges at various wall temperatures and Reynolds numbers A70-44737
Blunt trailing edge blading analysis in low and high speed flows
[AD-709472] N70-41476
TRAILING-EDGE FLAPS
Axial flow compressor off-design performance optimization by adjustable inlet guide vanes with variable trailing edge flaps A70-36846
Heat transfer measurements on flat plate with trailing edge flap in hypersonic flow
[NASA-TN-D-5899] N70-32828
Double hinged flap for boundary layer control over trailing edges of wings
[NASA-CASE-XLA-01290] N70-42016
TRAINING AIRCRAFT
Longitudinal handling qualities of variable stability flight simulator
[AD-703225] N70-35288
TRAINING DEVICES
Evaluation of low cost visual approach slope indicator as pilot training aid
[FAA-DS-70-4] N70-32530
TRAJECTORY ANALYSIS
Parachute trajectory and opening load prediction based on inflation process and added mass, determining drag area as function of distance
[AIAA PAPER 70-1168] A70-43993
Aircraft climb and descent trajectories approximation compatible with air traffic control operation, noting parameters effects A70-46239
Flight dynamics and trajectory calculations for winged rocket aircraft
[AD-706663] N70-38629
TRAJECTORY CONTROL
Airport capacity and terminal area safety increase by scanning beam instrument landing system, discussing automatic guidance trajectory example A70-37913
TRAJECTORY OPTIMIZATION
STOL takeoff trajectory optimization for heavily loaded helicopter, using optimal control theory A70-35841
Aircraft landing maneuver optimization by in-flight monitoring of approach and landing phases, furnishing decision making display
[AIAA PAPER 70-1000] A70-39531
Optimal longitudinal takeoff trajectories, formulating obstacle clearance criterion function based on aircraft design parameters effects
[AIAA PAPER 70-963] A70-39566
Space shuttle transition trajectory optimization for cruising flight entry, considering longitudinal control, pitchup instability and angle of attack A70-44623
Application of steepest descent method to trajectory optimization and aircraft performance problems
[NASA-CR-73366] N70-32760
Effects of meteorological parameters and instrument errors on vertical flight performance of supersonic transports
[NASA-CR-1570] N70-34253
Generation of suboptimal closed loop guidance for minimum time aircraft trajectories N70-37817
TRANSFER FUNCTIONS
Aircraft handling qualities specifications and definitions evolution based on test pilot rating correlation with engineering data and piloting ease evaluation with transfer functions
[ICAS PAPER 70-19] A70-44114
Variable structure systems and applications to flight automation problems
[AD-706798] N70-38534
TRANSIENT HEATING
Charring ablators transient heat transfer model, calculating surface temperature and recession and pyrolysis mass loss
[AIAA PAPER 70-1143] A70-40280
TRANSIENT PRESSURES
Fast response transducer for measuring transient pressures due to shock interaction A70-35484
Parachute canopy surfaces transient aerodynamic pressures during unsteady processes, using piston theory
[AIAA PAPER 70-1175] A70-41838
TRANSIENT RESPONSE
Liquid fuel jet engine thrust aftereffect momentum, investigating switching off transient process A70-37249
TRANSITION FLOW
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers A70-34465
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone A70-34466
Transitional flow separation upstream of compression corner at trailing edge of sharp leading edge flat plate
[AIAA PAPER 70-764] A70-34487
TRANSITION LAYERS
Parameter determination of atmosphere in transition domain at 80 to 120 km on blunt bodies N70-36963
TRANSLATIONAL MOTION
Lighthill aerodynamic noise theory fundamental equation for acoustic field density distribution, determining flow fields for surfaces in uniform translational motion A70-45268
TRANSMISSION LOSS
Acoustic pulse transmission through plane vortex sheet, examining zone of silence, geometrical acoustics and sound radiation A70-41243
TRANSONIC COMPRESSORS
Two dimensional compressor cascades of double circular arc and wedge shape blades testing performance in transonic and supersonic wind tunnels
[ASME PAPER 70-GT-7] A70-36829
Buzz-saw noise of transonic compressor due to rotating pressure field at supersonic blade tip speeds
[ASME PAPER 70-GT-54] A70-36838
Transonic high turning low aspect ratio stator cascades flow field performance prediction, reducing secondary flows by partial slots
[ASME PAPER 70-GT-63] A70-36875
Designing transonic compressors for investigating distortion tolerance of high tip speed fan stages
[NASA-CR-72720] N70-32895
TRANSONIC FLIGHT
Harrier aircraft development history, discussing V/STOL constraints on transonic flight properties
[ICAS PAPER 70-51] A70-44148
TRANSONIC FLOW
German monograph on transonic plane flow past wavy wall in blocked wind tunnel covering flow theory, interferometric density measurements, etc A70-35375
Lifting and side force distributions acting on body in transonic flow A70-35696
Modified linearized transonic flow theory application to pressure coefficient distribution on circular arc bodies of revolution A70-39614

Aerodynamics of steady, inviscid transonic flows around slender bodies and wing-body combinations at free stream Mach number one
[AIAA PAPER 70-798] A70-39900
Transonic turbine cascades exit flow parameters taking into account blade profile
A70-42346
Plane transonic flow around airfoils, using hodograph based methods for shock free flow and finite difference methods for flow with shock waves
[ICAS PAPER 70-12] A70-44123
High subsonic and transonic effects on pressure distributions for swept wing with oscillating control surface
A70-44763
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943
Performance of auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing edge flap over subsonic and transonic free stream range for supersonic aircraft
[NASA-TM-X-2034] N70-32047
Performance prediction for turbocompressor blades with high deflection and low aspect ratio in transonic flow
[VKI-TN-59] N70-34929
Lift and side force acting on bodies in transonic flow
N70-37314
Transonic compressor cascades - influence of compressibility and static pressure
N70-39094
Transonic flow over airfoils and prediction of buffet onset
[AD-709377] N70-41732
Asymptotic study of perfect aerodynamic fluid flows around weakly lifting three-dimensional bodies in sonic regime
[NASA-TT-F-13319] N70-42020

TRANSONIC FLUTTER
Sweptback thin cantilever wing transonic flutter characteristics, investigating concentrated mass spanwise location effects
A70-42274

TRANSONIC SPEED
Aerodynamic characteristics of transonic and supersonic blunt vehicles, reviewing numerical methods
A70-35895
Airframe installation effects at transonic speeds on underwing supersonic cruise exhaust nozzles, using flight and wind tunnel tests
A70-43274
Buffet boundaries on aircraft wings in transonic velocity determined using boundary layer theory
[NRC-TT-1408] N70-33426
Wind tunnel measurements of hemisphere cylinder yawmeter sensitivity at transonic speeds and Reynolds numbers
[ARL/A-320] N70-39031
Unsteady pressure distribution measurements on oscillating wing at subsonic and transonic speeds
[NASA-TT-F-13337] N70-42576

TRANSONIC WIND TUNNELS
Calibration tests in transonic wind tunnel with two and four sided perforation section
A70-38475
Transonic wind tunnel porous walls, investigating interference effects and aerodynamic characteristics
A70-42337
Wind tunnel testing at transonic speeds, discussing boundary layer transition and dynamic sting interference
A70-44581
Test section for use in short duration wind tunnel for simulating high Reynolds numbers over transonic speed range
[NASA-CASE-MFS-20509] N70-35676
Attitude sensing head using short protuding tubes in transonic wind tunnel at Mach numbers 0.5 to 1.1
[ARL/A-321] N70-39023
Sonic wind tunnel tests and characteristics
[NASA-TT-F-12986] N70-42052

TRANSPARENCE
Holographic interferometry for study of transparent media, noting application to aerodynamic phenomena
[ONERA-TP-851] A70-43455

TRANSPORT AIRCRAFT
Ti sheet welded construction for transport aircraft fuselages, assuming use of electron beam and plasma arc equipment
A70-34452
Maneuver load alleviation /MLA/ configurations for wing bending load relief on transport aircraft, showing improved payload and span performance
[AIAA PAPER 70-877] A70-34813
Wide body commercial jet transport structural design considerations applied to DC 10 aircraft
[AIAA PAPER 70-895] A70-35812
Large capacity transports influence on air cargo operations, and joint use cargo terminal planning
[AIAA PAPER 70-920] A70-35832
Air transport operations and economics in 1970 decade, taking into account cost-revenue ratio and cost effectiveness of various aircraft
A70-35852
Subsonic and supersonic transport aircraft design, discussing supercritical wing concept, fuel consumption reduction, composite aircraft structures, short haul transports, etc
A70-35854
European A-300-B Airbus program, discussing technical and economical aspects
A70-36509
V/STOL aircraft for short haul transportation, discussing speed, noise, reliability, economy, etc
[SAE PAPER 700333] A70-36797
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts
[SAE PAPER 700269] A70-36819
Military and commercial transports turbofan propulsion systems impact on future aircraft design and development
[SAE PAPER 700267] A70-36820
European airbuses designs, considering potential market and financial problems
A70-38952
Jumbo jets turbofan engines design, considering fuel consumption, maintenance, reliability, noise reduction, etc
A70-38953
Pilot/vehicle feedback systems with flight director computer for transport aircraft longitudinal control during landing, discussing design by manual control displays theory
[AIAA PAPER 70-1001] A70-39530
Transport aircraft noise at three major airports by noise exposure forecast /NEF/ contours methodology
A70-40896
Short haul jet transport aircraft design, discussing Computer Aid Design, Airline System Simulator and Traffic Demand Predictor computer programs
[ICAS PAPER 70-28] A70-44105
Emergency life saving instant exits for transport aircraft, using electromechanical confined transfer shaped explosive device
A70-44487
Commercial transport aircraft fatigue loading data from NASA VGH /airspeed-acceleration-altitude/ program, discussing instrumentation, sample sizes, etc
A70-44548
Airframe skin panels adhesive bonding in wide-bodied jet transports, emphasizing fuselage fatigue and corrosion resistance
[SAE PAPER 700863] A70-45875
Noise reduction regulations effects on subsonic transport design and configuration
[SAE PAPER 700806] A70-45876
Airline selection of Auxiliary Power Unit /APU/ for transport aircraft, noting benefits of air conditioning during ground operation
[SAE PAPER 700816] A70-45901

Noise reduction design for subsonic transport turbofan engines
[SAE PAPER 700807] A70-45907
Quiet V/STOL transport aircraft from DC-9-10 modification, discussing flying qualities, propulsion and control system interfaces, configurations, etc
[AIAA PAPER 70-1409] A70-45916
Air transportation beyond 1970, discussing general aviation, short haul systems, STOL, helicopter, V/STOL, subsonic, supersonic and hypersonic aircraft
[AIAA PAPER 70-1262] A70-45918
All-body configuration hypersonic transport aircraft performance by computer synthesis, considering sonic boom constraint, maximum payload ratio and optimal cruise speed
[AIAA PAPER 70-1224] A70-45957
Corporate/executive aircraft accident briefs in US general aviation
[PB-190409] N70-34525
Characteristics of severe turbulence encountered by civil jet transport aircraft
[ARC-CP-1098] N70-37086
Aircraft reliability and excess transport aircraft airspeed analyzed from flight records
[ARC-CP-1088] N70-37163
Engine performance design considerations for large subsonic transport with high by-pass ratio N70-37761
Flight investigation of roll requirements for transport airplanes in cruising flight
[NASA-TN-D-5957] N70-38625
Nacelle induced flutter effects in elastodynamic scaled model of fan jet transport aircraft mounted in wind tunnel
[NASA-TN-D-6003] N70-39907
Longitudinal aerodynamic characteristics of twin-turbofan supersonic transport with nacelles mounted under wings
[NASA-TN-D-5971] N70-40689
Aeromedical factors affecting airworthiness standards for SST aircraft N70-40782
Flight test data of turbulent wakes for jet transport aircraft N70-40911
Flight test evaluation of wing vortex wake generated by large jet transport aircraft N70-40912
Air navigation aids and hybrid navigation systems for transport and Comet 4 aircraft
[RAE-TR-69220] N70-42346
Anticollision lights for supersonic transport
[FAA-AM-70-9] N70-42404

TRANSPORT PROPERTIES
Conference on kinetics and thermodynamics of combustion and high temperature gases
[NASA-SP-239] N70-32106

TRANSPORTATION
Air freight containers in continuous air/land transportation chain, discussing weight, performance, cost, technical concepts and inter and nonintermodal prototypes A70-43273
Congressional hearings on federal transportation expenditure N70-41516

TRAPEZOIDAL WINGS
Aerodynamic lift, drag and momentum coefficients in supersonic regime for rectangular and trapezoidal wings with spanwise variable profile A70-42615

TROPICAL REGIONS
Humidity resistance test method involving flight simulation for airborne equipment in tropical environment A70-35159

TROPICAL STORMS
Occurrence of typhoons and tropical storms at selected locations for years 1949 to 1969
[AD-706408] N70-37861

TUBES
Composite compression tubes for VTOL aircraft components, describing weight parameters and mechanical properties
[AIAA PAPER 70-898] A70-35809

TUNGSTEN
Tungsten filled urethane in aircraft areas as balancing agent A70-35418

TUNING
Two stage gas turbine engine optimal tuning for RPM, thrust, fuel rate and gas temperature, describing automated bench tests A70-43361

TURBINE BLADES
Internal efficiency of turbine stages with long twist-varying blades A70-37250
Velocity distribution in boundary layer on thin rotating turbine blade of impeller driven at wind tunnel outlet, solving turbulent and laminar flows momentum equations A70-38224
Model gas turbine engine blades fatigue strength under stress conditions, considering tensile stresses reproducibility from centrifugal loads A70-38459
Transonic turbine cascades exit flow parameters taking into account blade profile A70-42346
Aircraft turbine engines durability estimated from rotor blade minimum tip clearance measurements A70-43529
Heat transfer at air cooled gas turbine blade trailing edges at various wall temperatures and Reynolds numbers A70-44737
Turbine blades aerodynamic forces theoretical and experimental investigation, noting cascade series interaction induced pressure pulsations A70-45504
Turbine blades deformation by centrifugal and aerodynamic forces, discussing theory for bending stress free blade design A70-45505
Reynolds number effect on tip losses
[AD-700578] N70-36419
Flow turbulence effect on turbine blade system efficiency
[NASA-TT-F-13180] N70-37524
Blade efficiency in producing vortex flow within two dimensional supersonic rotor blade sections
[NASA-TM-X-2095] N70-39419
Turbine blade corrosion and thickening effects on turbine efficiency N70-39449

TURBINE ENGINES
Vibration monitoring for turbine engine malfunction detection A70-35480
Sliding friction effects of nonlinear asymmetric supports on turbine engine rotor-shaft stability
[SAE PAPER 700320] A70-36799
Jet transport aircraft turbine engine performance monitoring by flight data, discussing historical highlights and future prospects
[SAE PAPER 700314] A70-36801
Aircraft turbine engines emission sampling, handling and measurement, evaluating various instruments and techniques
[SAE PAPER 700338] A70-36810
Fire and overheat detection system design for turbine powered vehicles
[ASME PAPER 70-GT-125] A70-36891
Soviet book on vibration and balancing of aircraft engine rotors covering structural deformation and dynamics of turbine engines and compressors A70-37237
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques A70-37241
Turbine engine combustion chambers with various frontal devices, investigating burnout mechanism and heat yield in secondary air flow injection zone A70-37246
Internal efficiency of turbine stages with long twist-varying blades A70-37250
Condition Monitored Maintenance program for turbine engines eliminating total overhauls at specified time, using NDT A70-38830
Aircraft turbine engines durability estimated from rotor blade minimum tip clearance measurements

A70-43529
Computerized simulation and hardware for propulsion control of turbine engines
[SAE PAPER 700827] A70-45892
Direct drive turbine engine control components and airframe accessories, noting weight and frontal area reduction
[SAE PAPER 700821] A70-45896
Aircraft and engine design problems for high Reynolds number, high speed, large subsonic aircraft - conference
[AGARD-LS-37-70] N70-37753
Engine performance design considerations for large subsonic transport with high by-pass ratio
N70-37761
Aerodynamics of engine component design problems for large subsonic aircraft
N70-37762
Turbine blade corrosion and thickening effects on turbine efficiency
N70-39449
Performance results of operating full annulus swirl-can primary combustor near stoichiometric temperature
[NASA-TM-X-52902] N70-40624
Analysis of capabilities and limitations of film air cooling methods for turbine engines
[NASA-TN-D-5992] N70-40659

TURBINE WHEELS
Sliding friction effects of nonlinear asymmetric supports on turbine engine rotor-shaft stability
[SAE PAPER 700320] A70-36799
Failure and defect formation in gas turbine engine disks made of steel alloys, stressing fabrication methods effect on reliability
A70-38469
Discrete components formation in noise spectra of axial turbocompressor intake, considering relationship between blades and rotor disk
A70-38652

TURBINES
Radial inflow turbine optimum design geometry, calculating nozzle and rotor geometrical parameters efficiency
A70-46012
Turbine aerodynamic and cooling requirements for turbojet powered Mach 3 transport using methane fuel
[NASA-TN-D-5928] N70-34015
Pliability calculation of elastic bearings for turbomachines
[AD-700690] N70-35204
Effects of variable turbine area on subsonic cruise performance of turbojets designed for supersonic application
[NASA-TN-D-5962] N70-42010

TURBOCOMPRESSORS
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629
Compressor erosion correlation with aerodynamic parameters in gas turbine engines
A70-34711
Rotating stall in axial compressors, using finite difference method
A70-35450
Pure impulse principle applied to axial compressor impellers with high solidity high camber blades
A70-36647
Three dimensional inviscid small perturbation compressible flow past lifting axial compressor rotor at subsonic and transonic speeds
A70-36691
Two dimensional compressor cascades of double circular arc and wedge shape blades testing performance in transonic and supersonic wind tunnels
[ASME PAPER 70-GT-7] A70-36829
Plane and annular cascade facilities data application to aerodynamic design of axial flow compressors
[ASME PAPER 70-GT-106] A70-36845
Axial flow compressor off-design performance optimization by adjustable inlet guide vanes with variable trailing edge flaps
A70-36846
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor
[ASME PAPER 70-GT-39] A70-36869
Axial flow compressor cascades, predicting total pressure losses for inlet relative Mach number greater than unity
[ASME PAPER 70-GT-57] A70-36872
Sound transmission and suppression in turbomachinery fans and compressor ducts, using three dimensional wave equation
[ASME PAPER 70-GT-58] A70-36873
Boundary layer optimization for high turning axial flow compressor blades, using flow theory and conformal mapping
[ASME PAPER 70-GT-88] A70-36879
End wall boundary layers effect included in performance prediction method for multistage axial compressors
[ASME PAPER 70-GT-80] A70-36884
Off-design pressure losses in single stage axial flow compressor, using test rotor in annular duct
[ASME PAPER 70-GT-78] A70-36886
Axial flow compressor stage efficiency under rotary separation conditions, investigating dependence on flow rate
A70-37252
Blade root design for axial flow compressors and turbines, avoiding tensile stress concentration
A70-38616
Discrete components formation in noise spectra of axial turbocompressor intake, considering relationship between blades and rotor disk
A70-38652
Axial compressor air intake wall design influence on sound propagation
A70-38653
Turbocompressor disk materials selection by low cycle fatigue tests, discussing stop and start repetition and cracks in stress concentration zones
A70-41261
Jet engine compressor noise analysis, noting inlet swirl role
A70-42725
Optimum manifold and injector hole area of pulsed exhaust systems of two cycle engine with turbosupercharger
A70-42809
German monograph on three dimensional flow and blade pressure measurements at axial flow compressor casing wall, discussing test control and digital data processing
A70-45093
German monograph on supersonic strongly deflecting retardation cascades covering flow geometry and application to axial flow compressor stage
A70-45095
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible working fluids
A70-45096
Turbine compressor blades vibration mode measurements by holographic interferometry
A70-45563
Axial flow compressor fan discrete tone noise radiation directivity pattern measurement and theoretical explanation for cut-off effect, power and harmonics
A70-46069
Turbofan, turbojet and turboprop engine development in aircraft gas turbine evolution, discussing VTOL propulsion, centrifugal and axial compressor engines
A70-46251
Matching of compressors and turbine parameters in gas turbine aircraft engines
[AD-701978] N70-32490
Turbine-compressor system for active cooling of hypersonic aircraft
[NASA-CR-66930] N70-33268
Performance prediction for turbocompressor blades with high deflection and low aspect ratio in transonic flow
[VKI-TN-59] N70-34929
Multistage multiple reentry axial flow reaction turbine with reverse flow reentry ducting
[NASA-CASE-XLE-00170] N70-36412

Axial compressor airfoils for supersonic Mach numbers
[AD-707144] N70-37673
Design and development of high performance axial and radial compressors including mass flow limitation, cascade performance, supersonic vaneless and vaned diffusers, and flow geometry
[AGARD-LS-39-70] N70-39091
Prediction performance of axial flow compressors using flow-through analysis
N70-39092
Transonic compressor cascades - influence of compressibility and static pressure
N70-39094
Secondary flow losses in axial compressors
N70-39095

TURBOFAN ENGINES
Cooperative airline program for aircraft turbofan engine parts aging and performance deterioration evaluations
[SAE PAPER 700329] A70-36798
High bypass turbofan engine design concepts and development program for airline operation
[SAE PAPER 700292] A70-36804
High bypass ratio aircraft turbofan engines, discussing program of factory, flight and operational suitability testing
[SAE PAPER 700290] A70-36806
JT9D engine design and performance, describing operational problems
[SAE PAPER 700288] A70-36807
Military and commercial transports turbofan propulsion systems impact on future aircraft design and development
[SAE PAPER 700267] A70-36820
Turbofan engine performance optimization by closed form solution of operating cycle parameter functions
[ASME PAPER 70-GT-65] A70-36840
Jumbo jets turbofan engines design, considering fuel consumption, maintenance, reliability, noise reduction, etc
A70-38953
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants
A70-39667
Turbofan engines afterburner flame stabilization at low inlet temperature, noting flame holder geometry role
A70-42336
Acoustically treated inlet and fan exhaust duct configurations for JT3D turbofan engine on DC 8 aircraft
A70-42533
High bypass model jet noise study, describing test setup and noise measurement results as function of secondary/primary flow velocity ratio
A70-44394
Allison/Rolls-Royce TF41 turbofan engine improved power and reduced weight versions, comparing afterburning Model 912-B23 to nonafterburning TF41-A-2
A70-44596
Noise suppression for high-bypass ratio CF6 turbofan engine in DC-10 airplane, considering effect on engine design
[SAE PAPER 700804] A70-45878
Engine control concepts for augmented turbofan, discussing integrated electrical/hydromechanical system
[SAE PAPER 700826] A70-45893
Turbojet and turbofan engine control evolution, noting increased complexity and adoption of hybrid fluidics and computer technologies
[SAE PAPER 700825] A70-45894
Noise reduction design for subsonic transport turbofan engines
[SAE PAPER 700807] A70-45907
Short length combustor and diffuser configuration for supersonic cruise turbofan engine
[NASA-CR-72734] N70-33771
Design and specifications for low-noise output turbofan engine for long-range subsonic transport aircraft
[NASA-TM-X-52640] N70-33773
Inlet pressure oscillation effects on turbofan engine compressor
[NASA-TM-X-2081] N70-39421
Turbofan engine with water injection in discharge duct for increasing propulsive efficiency
[AD-708044] N70-40023
Turbofan engine thrust control simulation
[AD-709411] N70-41750

TURBOFANS
Sound transmission and suppression in turbomachinery fans and compressor ducts, using three dimensional wave equation
[ASME PAPER 70-GT-58] A70-36873
Test rig vehicle design for noise research on single stage high bypass ratio fans for quieter turbofan power plants
[AIAA PAPER 69-492] A70-42708
Axial flow compressor fan discrete tone noise radiation directivity pattern measurement and theoretical explanation for cut-off effect, power and harmonics
A70-46069
Design of test facility and prototype fan for turbofan acoustic research
[NASA-TN-D-5877] N70-32721
Low-speed fan used for noise reduction data on fan and exhaust jet noise
[NASA-TM-X-52871] N70-41963

TURBOJET ENGINE CONTROL
Multidimensional control for turboramjet engine, relating system characteristics to invariance conditions during startup and ascent
A70-39847
Turbojet and turbofan engine control evolution, noting increased complexity and adoption of hybrid fluidics and computer technologies
[SAE PAPER 700825] A70-45894

TURBOJET ENGINES
Kuznetsov NK 8-4 bypass turbojet air entry vanes, pressure compressors, gear case, combustion chamber and turbine drives
A70-34629
Ground test noise measurements accuracy and repeatability on JT8D turbojet engine
A70-35183
Turbojet aircraft engine fuels quality control, considering chemical composition, physical properties and handling problems
A70-36550
Olympus 593 engine for Concorde aircraft, describing design and test procedures
[SAE PAPER 700291] A70-36805
Soviet book on VTOL design covering aerodynamic and weight characteristics, turboprop and turbojet engines, flight regimes, etc
A70-37233
Aircraft engine design combining turbojet and ramjet features to ensure optimum performance
A70-40148
Turbojet engines noise-suppressing nozzles flow rate and thrust characteristics calculation
A70-43371
NASA research in turbojet aircraft propulsion noting inlet, compressor, combustor, turbine and nozzle component technology
[ICAS PAPER 70-46] A70-44144
Performance analysis of rotary nozzle utilizing 30 deg spin angle rotor
[AD-705057] N70-32246
Matching of compressors and turbine parameters in gas turbine aircraft engines
[AD-701978] N70-32490
Turbine aerodynamic and cooling requirements for turbojet powered Mach 3 transport using methane fuel
[NASA-TN-D-5928] N70-34015
Indirect method of determining air flow through inside channel and gas temperature in front of double flow turbine
[NASA-TT-F-12982] N70-34312
Turbojet engine RD-3 M-500 data and operating conditions
[AD-700477] N70-36415
Telescoping-spike supersonic nozzle for turbojet or ramjet engines
[NASA-CASE-XLE-00005] N70-39899
Rotating stall study in turbine engine compressors
[AD-708484] N70-40756
Full-scale annular ram-induction combustor tests for Mach 3 cruise turbojet engine
[NASA-TN-D-6041] N70-41975

Effects of variable turbine area on subsonic cruise performance of turbojets designed for supersonic application
[NASA-TN-D-5962] N70-42010
Wall temperature and heat transfer characteristics of air cooled plug nozzle system for afterburning turbojet engine
[NASA-TM-X-52897] N70-42174

TURBOPROP AIRCRAFT
Servoactuator for stick force augmentation on light turboprop STOL aircraft at high angles of attack
[AIAA PAPER 70-909] A70-35821
Prototype grill device for turboprop aircraft engine inlet protection against bird ingestion, discussing performance tests
A70-35996

TURBOPROP ENGINES
Soviet book on VTOL design covering aerodynamic and weight characteristics, turboprop and turbojet engines, flight regimes, etc
A70-37233
Low and medium power turboprop engines for V/STOL aircraft, discussing development trends concerning operational control
A70-43081
Matching of compressors and turbine parameters in gas turbine aircraft engines
[AD-701978] N70-32490

TURBORAMJET ENGINES
Multidimensional control for turboramjet engine, relating system characteristics to invariance conditions during startup and ascent
A70-39847

TURBOSHAFTS
Computerized design of gas turbine mainshaft seals for operation to 500 ft/sec
[NASA-TM-X-52886] N70-40807

TURBULENCE
Thermal method of measuring turbulence in wind tunnels
[AD-704773] N70-32641
Fluctuating turbulent stresses in noise producing region of jet
[RR-10-PT-2] N70-40566

TURBULENCE EFFECTS
Turbulence effects on lateral directional flying qualities, examining pilot task performance, control workload and compensatory behavior
[AIAA PAPER 70-998] A70-39533
Atmospheric inhomogeneity and temperature gradient effects on sonic booms, discussing displacement, growth rate and shock wave radii refraction
A70-42311
Jet aircraft noise reduction devices directed at turbulence fluctuation noise sources, noting effects on flight characteristics
[ICAS PAPER 70-21] A70-44112
Aerodynamic drag and local convective heat transfer on smooth plate for various flow velocities, determining effects of turbulator in boundary layer transition region
A70-44733
Turbulence effects on flow past rigid circular cylinder at subcritical Reynolds number
[AD-704121] N70-38155
Wake turbulence dangers to light aircraft
N70-39350
Computer programs for determining performance of automatic aircraft landing system in turbulence
[NASA-TN-D-6066] N70-43146

TURBULENCE METERS
Airborne atmospheric turbulent flux measurement system with fast response wind velocity, temperature, humidity and aircraft motion sensors, discussing performance and data reduction
A70-40109

TURBULENT BOUNDARY LAYER
Axisymmetric blunt base cylindrical body with turbulent initial boundary layer, investigating flow structure in annular nozzle wind tunnel
[AIAA PAPER 70-796] A70-34464
Analytical model for jet interaction induced separation of supersonic turbulent boundary layers, conducting flat plat tests at Mach 4
[AIAA PAPER 70-765] A70-34486
Previous history effect on parameters relation in similar turbulent boundary layers under pressure distributions
A70-36375
Velocity distribution in boundary layer on thin rotating turbine blade of impeller driven at wind tunnel outlet, solving turbulent and laminar flows momentum equations
A70-38224
Turbulent boundary layer on cone in supersonic flow in presence of inflowing foreign substance, considering local surface friction coefficient
A70-39814
Steady incompressible turbulent boundary layer form on permeable curvilinear surface with uniform suction, assuming small pressure gradients
A70-42803
Entrainment theory for incompressible turbulent boundary layer velocity and drag on bodies of revolution employed in fuselage, submersible and cowlings for propulsion design
A70-44400
Heat transfer in turbulent boundary layer in wind tunnel with air flowing over partially heated aerodynamically smooth flat plate
N70-32346
Hydrodynamics of accelerated turbulent boundary layer with and without mass injection
[NASA-CR-110650] N70-32466
Wind tunnel investigation of Mach 2.2 turbulent boundary layers in nominally zero pressure gradient
[BL/TN/3] N70-36814
Aerodynamic nonlinearity and turbulent boundary layer effects on hypersonic panel flutter
[NASA-CR-112668] N70-36902
Turbulent boundary layer in adverse pressure gradient regions and distributed suction for higher aerodynamic lift coefficients
[ARC-R/M-3621] N70-37073
Hot-wire anemometer study of turbulent boundary layer flow characteristics over elastic sheets
N70-40556
Response of acoustically loaded panel excited by supersonically convected turbulence
[NASA-CR-113879] N70-41029
Laboratory simulation of atmospheric boundary layer
[AD-710250] N70-42338

TURBULENT DIFFUSION
Aerodynamics of turbulent diffusion flame in coaxial jets, physical model of flameholding on blunt bodies, and diffusion gas flame stability in wake of transverse air jets
[AD-700475] N70-36395

TURBULENT FLOW
Turbulent flow phase velocity fluctuations measurement by hot-wire anemometers, obtaining cross-spectral density by Fourier analysis digital techniques
A70-38019
Aerodynamic noise scattering by semiinfinite compliant plate in turbulent flow, using Lighthill theory and Wiener-Hopf technique
A70-43968
Experimental windage losses for close clearance rotating cylinders in turbulent flow
[NASA-TM-X-52851] N70-33066
Flow turbulence effect on turbine blade system efficiency
[NASA-TT-F-13180] N70-37524
Airfoil measurements that show behavior of wing sections in low-turbulence stream in Reynolds number range from 20,000 to 170,000
[NASA-TM-X-60976] N70-39001
Local pressure field in turbulent shear flow and its relation to aerodynamic noise
[NASA-CR-113881] N70-41283
Ignition and sustaining of combustion by energy addition in turbulent supersonic flow
[AD-710283] N70-42528

TURBULENT JETS
Viscosity effect on turbulent supersonic underexpanded jet flow into submerged region
A70-36262
Aircraft noise sources, examining compressors with dynamic pressure devices and jets with turbulence investigations
[ICAS PAPER 70-22] A70-44111

TURBULENT MIXING
Turbulent mixing in supersonic cone near wake, using laser planogram technique for flow visualization A70-37529
Interaction zone between gas flow and injected air jets, measuring turbulence characteristics by thermoanemometer A70-41773
Aerodynamics and gas jet calculations of gas flame theory
[AD-706646] N70-38635
Turbulent mixing of supersonic jets investigated for momentum and energy equations
[AD-708735] N70-40679
TURBULENT WAKES
Blunt based right circular cylindrical body at subsonic speed, investigating turbulent near wake in wind tunnel A70-34463
Turbulent near wake of symmetrical airfoil, determining universal constant in mixing length formula for inner wake A70-40276
Turbulent near-wake of blunt based, right circular cylinder immersed in uniform subsonic flow
[AD-705687] N70-34978
Kr 85 tracer for gaseous diffusion determination in atmospheric wakes and meteorological wind tunnels
[COO-2053-1] N70-40380
Flight test evaluation of wing vortex wake generated by large jet transport aircraft N70-40912
Results of flight test investigation of vortex wake turbulence generated by large jet transport aircraft N70-40913
Flight test data for vortex wake characteristics of transport aircraft N70-40914
Equations for determining vortex hazard index N70-40915
TURNING FLIGHT
Single and coaxial dual rotor helicopter piloting characteristics during turning flight, discussing operational problems in snow A70-43530
TWISTING
Internal efficiency of turbine stages with long twist-varying blades A70-37250
TWO BODY PROBLEM
Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem A70-43362
TWO DIMENSIONAL BODIES
Time dependent inviscid transonic flow past two dimensional and axisymmetric bodies, presenting numerical procedures including imbedded shock waves as discontinuities
[AIAA PAPER 70-1322] A70-45943
TWO DIMENSIONAL FLOW
Two dimensional supersonic wake behind heated slender flat plate, considering flow properties in transition zone A70-34466
Two dimensional hypersonic viscous flow, analyzing viscosity and bluntness induced pressure effects A70-35034
German monograph on oscillations of tandem wing without outgoing wake in plane incompressible flow, using numerical computations A70-35372
German monograph on transonic plane flow past wavy wall in blocked wind tunnel covering flow theory, interferometric density measurements, etc A70-35375
Pressure distribution shock pattern and impact wave resistance in frictionless plane parallel and source shaped supersonic flow A70-36385
Two dimensional cascades for incompressible plane potential flows with given velocity distribution
[ASME PAPER 70-GT-87] A70-36880
Method of characteristics for two dimensional steady supersonic gas flows with foreign particles in plane and axisymmetric nozzles A70-37228
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics A70-37242
Thin airfoil theory in magnetoaerodynamics, considering steady two dimensional flow of compressible perfectly conducting inviscid fluid in presence of uniform magnetic field A70-37597
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution A70-38350
Bearing force and moment produced by motion of inclined plate supported by compressed air in ground effect machines with small angle of attack A70-39140
Spoiler theory based on mathematical model, using two dimensional potential theory in conjunction with experimental data on wake phenomena A70-42273
Two dimensional turbine cascade air flow, examining boundary layer regime, thickness, velocity and pressure coefficient at any point by Mach-Zehnder interferometer A70-42344
Two dimensional flow about supersonic airfoil, considering trailing Taylor columns behavior like sonic booms A70-42629
Pressure distribution on thin nonlifting airfoils in steady two dimensional flow with freestream Mach number at or near unity A70-44583
Determining unsteady aerodynamics of two dimensional jet flap wing
[AD-704722] N70-33274
Two dimensional flow simulation around airfoils at various angles of attack
[AD-702863] N70-35305
Theoretical scheme for calculating effect of transverse stream contraction in compressor or turbine cascade on supersonic flow across cascade
[NASA-TT-F-13260] N70-39939
Hypersonic wake studies, including two dimensional wakes, sphere wakes, and sharp and blunt cone wakes
[AD-708757] N70-40162
TWO DIMENSIONAL JETS
Noise spectra of two dimensional jet flowing from nozzle ejector, using dispersion equation A70-38662
TWO PHASE FLOW
Two phase plume at various incidence angles on fla plate, determining impinging particle mass flux, forces and damage A70-44566
Separated flow regime of two phase flow
[PB-189804] N70-37342
TWO STAGE TURBINES
Two stage turbine engine parts adjustment optimization in terms of fuel consumption or thrust control by linear programming techniques A70-37241
Two stage gas turbine engine optimal tuning for RPM, thrust, fuel rate and gas temperature, describing automated bench tests A70-43361
Two shaft bypass jet engine analog simulation, determining angular acceleration dependence on angular velocity and fuel consumption A70-45442

U

U.S.S.R.
Soviet news releases on cloud study using thermal instrumentation and aircraft electronic phase marker N70-34885
Soviet meteorology abstracts, including storm development, aerological sounding, and

atmospheric diffusion studies
N70-37882
UH-1 HELICOPTER
UH-1C, AH-1G and UH-1H helicopters combat operational flight profiles, considering airspeed, altitude, rotor speed, load factor, etc
A70-34717
U.S. Army UH-1/AH-1 helicopter maintainability and reliability field program, including statistical data
A70-38827
Methodology for tactical utility helicopter information transfer study
[AD-710248] N70-42532
ULTRAHIGH FREQUENCIES
Ultrahigh frequency air traffic control satellite simulation experiment using high altitude balloons
[NASA-TM-X-65348] N70-41942
ULTRASONIC RADIATION
Ultrasonic sensor for detecting altitude and vertical velocity of aircraft near ground, applying to helicopter hovering flight or conventional airplane takeoff and landing
[AIAA PAPER 70-1031] A70-39506
ULTRASONIC TESTS
Ultrasonic crack detection in fastener holes in C-5A wings
A70-45571
UNDERWATER ACOUSTICS
German book on propeller theory covering airfoil theory, propeller flow and pressure fields, propeller vibrations, shrouded and tilted propellers, helicopter rotors, etc
A70-44097
UNIFORM FLOW
Axisymmetrical nozzle aerodynamic shape design for conical to axially uniform flow conversion, using method of characteristics
A70-44991
UNITED STATES OF AMERICA
Air traffic control system for continental U.S.A. in 1980s, discussing ATC Advisory Committee recommendations
A70-36400
Air traffic activity data for United States of America, 1969
N70-32361
National Aviation System Plan - 1971-1980
N70-37026
United States of America accident briefs on civil aviation
[PB-188859] N70-37606
Statistical analysis of United States of America civil aviation accidents - 1969
[PB-189247] N70-37608
UNLOADING
Extraction parachute deployment for airdropping multiple loads from C-5A aircraft
[AIAA PAPER 70-1203] A70-41814
Prototype cargo-recovery parachute assembly for airdropping heavy unit loads - design study
[AD-701004] N70-33952
UNSTEADY FLOW
Perfect and dissociating gas nonstationary supersonic flow around sharp profile of finite thickness analyzed by linearization and method of characteristics
A70-37242
Unsteady supersonic flow around oscillating cross-shaped wing-fuselage system, determining perturbation velocities and pressure distributions
A70-42609
Downwash angle behind straight wing for unsteady aperiodic flight at subsonic speeds, using vorticity model
A70-42802
Aerodynamic coefficients for control surface-tab coupling in subsonic, bidimensional, unsteady flow
[NASA-TT-F-12829] N70-32571
Force and moment impulses experienced by slender wings in unsteady flow
[NASA-TT-F-13066] N70-34048
Prediction of steady and unsteady airloads on space shuttles
N70-36607
UNSWEPT WINGS
Low speed wind tunnel tests on high aspect ratio unswept wings with boundary layer control by blowing over ailerons and trailing-edge flaps
[ARC-CP-1108] N70-43015
URBAN DEVELOPMENT
Evaluation of proposed airport sites in Chicago area
[FAA-RD-70-25] N70-32546
Determining intercity transportation requirements for Northeast Corridor
[PB-190929] N70-34648
URBAN RESEARCH
Metropolitan airports environmental considerations, noting aircraft noise role in planning
[SAE PAPER 700253] A70-36826
URBAN TRANSPORTATION
Computerized metropolitan air transit system, discussing system redundancy for safety level maintainance and all-weather dependability
A70-34730
Metropolitan air transit system design, considering compound helicopters, automatic control by central computer, onboard avionics system and terminal facilities
A70-41250
STOL system traffic analysis simulation model for interurban transportation system as tool for flight hardware evaluation
A70-43731
STOL operations from city centers, discussing safety requirements, navigation and guidance systems, airport criteria, etc
A70-44174
Planning criteria for optimum metropolitan airport system considering operational, physical, social and economic factors
[AIAA PAPER 70-1266] A70-45921
Short haul metropolitan air transportation, considering systems engineering as unifying technology
[AIAA PAPER 70-1281] A70-45927
Demand analysis data generation for V/STOL systems suitable for New York-Philadelphia- Washington business travel market, applying model to selected designs
[AIAA PAPER 70-1241] A70-45961
STOL aircraft operational constraints, considering economics, short haul market characteristics, community acceptance, speed, propulsion system, takeoff/landing performance and maneuverability
[AIAA PAPER 70-1283] A70-45972
Social costs and benefits from Northeast corridor transportation system
[PB-190944] N70-36515
Transportation requirements survey for Northeast Corridor
[PB-190930] N70-36810
Cost analysis for Northeast Corridor transportation system air and highway modes
[PB-190943] N70-36811
Bibliography on air travel demand, airport configurations, flow patterns, and ground transportation systems
[AD-708023] N70-40109
Preliminary report on Cleveland Before and After Study to reduce conjestion of highway facilities at airport by rapid rail extension
[PB-184060] N70-41400
Evolution of STOL/VTOL city center transportation system
N70-41539
URETHANES
Tungsten filled urethane in aircraft areas as balancing agent
A70-35418

V

V/STOL AIRCRAFT
V/STOL 5000 hp engine design optimization, considering component arrangements, rotor design, blade cooling method and fuel control
A70-34709
Convertible fan-shaft engine for V/STOL tactical and transport aircraft, discussing design and performance
A70-34710

On-line final V/STOL Wind Tunnel Data Encoding and Evaluation System /WINDEE/ for complex powered models, using computer monitoring
A70-35494
Static weight tare compensation for V/STOL wind tunnel models, using accelerometer outputs
A70-35500
Flight test instrumentation for V/STOL stability derivatives extraction, noting instrument errors and required compensation
A70-35502
Fluidic parallel flow low airspeed indicator for V/STOL instrumentation tested in wind tunnel
[AIAA PAPER 70-906] A70-35818
Ground simulations data of jet lift V/STOL compared with visual flight results, noting hover, lateral quick start and stop maneuver
A70-35954
V/STOL testing wind tunnel section with solid vertical and slotted horizontal zero interference walls
A70-36461
V/STOL aircraft for short haul transportation, discussing speed, noise, reliability, economy, etc
[SAE PAPER 700333] A70-36797
V/STOL attitude control system as integral propulsion system part, analyzing design and weight tradeoffs
[ASME PAPER 70-GT-31] A70-36832
Lightweight lift jet engine design, testing and performance for V/STOL aircraft
[ASME PAPER 70-GT-32] A70-36833
V/STOL short haul air transportation program in western U.S., assessing public acceptance and economic viability
[AIAA PAPER 70-888] A70-37394
Mass flow ion drift anemometer applicable to aircraft speed measurement including V/STOL
A70-37885
V/STOL aircraft automatic flight control, guidance and navigation by onboard computer, discussing mathematical model and simulation results
[AIAA PAPER 70-1035] A70-39502
High speed track facility for V/STOL aircraft tests, discussing characteristics and design
A70-40581
Radar inertial system flight evaluation, discussing V/STOL program for approach and landing by use of ground based radar for updating onboard inertial navigator
A70-42651
Harrier flight testing in terms of V/STOL capability compared with conventional aircraft
A70-42975
Low and medium power turboprop engines for V/STOL aircraft, discussing development trends concerning operational control
A70-43081
V/STOL aircraft landing performance, discussing relationships between approach speeds, rates of descent, structural criteria and weight penalties
[ICAS PAPER 70-53] A70-44149
Wind tunnel wall interference effects for V/STOL aircraft with lift jets, using modified theoretical model for complex jet arrangements
[ICAS PAPER 70-54] A70-44150
V/STOL guidance and control system with bad weather landing capability, requirements for V/STOL integration into overall air traffic, terminal area guidance procedures, etc
A70-44843
V/STOL powerplant development, discussion airframe and engine design, application to large aircraft and planned evolutionary process
[SAE PAPER 700809] A70-45905
Quiet V/STOL transport aircraft from DC-9-10 modification, discussing flying qualities, propulsion and control system interfaces, configurations, etc
[AIAA PAPER 70-1409] A70-45916
Demand analysis data generation for V/STOL systems suitable for New York-Philadelphia- Washington business travel market, applying model to selected designs
[AIAA PAPER 70-1241] A70-45961
Wind tunnel investigation of V/STOL transport model with four pod-mounted lift fans
[NASA-TN-D-5942] N70-34100
Computerized simulation and statistical analysis of V/STOL tactical landing system for helicopters
[AD-704324] N70-34849
Theoretical analysis of wing lift in wide and circular stripstreams, and engineering method for predicting practical V/STOL configuration characteristics
[NASA-CR-1632] N70-36851
Display instrumentation for V/STOL aircraft in simulated landing with steep angle approaches or zero-zero visibility
[NASA-CR-112779] N70-37158
Flight simulation of lateral directional handling qualities for V/STOL aircraft in low speed maneuvering flight
[AD-707831] N70-40002
Propeller static performance tests for V/STOL aircraft
[AD-708501] N70-40939
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - hardware and program summary
[NASA-CR-110822] N70-42428
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - test data
[NASA-CR-110821] N70-42429
Rotor/wing concept of stopped-rotor helicopter configuration
[AD-710425] N70-43132

VACUUM APPARATUS
Infrared radiation hot working for polystyrene aircraft maintenance tool kit tray manufacture
[A/AEE-NOTE-9001] N70-42525

VACUUM EFFECTS
Underexpanded carbon dioxide free jet expanding into vacuum from conical nozzles
A70-35246

VAPORIZING
Influence of surface melting or surface vaporization on temperature distribution in plate
[AD-705640] N70-33519

VARACTOR DIODE CIRCUITS
S band CW power amplifier and varactor doubler module for airborne phased arrays
A70-36674

VARIABLE GEOMETRY STRUCTURES
High lift flaps for sailplane cross country speed improvement by cruise-climb tradeoffs
[AIAA PAPER 70-878] A70-34814
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference
A70-36445
Potential flow around oscillating shell-plate structure subjected to supersonic gas flow at zero angle of attack, solving nonlinear aeroelasticity problem
A70-43362
Aerospace configuration with low and high aspect ratio variability for high and low speed flight
[NASA-CASE-XLA-00142] N70-33286
Variable geometry wind tunnel for testing aircraft models at subsonic speeds
[NASA-CASE-XLA-7430] N70-35678

VARIABLE MASS SYSTEMS
Automatic calculations for fuel volume mass properties in tanks at various angles of attack, considering total weight, gravity center moment and inertia product
[SAWE PAPER 850] A70-40376

VARIABLE SWEEP WINGS
Variable sweep high thrust-weight ratio multirole combat aircraft /MRCA/, discussing British-French cooperation, development programs and requirements
A70-34916
Critical flutter behavior of variable geometery aircraft with wing of 70 degree leading edge sweep, noting wing-tail interference
A70-36445
Variable wing sweep aircraft angular motion mathematical model, analyzing inertial moments influence on control dynamics
A70-40182

F-14 carrier based fighter development program requirements, inherent difficulties and variable geometry configuration A70-41264
Aircraft control surface aerodynamic characteristics, considering low aspect ratio wing elevons with variable sweep leading edge as longitudinal and lateral controls [ICAS PAPER 70-26] A70-44107
Variable sweep wing configuration for supersonic aircraft [NASA-CASE-XLA-00230] N70-33255
Variable aspect ratio and variable sweep delta wing planforms for supersonic aircraft [NASA-CASE-XLA-00221] N70-33266
Supersonic aircraft configuration providing for variable aspect ratio and variable sweep wings [NASA-CASE-XLA-00166] N70-34178
Flight tests of low speed controllability of BAC slender variable sweep wing research aircraft [ARC-CP-1102] N70-37062
Supersonic aircraft variable sweep wing planform for varying aspect ratio [NASA-CASE-XLA-00350] N70-38011

VELOCITY DISTRIBUTION
Aerofoil section characteristics in shear flows of arbitrary velocity profile calculated by Glauert image method A70-35957
Two dimensional cascades for incompressible plane potential flows with given velocity distribution [ASME PAPER 70-GT-87] A70-36880
Turbulent flow phase velocity fluctuations measurement by hot-wire anemometers, obtaining cross-spectral density by Fourier analysis digital techniques A70-38019
Velocity distribution in boundary layer on thin rotating turbine blade of impeller driven at wind tunnel outlet, solving turbulent and laminar flows momentum equations A70-38224
Steady two dimensional incompressible shear flow, correlating velocity profiles with resistance distribution A70-38350
Flat plate airfoil unsteady lift due to chordwise velocity perturbations, using Horlock frozen gust pattern theory A70-42303
Gas turbine engines flow velocity fields, comparing various calculation methods A70-44735
Combustion chamber flow visualization, obtaining information on pressure loss, velocity field, flow pattern and temperature gradients A70-45444
Calculating velocity distribution with altitude while braking bodies in atmosphere [AD-706171] N70-38655
Hot-wire anemometer study of turbulent boundary layer flow characteristics over elastic sheets N70-40556

VELOCITY MEASUREMENT
Turbulent flow phase velocity fluctuations measurement by hot-wire anemometers, obtaining cross-spectral density by Fourier analysis digital techniques A70-38019
Ultrasonic sensor for detecting altitude and vertical velocity of aircraft near ground, applying to helicopter hovering flight or conventional airplane takeoff and landing [AIAA PAPER 70-1031] A70-39506
Onboard velocity sensors for VOR/DME navigation systems positional accuracy improvement, describing optimal and suboptimal data filtering [AIAA PAPER 70-1024] A70-39511
Airborne computerized time frequency systems for aircraft range and velocity determination, using stable clocks with ambiguity resolution A70-42659

VENTING
Reducing aerodynamic noise and blade-vortex interaction by modifying tip vortex of helicopter rotors [AD-704804] N70-32556

VERTICAL AIR CURRENTS
Subsonic wing theory calculation method, obtaining close solutions for integral expression constants for downward air currents A70-38164

VERTICAL DISTRIBUTION
Critical height phenomenon for vertical jet exhausting into horizontal parallel plates channel simulating aircraft surfaces A70-36709
Lower atmosphere electric field vertical distribution measurement by combined balloon and rocket soundings A70-42797

VERTICAL FLIGHT
Aircraft indicator for pilot control of takeoff roll, climbout path and verticle flight path in poor visibility conditions [NASA-CASE-XLA-00487] N70-40157

VERTICAL LANDING
Vertically descending flight vehicle landing gear for rough terrain [NASA-CASE-XMF-01174] N70-41589

VERTICAL TAKEOFF
STOL takeoff trajectory optimization for heavily loaded helicopter, using optimal control theory A70-35841
Short haul intercity center facilities air transportation traffic alleviation by VTOL aircraft, emphasizing performance, ground facilities, system operation and economics [AIAA PAPER 70-1243] A70-45914

VERTICAL TAKEOFF AIRCRAFT
VTOL aircraft power plants optimization for future helicopter missions without restrictions of limited off-shelf inventory A70-34708
Tilt-fold-proprotor VTOL aircraft characteristics, stability and control, emphasizing flying qualities A70-34722
Parameter model of VTOL airplane in transition, considering aerodynamic forces and moments and digital simulation A70-34724
VAK 191 B VTOL aircraft fitting NATO Basic Military Requirements for low level reconnaissance-fighter operations developed from Fiat G-91 A70-34992
Composite compression tubes for VTOL aircraft components, describing weight parameters and mechanical properties [AIAA PAPER 70-898] A70-35809
Optimum approach and departure paths for VTOL aircraft simulated by hybrid computer under constraints [AIAA PAPER 69-209] A70-36452
Longitudinal dynamics of VTOL aircraft during hover-forward flight transition, using multiple time scale analysis [AIAA PAPER 69-130] A70-36681
Soviet book on VTOL design covering aerodynamic and weight characteristics, turboprop and turbojet engines, flight regimes, etc A70-37233
Exhaust gas ingestion suppression model tests for VTOL lift engines, measuring inlet thermal environment [AIAA PAPER 70-905] A70-37396
Fixed wing and VTOL aircraft all-weather landing guidance and control philosophy A70-38365
VTOL aircraft longitudinal motion automatic stabilization in presence of turbulence and internal disturbances, using rotors and jet engines A70-39838
Thrust deflector for VTOL aircraft fuselage mounted lift engines designed as isentropic plug nozzle, considering mass flow, pressure forces and Coanda effect [SAWE PAPER 841] A70-40379
Aerodynamic characteristics of elliptical airfoils with jet circulation control for VTOL rotors including dual jets and cyclic results [AIAA PAPER 69-741] A70-42705
VTOL aircraft ejector thrust augmentors, discussing configurations in wing root section [ICAS PAPER 70-56] A70-44152

Low disk loading rotors in high speed VTOL aircraft for economical vertical payload lift
[ICAS PAPER 70-57] A70-44153
VTOL aircraft instrument flight in terminal area, defining requirements and operating characteristics for vertical and low speed capabilities
[AIAA PAPER 70-1333] A70-45935
Airport accessibility role in planning V/STOL aircraft landing facilities
[AIAA PAPER 70-1311] A70-45947
Turbofan, turbojet and turboprop engine development in aircraft gas turbine evolution, discussing VTOL propulsion, centrifugal and axial compressor engines
A70-46251
Military helicopter test program application to commercial VTOL operations, discussing military-civil design and development relationships
[AIAA PAPER 70-1242] A70-46327
Automatic testing of landing aid for VTOL aircraft
N70-32177
Hot gas recirculation measurements on four different-size models of simple VTOL configuration
[NASA-TT-F-12604] N70-32535
Model scale effect on inlet temperature rise of VTOL jet configurations
[NASA-CR-66965] N70-34533
Study of high speed ground transportation for use as public transportation system in Northeast Corridor
[PB-190934] N70-34644
Scaling comparison of recirculation effects of VTOL YJ-85 lift engine pod with similar small-scale simulated engine pod
[NASA-CR-1625] N70-35846
Wind tunnel tests and flight performance of different models of VTOL aircraft
[NASA-TT-F-13181] N70-37542
Forces and moments induced on VTOL aircraft wing by intake and jet stream effects of two lift fan configurations
[NASA-TT-F-13277] N70-39849
Propeller static performance test data for V/STOL aircraft
[AD-708742] N70-40594
Model for testing effect of variations of parameters governing ground effect on vertical takeoff aircraft
[AD-709096] N70-41014
Short haul STOL and VTOL air transportation systems study
N70-41032
Rotary wing and vertical takeoff aircraft displays for steep angle approaches
[AD-709475] N70-41477
Evolution of STOL/VTOL city center transportation system
N70-41539
Pilot-vehicle analysis method for specification and evaluation of flying qualities with application to vertical takeoff aircraft
[AD-710590] N70-43030

VERY HIGH FREQUENCIES
Aircraft Doppler VHF omnidirectional radio range /DVOR/ performance test, noting improvement over VOR system
A70-46240
Crossed slot antenna array for very high frequency aircraft communication with satellites
[AD-705170] N70-32481
ATS-1 VHF communications experimentation
[FAA-RD-70-12] N70-36949

VHF OMNIRANGE NAVIGATION
Eurocontrol evaluation of navigational aid systems air traffic control, examining HARCO and VORDAC systems
A70-38641
Onboard velocity sensors for VOR/DME navigation systems positional accuracy improvement, describing optimal and suboptimal data filtering
[AIAA PAPER 70-1024] A70-39511
VHF omnirange propagation and stability study
[AD-705079] N70-33644
Implementation of 50 kHz frequency separation standard for ILS/VOR/DME frequency assignments
N70-41529

VIBRATION
Soviet book on vibrations in flight vehicle engines covering linear and nonlinear systems, computer methods, etc
A70-37229
Prevention and elimination of vibration of rotary machines
[AD-703063] N70-35499
Annotated bibliography of shock and vibration publications
[AD-700811] N70-40359
Digest of abstracts and literature reviews concerning shock and vibration
[AD-709734] N70-41450

VIBRATION DAMPING
Hingeless rotor helicopter airborne and ground resonance characteristics, noting feedback stability control interference with rotors aerodynamic damping
A70-34733
Helicopter vibration reduction techniques, considering antivibration devices design and comfort crossover speed increase
A70-34735
Flutter design charts for isotropic panels stressed to verge of buckling for tropical values of structural damping
A70-36446
Damping system for control of structural motion in flexible airframes
[NASA-CR-1557] N70-34004

VIBRATION ISOLATORS
Pliability calculation of elastic bearings for turbomachines
[AD-700690] N70-35204

VIBRATION MEASUREMENT
Engine vibration monitoring system for Boeing 747 aircraft, including piezoelectric transducer, transmission assembly and differential charge converter
A70-37898
High temperature transducer for engine vibration measurement, discussing piezoelectric accelerometers mechanical design, jet engines material evaluation, crystallographic considerations, etc
A70-38527
Helicopter vibration measurement techniques, discussing in-service fault diagnosis
A70-40582
Turbine compressor blades vibration mode measurements by holographic interferometry
A70-45563
Portable recording instrument for measuring and surveying noise and vibration
[AD-707826] N70-40026
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - hardware and program summary
[NASA-CR-110822] N70-42428
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - test data
[NASA-CR-110821] N70-42429

VIBRATION METERS
Vibration monitoring for turbine engine malfunction detection
A70-35480
Aircraft compressor and turbine vibration monitor, using velocity coil or piezoelectric transducers
A70-38525
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - hardware and program summary
[NASA-CR-110822] N70-42428

VIBRATION MODE
Thermal effects on aircraft elastic vibration mode shapes, recommending investigation to develop analysis and design tools
A70-36459
Tethered parachutes vibration modes, determining fundamental frequencies from canopy/lines mass ratio and materials elastic properties
[AIAA PAPER 70-1169] A70-41844
Orthogonality of eigenmodes of aircraft vibrations based on F-104G ground measurements
A70-44766

Turbine compressor blades vibration mode measurements by holographic interferometry A70-45563

VIBRATION TESTS
Ground vibration testing for aircraft and missile flutter prevention [ONERA-TP-816] A70-36508
Digital electrodynamic vibration exciter control for sinusoidal, random and shock spectrum testing of aircraft, missiles and satellites A70-37920
HF endurance tests of Al sheet alloy used in welded aircraft structural components, plotting curves for heat treated and untreated specimens A70-38431
Helicopter vibration measurement techniques, discussing in-service fault diagnosis A70-40582
Shakers and solid rocket propellant impulse generators for aeroelastic and vibration flight tests of Concorde aircraft structures [ONERA-TP-811] N70-37148
Linear and angular vibration measurements for V/STOL aircraft, and strapdown inertial guidance system performance - test data [NASA-CR-110821] N70-42429

VIBRATIONAL SPECTRA
Real time narrow band vibration spectrum analysis techniques, discussing application to failure prediction and flight and wind tunnel tests A70-38528

VIBRATIONAL STRESS
Calculating frequencies and modes using inertia matrix [AE-276-S] N70-33607

VIBRATORY LOADS
Short-term creep and erosion resistance testing of Ti alloy in high speed air flows under aerodynamic vibrations A70-45826

VIETNAM
CH-54A helicopter gas turbine engine air particle separator /EAPS/ field service in Vietnam, noting time before engine removal for erosion [ASME PAPER 70-GT-97] A70-36844

VISCOSITY
Viscosity effect on turbulent supersonic underexpanded jet flow into submerged region A70-36262

VISCOUS DRAG
Experimental windage losses for close clearance rotating cylinders in turbulent flow [NASA-TM-X-52851] N70-33066

VISCOUS FLOW
Hypersonic cruise vehicles viscous interactions areas, examining compression corners, shock interactions, laminar and turbulent flow, boundary layer separation, etc [AIAA PAPER 70-781] A70-34475
Two dimensional hypersonic viscous flow, analyzing viscosity and bluntness induced pressure effects A70-35034
Two dimensional time dependent solution for impulsive motion of circular cylinder involving viscous cross flow at moderate angles of attack A70-36454
Subcritical viscous flow around arbitrary airfoils, calculating boundary layer effect on pressure distribution from inviscid flow approximation A70-40924
Steady viscous flow past oblique flat plate at high Reynolds number, using Oseen linearized approximation A70-41714
Lift and side force acting on bodies in transonic flow N70-37314

VISIBILITY
Aircraft accident report for Convair 580 near Bradford, Pennsylvania on Dec. 24, 1968 [PB-189649] N70-37196
Ceiling and visibility atlas for Southeast Asia /1000 ft and 2 1/2 mi/ [AD-707496] N70-37708
Ceiling and visibility atlas for Southeast Asia /5000 ft and 5 mi/ [AD-707494] N70-37709
Visibility measurements for aircraft landings and takeoffs N70-40785
Lower ILS altitude and visibility minimums for light aircraft [AD-708294] N70-41156

VISUAL FLIGHT
Ground simulations data of jet lift V/STOL compared with visual flight results, noting hover, lateral quick start and stop maneuver A70-35954

VISUAL FLIGHT RULES
Runway traction, STOL aircraft, ice prevention, IFR/VFR rules, aerospace medicine, sonic booms, jet aircraft noise, air traffic control, general aviation aircraft N70-40776
VFR and IFR training program and ice prevention and removal for general purpose aircraft N70-40781

VISUAL PERCEPTION
Low visibility aircraft landing problem concerning pilot instrument and visual cue and federal regulations governing operational approval [AIAA PAPER 70-936] A70-35845
Fixed-base visual simulation study for ability determination of onboard pilot during landing [NASA-TN-D-5940] N70-35927

VOLUMETRIC ANALYSIS
Vapor volume entrained in liquid bulk from boundary layer boiling on vertical plate in low gravity field A70-41055

VORTEX GENERATORS
Surface pressure and lift measurement on model lifting rotor blade as function of vortex interaction, using flush mounted pressure transducers A70-34737
Blade efficiency in producing vortex flow within two dimensional supersonic rotor blade sections [NASA-TM-X-2095] N70-39419

VORTICES
Vortex visualization applications in helicopter noise research, using smoke generator in rotor blade tip A70-34712
Pulling force during motion of sinusoidally deformable flat profile, taking into account trailing edge vortices A70-36280
Forced vortex impeller in axial flow fan without inlet vanes, presenting lift and drag coefficients of blade sections, loss of head, etc A70-38222
Three dimensional flow through rotor of axial vortex flow fan, using airfoil method for design A70-38248
Sound wave radiation and excitation in plane infinite plate by vortices A70-38722
Three dimensional boundary layer on lee- and windside of prolate spheroid, emphasizing separation and embedded streamwise vortices A70-39359
Acoustic pulse transmission through plane vortex sheet, examining zone of silence, geometrical acoustics and sound radiation A70-41243
Continuous trailing vortex sheet rolling up into two discrete vortices, discussing wing lift limitations A70-43890
Wing lift increase by spanwise blowing along upper surface, causing flow reattachment on wing and vortex induced effective aerodynamic camber increase [ICAS PAPER 70-09] A70-44120
Reducing aerodynamic noise and blade-vortex interaction by modifying tip vortex of helicopter rotors [AD-704804] N70-32556
Comparison between experimental data and lifting surface theory calculation of vortex induced loads on single-bladed rotary wings [NASA-CR-112769] N70-36986
Filtration methods for aircraft fuel systems presenting vortex separation principle

[AD-707058] N70-38574
Laser system for monitoring wingtip vortices on runways
[NASA-TM-X-64525] N70-42182
VORTICITY
Aircraft condensation trails formation by interactions of exhaust emission, vorticity of wing induced downwash and ambient atmosphere
A70-42684

W

WAKES
Dihedra placed at angle of attack in hypersonic rarefied gas flow, investigating base flow and near wakes
A70-35047
Rotor wakes intrastator transport effects on high Mach number axial flow compressors performance, considering stagnation temperature profile and rotor blade loss factor
[ASME PAPER 70-GT-39] A70-36869
Spoiler theory based on mathematical model, using two dimensional potential theory in conjunction with experimental data on wake phenomena
A70-42273
Wave-riders aerodynamics and heat transfer, investigating lift to drag ratios for supersonic and hypersonic vehicles
[ICAS PAPER 70-18] A70-44129
WALL FLOW
German monograph on transonic plane flow past wavy wall in blocked wind tunnel covering flow theory, interferometric density measurements, etc
A70-35375
Annulus wall boundary layers in axial flow turbomachines, taking into account boundary layer growth and associated secondary flows
[ASME PAPER 70-GT-92] A70-36877
End wall boundary layers effect included in performance prediction method for multistage axial compressors
[ASME PAPER 70-GT-80] A70-36884
German monograph on three dimensional flow and blade pressure measurements at axial flow compressor casing wall, discussing test control and digital data processing
A70-45093
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible working fluids
A70-45096
Method for calculating interaction of cylindrical wall with circular straight section with flow from doublet placed in wall
[NASA-TT-F-13155] N70-33808
WALL JETS
High lift airfoils boundary layer separation suppression by blowing, describing wall jets streamwise development prediction methods
[AIAA PAPER 70-872] A70-34818
Critical height phenomenon for vertical jet exhausting into horizontal parallel plates channel simulating aircraft surfaces
A70-36709
WALL PRESSURE
Sound field produced in uniform moving ideal fluid stream by nonuniform oscillating elastic wall
A70-38657
WALL TEMPERATURE
Hypervelocity wind tunnel tests to determine local cold wall convective heating rates to small rectangular cavities
[NASA-TN-D-5908] N70-37168
Wall temperature and heat transfer characteristics of air cooled plug nozzle system for afterburning turbojet engine
[NASA-TM-X-52897] N70-42174
WANKEL ENGINES
Rotary piston engine for powered gliders and light aircraft power source by modifying industrial Wankel engine
A70-34690
WARFARE
Army aviation requirements in high intensity conflicts, discussing transportation, communications, intelligence acquisition, organization and suitable aircraft types
A70-44855
WARNING SYSTEMS
Gallium arsenide laser ranging system for helicopters obstacle warning
A70-34720
Netherlands Air Force bird strike problem and warning system
A70-35977
Fire and overheat detection system design for turbine powered vehicles
[ASME PAPER 70-GT-125] A70-36891
ATA Collision Avoidance System based on time and frequency synchronization via ground stations or other aircraft
A70-38239
Collision Avoidance System /CAS/ and Proximity Warning Indicator /PWI/ for preventing midair aircraft collisions
A70-44175
Flight test and evaluation of airborne collision avoidance system
[AD-705529] N70-33674
Collision prevention conference, including pilot warning indicators, air traffic control systems, and collision avoidance systems
N70-40927
Simulation study of optical pilot warning indicator in terminal area traffic
N70-40928
Project objectives for visual collision avoidance problem solution with pilot warning instrument
N70-40932
Computerized flight simulation to determine resolution of pilot warning indicator device
[NASA-CR-113808] N70-41040
Display research for aircraft collision warning systems
[NASA-CR-113886] N70-41493
WASTE UTILIZATION
Turbofan engine aerodynamic interactions, cryogenic space storable propellants, space station attitude control biowaste resistojet and long burning time solid propellants
A70-39667
WATER
Water ballast loadings on sailplane Cobra 17, considering wing, aileron, tailplane, fuselage and landing gear
A70-42962
WATER EROSION
Artificial rain erosion effects on missile and spacecraft recorded via high speed photography
A70-40531
WATER INJECTION
Turbofan engine with water injection in discharge duct for increasing propulsive efficiency
[AD-708044] N70-40023
WAVE DIFFRACTION
Shock wave diffraction by moving thin wing over flat terrains, discussing aircraft blast encounter
A70-36195
Sonic boom waves diffraction and reflection, developing analytical method for pressure-time history in vicinity of walls and corners
A70-45266
WAVE DISPERSION
Multilayered and multiple supersonic jets, deriving dispersion equations for boundaries stability
A70-38663
WAVE DRAG
Minimum-drag boattail configurations optimization for supersonic flow, determining wave drag coefficients
A70-42714
Calculating velocity distribution with altitude while braking bodies in atmosphere
[AD-706171] N70-38655
WAVE EQUATIONS
Similarity transformations and boundary value problems of hyperbolic partial differential equations with wave solutions
[AD-710403] N70-42747
WAVE FRONTS
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind

tunnel flow
A70-35962
WAVE INTERACTION
Intersecting shock waves propagation, deriving equations for aircraft sonic boom intensity
A70-38484
WAVE REFLECTION
Sonic boom waves diffraction and reflection, developing analytical method for pressure-time history in vicinity of walls and corners
A70-45266
WAVEFORMS
Aircraft streamer /spark/ discharges formation, waveforms and RF noise levels, using mathematical model for electric field strength
A70-38179
WAVEGUIDES
Subsonic jet engine intake duct radar cross section calculation using waveguide model
A70-43584
WEAPON SYSTEMS
Tactical aircraft performance, discussing electro-optical devices, weaponry, communication and navigational networks, information displays and real time remotely manned control systems
A70-34672
S-3A carrier based ASW weapons system, discussing onboard equipment, navigation, avionics integration, etc
[AIAA PAPER 70-882] A70-35802
Air superiority fighter design philosophy, including tradeoffs between armament, detection capability, thrust, speed and load factor
[AIAA PAPER 70-930] A70-35840
Weapon systems effective reliability analysis, using degraded mode evaluation and deterministic computer program
A70-38833
Avionics system for fighter aircraft, discussing weapons design, navigation-attack systems integration, etc
A70-44413
Nonlinear equations of motion approximate solution, determining ordnance weapons aerodynamic stability coefficients from angle of attack
[AIAA PAPER 69-135] A70-44515
Integrated dynamic tests at flight line maintenance echelon for weapon systems
N70-32153
WEAPONS DEVELOPMENT
Military system development planning for operational capability needs
N70-40720
WEAR TESTS
Helicopter parts and assemblies fatigue life estimation and testing, discussing loading spectra, service conditions, etc
A70-43119
Jet engines and fuels
[AD-706167] N70-37640
WEATHER
Aviation climatology in aviation technology and airport planning
[TT-69-55100] N70-33233
General aviation weather avoidance sensor study
[NASA-CR-112774] N70-36981
WEATHER FORECASTING
Forecasting methods for snowshowers at military air facility in Japan
[AD-705567] N70-33804
Value of static and trend persistance in one-hour prediction of ceiling and visibility
[AD-703305] N70-35342
Measuring forecasting performance relative to previous performance and use of automated forecast verification as management tool
[AD-707498] N70-37703
WEATHER MODIFICATION
Weather modification by jet aircraft contrails, discussing cloud seeding observations in Alaska
A70-45421
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875
WEDGE FLOW
Wedge and cylinder high supersonic wakes stability and transition at various Reynolds numbers
A70-34465
Yawed two dimensional wedges in hypersonic stream, including leading edge bluntness, viscous interaction and angle of attack effects
[AIAA PAPER 70-783] A70-34503
Pressure distribution measurements on wedges in compressible flow at Mach 0.5-2.2, discussing wedge angle, Mach number and boundary layer thickness effects
A70-35923
Laminar heating in hypersonic vehicles interior corners, analyzing helium tunnel heat transfer data for various intersecting wedge corners
A70-39700
WEDGES
Wedge angle large amplitude slow oscillations in hypersonic and supersonic flows, examining attached bow shock
A70-40288
WEIGHT (MASS)
Bobweights effects on pilot induced oscillations, noting role in flying qualities and control system design
[AIAA PAPER 70-1002] A70-39529
WEIGHT ANALYSIS
Normalization of mechanical properties of aircraft engine components, increasing weight efficiency and reliability
A70-37254
Weight growth factor in aircraft design, discussing fixed and variable weight, payload, performance, flight quality, structural criteria and life expectancy
[SAWE PAPER 839] A70-40363
Landing gear weight analytical estimation, discussing ground loads, member cross sectional area, parametric variations, etc
[SAWE PAPER 829] A70-40366
Fuselage frames minimum weight analysis by automatic iterative method
[SAWE PAPER 826] A70-40370
Fighter aircraft configuration design balancing, comparing weight penalties
[SAWE PAPER 840] A70-40380
Disposable load drop effect on aircraft range, using Breguet equations for graphic determination of bombing range
A70-40868
Aircraft-borne and descent systems performance and weight optimized for midair retrieval
[AIAA PAPER 70-1201] A70-41805
Optimum light construction design of glider wings, considering spar weight, aluminum honeycomb structure and repair
A70-42961
Weight optimization in structural sandwich panel design
[AD-709656] N70-42286
WEIGHT MEASUREMENT
Asymmetric rotating bodies mass properties measurement on Dynamic Balancing Machine, taking into account aerodynamic forces
[SAWE PAPER 818] A70-40351
L-1011 onboard system for gross weight and center of gravity determination, describing transducers placement, computer design and display panel
[SAWE PAPER 837] A70-40359
WEIGHTLESSNESS
Use of fighter aircraft to provide zero gravity environment in support of space manufacturing experiments
[NASA-TM-X-53896] N70-37570
WELDED STRUCTURES
Ti sheet welded construction for transport aircraft fuselages, assuming use of electron beam and plasma arc equipment
A70-34452
HF endurance tests of Al sheet alloy used in welded aircraft structural components, plotting curves for heat treated and untreated specimens
A70-38431
Concorde downstream thrust reversal nozzle, noting weight saving by use of welded stainless steel honeycomb construction
A70-43213
Magnesium aluminum alloy as filler material in steel welds for rotor construction
[M70-111-ROM/VDT/NAT] N70-35540
WIND DIRECTION
Hovercraft wind directional stability and control

by cam operated fin-tab assembly
A70-38942
Instrument for measuring wind velocity and direction in wind tunnels using pressure sensors
[NASA-TM-X-66391] N70-42824

WIND EFFECTS
Automatic control systems for aircraft approach to landing path and subsequent stabilization on trajectory, compensating for cross wind action and radio noise disturbances
A70-39842
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models and simulating effects on XV-5 V/STOL aircraft
A70-40784
Aircraft flying at constant speed in circular orbits, calculating flight path under effect of uniform velocity wind
A70-40920
Gliding parachute air cargo systems using nonproportional and proportional automatic manual control, estimating wind effects on ground track and impact computer simulation
[AIAA PAPER 70-1193] A70-41823
Aircraft control, considering wind gradient effects on takeoff, ascent and overflight conditions
A70-43082
Mathematical modeling of atmospheric gusts in stratosphere, mountain wave and thunderstorm conditions relevant to aircraft design
A70-45420
Aerodynamic characteristics of vehicle bodies at crosswind conditions in ground proximity
[NASA-TN-D-5935] N70-37030

WIND MEASUREMENT
Continuous variation measurements of wind tunnel parameters minimizing testing time, discussing flow characteristics measurements during angle of attack variation
A70-34775
Highly localized clear air turbulence at aircraft flight level over Mediterranean, noting simultaneous temperature rise
A70-38948
Wind tunnel response tests of cup, vane and propeller wind sensors, determining wind direction and speed parameters, damped and natural frequencies, etc
A70-42914

WIND PRESSURE
Wind pressure measurements on wind tunnel models of closely-spaced cylindrical silos
[NPL-AERO-NOTE-1088] N70-34941

WIND PROFILES
Aircraft control, considering wind gradient effects on takeoff, ascent and overflight conditions
A70-43082
Meteorological wind and temperature distributions on selected routes at Concorde cruising level, noting computer use for flight planning
A70-46204

WIND TUNNEL APPARATUS
Wind tunnel balance for measuring small aerodynamic loads on scale models, describing three component construction
A70-35490
On-line final V/STOL Wind Tunnel Data Encoding and Evaluation System /WINDEE/ for complex powered models, using computer monitoring
A70-35494
Digital computer for high speed wind tunnel data acquisition, processing and operations control
A70-37923
High speed holographic recording of transient events by single shot ruby and Nd-doped pulsed lasers, applying to shock tubes and wind tunnels
[SMPTE PREPRINT 3] A70-43056
Test section for use in short duration wind tunnel for simulating high Reynolds numbers over transonic speed range
[NASA-CASE-MFS-20509] N70-35676
Blowdown, supersonic, and hypervelocity wind tunnel apparatus at the Centre Ricerche Aerospaziali, Rome, Italy
N70-37016
Laser Doppler velocimeter for low speed V/STOL wind tunnel
[AD-708717] N70-40796
Sonic wind tunnel tests and characteristics
[NASA-TT-F-12986] N70-42052
Instrument for measuring wind velocity and direction in wind tunnels using pressure sensors
[NASA-TM-X-66391] N70-42824

WIND TUNNEL CALIBRATION
Calibration tests in transonic wind tunnel with two and four sided perforation section
A70-38475
Research and development activities of National Aeronautical Laboratory in 1968-1969
N70-35198
Calibration of blowdown wind tunnel for Concorde aircraft jet exhaust nozzle studies
[ONERA-NT-160] N70-42475

WIND TUNNEL DRIVES
Low-speed fan used for noise reduction data on fan and exhaust jet noise
[NASA-TM-X-52871] N70-41963

WIND TUNNEL MODELS
Hypersonic flow field around yawed half angle cone from wind tunnel measurements including surface pressure distributions and flow visualization photographs
A70-34485
Free flight wind tunnel test for feasibility of hypersonic drogue deployment into reentry vehicle wake
[AIAA PAPER 70-587] A70-35195
Low pressure measuring system for aerodynamic models tested in Mach 12-14 wind tunnel, discussing transducers and high speed digital recording and data processing system
A70-35493
Static weight tare compensation for V/STOL wind tunnel models, using accelerometer outputs
A70-35500
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models
[AIAA PAPER 69-350] A70-35657
Flow field on suction side of slender body of revolution with/without wings, investigating by directional probe in wind tunnel
A70-35924
Significant terms in equations of motion for parachutes inflating in free air and in wind tunnel experiments
[AIAA PAPER 68-924] A70-36449
Dynamic airfoil stall simulation in wind tunnels, considering pitch rate, Reynolds number, oscillation and test equipment effects
[AIAA PAPER 70-945] A70-39582
Hypersonic aerodynamic deceleration devices for axisymmetrical bodies with cylindrical main sections and various front sections, using gun tunnel techniques
[AIAA PAPER 70-1174] A70-41839
Dust content effect on hypersonic wind tunnel flow test results, noting drag force on slender and blunt nosed models
A70-42224
Spark photography of models in free flight in hypersonic shock tunnel
[SMPTE PREPRINT 99] A70-43035
Determination of inflated shape and inertial properties of all-flexible parawing
[NASA-TN-D-5900] N70-32259
Scale effects on oscillatory control surface stability derivatives and three dimensional wind tunnel model tests without boundary layer transition
[NPL-AERO-1283] N70-34928
Pressure operated electrical switch for positioning protective cone in front of model in hypersonic wind tunnel
[NASA-CASE-LAR-10137-1] N70-35597
Variable geometry wind tunnel for testing aircraft models at subsonic speeds
[NASA-CASE-XLA-7430] N70-35678
Wind tunnel tests and flight performance of different models of VTOL aircraft
[NASA-TT-F-13181] N70-37542
Scaling and Reynolds number effects on predicting drag from tests on wind tunnel models
N70-37757
Wind tunnel measurements of flow field behind model of twin-propeller deflected slipstream

STOL aircraft
[NAL-TR-197T] N70-40562
Wind tunnel model and flight tests of parawing lifting body landing system
[NASA-TN-D-5893] N70-40667
Autorotation of flat plate wing model about spanwise axis
[AD-710288] N70-43141
WIND TUNNEL NOZZLES
Feasibility of uncooled nozzle throat for hypersonic wind tunnel facility
[AD-705577] N70-33910
WIND TUNNEL STABILITY TESTS
Two-point suspension system with longitudinally displaced cargo hooks for handling helicopter loads, discussing wind tunnel and flight tests A70-34714
Minimal interference thin metal strap support system for dynamic stability tests of high fineness ratio wind tunnel models
[AIAA PAPER 69-350] A70-35657
Nonequilibrium gas states evolution in detached wave front of hypersonic blunt body, comparing vibrational relaxation in free flight and wind tunnel flow A70-35962
Continuous surface of revolution parachute for supersonic/hypersonic speeds, performing wind tunnel tests
[AIAA PAPER 70-1173] A70-41840
Reefed and unreefed disk gap band parachutes tested in supersonic and subsonic wind tunnels to determine stability and performance
[AIAA PAPER 70-1172] A70-41841
Short wing lift investigated via lateral fluid jets fired in wind tunnel for various lengths A70-42614
Helicopter rotor tests in large wind tunnel for increased flight speed, noting pressure and noise measurements
[ICAS PAPER 70-44] A70-44142
Determining unsteady aerodynamics of two dimensional jet flap wing
[AD-704722] N70-33274
Angle of attack and bluntness effects on hypersonic flow over 15 deg semiapex cone in helium
[NASA-TN-D-5903] N70-34073
Wind tunnel investigation of V/STOL transport model with four pod-mounted lift fans
[NASA-TN-D-5942] N70-34100
Wind tunnel characteristics of X-24A aircraft
[NASA-TN-D-5932] N70-34385
Parameter determination of atmosphere in transition domain at 80 to 120 km on blunt bodies N70-36963
Wind tunnel tests measuring transverse jet plumes
[GSL-TR-70-4] N70-37120
Low speed wind tunnel measurements of lateral stability derivatives for HP-115 aircraft
[ARC-CP-1097] N70-37241
Flow turbulence effect on turbine blade system efficiency
[NASA-TT-F-13180] N70-37524
Computer code for plotting wind tunnel aerodynamic data
[SC-DR-69-690] N70-39164
Wind tunnel test data for predicting aerodynamic loads on single engine light aircraft N70-39253
Spin tunnel investigation of 1/20 scale model of modified straight-wing, twin boom, counter insurgency airplane
[NASA-TM-X-2053] N70-40657
Wind tunnel test of canopy construction methods, design details, and canopy slots effects on aerodynamic characteristics of small scale all flexible parawings
[NASA-TN-D-5974] N70-40751
Sonic wind tunnel tests and characteristics
[NASA-TT-F-12986] N70-42052
Boattail and plug area variation effect on convergent and plug nozzle efficiency at Mach 0 to 1.97
[NASA-TM-X-2112] N70-42438
Unsteady pressure distribution measurements on oscillating wing at subsonic and transonic speeds
[NASA-TT-F-13337] N70-42576
High lift low drag airfoil investigation
[REPT-6802] N70-43048
WIND TUNNEL WALLS
V/STOL testing wind tunnel section with solid vertical and slotted horizontal zero interference walls A70-36461
* Wind tunnel wall interference effects for V/STOL aircraft with lift jets, using modified theoretical model for complex jet arrangements
[ICAS PAPER 70-54] A70-44150
WIND TUNNELS
Atmospheric contaminants dispersion simulation in meteorological wind tunnel with capability to simulate thermally stratified boundary layers A70-34496
Continuous variation measurements of wind tunnel parameters minimizing testing time, discussing flow characteristics measurements during angle of attack variation A70-34775
German monograph on transonic plane flow past wavy wall in blocked wind tunnel covering flow theory, interferometric density measurements, etc A70-35375
ONERA low pressure wind tunnel equipped with electron beam probing device to visualize flows too rarefied for optical methods A70-37208
Ultraminiature pressure transducer for airplane model and inlet/engine subsystem in wind tunnel tests, considering design, calibration, environments, etc A70-38523
Runway test vehicle for lifting rotor performance in simulated forward flight, comparing with wind tunnel tests A70-38611
Laminar heating in hypersonic vehicles interior corners, analyzing helium tunnel heat transfer data for various intersecting wedge corners A70-39700
Simulated neutral atmospheric boundary layer measurements in wind tunnel, extending power spectral and correlation determinations A70-40139
Conducting fluid supersonic flow past slender body of revolution in circular wind tunnel under inclined magnetic field, investigating MHD interference problem A70-42669
European wind tunnels suitable for Post Apollo Program aerodynamic testing, presenting detailed tabulated information on available facilities A70-43503
NACA/NASA rotary wing aircraft research history 1915-1970, Part 3, covering rotor and helicopter theory, related flight and wind tunnel testing, etc A70-44853
Heat transfer in turbulent boundary layer in wind tunnel with air flowing over partially heated aerodynamically smooth flat plate N70-32346
Thermal method of measuring turbulence in wind tunnels
[AD-704773] N70-32641
Slingshot method of mechanically setting fluids into motion with respect to models
[AD-702052] N70-32870
Research on surface catalysis in nonequilibrium flow
[AD-704814] N70-33275
Research and development activities of National Aeronautical Laboratory in 1968-1969 N70-35198
Wind tunnel measurements of hemisphere cylinder yawmeter sensitivity at transonic speeds and Reynolds numbers
[ARL/A-320] N70-39031
Kr 85 tracer for gaseous diffusion determination in atmospheric wakes and meteorological wind tunnels
[COO-2053-1] N70-40380
Wind tunnel and flight evaluation Rosemount shielded pitot static tube model 850N
[AD-708859] N70-40514

Velocity mapping at successive cross-sectional planes in open-jet wind tunnel test section [AD-709158] N70-41001

WIND VELOCITY MEASUREMENT
Velocity mapping at successive cross-sectional planes in open-jet wind tunnel test section [AD-709158] N70-41001
Instrument for measuring wind velocity and direction in wind tunnels using pressure sensors [NASA-TM-X-66391] N70-42824

WINDSHIELDS
Glass plastic composite electrically heated windshields for aircraft, discussing design, fabrication, qualification testing and service experience A70-41137

WING CAMBER
Wing lift increase by spanwise blowing along upper surface, causing flow reattachment on wing and vortex induced effective aerodynamic camber increase [ICAS PAPER 70-09] A70-44120

WING FLAPS
Extensible wing flap system for cargo aircraft, discussing structural design details and advantages [AIAA PAPER 70-911] A70-35823
Propulsion system impact on military/commercial STOL transport aircraft commonality, taking into account augmented jet flap and externally blown flap powered lift wing concepts [SAE PAPER 700269] A70-36819
Increased lift via hinge suction jet flaps on augmentor wings, using thin airfoil model and small disturbance theory A70-43432
Upper surface, external flow, jet-augmented flap configuration for high wing jet aircraft for noise reduction [NASA-CASE-XLA-00087] N70-33332

WING FLOW METHOD TESTS
Short wing lift investigated via lateral fluid jets fired in wind tunnel for various lengths A70-42614

WING LOADING
Maneuver load alleviation /MLA/ configurations for wing bending load relief on transport aircraft, showing improved payload and span performance [AIAA PAPER 70-877] A70-34813
Water ballast loadings on sailplane Cobra 17, considering wing, aileron, tailplane, fuselage and landing gear A70-42962
Similarity rules for sinusoidal gust loads on thin two dimensional wing in nonstationary subsonic flows A70-43970
Aircraft wing box beams bending tests to failure loads, considering crushing pressure, bulkhead flexural deformations, structure initial imperfections and instability phenomena [ICAS PAPER 70-33] A70-44103
Unsteady aerodynamic loading of wings with control surfaces, discussing Kuessner integral equation of subsonic lifting theory A70-44761
Numerical technique for computing optimum spanwise load distribution on nonplanar wings of arbitrary shape minimum induced drag [AD-704502] N70-36322
Theoretical analysis of wing lift in wide and circular stripstreams, and engineering method for predicting practical V/STOL configuration characteristics [NASA-CR-1632] N70-36851
Airfoil measurements that show behavior of wing sections in low-turbulence stream in Reynolds number range from 20,000 to 170,000 [NASA-TM-X-60976] N70-39001
Forces and moments induced on VTOL aircraft wing by intake and jet stream effects of two lift fan configurations [NASA-TT-F-13277] N70-39849
Aerodynamic model for calculating airloads and blade motion of helicopter rotor blades [AD-707939] N70-39885

WING OSCILLATIONS
German monograph on oscillations of tandem wing without outgoing wake in plane incompressible flow, using numerical computations A70-35372
Rectangular wing with oscillating control surface, measuring induced unsteady pressure field for comparison with computations based on lifting surface theory A70-41407
Oscillating wing aerodynamic load boundary value problem reduction to sequence of steady lifting-surface problems A70-42715
Harmonically oscillating wing linearized motion in subsonic flow, calculating generalized aerodynamic forces A70-43118
High subsonic and transonic effects on pressure distributions for swept wing with oscillating control surface A70-44763
Pressure measurements on harmonically vibrating sweptback wing with two control surfaces in incompressible flow A70-44768
Oscillatory motion of triangular wing with conical body of arbitrary cross section in supersonic flow, considering wing-body interference effects A70-45592
Calculations on thin profile oscillations in subsonic flow near rigid boundary [NASA-TT-F-12966] N70-34182
Stability of motion of wing near interface of two media [AD-702836] N70-35650
Using oscillatory aerodynamic theory for calculating dynamic stability derivatives with respect to unsteady lifting surface theory N70-35873
Low speed wind tunnel study of oscillatory rolling moments of slender wing with sharp leading edge and frequency and ground effects [ARC-R/M-3617] N70-37162
Unsteady pressure distribution measurements on oscillating wing at subsonic and transonic speeds [NASA-TT-F-13337] N70-42576

WING PANELS
Boeing 747 wing panels shot peening process, discussing machine, control technique and operational requirements A70-38498

WING PLANFORMS
Packable near weightless nylon cloth wings without rigid members for improved aeronautical efficiency in cargo delivery, powered flight and rocket and spacecraft recovery [AIAA PAPER 70-880] A70-34815
Composite wing section design and fabrication utilizing unidirectional glass reinforcement [AIAA PAPER 70-919] A70-35813
Subsonic high lift cruise wing optimal design using kernel function method of planar lifting surface theory A70-42709
Downwash angle behind straight wing for unsteady aperiodic flight at subsonic speeds, using vorticity model A70-42802

WING PROFILES
Stress concentration on axisymmetric annular wings calculated using method of singularities A70-36377
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution A70-40918
Planar wing with end plates in ground effect, calculating minimum induced drag by approximation theory A70-40919
Near field flow effects on sonic boom for incident triangular wing with constant lift distribution [ICAS PAPER 70-20] A70-44113
Supersonic aircraft configuration providing for variable aspect ratio and variable sweep wings [NASA-CASE-XLA-00166] N70-34178
Autorotation of flat plate wing model about spanwise axis [AD-710288] N70-43141

WING ROOTS
Static stability requirements relaxation and wing control devices additions for alleviating wing root bending moments in controls comfigured vehicle /CCV/ design concepts A70-37395
VTOL aircraft ejector thrust augmentors, discussing configurations in wing root section [ICAS PAPER 70-56] A70-44152
Wing root shapes and pressure distribution of swept wing aircraft configurations at supersonic speeds [ARC-CP-1109] N70-43087
WING SLOTS
Flow rates of slotted engine intakes in upper wing surface [LR-526] N70-35142
WING SPAN
Maneuver load alleviation /MLA/ configurations for wing bending load relief on transport aircraft, showing improved payload and span performance [AIAA PAPER 70-877] A70-34813
Flow velocity and pressure on thin wing of small span width near sonic speed, using parabolic type linear equation A70-36374
Soviet book on passenger aircraft aerodynamics covering motions of gases and immersed bodies, similarity laws, boundary layer theory, finite span wing, etc A70-36507
Aerodynamic lift, drag and momentum coefficients in supersonic regime for rectangular and trapezoidal wings with spanwise variable profile A70-42615
WING TANKS
Nonlinear balance mass solutions for tab-aileron flutter free operation of jet trainer for arbitrary store configuration A70-34923
Elastic coupling and dynamic equations for flight elastomechanical vibration systems, including tiptanks on aircraft wings A70-44767
WING TIPS
Laser system for monitoring wingtip vortices on runways [NASA-TM-X-64525] N70-42182
WINGED VEHICLES
Propulsive evaluation of ramjet installed under wing and up to Mach 7 [NASA-TT-F-12951] N70-33230
WINGS
Subsonic wing theory calculation method, obtaining close solutions for integral expression constants for downward air currents A70-38164
One dimensional channel flow theory for ram wings, deriving lift and drag laws for comparison with wind tunnel and free flight tests results [AIAA PAPER 70-971] A70-39558
Free wing aircraft dynamic characteristics, discussing gust alleviation and handling qualities [AIAA PAPER 70-947] A70-39580
Optimum light construction design of glider wings, considering spar weight, aluminum honeycomb structure and repair A70-42961
Continuous trailing vortex sheet rolling up into two discrete vortices, discussing wing lift limitations A70-43890
Ultrasonic crack detection in fastener holes in C-5A wings A70-45571
STOL aircraft augmentor wing concept, examining noise suppression, flight research vehicle program and application to turbofan production aircraft [SAE PAPER 700812] A70-45903
Buffet boundaries on aircraft wings in transonic velocity determined using boundary layer theory [NRC-TT-1408] N70-33426
Heating estimation of aircraft wing from lightning bolt using Joule heating [AD-705645] N70-33442
Surface pressure measurements of wing immersed in propeller slipstream [NAE-LR-525] N70-35551
Applications of advanced composite materials to C-130 center wing box [NASA-CR-66979] N70-42183
WIRE
Glauert equations applied to trailing wire shape for steady state aerodynamic forces on aircraft and trailing antennas, discussing computer solutions A70-43893
WIRING
Aircraft electrical system multiplexing, discussing design features and advantages over conventional hard wired systems [SAE PAPER 700303] A70-36811
Boeing 747 aircraft passenger entertainment and service system controls electronics design and wire installation improvement by multiplexing techniques A70-44543
Boeing 747 airliner passenger entertainment and service electronics multiplexing system, discussing cable and connectors selection and design A70-44544
Superjet airliners wiring connectors for power distribution, signal circuitry and self ejecting push buttons for passenger seats A70-44545
Brayton engine electrical subsystem design and computerized technique used to document wiring [NASA-TM-X-2079] N70-39388
WORK CAPACITY
Aircraft crew and pilot in-flight work load measurement and simulator [ICAS PAPER 70-43] A70-44141
WORK HARDENING
Plastic strain in metals, including work hardening and recovery, atomic lattice distortions, and metallurgical transformations N70-37804
WORKING FLUIDS
German monograph on casing and hub wall friction effects on three dimensional flow in turbocompressors in subsonic compressible working fluids A70-45096

X

X-15 AIRCRAFT
Drag coefficients from modified X-15-2 aircraft configurations at speeds up to Mach 6.7 [NASA-TM-X-2056] N70-35693
X-15 aircraft maintenance schedule and transfer to space shuttle requirements N70-39605
X-24 AIRCRAFT
Wind tunnel characteristics of X-24A aircraft [NASA-TN-D-5932] N70-34385
XENON LAMPS
Xenon flash lamp application in collision avoidance [AD-709191] N70-41191
XV-5 AIRCRAFT
Gust field in lowest atmospheric layer over homogeneous terrain, deriving statistical models and simulating effects on XV-5 V/STOL aircraft A70-40784

Y

YAW
Hypersonic flow field around yawed half angle cone from wind tunnel measurements including surface pressure distributions and flow visualization photographs A70-34485
Yawed two dimensional wedges in hypersonic stream, including leading edge bluntness, viscous interaction and angle of attack effects [AIAA PAPER 70-783] A70-34503
Steady supersonic flow past conical bodies at yaw, adapting Telenin numerical method A70-35889
Compression and expansion characteristics of steady supersonic flow passing along yawing slender body of rotation, linearizing differential equations

A70-36382
Hypersonic flat and biconvex conical wings, calculating yaw effects on shock shape and pressure distribution
A70-40918
Hybrid fluidic damper control for yaw axis stability augmentation of commercial jet aircraft
[SAE PAPER 700794] A70-45853
Evaluation of effect of yaw-rate damper on flying qualities of light twin-engine airplane
[NASA-TN-D-5890] N70-32770
Elevon design for lifting reentry vehicles to eliminate cross coupling and yaw at supersonic and hypersonic speeds
[NASA-CASE-XLA-89670] N70-36056

YAWING MOMENTS
Moments of inertia, liquid sloshing effects, and rolling, pitching, and yawing moment measurements on FD 2 aircraft
[ARC-R/M-3620] N70-37161

YIELD STRENGTH
Ti alloy forgings for aircraft industry, utilizing high strength/weight ratio
A70-34357

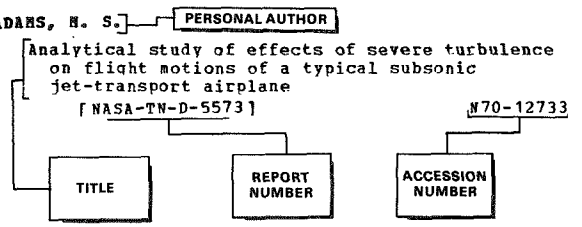
Z

ZERO ANGLE OF ATTACK
Free jet flow axial gradient effects on drag coefficient measurement of slender blunted cones at zero attack angle
A70-44584

ZERO SOUND
Acoustic pulse transmission through plane vortex sheet, examining zone of silence, geometrical acoustics and sound radiation
A70-41243

PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The accession number is located beneath and to the right of the title, e.g., N70-12733. Under any one author's name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

A

AARONS, R. N.
Cooling it - The light aircraft, that is
A70-38500
The SN-600 Corvette
A70-42175

ABBOTT, N. J.
Fabrics for gliding decelerators
[AIAA PAPER 70-1180] A70-41833

ABIANTS, B. KH.
Current state and development prospects of aviation gas turbines
A70-37238

ABZUG, M. J.
Dynamics and control of helicopters with two-cable sling loads
[AIAA PAPER 70-929] A70-35839
Satellite-based navigation/air traffic control systems for short range aircraft
[AIAA PAPER 70-1338] A70-45930

ADAMS, J. G.
Remarks of John G. Adams, member, Civil Aeronautics Board before the Association of Local Transport Airlines Spring Quarterly Regional Meeting
N70-41437

ADAMS, W.
A comparative analysis of individual and system performance indices for the air traffic control system Final report
[NA-69-40] N70-37033

ADAMSON, D. S.
TRANSOP model methodology Final report
[PB-190936] N70-34622

ADDY, A. L.
Experimental-theoretical correlation of supersonic jet-on base pressure for cylindrical afterbodies
A70-42713

ADGAMOV, R. I.
Optimization of the tuning of gas turbine engines
A70-43361

AEBISCHER, A. C.
Development status of BALLUTE system for stabilization and retardation of aircraft stores
[AIAA PAPER 70-1200] A70-41816

AFANASEVA, I. N.
Variable aerodynamic forces in a turbine stage induced by a vane cascade in the wake of a preceding cascade
A70-45504

AGEEV, ZH. S.
Influence of wing sweep variation on the dynamics of control processes
A70-40182

AIELLO, G. F.
Hypersonic flow on yawed two-dimensional wedges with leading-edge bluntness and viscous interaction
[AIAA PAPER 70-783] A70-34503

AIHARA, Y.
High enthalpy nozzle flow with heat exchange
A70-35238

AIKMAN, E.
A suggested action program for the relief of airfield congestion at selected airports, supplement
[AD-702777] N70-33880

AKINRELERE, E. A.
The calculation of inviscid hypersonic flow past the lower surface of a delta wing
A70-46245

ALEKSANDROV, G. V.
Pilot influence on the dynamic design of aircraft
[ICAS PAPER 70-37] A70-44134

ALEKSEEV, IU. S.
Turbulence in the zone of interaction between a jet and a flow
A70-41773

ALEXANDER, W. L.
Hybrid microcircuit design and procurement guide
[AD-705974] N70-34087

ALEXANDER, W. T.
Collection and analysis of helicopter combat flight loads data from AH-1G helicopters in Southeast Asia
A70-34706
Measurement and evaluation of helicopter flight loads spectra data
A70-35955

ALFORD, W. J., JR.
Variable sweep wing configuration Patent
[NASA-CASE-XLA-00230] N70-33255

ALLCOCK, S.
The Anglo French Jaguar flight test data processing systems
A70-38536

ALLEGRE, J.
Near wakes of dihedra placed at an angle of attack in a hypersonic rarefied gas flow
A70-35047

ALLEN, C. H.
Sonic boom simulation by means of low-pressure sources
[NASA-CR-66969] N70-33864

ALLEN, L. H.
APU selection - An airline viewpoint
[SAE PAPER 700816] A70-45901

ALLEN, L. H., JR.
Early experience with the 747
[AIAA PAPER 70-886] A70-40740

ALLEN, W. K.
Traffic control system and method Patent Application
[NASA-CASE-GSC-10087-4] N70-41978

ALTMAN, H. B.
Passenger emergency evacuation briefing cards - Recommendations for presentation style.
A70-44486

ALWANG, W.
Analysis of the behavior modes of turbine components by means of holographic interferometry
A70-45563

ALZNER, E.
Three dimensional mixing of jets
[NASA-CR-111782] N70-43101

AMER, K. B.
Engine rotor matching for tip propulsion of large helicopters
[ASME PAPER 70-GT-68] A70-36842
ANCELL, J. E.
Model study of high bypass jet noise
A70-44394
ANDERSON, D. N.
Performance of a swirl-can primary combustor to outlet temperatures of 3600 F /2256 K/
[NASA-TM-X-52902] N70-40624
ANDERSON, P. A.
IFR formation flight display/system requirements for advanced rotary-wing and jet- fighter aircraft Final technical report, Jun. 1968 - Jun. 1969
[AD-705133] N70-32317
ANDERSON, R. O.
A new approach to the specification and evaluation of flying qualities Final report
[AD-710590] N70-43030
ANDERSON, W. E.
Recent experiments in supersonic regime with electrostatic charges
[AIAA PAPER 70-759] A70-34492
A two-dimensional mixed-compression inlet system designed to self-restart at a Mach number of 3.5
[AIAA PAPER 69-447] A70-42707
ANDERSON, W. J.
Aeroelastic stability of plates and cylinders
A70-38342
ANDERTON, D. A.
America in space. The first decade, aeronautics
N70-36782
ANDO, T.
An experimental study on heaving motion of peripheral jet ground effect machines
A70-42281
ANDREOLI, A. E.
Metropolitan air transit system
A70-34730
The helicopter - An offer of new hope for the commuter, airline passenger
A70-41250
ANDREW, C.
Angular contact ball bearings - Track position at high speeds
A70-40141
ANDREW, G. M.
Recent experiments in supersonic regime with electrostatic charges
[AIAA PAPER 70-759] A70-34492
ANDREWS, E. J.
The external aerodynamics of hovercraft
A70-34919
ANDREWS, W. H.
Flight-test evaluation of the wing vortex wake generated by large jet-transport aircraft
N70-40912
ANGELOS, T. G.
Airline area navigation in continental US
A70-38233
ANGLIN, E. L.
Effects of a pointed nose on spin characteristics of a fighter airplane model including correlation with theoretical calculations
[NASA-TN-D-5291] N70-37395
ANNIN, G.
Electronic attitude director development for the supersonic transport
A70-37911
ANTONA, E.
A theoretical contribution to the study of weight growth factor in aircraft design
[SAWE PAPER 839] A70-40363
An experimental investigation on wing box beams in bending
[ICAS PAPER 70-33] A70-44103
ANTONAZZI, M.
Automated production testing and troubleshooting of avionics products
N70-32155
APPARAO, T. A. P. S.
Gas turbine cycle calculations - The effects of fuel composition and heat of combustion
A70-43439
APPLEMAN, H. S.
The use of jet aircraft engines to dissipate warm fog
A70-35929
APPUSAMY, K. G.
Technical evaluation of future generation of aircraft
A70-38249
ARATA, W. H., JR.
Planning airports to serve air transportation in underdeveloped and emerging nations
[AIAA PAPER 70-1268] A70-45926
ARCHER, D. D.
747 flight test certification
[SAE PAPER 700828] A70-45891
ARCIDIACONO, P. J.
Analytical study of helicopter rotor stall flutter
A70-34734
ARDEMA, M. D.
Hypersonic transport preliminary performance estimates for an all-body configuration
[AIAA PAPER 70-1224] A70-45957
Analysis of bending loads of hypersonic aircraft
[NASA-TM-X-2092] N70-40808
ARDIZZI, P. F.
High current /short-circuit/ facilities for aircraft control and protective devices Progress report
[AD-705504] N70-36423
ARENDTS, F. J.
Comparing the classification of the fatigue strength behaviour of small specimens and large scale components
[ICAS PAPER 70-34] A70-44131
ARIE, M. IA.
Approximate method of calculating a turbulent boundary layer on a permeable curvilinear surface
A70-42803
ARKHIPOV, I. K.
A nonlinear aeroelasticity problem for a two body combination
A70-43362
ARMAND, C.
Helicopter rotor tests in the large wind tunnel of Modane
[ICAS PAPER 70-44] A70-44142
ARMSTRONG, F. W.
Some experiments on two-stream propelling nozzles for supersonic aircraft
[ICAS PAPER 70-48] A70-44145
ARNDT, R. E. A.
Noise radiation from helicopter rotors operating at high tip Mach number
A70-34729
ARNOLD, B. R.
A cooperative airline program to evaluate engine parts aging effects on a current turbofan engine model
[SAE PAPER 700329] A70-36798
ARNOLD, R. J.
Designing the OV-10A forward air control and light attack aircraft
[SAE PAPER 700837] A70-45883
ARONOWITZ, L.
Air pollution by airports
A70-35177
ARRIBAT, J. C.
Environment problems affecting helicopter engine operation
[ASME PAPER 70-GT-96] A70-36843
ARTEMOV, YE. A.
Calculating the pliability of elastic bearings for turbomachines
[AD-700690] N70-35204
ASANO, H.
Eigen motion of airplane. I - Lateral motion
A70-42515
ASHILL, P. R.
On the minimum induced drag of ground-effect wings
A70-40919
ASHLEY, H.
On the unsteady aerodynamic loading of wings with control surfaces
A70-44761
ASHTON, S. J.
The influence of microstructure on the mechanical properties of forged alpha/beta titanium alloys
A70-34427
ASHTON, W. F.
Displays in air traffic control
A70-38645

ASHALOVSKII, V. A.
Temperature distribution in the cylinder of an aircraft internal combustion rotary engine with air cooling
A70-44742
ASSEO, S. J.
Application of optimal control to perfect model following
A70-36443
ATVARS, J.
Parametric studies of the acoustic behavior of duct-lining materials
A70-42532
AUSTIN, F. H., JR.
Reliability of in-flight escape systems and survival equipments in U.S. Navy ejections - Successful and unsuccessful
A70-44460
AUTORINO, D.
Electronic diagnostic techniques for analyzing gas turbine performance
[ASME PAPER 70-GT-131] A70-36857
AVDUEVSKII, V. S.
Flow in a supersonic viscous underexpanded jet
A70-36262
AVESTON, J.
Fibres of high thermal stability
A70-42480
AVILOVA-SHULGINA, M. V.
Investigation of heat exchange processes in cooled gas turbine blades
A70-44737
AXELSON, J. A.
Longitudinal aerodynamic characteristics of three representative hypersonic cruise configurations at Mach numbers from 0.65 to 10.70
[NASA-TM-X-2113] N70-42574
Effects of wing elevation, incidence, and camber on the aerodynamic characteristics of a representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737
AYERS, J. G.
The case for an integrated flight management system
[AIAA PAPER 70-908] A70-35820
AYSON, E. D.
The 747 fuel system
[SAE PAPER 700276] A70-36816

B

BAALS, D. D.
Aerodynamic design integration of supersonic aircraft
[AIAA PAPER 68-1018] A70-42701
BABISH, C. A., III
A continuous surface of revolution parachute for supersonic/hypersonic speeds
[AIAA PAPER 70-1173] A70-41840
BACHELOT, B.
Testing of onboard avionic systems
N70-32169
BACHMANN, B. A.
Power-available calculation procedure and operational aspects of a tipjet-propelled rotor system
A70-34707
BADGLEY, R. H.
Rigid-body rotor dynamics - Dynamic unbalance and lubricant temperature changes
[ASME PAPER 69-LUB-14] A70-37606
BAEV, B. S.
Flight safety of modern automated aircraft
A70-42804
BAGBY, C. L.
Power plant design for noise suppression
[SAE PAPER 700804] A70-45878
BAGLEY, C. J.
Sonic boom modeling investigation of topographical and atmospheric effects Final report, Jun. 1969 - Jul. 1970
[MDC-J0734/01] N70-36809
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[NASA-CASE-XLA-00100] N70-36807
BAILEY, M. C.
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[NASA-CASE-LAR-10545-1] N70-35524
BAKER, D. A.
Production of precision foam plastic products by pressure molding of foam slabs in a hot mold
N70-33653
BAKER, J. H.
Airport development or redevelopment - Financial considerations
[AIAA PAPER 70-1267] A70-45920
BAKER, P.
Operational experience with STOL aircraft
N70-41079
BAKER, P. A.
Flight evaluation of ground effect on several low-aspect-ratio airplanes
[NASA-TN-D-6053] N70-42738
BAKER, W. H.
The helicopter - Hazardous at any height
A70-46383
BAKUM, B. I.
Influence of the dust content of the flow on the results of hypersonic wind tunnel experiments
A70-42224
BALJE, O. E.
Loss and flow path studies on centrifugal compressors. II
[ASME PAPER 70-GT-12] A70-36863
Loss and flow path studies on centrifugal compressors. I
[ASME PAPER 70-GT-12] A70-36864
BALKE, R. W.
Recent advances in helicopter vibration control
A70-34735
BALL, J. T.
Cloud and synoptic parameters associated with clear air turbulence Final report
[NASA-CR-111778] N70-40766
BALMFORD, D. E. H.
Vibration testing of helicopters
A70-40583
BALOEV, A. A.
Optimization of stochastic processes
A70-43352
BALTAKIS, F. P.
Development of a fast-response pressure transducer
A70-35484
BALZER, R. L.
A method for predicting compressor cascade total pressure losses when the inlet relative Mach number is greater than unity
[ASME PAPER 70-GT-57] A70-36872
BARBATO, P. J.
Northeast Corridor Transportation Project report
[PB-190929] N70-34648
BARBER, H. W.
Negative G Drone aircraft surface tension fuel system
[AIAA PAPER 70-910] A70-35822
BARBHAM, R. C.
The internal avionics - Test equipment interface
N70-32164
BARNES, C. S.
Preliminary flight assessment of the low-speed handling of the BAC 221 ogee-wing research aircraft
[ARC-CP-1102] N70-37062
Measurement of the moments and product of inertia of the Fairey Delta 2 aircraft
[ARC-R/M-3620] N70-37161
BARNES, J. A.
Tactical utility helicopter information transfer study
[AD-705594] N70-34499
Methodology for a tactical utility helicopter information transfer study
[AD-710248] N70-42532
BARRETT, R. O.
Equipment design constraints for automated testing
A70-44538
BARROIS, W. G.
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[AGARD-MAN-8-70-VOL-1] N70-37802
BARROWS, J. F.
On the generation of a two-dimensional shear flow
A70-38350
BARTHOLIC, K. R.
Expansion of crash recording systems to AIDS
A70-37893

BARTZ, J. A.
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BASHARINOV, A. E.
The terrestrial thermal radio-emission field A70-45192
BASNIGHT, A. O.
Airport and air traffic requirements for Short Haul Air Transportation
[AIAA PAPER 70-1288] A70-45973
BATDORF, S. B.
On alleviation of the sonic boom by thermal means
[AIAA PAPER 70-1323] A70-45942
BATZER, H.-J.
Employment of electronical data processing systems for air traffic control A70-36395
BAUER, A. B.
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[MDC-J0734/01] N70-36809
BAUGHMAN, F. H.
Development of the S-3A carrier-based ASW weapons systems
[AIAA PAPER 70-882] A70-35802
BAUM, E.
A theoretical model of the near wake of a slender body in supersonic flow A70-34467
BAYLEY, F. J.
The transpiration-cooled gas turbine
[ASME PAPER 70-GT-56] A70-36839
BAZHENOV, D. V.
Study of the discrete components in the noise spectrum of an axial compressor A70-38652
The influence of air-intake wall design in an axial compressor on the propagation of sound A70-38653
Experimental study of the effect of the surface roughness of a rod on the intensity and frequency of eddying sound A70-38654
BAZHENOVA, L. A.
Study of the discrete components in the noise spectrum of an axial compressor A70-38652
The influence of air-intake wall design in an axial compressor on the propagation of sound A70-38653
Experimental study of the effect of the surface roughness of a rod on the intensity and frequency of eddying sound A70-38654
BAZOV, D. I.
Helicopter aerodynamics A70-37390
BRANLAND, M. H.
Olympus 593 - Concorde development report
[SAE PAPER 700291] A70-36805
BECHTEL, B.
Radar independent landing monitors
[AIAA PAPER 70-1336] A70-45932
BECKEL, K.
Investigation regarding the optimum light construction of the wings of gliders. II A70-42961
BECKER, B.
Studies of strongly deflecting supersonic retardation cascades and the possibilities of employing them in an axial-flow compressor stage A70-45095
BECKER, J. V.
New approaches to hypersonic aircraft
[ICAS PAPER 70-16] A70-44127
BECKERS, P.
Stress analysis of a fuselage section by finite elements A70-41260
BECKMAN, W. R.
Maintenance recording applied to advanced aircraft A70-35516
BEEBE, T.
A comparative analysis of individual and system performance indices for the air traffic control system Final report
[NA-69-40] N70-37033
BEELE, B. J.
Load estimation and aeroelasticity in the initial stages of advanced combat aircraft design N70-40713
BEER, H.
Steam film cooling in combustion chambers of aircraft propulsion units A70-43199
BEGLEY, R.
Correction of hover flight test results taken in wind
[AD-704349] N70-32069
BEHRENS, F. H.
Individually built-in self test techniques as applied to terrain-following radar systems N70-32162
BEHRENS, W.
Wake stability and transition studies at Mach 4.5 A70-34465
BEINER, L.
Aeroelastic stability of thin heterogeneous circular cylindrical panels A70-42603
BEKNEV, V. S.
Profiling plane diffuser grids for subcritical velocities of the oncoming flow A70-36129
BELAYGUE, P.
Theoretical and experimental determination of pressure losses in a single-stage axial flow compressor
[ASME PAPER 70-GT-78] A70-36886
BELL, R. A.
Passenger seaplanes and their bases A70-43887
BELLO, M.
Model for the prediction of closed compartment fire propagation A70-35646
BELLOMO, N.
Analytical method for determining the aerodynamic shape of an axisymmetrical nozzle A70-44991
BELLOWS, G.
Surface integrity of electrochemical machining
[ASME PAPER 70-GT-111] A70-36849
BELOHOUBEK, E.
S-band cw power module for phased arrays A70-36674
BELOTSERKOVSKII, O. M.
Numerical methods of some transsonic aerodynamics problems A70-35895
BENCIVENGA, V. L.
Test and evaluation of an advanced integrated landing system for all-weather landing Final report, Aug. 1965 - Feb. 1970
[FAA-RD-70-28] N70-41271
BENDIXEN, C. D.
Evaluation of the lap belt and pre-inflated air bag during impact with human sled subjects A70-44456
BENEJAM, E.
Study of aircraft traffic on the ground at an airport - Utilization of digital simulation A70-36390
BENINGFIELD, H. W.
General aviation's immediate ground hardware needs A70-42385
BENJAMIN, J.
The application of correlation techniques to ILS and Terminal Area traffic control A70-42667
BENNETT, R. L.
The effects of temporal and spectral combinations on the judged noisiness of aircraft sounds Final report
[FAA-NO-69-3] N70-42217
BENNETT, W. L.
The aircraft maintenance department and regularity A70-35855
BENOIT, A.
Study of automatic conflict detection and resolution in air traffic control planning
[ICAS PAPER 70-58] A70-44154

Aircraft trajectories - An approach to the calculation of aircraft trajectories for possible application in air traffic control A70-46239

BENTFELD, G.
Distance requirements during takeoffs and landings N70-41595

BENTIVOGLIO, L. M.
Juridical problems of sub-orbital space transports A70-36661

BENTZ, C. E.
Propulsion system control requirements, capabilities and opportunities
[SAE PAPER 700827] A70-45892

BENZAKEIN, M. J.
Sound transmission and suppression in turbomachinery ducts
[ASME PAPER 70-GT-58] A70-36873
Noise considerations in the design of advanced subsonic transport turbofan engines
[SAE PAPER 700807] A70-45907

BERANEK, J.
Experience from the operation of the digitally controlled milling machine FA 4 VN A70-43117

BERG, D. E.
Program WTDPLT - A computer code for plotting aerodynamic data
[SC-DR-69-690] N70-39164

BERG, R. A.
A flight simulator study of STOL transport lateral control characteristics Final report
[FAA-RD-70-61] N70-42013

BERG, R. O.
An associative memory for executive control functions in an advanced avionics computer system A70-43105

BERGH, H.
High subsonic and transonic effects on pressure distributions measured for a swept wing with oscillating control surface A70-44763

BERMAN, C. H.
Instability of a two-dimensional compressible jet
[AD-707257] N70-37667

BERNDT, R. J.
The opening force of solid cloth, personnel type parachutes
[AIAA PAPER 70-1167] A70-43992

BERNER, F.
Aerodynamic energy exchangers for hybrid airbreathing-rocket propulsion systems
[ICAS PAPER 70-61] A70-44156

BERNERT, J. H.
Aircraft operating procedure development using integral-variational performance analysis methods
[AIAA PAPER 70-876] A70-34812

BETEILLE, R.
The basic problems posed by the development of the European Airbus A70-36509

BETTI, A.
Operational experience with STOL aircraft N70-41079

BHADSAVLE, A. G.
Study of convective heat transfer to cones and cylinders at angle of attack Final report
[NASA-CR-102824] N70-37466

BHATIA, P.
A method for calculation of frequencies and modes using an improved inertia matrix
[AE-276-S] N70-33607

BICKEL, D. C.
A method for predicting forcing functions for structures being tested in a shock tube A70-35180

BIESTEK, A.
Linear theory of sonic booms A70-38484
Sonic booms in an inhomogeneous atmosphere A70-42311

BIHRLE, W., JR.
The influence of the static and dynamic aerodynamic characteristics on the spinning motion of aircraft
[AIAA PAPER 70-946] A70-39581

BIRD, B. J.
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BIRDSALL, D. L.
A non-linear solution to a tab-aileron flutter problem A70-34923

BIRDSALL, G. A.
Maintenance recording applied to advanced aircraft A70-35516

BISHOP, D. E.
Aircraft noise exposure tradeoff studies at three major airports A70-40896
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[FAA-NO-70-9] N70-42218
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[FAA-NO-70-8] N70-42219

BISHOP, L. L.
Utilization of Army aviation experiences via RAMMIT A70-38826

BISHOP, W. B.
On the reduction of interference between two sequences of events
[AD-702734] N70-34878

BISWAS, B. K.
Some characteristics of stabilized smoke flames A70-40887

BITTERLICH, W.
Effect of casing and hub wall friction on the three-dimensional flow in axial-flow compressors in compressible working media at subsonic speeds A70-45096

BITTNER, A. C., JR.
In-flight comparison of the Kaiser FP-50 flight director with standard C-131 instruments
[AD-702748] N70-36264

BLACKLOCK, J. R.
The application of finite element stiffness matrix for composite structures A70-40040

BLACKMAN, I. B.
Improved test procedure for evaluation of humidity resistance of airborne aeronautical equipment A70-35159

BLACKSTOCK, T. A.
Ferry system Patent Application
[NASA-CASE-LAR-10574-1] N70-41958

BLACKWELL, R. H.
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[AIAA PAPER 70-909] A70-35821

BLAHA, B. J.
Flight and wind tunnel investigation of installation effects on underwing supersonic cruise exhaust nozzles at transonic speeds A70-43274

BLAKEMORE, T. L.
Investigation of Newtonian static longitudinal aerodynamic characteristics of bodies of revolution with various heat-shield curvatures, afterbody angles, and corner-edge radii
[NASA-TM-X-64332] N70-34532

BLAND, M. J.
History of the development of light weight lift jets
[ASME PAPER 70-GT-32] A70-36833

BLOM, J.
An experimental determination of the turbulent Prandtl number in a developing temperature boundary layer N70-32346
BLONSTEIN, J. L.
The role of small earth stations in civil communication satellite systems A70-39409
The role of small earth stations in civil communication satellite systems A70-40764
BLOOM, M. H.
Slingshot - An advanced aerodynamic test facility [AD-702052] N70-32870
BLOXSOM, D. E., JR.
Experimental equilibrium conditions of dissociated and ionized hydrogen hypersonic flows A70-42759
BLUHM, S. R.
Development of a hybrid fluidic damper control for an aircraft yaw axis [SAE PAPER 700794] A70-45853
BOARDMAN, W. E.
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BOBBITT, P. J.
Supersonic and subsonic wind-tunnel tests of reefed and unreefed disk-gap-band parachutes [AIAA PAPER 70-1172] A70-41841
BODNER, V. A.
Relation between invariance conditions and the characteristics of a multidimensional control system for a turboramjet engine A70-39847
BOEHM, M.
Automatic test equipment for ORTAC, a VTOL aircraft mobile landing aid N70-32177
BOERSTOEL, J. W.
Lifting aerofoils with supercritical shock-free flow [ICAS PAPER 70-15] A70-44126
BOGACHEV, I. N.
Study of the short-term creep of the OT-4 alloy in high-speed air flows under aerodynamic vibrations A70-45826
BOGDONOFF, S. M.
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BOGER, R. C.
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BOICHUK, L. M.
Structural synthesis of invariant systems for automatic control of plant motion along a given trajectory A70-39844
BOLTHOUSE, A. S.
The case for an integrated flight management system [AIAA PAPER 70-908] A70-35820
BOND, A. R.
Non-destructive testing for maintenance A70-45677
BOND, W. H.
Moving skin boundary layer control [AIAA PAPER 70-881] A70-34808
BOOKER, J. F.
Rigid-body rotor dynamics - Dynamic unbalance and lubricant temperature changes [ASME PAPER 69-LUB-14] A70-37606
BORCHARD, R. L.
Development of a true RMS acoustic analysis capability A70-37910
BORGER, J. G.
Early experience with the 747 [AIAA PAPER 70-886] A70-40740
BORGMAN, D. C.
Noise radiation from helicopter rotors operating at high tip Mach number A70-34729
BORING, J. W.
Drag coefficients for free molecule flow in the velocity range 7-37 km/sec A70-41743
BORIS, P. M.
Fire test criteria for recorders Final report [FAA-NA-70-25] N70-33798
BORISOV, IU. IA.
The frequency characteristics of gas-jet stem radiators A70-38658
BORN, G.
A new mass flow measuring system applicable to aircraft speed measurement including V/STOL A70-37885
BORROK, M. J.
Results of the ATA CAS flight test program A70-38240
BORTKIEWICZ, J. F.
Flight evaluation of helicopter gas turbine engines [ASME PAPER 70-GT-38] A70-36836
BOSSE, P. C.
Preliminary design and analysis of an advanced convertible fan/shaft engine for V/STOL tactical and transport aircraft A70-34710
BOULGER, F. W.
Heavy press forging of large titanium alloy parts for aircraft and aerospace applications A70-34360
BOURNOT, P.
Theoretical study of the variation of aerodynamic parameters of a supersonic flow of ionized argon subjected to Laplace accelerating forces A70-41444
BOWERS, C. G.
Opportunities for development of a national airport system N70-36030
STOL Conference objectives N70-41077
BOWES, C. A.
Engine vibration monitoring on the Boeing 747 aircraft A70-37898
BOWMAN, J. S., JR.
Effects of a pointed nose on spin characteristics of a fighter airplane model including correlation with theoretical calculations [NASA-TN-D-5291] N70-37395
BOYLE, R. E.
Optimum loading on nonplanar wings at minimum induced drag [AD-704502] N70-36322
BOZACK, T. J.
The effect of variations in drogue gun firing angle on stabilization times for the MEW ejection seat system [AIAA PAPER 70-1208] A70-41810
BRADBURY, J. N.
Operation of a three-frequency riometer system on the NASA 711 aircraft during the 1969 auroral expedition [NASA-CR-112356] N70-36632
BRADBURY, J. T.
Radiolocation systems for dynamic gravimetry A70-43661
BRADLEY, A. D.
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BRADLEY, E. P.
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BRADLEY, J. R., JR.
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BRADSHAW, C.
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BRADSHAW, C. F.
Aerodynamic and deployment characteristics of

single-keel solid and single-keel slotted personnel parawings
[NASA-TN-D-5911] N70-32844
BRADSHAW, P.
Prediction of the turbulent near-wake of a symmetrical aerofoil
A70-40276
BRAGINA, T. K.
Typical cases of failure and formation of defects in gas turbine discs
A70-38469
BRANDNER, J. J.
Investigation and development of new concepts for improvement of aircraft electrical power systems. 1 - A review of the electrical power systems and equipment in existing commercial aircraft Interim technical report
[NASA-CR-110693] N70-32344
BRAUN, J. F.
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A70-34706
BRAY, K. N. C.
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BREACH, F.
The philosophy of flight data acquisition systems
A70-36340
BREARLEY, M. N.
On the flight path relative to the air of an aircraft circling in a uniform wind
A70-40920
BREITBACH, E.
Determination of the coupling terms and equations of motion for a flight structure composed of several elastomechanical subsystems
A70-44767
BREKHOV, A. F.
Determination of the efficiency of an axial- flow compressor stage under conditions of rotary separation
A70-37252
BRENNAN, T. J.
Cost estimating techniques for advanced technology engines
[SAE PAPER 700271] A70-36818
BRENNER, H.
VAK 191 B /VAK 191 B/
A70-34992
BRENNER, W.
Non-avionics integrated data system for an advanced high performance aircraft
A70-37891
BRENT, I. D., II
The role of spectrometric oil analysis instrumentation in the advance detection of aircraft engine failures
A70-35481
BREUGELMANS, F.
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BREWSTER, E. G.
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A70-38594
BRIARDY, F. J.
Rotor/wing Final technical report
[AD-710425] N70-43132
BRIDGEWATER, J.
Influence of wing root shaping on the pressure distribution of swept-wing body configurations
[ARC-CP-1109] N70-43087
BRIDSON, D. W.
Maximum lift on slender wings
A70-40585
BRIERTON, J. L.
Automatic test equipment implementation techniques to realize cost effective support
N70-32172
BRINK, B. W.
Military airlift command bird strike control programme
A70-35988
BRITNELL, W.
Propulsion control integration for power management
[SAE PAPER 700818] A70-45899
BRITTING, K. R.
Self-alignment techniques for strapdown inertial navigation systems with aircraft application
A70-36442
BROCARD, J.
Inventory of the principal European wind tunnels capable of being used for aerodynamic tests in the Post Apollo Programme
A70-43503
BRODIE, P. M.
Short range transportation - A system engineering challenge
[AIAA PAPER 70-1281] A70-45927
BRODZKI, Z.
Helicopter testing in a wind tunnel
N70-34028
BROMBERG, A. A.
Mechanical and power equipment of airports
[AD-709693] N70-41055
BROMLEY, E., JR.
Visibility measurement for aviation use
N70-40785
BROOKLEY, W. Q.
USAF, C141 and C-135 fuel tank nitrogen inerting tests
N70-42755
BROOKS, E. N., JR.
Supersonic flow of nonuniform free-streams past aerodynamic decelerators
[AIAA PAPER 70-1176] A70-41837
BROUSSAUD, G.
Detection of clear air turbulence by infrared radiometry
A70-46093
BROUSSAUD, P.
Installation for the study of multiple flow jet exhaust nozzles
[ONERA-NT-160] N70-42475
BROWN, D. E.
Dynamic integrated flight line checkout of avionics systems
N70-32153
BROWN, D. G.
The case for V/STOL aircraft in short-haul transportation
[SAE PAPER 700333] A70-36797
BROWN, D. N.
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BROWN, G. S.
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[FAA-RD-70-40] N70-37021
BROWN, I. S. H.
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[ARC-CP-1092] N70-42770
BROWN, J. H., JR.
The gust-alleviation characteristics and handling qualities of a free-wing aircraft
[AIAA PAPER 70-947] A70-39580
BROWN, M.
Correction of hover flight test results taken in wind
[AD-704349] N70-32069
BROWN, P. F.
Bearings and dampers for advanced jet engines
[SAE PAPER 700318] A70-36800
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[ASLE PREPRINT 70AM 2D-1] A70-38805
BROWN, S. N.
Trailing-edge stall
A70-36194
BROWN, W. P.
The CH-47 cruise guide indicator
A70-34705
BROWNE, S. D.
Remarks by the Honorable Secor D. Browne, chairman, Civil Aeronautics Board, before the Society of Automotive Engineers' air transportation luncheon
N70-41394

Remarks by the Honorable Secor D. Browne, chairman, Civil Aeronautics Board, to Metropolitan Board of Trade Aviation Committee N70-41438
Remarks by the Honorable Secour D. Browne, chairman, Civil Aeronautics Board at the University of South Florida's symposium, 'Air 70' N70-41439

BROWNING, W. A.
Evaluation tests of precision taxi and docking guidance systems
[AIAA PAPER 70-916] A70-35828

BROWNLOW, C.
Armor used as airframe for helicopter A70-44095

BRUNE, G. W.
Reduction of the low-frequency unsteady lifting-surface problem A70-42715

BRUNER, G.
The Grumman F-14 American Navy fighter A70-41264

BRUNNER, T. W.
Initial results on theoretical prediction of drag for a trailing decelerator at supersonic speeds
[AIAA PAPER 70-1177] A70-41836

BRUSHKOVSKII, A. L.
Joining three-layer fiberglass-reinforced plastic panels by means of bilateral cover plates A70-42812

BRYAN, W.
Analysis of data acquired during simulation of a V/STOL tactical landing system for helicopters
[AD-704324] N70-34849

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On equations of three-dimensional laminar boundary layer of bodies of revolution A70-43323

BULEY, G.
STOL runway length determination N70-41080

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BULYGIN, I. P.
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BURCKHARDT, P. L.
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BURFORD, R. J.
Operational analysis and the use of fast-time simulation models in ATC system development A70-38637

BURG, K.
A new method for the calculation of the flow around the wing of small span width near sonic speed A70-36374

BURGESS, E. H.
The Concorde flight test programme A70-40580

BURK, S. M., JR.
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BURKDOLL, F. B.
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Atmospheric gusts - A review of the results of some recent research at the Royal Aircraft Establishment A70-45420
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BUSSARD, D. L.
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BUTLER, T. W.
Development of tension-torsion machine from an aircraft-carrier catapult problem A70-43453

BUTLER, W.
Systems approach to on-board checkout N70-32167

BUXMANN, J.
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BYRER, T. G.
Heavy press forging of large titanium alloy parts for aircraft and aerospace applications A70-34360

BYRON, S. R.
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CABANNES, H.
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CALVERT, G. S.
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N70-39640
DE REGIBUS, M.
The application of the inertial system in the field of air navigation
A70-42654
DE RICHEMONT, G.
The integration of the propeller and the airframe on a supersonic combat aircraft
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[SAWE PAPER 818] A70-40351
DEI ROSSI, J. A.
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[AD-706885] N70-37723
DEJARNETTE, F. R.
Supersonic flow of nonuniform free-streams past aerodynamic decelerators
[AIAA PAPER 70-1176] A70-41837
DEL BALZO, J. M.
ATC integration of the SST
A70-38633
DELAHUNTY, A. S.
The interdependence of 'built in', 'on board' and 'ground based' test facilities
N70-32158
DELAY, D. G.
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DEMETRIADES, A.
Observations on the transition process of two-dimensional supersonic wakes
A70-34466
DEMIDOVICH, V. M.
Analysis of the conditions of operation of gas-turbine rotor bearings from the results of a computer calculation of their thermal regime
A70-41777
DENNING, R. M.
Prospects for improvement in efficiency of flight-propulsion systems
[AIAA PAPER 70-873] A70-34810
DEPLANTE, M.
Army aircraft - Programs and realizations
N70-40704
DERICK, C. T.
Tailpipe effects on gas turbine diffuser performance with fully developed inlet conditions
[ASME PAPER 70-GT-86] A70-36881
DESTUYNDER, R.
Measurement of the pressure field induced by the oscillation of a control surface and comparison with theoretical results
A70-41407
DEVINE, R. L.
A certificated stick force augmentation system for light STOL aircraft
[AIAA PAPER 70-909] A70-35821
DEWEESE, J. M.
The opening force of solid cloth, personnel type parachutes
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DEWOLF, B.
Increasing airport capacity and terminal area safety by means of the scanning beam instrument landing system
A70-37913
Increasing airport capacity and terminal area safety by means of the scanning beam instrument landing system
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DHANANI, R. R.
The 747 fuel system
[SAE PAPER 700276] A70-36816
DIATLOV, I. N.
Effect of air-mechanical fuel injection on certain indices of the working process of a gas turbine engine combustion chamber
A70-37248
DICKEY, T. A.
Design optimization of a V/STOL 5000 hp engine
A70-34709
DICKINSON, D. R. H.
The Jaguar
A70-38534
DIEDERIKS-VERSCHOOR, I. H.
Liability for damages caused by supersonic flights
A70-37561
DIENEMANN, P. F.
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DIFRANCO, D. A.
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DIKUN, I. A.
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A70-42804
DINEFF, J.
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DIPIERRO, A. R.
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DIX, A. F.
Titanium metal fabrications in aero engines
A70-34450
DMITROCHENKO, L. A.
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DOBSON, M. D.
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DODGE, R. N.
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DONACHIE, M. J., JR.
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DONALDSON, I. S.
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DONALDSON, J.
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[PB-190933] N70-36452
DONELAN, M.
Airborne measurement of turbulent fluxes A70-40109
DONOW, A. P.
Air transport mission capability analysis
[AIAA PAPER 70-899] A70-35815
DOOLEY, P. G.
Jet engine control systems - Their evolution, future requirements and potential limitations
[SAE PAPER 700825] A70-45894
DOOLITTLE, D. B.
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[SAE PAPER 700264] A70-36821
DORAN, P. D.
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[SAE PAPER 700314] A70-36801
DORONIN, V. M.
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DOTSETH, W. D.
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[AIAA PAPER 70-893] A70-35810
DOUGHERTY, J. E., JR.
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DOWLING, C. E., JR.
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DOWNEY, J. D.
Design increments in planning a regional airport A70-39673
DOYLE, J. R.
High strength titanium alloys for aircraft gas turbine application A70-34436
DOYLE, V. L.
Evaluation of range and distortion tolerance for high Mach number transonic stages
[NASA-CR-72720] N70-32895
DRAGOS, L.
The flow of fluids with a conductivity tensor in the presence of a thin section A70-37599
DRAKE, D. E.
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DREIER, G. H.
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DREKSLER, IA.
Synthesis of load loops with a random force signal for endurance testing of aircraft structures A70-39913
DRELL, H.
Impact of noise on subsonic transport design
[SAE PAPER 700806] A70-45876
DREW, G. R.
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DREXELIUS, W. W.
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DRIFTMYER, R. T.
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[AIAA PAPER 70-765] A70-34486
DRINKWATER, F. J., III
Flight-test evaluation of the wing vortex wake generated by large jet-transport aircraft N70-40912
A piloted simulator investigation of ground effect on the landing maneuver of a large, tailless, delta-wing airplane
[NASA-TN-D-6046] N70-42810
DROPPLEMAN, J. D.
An airborne measurement of the salinity variations of the Mississippi River outflow A70-45979
DU PONTAVICE, E.
The status of the hovercraft A70-43499
DUBERG, J.
National Bureau of Standards modeling for the Northeast Corridor Transportation project
[PB-190933] N70-36452
DUBIEL, S.
Certain cases of dynamic loads acting on subsonic and supersonic aircraft A70-34685
DUBOVKIN, N. F.
Influence of injector characteristics, temperature, and the fuel's physicochemical properties on the combustion efficiency in the combustion chamber of a gas turbine engine A70-37247
Influence of the nozzle characteristics, temperature, and physicochemical properties of the fuel on the starting characteristics of gas turbine engine combustion chambers A70-43356
DUBROVSKII, E. N.
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[AD-706798] N70-38534
DUCARME, J.
Requirements posed by high speed flights N70-39639
DUDENEY, P. N.
The role of spectrometric oil analysis instrumentation in the advance detection of aircraft engine failures A70-35481
DUDIN, L. A.
Turbulence in the zone of interaction between a jet and a flow A70-41773
DUEKER, J. E.
Holographic subsonic flow visualization A70-40809
DUERDEN, J. C.
Titanium hot forming A70-34444
DULLER, C. E.
Effects of angle of attack and bluntness on the hypersonic flow over a 15 deg semiapex cone in helium
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DUNCAN, R. M.
The role of depth hardenability in the selection of high strength alloys for aircraft applications
A70-34434
DUNFEE, J. D.
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DUNHAM, R. E., JR.
Evaluation of a moving-graph instrument display for landing approaches with a helicopter
[NASA-TN-D-6025] N70-41183
DUNN, J. H.
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DUNN, R.
Airframe requirements for future communications
A70-41349
DUONG, T.-S.
Study of the transition on a plate to sinusoidal wall in incompressible flow
A70-41440
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A70-37885
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DUTT, M.
Thermal recovery and the accuracy of air total temperature sensors
A70-37882
DWYER, H. A.
Hele-Shaw and porous medium flow for space fuel cells
A70-35661
DWYER, J. W.
The Washington-Baltimore regional air freight transport system
[AD-708623] N70-40542
DYSON, R. B.
Consideration of performance and cost in future military aircraft engines
[SAE PAPER 700272] A70-36817

E

EAKINS, H. W.
STOL port safety
N70-41084
EBEL, G. H.
Crash recorder data from 'non-crash' recorders
A70-35518
ECCLES, E. S.
Digital computer control of gas turbine engines
[ASME PAPER 70-GT-40] A70-36870
ECKERT, E. R. G.
Local heat transfer around a circular cylinder at low Reynolds number and in transverse slip flow
A70-41035
ECKHARDT, H. D.
Miniature laser obstacle warning systems for helicopters
A70-34720
ECKHOLDT, D. C.
An assessment of the interfacing problems with CCV design concepts
A70-37395
ECKSTROM, C. V.
Low- and high-altitude tests of parachutes designed for use in low-density atmospheres
[AIAA PAPER 70-1164] A70-41846
EDDY, W. C., JR.
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A70-38828
EDGE, P. M., JR.
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EDWARDS, B.
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EHLERS, F. E.
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The influence of surface melting or surface vaporization on the temperature distribution in a plate
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EHRICH, F. F.
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EICHLER, J.
A regression analysis of pilot-induced oscillation ratings
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EISENBERG, R. L.
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ELIAS, L.
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ELSON, B. M.
Electronic unit to control inlet for SST
A70-46214
ELSWOOD, E. L.
Vibration monitoring as a tool for turbine engine malfunction detection
A70-35480
ENDRES, R. J.
Formulation of design criteria
N70-41078
ENEVOLDSON, E. K.
Evaluation of the effect of a yaw-rate damper on the flying qualities of a light twin-engine airplane
[NASA-TN-D-5890] N70-32770
ENGELS, D.
Stabilization and control of the space shuttle orbiter during entry/pitchdown maneuvers
N70-40963
ENGRAND, D.
Measurement of the inertial constants of a structure of arbitrary shape, rigid or flexible, by means of a vibration test
A70-41408
ENOMOTO, S.
Aircraft inspection by Ir-192 and Tm-170 gamma-ray radiography
A70-45725

ERICKSON, D.
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A70-34718
Dynamic stall simulation problems
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Loads induced by terminal-shock boundary-layer interaction on cone-cylinder bodies
A70-41863
Boundary-layer transition and dynamic sting interference
A70-44581

ERNST, H. L.
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ERSHOV, V. N.
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A70-37252

ERWIN, R. L., JR.
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A70-38237

ESGAR, J. B.
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A70-43275
An analysis of the capabilities and limitations of turbine air cooling methods
[NASA-TN-D-5992] N70-40659

ESLINGER, D.
Development of a true RMS acoustic analysis capability
A70-37910

ESMEIER, E. F.
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ESSENHIGH, R. H.
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A70-40887

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ESTRINE, E.
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ETSION, I.
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EVANS, D. G.
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EVTEEV, B. F.
A thunderstorm cloud
A70-42775

F

FABRI, J.
Use of supersonic cascades made of blades of simple geometric shapes for cascade wind tunnel performance evaluation
[ASME PAPER 70-GT-110] A70-36848
Mass flow limitation in supersonic compressors
N70-39093

FAHLBUSCH, H.
The air freight container in the non- interrupted transport chain
A70-43273

FAHLEY, W. A.
Hybrid microcircuit design and procurement guide
[AD-705974] N70-34087

FAIL, R. A.
Low-speed wind-tunnel measurements of the oscillatory lateral stability derivatives for a model of a slender aircraft /HP 115/ including the effects of frequency parameter
[ARC-CP-1097] N70-37241

FAL, A. M.
Application of methods of invariance theory to the development of high-frequency automatic aircraft flight control systems
A70-39839

FALANGA, R. A.
An inverse-method solution for radiating, nonadiabatic, equilibrium inviscid flow over a blunt body
[NASA-TN-D-5907] N70-34016

FALARSKI, M. D.
Full-scale wind-tunnel investigation of the aerodynamic characteristics of the X-24A lifting body aircraft
[NASA-TN-D-5932] N70-34385

FALCON, K. C.
Angular contact ball bearings - Track position at high speeds
A70-40141

FALECKI, J.
The Wankel engine as a future power source for powered gliders and light aircraft
A70-34690

FAN, C.
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FANCETT, R. K.
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A70-40282

FARLEY, J. F.
Harrier development from the flight test point of view
A70-42975

FARMER, M. G.
Flutter studies to determine nacelle aerodynamic effects on a fan-jet transport model for two mount systems and two wind tunnels
[NASA-TN-D-6003] N70-39907

FASSO, G.
Installation for the study of multiple flow jet exhaust nozzles
[ONERA-NT-160] N70-42475

FAUROTE, G. L.
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[AIAA PAPER 70-1172] A70-41841
Design of disk-gap-band and modified ringsail parachutes and development of ballute apex inlet for supersonic application
[NASA-CR-66909] N70-32884

FAWKE, A. J.
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FAY, J. A.
Air pollution from future giant jetports
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FEILER, C. E.
Low-noise propulsion systems for subsonic transports
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FEINTUCH, M.
Built in test equipment for advanced flight guidance systems
N70-32160

FELDHUHN, R. H.
An experimental investigation of the flow field around a yawed cone A70-34485
FELDMAN, E. L.
Basic technical data of the engine [AD-700477] N70-36415
FELSCH, K.-O.
Theoretical and experimental results regarding the effect of the 'previous history' at turbulent boundary layers A70-36375
FELTHAM, R. G.
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FERRANTE, L. P., JR.
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FERRELL, K. R.
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FERRI, A.
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FETT, F.
Control behavior of jet engines A70-44396
FETTERMAN, D. E.
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FEYER, W.
DVOR - Testing of new radio-navigation facilities A70-46240
FILCHAKOVA, V. P.
A complete system of equations for Sedov's integral A70-39767
FINKE, R. G.
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FINKIN, E. F.
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FINNEY, R. E., JR.
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FISCHER, C.
VFW's H3-E Sprinter A70-35626
FISCHER, N. H.
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FISHER, M. J.
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FISHER, R. K., JR.
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FISHER, S. A.
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FLANDERS, T. A.
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FLATAU, A.
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FLENER, W. M.
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FLETCHER, R. S.
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FLORSHEIM, B. H.
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FLOWER, J. W.
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FLOWER, S.
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FOERSCHING, H.
Theoretical treatment of aeroelastically excited vibrations of circular cylindrical structures in the presence of periodic vortex excitation A70-44764
Problem of orthogonality of the eigenmodes of aircraft vibrations A70-44766
FOLCK, J. L.
Hypersonic flow diagnostic studies in a large arc-heated wind tunnel A70-40270
FOLLAND, E. P.
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FOMBONNE, P.
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FONTAINE, B.
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FORESTIER, B.
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FORLIFER, W. R.
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FORMAN, I.
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FORTNER, L. E., JR.
Aerospace sciences - Terminal forecast verification [AD-707498] N70-37703
FOSTER, J. D.
Investigation of a digital automatic aircraft landing system in turbulence [NASA-TN-D-6066] N70-43146
FOULON, A.
Synthetic resin adhesives in the aircraft industry A70-40532
FOURNIER, P. G.
Low-speed wind-tunnel investigation of all-flexible twin-keel tension-structure parawings [NASA-TN-D-5965] N70-40688
Wind tunnel studies of effects of construction methods, design details, and canopy slots on the aerodynamic characteristics of small-scale all-flexible parawings [NASA-TN-D-5974] N70-40751
FOWKE, J. G.
A three-component wind-tunnel balance for measuring extremely small forces A70-35490
FOX, D. C.
Basic principles of digital interior communication systems [SAE PAPER 700302] A70-36813
FOX, H.
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FOY, E. D.
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[ICAS PAPER 70-53] A70-44149
FOZARD, J. W.
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[ICAS PAPER 70-51] A70-44148
FRANCIS, J.
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[PB-190118] N70-37337
FRANKLIN, J. A.
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[AIAA PAPER 70-998] A70-39533
FREARSON, D. E.
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[AIAA PAPER 70-925] A70-35836
FREE, F. W.
Russian helicopters
A70-43895
FREENY, C. C.
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N70-32162
FRENCH, M. W.
Engine control concepts for the augmented turbofan
[SAE PAPER 700826] A70-45893
FRETIGNY, G.
The Concorde simulator
[NLL-M-9223-/5828.4F/] N70-36216
FREY, W. P.
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[SAE PAPER 700816] A70-45901
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FRICK, F. C.
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FRIEDLANDER, G. D.
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A70-35185
At the crossroads in air-traffic control. III
A70-39198
FRITSCH, E.
Some remarks on dynamic soaring
[NASA-TT-F-13217] N70-36081
FRITZ, L. J.
Surface integrity in conventional machining
[ASME PAPER 70-GT-100] A70-36888
FROHN, A.
Flow about the edges of tapered wings set at an angle of attack
A70-36376
FROST, W. O.
Multiplex data bus techniques
N70-40957
FRUENGEL, F.
Spark tracing method progress in the analysis of gaseous flows
[SMPTE PREPRINT 41] A70-43041
FUJII, H.
Take-off and landing performances of a GETOL airplane
A70-42282
FUKUHARA, Y.
Properties and application of Ti-5Al-2Cr-1Fe alloy /KS150B/
A70-34428
FULTON, K.
Forty years of the aircraft gas turbine
A70-46251
FULTON, K. T.
The widebodies- Superjets and airbuses - Fanjets for the widebodies
A70-38953
FUNK, B. H.
Laser net - A system for monitoring wingtip vortices on runways
[NASA-TM-X-64525] N70-32182
FURGALUS, K. A.
Turbine aerodynamic and cooling requirements for a turbojet powered Mach 3 transport using methane fuel
[NASA-TN-D-5928] N70-34015

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GABBERT, R. D.
An investigation of perforation mechanics in thin aluminum plates
[AD-707837] N70-40024
GABRIELLI, G.
An experimental investigation on wing box beams in bending
[ICAS PAPER 70-33] A70-44103
GAERTNER, R. M.
Aerodynamic parameters that affect compressor erosion in gas turbine engines
A70-34711
GAGNON, J.
What is an optimum airport system
[AIAA PAPER 70-1266] A70-45921
GAIDACHUK, V. E.
Joining three-layer fiberglass-reinforced plastic panels by means of bilateral cover plates
A70-42812
GAIDSICK, H. G.
Experience with unpowered terminal-area instrument approaches
N70-40960
GAIT, P. A.
Reduction of a class of stochastic control problems
A70-35973
GALANIS, N.
On the generation of a two-dimensional shear flow
A70-38350
GALIGHER, L. L.
Supersonic and subsonic wind-tunnel tests of reefed and unreefed disk-gap-band parachutes
[AIAA PAPER 70-1172] A70-41841
GALKINA, A. P.
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GANZER, U.
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GARDNER, L.
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A70-44760
GARTNER, W. B.
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GATES, J. W. C.
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GAUS, J.
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A70-43269
Computers in air cargo
A70-43271
GAVEL, IA.
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A70-39913
GEAN, J. E.
The Huey/Cobra M and R Field Program results and significance
A70-38827
GEBHARD, D. F.
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[SAWE PAPER 842] A70-40360
GECHELE, G. B.
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A70-38700
GEE, S. W.
Experience with unpowered terminal-area instrument approaches
N70-40960
GEIGNER, O. L.
Operational, technical and economic aspects of an aeronautical satellite system for civil air traffic control
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GEISSLER, W.
Calculation of stress distribution on axisymmetric annular wings by means of the method of singularities
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GERATHEWOHL, S. J.
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GERCBACH, I. B.
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GHOLSON, D. P.
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GIBSON, G. E.
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GIBSON, R. E.
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GIESING, J. P.
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N70-35873
GIESSLER, F. J.
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A70-34706
GILBERT, G. A.
Improving landing/takeoff and terminal area safety
A70-42296
GILBERT, N. E.
Free flight measurement of aerodynamic lateral force and moment coefficients on bombs with freely spinning cruciform and monoplane tails and fixed split skirts
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GILCHRIST, L. P.
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GILINSKIY, S. M.
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GILSTER, H. L.
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GINSBURGH, I.
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GIORDANO, V.
Integral equation for the aerodynamic calculation of propellers
A70-44993
GIRARD, L. A.
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GISH, D. B.
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A70-35480

GLEICH, W.
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A70-35372
GLIETSCH, W.
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A70-37909
GLOSS, B. B.
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GLYNKINA, N. M.
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GOETZ, R. C.
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A70-35448
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A70-38235
GOLDMAN, L. J.
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GOLDMAN, R.
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GOLDSMITH, E. L.
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N70-36963
GOLUBEV, I. S.
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A70-37025
GOLUBINSKII, A. I.
Impulse of forces and moments experienced by a slender wing in unsteady flow
[NASA-TT-F-13066] N70-34048
GOMAN, O. G.
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A70-42209
GONOR, A. L.
Hypersonic flow around a delta wing of finite thickness
A70-36260
Hypersonic flow past a trianqular wing
A70-40609
GOODERUM, P. B.
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A70-39701
GOODMAN, D. M.
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A70-40766
GOODRICK, T. F.
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GOODWIN, J. E.
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A70-35600
GORBUNOV, G. M.
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A70-37246
GORLAND, S. H.
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GORMAN, J. T.
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A70-37247
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A70-43356
GOTLIEB, P.
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GRABER, E. J.
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GRAENGSJOE, B.
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A70-35880
GRAGG, C. D.
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A70-44456
GRAHAM, G. L.
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GRAHAM, J. M. R.
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A70-43970
GRAHAM, R. E.
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GRANDCOING, J.
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GRAY, K. P.
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A70-37914
GRAY, W. E.
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GREEN, R. D.
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GREENBERG, M. D.
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GREENE, G. C.
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A70-44531
GREENE, L. P.
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N70-40715
GREENE, T. E.
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A70-34672
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GREENEWALT, D.
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A70-43662
GREENWOOD, G. H.
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GREGORY, T. J.
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A70-39843
GRODZOVSKII, G. L.
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A70-45021
GROSCHE, F.-R.
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A70-35924
GROSS, R.
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GROSSMAN, B.
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GROVES, W. E. J.
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GRUAT, J.
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GRUNWALD, K. J.
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A70-40799
GUERNSEY, J. B.
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A70-39966
GUHNE, H.
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[ASME PAPER 70-GT-104] A70-36890
GUINARD, J. P.
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A70-43501
GULLAND, J.
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A70-38618
GUMERT, W. R.
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A70-43663
GUMTO, K.
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GUNZBURGER, M.
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A70-36195
GUROV, S. V.
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A70-44737
GURSAHANEY, H. J.
Work of ICAO in the field of bird hazard reduction
A70-35997
GURVICH, A. S.
The terrestrial thermal radio-emission field
A70-45192
GUSAK, IA. M.
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A70-43941
GUSTAFSON, F. B.
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A70-44851
History of NACA/NASA rotating-wing aircraft research, 1915-1970. II
A70-44852
History of NACA/NASA rotating-wing aircraft research, 1915-1970. III
A70-44853
History of NACA/NASA rotating-wing aircraft research, 1915-1970. III Cont'd
A70-44856
GUTHERIE, L. E.
Federal assistance in funding STOL port development
N70-41087

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HADEL, J. J.
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A70-38833

HAENI, B.
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HAENSCH, D. E.
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N70-32179
HAGUE, D. S.
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HALL, R. G. N.
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A70-43890
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A70-40585
HANDLEY, L. E.
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N70-32163
HANDS, D. L. A.
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A70-38224
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A70-42660
HARDY, I. N. M.
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N70-40781

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A70-44329

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A70-38543
The interdependence of 'built in', 'on board' and 'ground based' test facilities
N70-32158

HAYS, G. E.
Fuel tank deposits in an SST environment
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HEATH, B. O.
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A70-34916
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N70-40703

HEATH, J. B. R.
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N70-33654

HEATH, W. C.
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[AIAA PAPER 70-900] A70-35816

HEBBAR, K. S.
Performance of conical jet nozzles in terms of discharge coefficient
A70-38243

HECKL, M.
Flow noises
A70-38474

HEFER, G.
Investigation of a wave-rider at low Reynolds numbers
[AVA-FB-7029] A70-44668

HEFFTER, M. S.
Problems of airport congestion by 1975
N70-41273

HEINRICH, H. G.
Analysis of parachute opening dynamics with supporting wind-tunnel experiments
[AIAA PAPER 68-924] A70-36449
Flexibility as parameter of model parachute performance characteristics
[AIAA PAPER 70-1166] A70-41845

HEITMEYER, R.
Operations and economics in the 1970's
A70-35852

HEKTNER, T. R.
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HELDENFELS, R. R.
Frontiers in aircraft structural design
[AIAA PAPER 70-1232] A70-45917

HELLER, G. B.
The status of thermophysics as a multidiscipline area in astronautics and aeronautics
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HELLYAR, M.
VTOL short haul systems
[AIAA PAPER 70-1243] A70-45914

HEMESATH, N. B.
Optimal and suboptimal velocity-aiding for VOR/DME systems
[AIAA PAPER 70-1024] A70-39511

HENDERSON, A., JR.
Hypersonic viscous flows
A70-35034

HENDERSON, H. T.
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[SAE PAPER 700257] A70-36824

HENDRICKS, P.
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A70-41745

HENNEY, M. L.
The Anglo French Jaguar flight test data processing systems
A70-38536

HENRICH, J. E.
A comparison of pulse techniques for surveillance of cooperative aircraft with satellites
A70-36391

HERB, H.
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[NASA-TT-F-13181] N70-37542

HERBST, W.
What does development time cost
A70-39644

HERMANN, M.
Aerodynamic energy exchangers for hybrid airbreathing-rocket propulsion systems
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HERRMANN, H.-D.
A terminal for centralized air cargo handling
A70-43270

HERZBERGER, F.
Thermostatic examination of glass fiber reinforced composite plastic materials subjected to solar irradiation and surrounding warm air
A70-37370

HESTER, R. L., JR.
One-hundred ton airdrop from a C-5A aircraft
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N70-37762

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HILD, J.
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A70-35979

HILL, E. C.
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HILL, R. W.
Instrumentation for the extraction of V/STOL stability derivatives A70-35502
HILLE, H. K.
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HILLIER, R.
The effects of yaw on conical wings at high supersonic speeds A70-40918
HINDERS, U. A.
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HINTZE, C., JR.
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HINZ, E. R.
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HIRANO, H.
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HIRANO, K.
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HITCH, H. P. Y.
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HO, F. H.
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HOENER, R. F.
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HOEPER, H. J.
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HOFFMAN, W. C.
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HOHENEMSER, K. H.
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HOLAHAN, J.
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HOLDEN, P.
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HOLLAND, F. C.
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HOLT, M.
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HONG, J.
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HOOPER, J. A.
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A70-41243
HOWELL, G. C.
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N70-40717
HOWLETT, R. W.
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HU, J. J.
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[AD-708396] N70-39937
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A70-38179
HUANG, J. T.
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HUCKINS, E. K., III
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HUDDIE, D.
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HUET, C.
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A70-45441
HULEY, W. G.
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A70-41743
HUNTER, I. M.
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A70-42659
HUNTER, P. A.
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HURLEY, F. X.
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A70-35827
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I

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A70-45644
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A70-35986
IATSKOV, N. A.
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IDA, T.
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A70-38222
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N70-32152
II, J. M.
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ILIUKHIN, M. K.
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A70-44742
IMAI, I.
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A70-37597
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A70-38800
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A70-42775
INAGAKI, Y.
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A70-42282
INGERMAN, D.
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INGRAM, C. W.
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A70-35184
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A70-36550
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ISAY, W.-H.
Modern problems of propeller theory
A70-44097
ISHIHARA, T.
Generation of suboptimal, closed loop guidance for minimum time aircraft trajectories
N70-37817
ISING, H.
Sound generation by a fluctuating jet
A70-41422
ISMAIL, A.
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A70-40110
IUDELOVICH, M. IA.
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A70-36262
IVANOV, A. V.
Flow in a supersonic viscous underexpanded jet
A70-36262

J

JACKSON, C. E. P.
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A70-40582
JACKSON, F. C.
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[AD-705268] N70-36237
JACKSON, H. A.
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[SAE PAPER 700288] A70-36807
JACOBS, E.
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JACOBSON, M. J.
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[AIAA PAPER 70-897] A70-35814
JACOBY, G.
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A70-39622
JAFFEE, R. I.
A70-34351
JAGIRDAR, S. S.
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[AE-276-S] N70-33607
JAHNKE, L. P.
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A70-34448
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JANSEN, G. R.
Flight evaluation of direct lift control on the DC-8 Super 63
A70-35496
JANSEN, T. W.
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[SAE PAPER 700785] A70-45859
JANSSENS, G.
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[ASME PAPER 70-GT-110] A70-36848
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[NASA-TT-F-13260] N70-39939
JENG, D. C.
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[AIAA PAPER 70-1241] A70-45961
JENKINS, J. E.
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A70-37395
JENNEY, D. S.
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A70-34723
JENNEY, G. D.
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A70-40786
JENNY, R.
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[NASA-TT-F-12604] N70-32535
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A70-36763
JOERGEN, G. OE.
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JOHANNES, R. P.
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JOHNS, A. L.
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JOHNS, D. J.
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JOHNSON, A. L.
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A70-35646
JOHNSON, A. R.
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[RM-487] N70-42113
JOHNSON, B. V.
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[ASME PAPER 70-GT-79] A70-36885
JOHNSON, C. B.
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effects of transition included
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JOHNSON, C. L.
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A70-36451
JOHNSON, D.
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A70-38533
JOHNSON, E. G.
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A70-37881
JOHNSON, G. S.
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[AIAA PAPER 70-948] A70-39579
JOHNSON, I. B.
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A70-40619
JOHNSON, K. G.
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[NASA-TN-D-5963] N70-40743
JOHNSON, M. D.
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A70-43105
JOHNSON, P. J.
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JOHNSON, P. M.
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A70-37912
JOHNSON, R. L.
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JOHNSON, W.
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JONES, A. R.
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A70-38365
JORGENSEN, S. W.
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A70-37912
JOSE, D. K.
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JUNGBLUTH, H.
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A70-35375
JUNKHAN, G. H.
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JURENKO, J. A.
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N70-32161

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A70-42880
KALININ, B. L.
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A70-39716
KALITIEVSKII, L. F.
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A70-42801
KAMALDINA, I. I.
A thunderstorm cloud
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KANIUKA, W. W.
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high performance aircraft
[SAE PAPER 700785] A70-45859
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KARI APPA
Kinematically consistent unsteady aerodynamic coefficients in supersonic flow A70-45154
KARIAPPA, V.
Flutter of skew panels by the matrix displacement approach A70-40586
KARPMAN, I. M.
Flow in a supersonic viscous underexpanded jet A70-36262
KARWATH, K. E.
IATA policy on the future development of ATS A70-38630
Area navigation and the associated display methods A70-42658
KASS, G. J.
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KAUFMAN, A.
An analysis of the capabilities and limitations of turbine air cooling methods
[NASA-TN-D-5992] N70-40659
KAUFMAN, L. G., II
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and on fin-plate models
[RM-487] N70-42113
KAULE, W.
A new method for wall thickness measurements down to 0.2 mm with an accuracy of better than 10 micrometers A70-45681
KAWAHATA, N.
Wind tunnel investigations of the STOL airplane, with attention to the relations between the aerodynamic characteristics and the wake structure
[NAL-TR-197T] N70-40562
KAY, S. E.
A new high strength glass for aircraft transparencies A70-41891
KAYS, W. M.
Experimental hydrodynamics of the accelerated turbulent boundary layer with and without mass injection
[NASA-CR-110650] N70-32466
KAYTEN, G. G.
The expanding horizons of air transport A70-35854
KAZAKOV, I. E.
Statistical methods of designing control systems A70-37403
KEEL, A. G., JR.
Determination of axial gradient effects in freejet flows A70-44584
KEEN, J. M. S.
Development of the Rolls-Royce RB.211 turbofan for airline operation
[SAE PAPER 700292] A70-36804
KEENE, L. C.
Data Link communications for the seventies A70-41348
KEEPERS, W. C.
A suggested action program for the relief of airfield congestion at selected airports, supplement
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KEHLET, A. B.
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KEIL, W.
Investigations of the bird hazard problem in the Federal Republic of Germany A70-35980
KEITH, A. L., JR.
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KELDYSH, V. W.
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KELLEM, C. W.
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KELLER, J. D.
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KELLEY, H. L.
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KELLY, T. W.
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KELNHOFER, W. J.
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KEMPKE, E. E., JR.
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KENNER, P. M.
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KENNY, D. P.
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KEONJIAN, E.
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KERREBROCK, J. L.
Intra-stator transport of rotor wakes and its effect on compressor performance
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KETTLER, L. K.
Portable instrument package /Portapak/ for the measurement of noise and vibration
[AD-707826] N70-40026
KEY, D. L.
Models for a VTOL airplane in transition A70-34724
KEY, E. J.
Aircraft braking friction trials on a coarse open graded macadam runway surface
[RAE-TR-69123] N70-37172
KEYES, J. W.
Laminar heating in interior corners at Mach 19 A70-39700

KHOLSHCHEVNIKOV, K. V.
Matching of compressors and turbine parameters in gas turbine aircraft engines
[AD-701978] N70-32490
KHRISTICH, V. A.
Correlation between flame-out and ignition characteristics for diffusion-type fuel burnup behind a system of angled stabilizers
A70-36127
KHRISTOFOROV, I. L.
Fuel burnout mechanism and heat yield in the secondary air flow injection zone of turbine engine combustion chambers with various frontal devices
A70-37246
KHRONIN, D. V.
Theory and calculation of vibrations in flight vehicle engines
A70-37229
KICKS, J. C.
Development and refinement of an ultraminiature pressure transducer and application to airplane model and airplane subsystem testing in wind tunnels
A70-38523
KIDA, T.
A linear theory of a jet-flapped airfoil in a jet stream with fully developed wake
A70-43737
KIDD, D. L.
Recent advances in helicopter vibration control
A70-34735
KIDWELL, J. C.
Model testing to establish ditching and flotation stability characteristics of helicopters
A70-34738
KIEFER, D. W.
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A70-38399
KIRKHAM, F. S.
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KIRKPATRICK, D. L. I.
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KIRKPATRICK, G. M.
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KITAMURA, K.
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KLANSNIC, J. E.
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KLAWA, R. F.
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N70-40954
KLEIN, R. H.
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KLEIN, R. L.
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A70-38399
KLEINER, W. O.
A terminal for centralized air cargo handling
A70-43270
KLEPINGER, R. H.
Future advances in the aerodynamics of military strike aircraft
N70-40708
KLOPFENSTEIN, H. S.
Evaluation of the lap belt and pre-inflated air bag during impact with human sled subjects
A70-44456
KLOPFSTEIN, A.
The Emmanuel airborne magnetic recording system
A70-38547
KLUEG, E. P.
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KNORR, M. M.
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KNOWLES, W. E.
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A70-38840
KNUDSEN, G. E.
The Huey/Cobra M and R Field Program results and significance
A70-38827
KOBAYASHI, M.
Aircraft inspection by Ir-192 and Tm-170 gamma-ray radiography
A70-45725
KOBAYASHI, S.
A method to calculate the supersonic flutter speed of plate wings
A70-42276
KOBAYASHI, Y.
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A70-35246
KOBRYNSKI, M.
Determination of the field of sound produced by a jet aircraft in motion
[NASA-TT-F-13096] N70-32947
KOCH, C. C.
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KOCH, C. R.
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KOCKA, V.
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[ICAS PAPER 70-25] A70-44108
KOERNER, W.
The break-up of a liquid droplet due to aerodynamic forces
A70-43741
KOESTER, K. L.
Millimeter radar for landing applications
A70-34721

KOHN, M.
Divergent conceptions in the interpretation of Article 3 of the Warsaw convention and the Hague protocol
A70-37562
KOLESNIKOV, L. A.
Joining three-layer fiberglass-reinforced plastic panels by means of bilateral cover plates
A70-42812
KOMASHENKO, A. P.
Calculation of flows past bodies in the presence of strong blowing
A70-39771
KONDO, J.
Application of computer techniques to aircraft design problems
[ICAS PAPER 70-28] A70-44105
KOPELEV, S. Z.
Investigation of heat exchange processes in cooled gas turbine blades
A70-44737
KOPPENWALLNER, G.
Experimental and theoretical investigations of different configurations of lifting re-entry vehicles in hypersonic low density flow
[ICAS PAPER 70-03] A70-44117
KORDONSKY, H. B.
Central aviaschedule as a part of air traffic control system
A70-36397
KORDZINSKI, W.
Trends in the construction of low- and medium-power turboprop engines. II
A70-43081
KORKEGI, R. H.
Viscous interactions and flight at high Mach numbers
[AIAA PAPER 70-781] A70-34475
KOSOWSKY, L. H.
Millimeter radar for landing applications
A70-34721
KOSTER, W. P.
Surface integrity in conventional machining
[ASME PAPER 70-GT-100] A70-36888
KOSTERIN, V. A.
Turbulence in the zone of interaction between a jet and a flow
A70-41773
KOSYKH, A. P.
Explicit schemes of the location method in the problem of supersonic flows around a blunt body
[NASA-TT-F-13230] N70-42136
KOVACH, M.
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KOVALEVSKII, M. M.
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KOZHEVNIKOV, IU. V.
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A70-37241
Optimization of the tuning of gas turbine engines
A70-43361
KOZIOL, J. S., JR.
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KRAEMER, A. R.
Optical communications in space
A70-37878
KRAEMER, K.
Vibrational relaxation in flight and in wind tunnels
A70-35962
KRAIKO, A. N.
Design of an optimal stern section of a plane body at a supersonic flow rate
A70-36261
Method of characteristics for calculating supersonic gas flows with foreign particles in plane and axisymmetric nozzles
A70-37228
KRALL, K. M.
Local heat transfer around a circular cylinder at low Reynolds number and in transverse slip flow
A70-41035
KRAMER, J. J.
Low-noise propulsion systems for subsonic transports
[NASA-TM-X-52640] N70-33773
KRASNOSHAPKA, N. G.
Stability of the elastic fuselage of a flight vehicle when stabilized by a nonideal static automatic pilot during a supersonic flight
A70-44157
KRAUS, P. R.
An analytical approach to landing gear weight estimation
[SAWE PAPER 829] A70-40366
KRAVCHENKO, IU. B.
The influence of air-intake wall design in an axial compressor on the propagation of sound
A70-38653
KRAVETS, V. N.
A method of determining the lift of a profile
A70-44158
KREBS, J. N.
Advanced military transport engines
[SAE PAPER 700267] A70-36820
KREUTZ, F.
Airborne flight test data acquisition and automatic data processing system for helicopter test and development programs
A70-34713
KRIER, G. E.
Flight-test evaluation of the wing vortex wake generated by large jet-transport aircraft
N70-40912
KROGULL, B.
The analysis of the effective reliability of a system
A70-38833
KRYTER, K. D.
Judgment tests of flyover noise from various aircraft
[NASA-CR-1635] N70-35881
Possible modifications to the calculation of perceived noisiness
[NASA-CR-1636] N70-35898
KU, R.
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[PB-190933] N70-36452
KUBOZONO, A.
Porous wall interference in transonic wind tunnel
A70-42337
KUCHTA, J. M.
Oxygen dilution requirements for inerting aircraft fuel tanks
N70-42756
KUECHEMANN, D.
A survey of some European hypersonic research
A70-43507
KUHN, P. M.
Airborne observations of contrail effects on the thermal radiation budget
A70-44033
KUJAWSKA, D.
Future development of long-range air transport
A70-43533
KUJAWSKI, B. T.
An assessment of the interfacing problems with CCV design concepts
A70-37395
KUKAR, J.
Advanced baggage handling and processing concepts
[AIAA PAPER 70-917] A70-35829
KULBASHNYI, P. F.
Investigation of the endurance of aluminum alloy AMg6M sheet at frequencies of 2500, 7500, and 12,500 Hz
A70-38431
KULIKOWSKI, J. L.
Statistical properties of an air-traffic control system based on a central processor
A70-36394
KUMPITSCH, R. C.
Liquid metal servoactuation packages for flight controls
A70-40785
KURATA, T.
Porous wall interference in transonic wind tunnel
A70-42337
KURN, A. G.
Pressure measurements on a slender rhombic cone at

incidence at Mach numbers from 0.4 to 1.1
[ARC-R/M-3626] N70-42500
KUROCHKIN, F. P.
Principles of VTOL design
A70-37233
KURODA, I.
A method of analyzing aircraft accident data by FORTRAN programs
A70-42880
KURTZ, D. W.
Detailed pressure distribution on a blunted 60-deg half-angle cone at Mach numbers of 6.08 and 9.46
[NASA-CR-109982] N70-35952
KURZE, U. J.
Sonic boom simulation by means of low-pressure sources
[NASA-CR-66969] N70-33864
KUSAMICHI, H.
Properties and application of Ti-5Al-2Cr-1Fe alloy /KS150B/
A70-34428
KUSUKAWA, K.-I.
On the steady flow past an oblique flat plate at a high Reynolds number
A70-41714
KUTSCHENREUTER, P. H., JR.
Inlet data for engine analysis
[AIAA PAPER 70-1214] A70-41320
KUTSUMI, M.
A consideration on recirculating jet curtain flow
A70-42278
KUYPERS, P.
Study of automatic conflict detection and resolution in air traffic control planning
[ICAS PAPER 70-58] A70-44154
Aircraft trajectories - An approach to the calculation of aircraft trajectories for possible application in air traffic control
A70-46239
KVITKA, V. E.
Calculation of the characteristics of random vibrations of a panel in the acoustic field of an exhaust jet
A70-36301

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LA FORGE, S. V.
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[AD-710425] N70-43132
LAACK, D. R.
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[AD-704509] N70-36487
LABRUJERE, TH. E.
Computer application of a linearised supersonic lifting surface theory on a certain class of wings
[NLR-TR-G-50] N70-37079
LADERMAN, A. J.
Two-phase plume impingement effects
A70-44566
LAGO, A. M.
External costs and benefits analyses, NECTP
[PB-190944] N70-36515
LAGUTIN, V. I.
Influence of the dust content of the flow on the results of hypersonic wind tunnel experiments
A70-42224
LAI, J. L.
Parametric shimmy of a nosegear
A70-36455
LAMB, R. H.
Computer program to predict the Newtonian aerodynamics of general bodies approximated by flat plates
[NASA-TM-X-64431] N70-35621
LAMP, R.
The frequency of low visual ranges and ceilings at German civil airports
A70-37925
The reappearance of fog layers
A70-43246
LAND, P. L.
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LANDGREBE, A. J.
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A70-34704
LANGFELDER, H.
The use of trade-off studies in preliminary design
N70-40705
LANGLEY, H.
The birdstrike problem
A70-36319
LANIER, W. P.
Ultrasonic inspection of fastener holes protects C-5 wings
A70-45571
LANNEFELD, T. E.
Fabrics for gliding decelerators
[AIAA PAPER 70-1180] A70-41833
LAPIN, A. D.
The radiation of a non-uniform elastic wall in a moving medium
A70-38657
LAQUERBE, M.
Study of the motion of a sphere in a laminar flow - Determination of the lifting force
A70-37647
LARGE, J. P.
Cost analyses for NECTP. Volume 1 - High speed ground modes
[PB-190942] N70-35446
LASCHKA, B.
Flutter induced by aerodynamic interference between wing and tail
A70-36445
Interfering lifting surfaces in subsonic flow
A70-44765
LASHLEY, J.
GPATS, the AN/GSM-204/V/
A70-40771
LASKIN, A. S.
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A70-45504
LAUGHLIN, C. R.
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LAURAS, D.
The MADAP air traffic control system
A70-44860
LAURENCE, W. M.
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[AIAA PAPER 70-895] A70-35812
LAVI, R.
Negative G Drone aircraft surface tension fuel system
[AIAA PAPER 70-910] A70-35822
LAVRIK, V. S.
Pilot, attention - Birds
A70-44099
LAWACZECK, O.
Method for the determination of exit flow parameters of transonic turbine lattices
A70-42346
LAWFORD, J. A.
Low-speed wind-tunnel tests on an unswept wing-fuselage model of aspect ratio 9.8, with tangential blowing over trailing-edge flaps and ailerons, including the effect of slipstream
[ARC-CP-1108] N70-43015
LAWRENCE, R. D.
Assurance of integrity in modern adhesive bonded structures
A70-38594
LAZAR, M.
Unique connectors developed for U.S. super jet airliners
A70-44545
LAZZARINO, L.
A theoretical and experimental research on the fatigue behavior of reinforced sheets
[ICAS PAPER 70-35] A70-44132
LE BOT, Y.
Theoretical and experimental determination of pressure losses in a single-stage axial flow compressor
[ASME PAPER 70-GT-78] A70-36886

LEANORD, B. R.
Low-noise propulsion systems for subsonic transports
[NASA-TM-X-52640] N70-33773
LEATHERWOOD, J. D.
Heave dynamics of tracked air-cushion vehicles
A70-35178
LEATHWOOD, W.
Cost analyses for NECTP. Volume 2 - Air and highway modes
[PB-190943] N70-36811
LECARME, M.
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LEE, H. A.
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LEE, S.-Y.
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LEET, J. R.
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[AIAA PAPER 69-209] A70-36452
LEGG, K.
Mass air transport
A70-36656
LEIGH, C. H.
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N70-40928
LEIGH, J. K.
Aircraft fuel contents gauging in the seventies
A70-40619
LEISHER, W. B.
A method for predicting forcing functions for structures being tested in a shock tube
A70-35180
LEMCKE, B.
Comparison of heat transfer measurements in free flight and in a wind tunnel at M equals 7 at similar Reynolds numbers and temperature ratios
[ICAS PAPER 70-06] A70-44115
LEMON, J. H.
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[FPRC/MEMO-248] N70-36581
LENA, P.
The aircraft as scientific observation platform
A70-43146
LENG, J.
Exploratory tests using temperature-sensitive paints to obtain hypersonic heat transfer data on spheres and on fin-plate models
[RM-487] N70-42113
LENGELLE, G.
Study of the transition on a plate to sinusoidal wall in incompressible flow
A70-41440
LENNON, C. J.
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[NASA-TM-X-2068] N70-36660
LEONARD, B. R.
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[NASA-TN-D-5877] N70-32721
LEPPINGTON, F. G.
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A70-43968
LERNER, J. I.
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[NASA-CR-112668] N70-36902
LEUCHTER, O.
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A70-34773
LEVIT, M. E.
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A70-37237
LEWIS, A. M.
Concorde thrust management
[SAE PAPER 700817] A70-45900
LEWIS, C. H.
Two-phase plume impingement effects
A70-44566
LEWIS, J. E.
Wake stability and transition studies at Mach 4.5
A70-34465
LEWIS, R. B., II
Hueycobra maneuvering investigations
A70-34716
LEWIS, W. G. E.
Some experiments on two-stream propelling nozzles for supersonic aircraft
[ICAS PAPER 70-48] A70-44145
LEWITOWICZ, J.
Certain possibilities of using radioactive isotopes in testing aircraft equipment
A70-43083
LEWY, S.
Wind tunnel flow visualizations with electron beam
A70-37208
LEYNAERT, J.
Buzz in supersonic air intakes
A70-41262
LIBBEY, C. E.
Flexible wing deployment device Patent
[NASA-CASE-XLA-01220] N70-41863
LIBBY, P. A.
Analysis of an active thermal protection system for high-altitude flight
A70-41745
LIBRESCU, L.
Aeroelastic stability of thin heterogeneous circular cylindrical panels
A70-42603
LIBRIZZI, J.
Slingshot - An advanced aerodynamic test facility
[AD-702052] N70-32870
LIBURA, M.
Algorithm and general principles of information processing in a civil aviation traffic system
A70-38161
LICHTEN, R. L.
Design problems and solutions for five types of low-disk-loading, high-speed VTOL aircraft
[ICAS PAPER 70-57] A70-44153
LIEBECK, R. H.
Optimization of airfoils for maximum lift
[AIAA PAPER 69-739] A70-42704
LIGHTFUSS, H. J.
Some experimental results of two-dimensional compressor cascades at supersonic inlet velocities
[ASME PAPER 70-GT-7] A70-36829
LIGHTHILL, M. J.
The theory of trailing Taylor columns
A70-42629
LIM, A. K.
On the use of slotted walls in two-dimensional testing of low-speed airfoils
[ICAS PAPER 70-08] A70-44119
LINDEN, T. L. J.
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[NASA-CR-113879] N70-41029
LINDSAY, K. L.
The combined effect of gravity gradient and aerodynamic torques on the attitude control of the Apollo/S-4B in a circular orbit about the earth
[NASA-TM-X-64300] N70-34218

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LITOSHENKO, V. N.
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LOCKE, B.
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LOKAI, V. I.
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LOKTEV, B. E.
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LOOMIS, J. P.
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LOPATIN, V. I.
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LORD, R. N.
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LOTH, J. L.
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LOWSON, M. V.
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LYONS, R. E.
The application of associative processing to air traffic control A70-36392
LYTWYN, R. T.
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MACKINNON, D.
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A70-37913
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MAEDA, S.
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MAESTRELLO, L.
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MAININ, V. M.
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MAISE, G.
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MAIUZZO, M.
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MAKHIN, V. A.
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MAKSUDYAN, A. S.
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A70-42657
MANZUK, R. J.
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MARIA-SUBE, R.
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A70-45269
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MARSH, H.
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MARSHALL, F. J.
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MARTI, V. M.
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A70-46239
MARX, H. M.
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A70-43269
MARYNIAK, J.
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A70-35190
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MASEK, R. V.
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A70-42615
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A70-45592
MATRAND, C.
Near wakes of dihedra placed at an angle of attack in a hypersonic rarefied gas flow
A70-35047
MATSUO, Y.
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A70-45725
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A70-35517
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A70-44395
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N70-32176
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A70-36691
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A70-39202
MCDONALD, J. W.
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A70-34463
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MCFARLAND, R. H.
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A70-34708
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Airborne measurement of turbulent fluxes
A70-40109
MIYAKE, M.
Airborne measurement of turbulent fluxes
A70-40109
MIYAMOTO, K.
Properties and application of Ti-5Al-2Cr-1Fe alloy /KS150B/
A70-34428
MIZUTANI, Y.
The role of chemistry in gas turbine emissions
[ASME PAPER 70-GT-81] A70-36883
MKHITARIAN, A. M.
Aerodynamics
A70-36507

MODI, V. J.
Unsteady aerodynamics of stationary elliptic cylinders in subcritical flow
[AIAA PAPER 69-745] A70-44564
MOELLER, J. H.
Parawing technology for spacecraft land landing - A progress report
[AIAA PAPER 70-1187] A70-41828
MOFFAT, R. J.
Experimental hydrodynamics of the accelerated turbulent boundary layer with and without mass injection
[NASA-CR-110650] N70-32466
MOFFATT, W. C.
Optimum cycle parameters for turbofan engines
[ASME PAPER 70-GT-65] A70-36840
MOHAMMED, P. M. P.
A remote temperature and dewpoint indicating and recording device
A70-40760
MOHLER, S. R.
Aeromedical research - The new generation aircraft
N70-40782
MOLL, J. W.
Calculation of radar reflecting properties of jet engine intakes using a waveguide model
A70-43584
MONSON, D. S.
Optimization study for VTOL aircraft powerplants
A70-34708
MONTEITH, J. H.
A flow velocity and direction instrument
[NASA-TM-X-66391] N70-42824
MONTOYA, L. C.
Drag characteristics obtained from several configurations of the modified X-15-2 airplane up to Mach 6.7
[NASA-TM-X-2056] N70-35693
MOON, H. H., JR.
Acceptance criteria for demonstrating system safety requirement
A70-38840
MOORE, A. W.
Scale effects on oscillatory control-surface derivatives
[NPL-AERO-1283] N70-34928
MOORE, C. P.
C-5 flight simulation program
[AIAA PAPER 70-922] A70-35833
MOORE, F. G.
Supersonic flow of nonuniform free-streams past aerodynamic decelerators
[AIAA PAPER 70-1176] A70-41837
MOORE, G. R.
The growth of air cargo transport
A70-35853
MOORE, M. T.
Inlet data for engine analysis
[AIAA PAPER 70-1214] A70-41320
MOORE, S. B.
Weight tare compensation for V/STOL wind tunnel testing
A70-35500
MORCOM, A. R.
Flight data recording systems
A70-36341
MOREHOUSE, G. G.
New insights into the design of swept-tip rotor blades
A70-34736
MORETTI, G.
Time-dependent computation of transonic flows
[AIAA PAPER 70-1322] A70-45943
Slingshot - An advanced aerodynamic test facility
[AD-702052] N70-32870
MORFEY, C. L.
Shock-wave radiation from a supersonic ducted rotor
A70-38614
Lift fluctuations associated with unsteady chordwise flow past an airfoil
A70-42303
MORGAN, H. L., JR.
Aerodynamic and deployment characteristics of single-keel solid and single-keel slotted personnel parawings
[NASA-TN-D-5911] N70-32844
MORI, A. S.
XB-70 structural mode control system design and performance analyses
[NASA-CR-1557] N70-34004
MORISHITA, N.
Satellite-based navigation/air traffic control systems for short range aircraft
[AIAA PAPER 70-1338] A70-45930
MORISSET, J.
USSR - The Kuznetsov NK 8-4 bypass turbojet /URSS - Le turboreacteur a double flux Kuznetsov NK 8-4/
A70-34629
Concorde - The downstream reverse nozzle /TRA/ which makes it possible to gain one ton per aircraft /Concorde - La tuyere a reverse aval /TRA/ permettra de gagner une tonne par avion/
A70-43213
MORITA, T.
Some effects of systematically varied location of one concentrated mass on transonic flutter characteristics of sweptback thin cantilever wing. I
A70-42274
MORRALL, J. C.
Low speed flight tests on a tailless delta wing aircraft /Avro 707B/. Part 2 - Longitudinal stability and control
[ARC-CP-1105] N70-37164
MORRIS, A. L.
Comparison of performance of supersonic blading in cascade and in compressor rotors
[ASME PAPER 70-GT-79] A70-36885
MORRIS, C. E., JR.
A note on a phenomenon affecting helicopter directional control in rearward flight
A70-44323
MORRIS, E. W.
Anticollision lights for the supersonic transport /SST/
[FAA-AM-70-9] N70-42404
MORRIS, J. J.
The stability deprivatives of the Navion aircraft estimated by various methods and derived from flight test data
N70-39253
MORRIS, J. P.
Evaluation and test on flat conductor feeders
[AD-705969] N70-34072
MORRISON, K. R.
A history of the development of the ARINC 573 digital flight data recording specification
A70-37892
MORSE, J. T.
Activities of the Federal Aviation Administration and the United States Inter-Agency Bird Hazard Committee on bird hazards to aircraft
A70-35982
MORT, K. W.
Full-scale wind-tunnel investigation of the aerodynamic characteristics of the X-24A lifting body aircraft
[NASA-TN-D-5932] N70-34385
MOSES, H. J.
Electronic diagnostic techniques for analyzing gas turbine performance
[ASME PAPER 70-GT-131] A70-36857
Computerized airborne integrated data systems
[AIAA PAPER 70-935] A70-37393
MOUILLE, R.
The 'Fenestron' shrouded tail rotor of the SA.341 Gazelle
A70-44322
SA-341 Gazelle
A70-44854
MUELLER, J.
Determination and simulation of the dynamics of a two-shaft bypass jet engine
A70-45442
MUELLER, T. J.
Physical and numerical experiments in laminar incompressible separating and reattaching flows
[AIAA PAPER 70-763] A70-34488
MUELLER, W. R.
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MUIRHEAD, J. C.
A review of DRES studies on the effect of blast on gas turbine engines

[DRES-267] N70-36951
MULLEN, J. P.
VHF atmospheric studies and communications and navigation systems N70-32235
MULLINS, W. M.
Stress analysis of spacecraft parachutes using finite elements and large deformation theory
[AIAA PAPER 70-1195] A70-41821
MUNCH, C. L.
An application of theory to compressor noise A70-42725
MUND, M. G.
Gas turbines-dust-air cleaners - Experience and trends
[ASME PAPER 70-GT-104] A70-36890
MUNDY, R. W. G.
The air traffic dilemma and possible cures A70-35857
MUNSHTUKOV, D. A.
Experimental investigation of pulsed exhaust systems of a two-cycle engine with turbosupercharger A70-42809
MURAO, R. S.
A consideration on recirculating jet curtain flow A70-42278
MURAYAMA, T.
Eigen motion of airplane. I - Lateral motion A70-42515
MURCRAY, W. B.
On the possibility of weather modification by aircraft contrails A70-45421
MURPHY, J. P.
Gas turbine sand and dust effects and protection methods
[SAE PAPER 700705] A70-42671
MURRAY, D. M.
Low pressure data acquisition techniques in a hypersonic wind tunnel A70-35493
MURROW, H. N.
Low- and high-altitude tests of parachutes designed for use in low-density atmospheres
[AIAA PAPER 70-1164] A70-41846
MURTHY, P. N.
Complicated nodal patterns on a thin elastic circular plate vibrating in flexure A70-38245
MYACHIN, V. YE.
Dynamic balancing of rotors N70-37790
MYKYTOW, W. J.
The relevance of recent advances in unsteady aerodynamics to the space shuttle program N70-36607

N

NAESETH, R. L.
Model wind-tunnel and flight investigation of a parawing lifting body landing system
[NASA-TN-D-5893] N70-40667
NAGAMATSU, H. T.
Flow and acoustic characteristics of subsonic and supersonic jets from convergent nozzle A70-34460
Heat transfer on a flat plate in helium at Mach numbers 67.3 and 87.6 and in hypersonic corner flow with air at Mach number of 19
[NASA-CR-114257] N70-42365
NAGANO, S.
Nonlinear analysis of rotating stall A70-35450
NAKAI, E.
Some effects of systematically varied location of one concentrated mass on transonic flutter characteristics of sweptback thin cantilever wing. I A70-42274
NARAYANA, C. L.
Spline approximation as applied to aeronautical problems
[NAL-TN-20] N70-41882
A modified Multhopp's lifting surface theory as programmed for the NAL Sirius computer
[NAL-TN-17] N70-41883
NARDI, L. U.
XB-70 structural mode control system design and performance analyses
[NASA-CR-1557] N70-34004
NAROVLYANSKII, G. YA.
Aviation climatology
[TT-69-55100] N70-33233
NATH, G.
Investigation of three-dimensional flow through the rotor of an axial fan A70-38248
NATKE, H. G.
Application of an experimental-computational procedure for the determination of the natural vibration parameters of an elastomechanical system at one exciter configuration A70-43200
Comments on the approximate solution of the classical flutter problem
[RAE-LIB-TRANS-1296] N70-32148
NATORI, M.
A method to calculate the supersonic flutter speed of plate wings A70-42276
NAUMANN, E. C.
Fatigue testing device Patent
[NASA-CASE-XLA-02131] N70-42003
NAVICKAS, J.
Vapor volume entrained in the boundary layer due to boiling on a vertical plate in a low gravity field A70-41055
NAYSMITH, A.
Comparison of heat transfer measurements in free flight and in a wind tunnel at M equals 7 at similar Reynolds numbers and temperature ratios
[ICAS PAPER 70-06] A70-44115
NAZAROVA, L. I.
The dispersion equation of a 2-dimensional ejector A70-38662
NDEFO, D. E.
A numerical method for calculating steady unsymmetrical supersonic flow past cones A70-35889
NEAL, T. P.
Development of a flying qualities criterion for the design of fighter flight control systems
[AIAA PAPER 70-927] A70-35837
The influence of bobweights on pilot-induced oscillations
[AIAA PAPER 70-1002] A70-39529
NEFF, J. R.
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NEITZEL, R. E.
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[SAE PAPER 700807] A70-45907
NEJEDLY, V.
Some problems involved in testing the fatigue life of helicopter parts and assemblies A70-43119
NELMS, W. P., JR.
Longitudinal aerodynamic characteristics of three representative hypersonic cruise configurations at Mach numbers from 0.65 to 10.70
[NASA-TM-X-2113] N70-42574
Effects of wing elevation, incidence, and camber on the aerodynamic characteristics of a representative hypersonic cruise configuration at Mach numbers from 0.65 to 10.70
[NASA-TN-D-6049] N70-42737
NELSON, J. R.
All weather landing development tests N70-40784
NELSON, R. A.
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NENNI, J. P.
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NEPPERT, H.
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[NASA-TT-F-13277] N70-39849
NEREM, R. M.
Initial results on theoretical prediction of drag

for a trailing decelerator at supersonic speeds
[AIAA PAPER 70-1177] A70-41836
NESS, W. G.
Maintenance and Reliability Simulation modeling for airfreighters
A70-38835
NESTEROV, E. D.
Preliminary estimate of the flow rate and thrust characteristics of noise-suppressing nozzles of turbojet engines
A70-43371
NESTOR, J.
Review of the Brayton engine electrical subsystem design and computerized technique used to document wiring
[NASA-TM-X-2079] N70-39388
NEUMAN, F.
Investigation of a digital automatic aircraft landing system in turbulence
[NASA-TN-D-6066] N70-43146
NEUMANN, H. E.
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NEVINGER, D. O.
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A70-43731
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NEWSOM, W. A., JR.
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[NASA-TN-D-5942] N70-34100
NEWTON, A. G.
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[SAE PAPER 700809] A70-45905
NICHOLAS, O. P.
Preliminary flight assessment of the low-speed handling of the BAC 221 ogee-wing research aircraft
[ARC-CP-1102] N70-37062
NICHOLSON, R.
Stability and control considerations for a tilt-fold-proprotor aircraft
A70-34722
NICOLAIDES, J. D.
Improved aeronautical efficiency through packable weightless wings
[AIAA PAPER 70-880] A70-34815
Parafoil flight performance
[AIAA PAPER 70-1190] A70-41826
A review of para-foil applications
A70-42706
Investigation of the nonlinear flight dynamics of ordnance weapons
[AIAA PAPER 69-135] A70-44515
NICOLL, W. B.
Flow development in conical diffusers with annular injection at inlet
[RR-14] N70-40472
NIEDERDRENK, P.
Compression and expansion areas in steady supersonic flows past yawing bodies of rotation
A70-36382
NIEDZWIECKI, R. W.
Performance of a swirl-can primary combustor to outlet temperatures of 3600 F /2256 K/
[NASA-TM-X-52902] N70-40624
NIELSEN, J. N.
Theoretical investigation of the aerodynamic characteristics of all-flexible parawings
[AIAA PAPER 70-1188] A70-41827
NIEMELA, J. R.
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[AD-706827] N70-37871
NIKITIN, YU. M.
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[AD-704730] N70-32985
NISHI, A.
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A70-46012
NISHIMURA, Y.
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NISHIYAMA, T.
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A70-35957
NISSEN, J. M.
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NORMAN, L. C.
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[NASA-TN-D-5968] N70-35910
NORTH, R. J.
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NOUHANT, J.
Simulation applied to the problems of air traffic control
A70-36398
Simulation methods and techniques used at Bretigny
A70-38638
NOVAK, D. J.
Recording effects of rain erosion with high speed photographic techniques
A70-40531
NOVAK, L. R.
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[AIAA PAPER 70-1409] A70-45916

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[AIAA PAPER 70-1334] A70-45934
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ODINTSOV, V. A.
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[AD-704025] N70-32575
ODONNELL, C. F.
Through the central 'multiprocessor' avionics enters the computer era
A70-34673
ODONNELL, R. F.
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[SAE PAPER 700272] A70-36817

OEHLER, C.
Contribution to the calculation method of subsonic wing theory
A70-38164
OGAWA, T.
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A70-42797
OGDEN, H. F.
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OHARA, F.
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A70-35859
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OHHARA, S.
A method of analyzing aircraft accident data by FORTRAN programs
A70-42880
OHRENBERGER, J. T.
A theoretical model of the near wake of a slender body in supersonic flow
A70-34467
OHYA, Y.
Basic study of the after-burner
A70-42336
OJDANA, E. S., JR.
Low pressure data acquisition techniques in a hypersonic wind tunnel
A70-35493
OKAPUU, U.
Cooled radial turbine for high power-to-weight applications
A70-36450
OKAUE, M.
A method of analyzing aircraft accident data by FORTRAN programs
A70-42880
OKEEFE, J.
The widebodies- Superjets and airbuses - The American superjets
A70-38951
OKIISHI, T. H.
Experimental performance in annular cascade of variable trailing-edge flap, axial-flow compressor inlet guide vanes
[ASME PAPER 70-GT-106] A70-36845
OKUROUNMU, O.
Three-dimensional vortex theory for axial compressor blade rows at subsonic and transonic speeds
A70-36691
OLBRECHTS, G. R.
Programming of variable loads by means of a semi-computer/semi-hardware method
A70-35511
OLEARY, R. A.
Physical and numerical experiments in laminar incompressible separating and reattaching flows
[AIAA PAPER 70-763] A70-34488
OLLERHEAD, J. B.
An application of theory to compressor noise
A70-42725
OLSEN, J. J.
The relevance of recent advances in unsteady aerodynamics to the space shuttle program
N70-36607
OLSON, D. N.
The use of an attached inflatable decelerator for store delivery from high speed aircraft from low altitude
[AIAA PAPER 70-1199] A70-41817
OLSON, W. T.
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OLSSON, C. O.
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A70-38643
ONCLEY, P. B.
Propagation of jet engine noise near a porous surface
A70-46068
ONEAL, W.
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[PB-190933] N70-36452
ONJI, A.
Drag measurement in nearly-free-molecule-flow regime
[NAL-TR-191] N70-40442
ORAZIO, F. D., SR.
Reactor for nuclear extended range aircraft
A70-43188
ORGERON, G. P.
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[AD-708167] N70-39778
ORNSBEE, A. I.
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[AIAA PAPER 69-739] A70-42704
OSBORN, M. S.
Basic principles of digital interior communication systems
[SAE PAPER 700302] A70-36813
OSBORNE, J., SR.
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[ICAS PAPER 70-14] A70-44125
OSDER, S. S.
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N70-40962
OSGERBY, I. T.
Supersonic combustion tests with a double-oblique-shock SCRAMjet in a shock tunnel
[AIAA PAPER 69-827] A70-41752
OSHIMA, K.
Experimental study of underexpanded jet expanding into vacuum
A70-35246
OSTAPENKO, N. A.
Hypersonic flow around a delta wing of finite thickness
A70-36260
OSTOSLAVSKII, I. V.
Flight dynamics - Trajectories of flight vehicles
[AD-706663] N70-38629
OSWATITSCH, K.
The influence of near-field flow on the sonic boom
[ICAS PAPER 70-20] A70-44113
OTSUKA, S.
Performances of cascade of blades with small aspect ratio. I
A70-42272
OTTE, A. A.
Development of a low-mass flow, high temperature, high-pressure, continuous-source hot-gas facility
A70-35157
OTTEN, D. D.
Satellite-based collision avoidance system concepts
A70-38242
OWEN, T. B.
Low-speed wind-tunnel measurements of oscillatory rolling derivatives on a sharp-edged slender wing. Effects of frequency parameter and of ground
[ARC-R/M-3617] N70-37162
OWENS, T.
Warm fog dispersal methods and fog characteristics at Monterey, California
[AD-706738] N70-37875
OZAWA, S.
Spring constants of a peripheral-jet air cushion vehicle in heaving motion
A70-42279

P

PABST, B. H.
747 operations - The first 100 days - Maintenance
[AIAA PAPER 70-890] A70-35807
PAGE, R. K.
Some fluid-dynamics considerations relating to the preliminary design of combat aircraft
N70-40707

PALCZA, L. J.
Performance analysis of a rotary nozzle utilizing a 30 deg spin angle rotor
[AD-705057] N70-32246
PALSSON, T.
Self-alignment techniques for strapdown inertial navigation systems with aircraft application
A70-36442
PAPAILIOU, K. D.
Boundary layer optimization for the design of high turning axial flow compressor blades
[ASME PAPER 70-GT-88] A70-36879
PAPCHENKO, O. M.
Approximate method of calculating the downwash behind a straight wing for unsteady aperiodic motion at subsonic flight speeds
A70-42802
PARANJPE, P. A.
Performance of conical jet nozzles in terms of discharge coefficient
A70-38243
PARFENOVA, N. I.
Statistical estimation of heat-resistance characteristics of materials for gas-turbine engines
A70-43940
PARKER, A. H.
Testing avionic systems automatically - The economics scope and essentials
A70-38544
Testing avionic systems automatically - The economics scope and essentials
N70-32170
PARKER, G. A.
The 747 fuel system
[SAE PAPER 700276] A70-36816
PARKIN, J. B.
Joint-use cargo terminal planning
[AIAA PAPER 70-920] A70-35832
PARKIN, R.
Titanium metal fabrications in aero engines
A70-34450
PARKINSON, G. V.
On the use of slotted walls in two-dimensional testing of low-speed airfoils
[ICAS PAPER 70-08] A70-44119
PARKS, D. L.
Simulator development and flight validation of a perspective display as an independent landing monitor
[AIAA PAPER 70-924] A70-35835
PARR, F.
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PARRAS, A. N.
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[AD-709411] N70-41750
PARRAUD, P.
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A70-41444
PARRY, I. S.
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A70-40119
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PARTIDA, J. B.
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[SAWE PAPER 836] A70-40364
PASIUK, L.
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A70-34485
PASLEY, L. H.
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[AIAA PAPER 70-875] A70-34816
PATAY, S. A.
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PATE, S. R.
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Some problems and features of transonic aerodynamics
[ICAS PAPER 70-14] A70-44125
PEARSONS, K. S.
The effects of temporal and spectral combinations on the judged noisiness of aircraft sounds Final report
[FAA-NO-69-3] N70-42217
PECK, W. R.
Design philosophy of the SIIIS-3 ejection seat escape system
[AIAA PAPER 70-1211] A70-41808
Design achievements with the SIIIS-3 ejection seat escape system
A70-44499
PECKHAM, C. G.
Crash recorder data from 'non-crash' recorders
A70-35518
PEELE, E. L.
A simplified method of estimating the response of light aircraft to continuous atmospheric turbulence
[AIAA PAPER 69-766] A70-42703
PENNOCK, A. P.
Development of C-5A propulsion system monitoring
A70-35497
PERELSHTEIN, B. KH.
Investigation of the cycle of a continuous combustion gas turbine engine with a stepwise heat removal
A70-43372
PERKINS, C. D.
Development of airplane stability and control

technology /1970 Von Karman Lecture/ A70-36441
PERKINS, P. J.
Tests of a full-scale annular ram-induction combustor for a Mach 3 cruise turbojet engine [NASA-TN-D-6041] N70-41975
PERKINSON, R. E.
Avoiding collisions in a timely manner A70-38239
PERNET, D. F.
Propagation of finite-amplitude sound waves in tubes [NPL-AERO-AC-43] N70-35068
PERRY, J.
An economical approach to advanced air traffic control processing and display A70-45044
PERVYSHIN, N. V.
Indirect method of determining air flow through inside channel and gas temperature in front of double flow turbine [NASA-TT-F-12982] N70-34312
PESCHON, J.
Information requirements for supersonic transport operation Final report [NASA-CR-1570] N70-34253
PETERS, D. A.
Application of the Floquet transition matrix to problems of lifting rotor stability A70-34726
PETERS, O.
Problem of the operational reliability of flight control systems and automatic piloting of aircraft [NASA-TT-F-610] N70-35169
PETERSON, G. P.
Advanced composites - A state-of-the-art assessment [ASME PAPER 70-GT-120] A70-36851
PETIT, P. H.
An applications study of advanced composite materials to the C-130 center wing box [NASA-CR-66979] N70-42183
PETRICONE, R.
Vibration characteristics of low aspect ratio compressor blades [ASME PAPER 70-GT-94] A70-36876
PETROV, B. N.
Influence of wing sweep variation on the dynamics of control processes A70-40182
PETRY, G. A.
One-hundred ton airdrop from a C-5A aircraft [AIAA PAPER 70-1203] A70-41814
PETTIT, W. T.
Heat transfer on a flat plate in helium at Mach numbers 67.3 and 87.6 and in hypersonic corner flow with air at Mach number of 19 [NASA-CR-114257] N70-42365
PETTY, J. S.
Lower bounds for sonic boom considering the negative overpressure region A70-36456
PFEIFFER, H.
The H2 hypersonic wind tunnel of the DFVLR at Porz-Wahn [DFVLR-SONDDR-19] A70-44799
PFLEIDERER, K.
Comparing the classification of the fatigue strength behaviour of small specimens and large scale components [ICAS PAPER 70-34] A70-44131
PHILLIPS, R. C., III
Application of computers to airport planning and design A70-37749
PHILPOT, M. G.
The buzz-saw noise generated by a high duty transonic compressor [ASME PAPER 70-GT-54] A70-36838
PIANKO, M.
Aircraft engine noise and sonic boom Technical evaluation report on AGARD specialists' meeting [AGARD-AR-26-70] N70-38782
PIAZZOLI, G.
Aeroelastic test equipment for the 'Concorde' SST A70-38548
Aeroelastic test equipment for the Concorde SST [ONERA-TP-811] N70-37148
PICKEN, J.
Comparison of heat transfer measurements in free flight and in a wind tunnel at M equals 7 at similar Reynolds numbers and temperature ratios [ICAS PAPER 70-06] A70-44115
PIERCE, C. M.
Structural alloys - Favorites retain their lead A70-34675
PIERRE, M.
Characteristics and possibilities of the large sonic wind tunnel at Modane-Avrieux [NASA-TT-F-12986] N70-42052
PINELIS, R. G.
Theory of an aircraft vertical gyro with a hydraulic damping device A70-39733
PINET, J.
Aircraft simulation application to the development of the Concorde project [AIAA PAPER 70-923] A70-35834
PITTS, F. L.
An electronic strain-level counter for aircraft structural members [NASA-TN-D-5944] N70-39377
PIVKO, J.
Method of estimating aerodynamic properties of an airfoil with a hinged flap and spoiler [NASA-TT-F-13131] N70-34693
PLASA
Travel, commuter and acrobatics aircraft MBB Bo-209 Monsun A70-37388
PLETIN, M.
Installation for the study of multiple flow jet exhaust nozzles [ONERA-NT-160] N70-42475
PLUMER, J. A.
Lightning induced voltages in electrical circuits associated with aircraft fuel systems N70-42759
POGORELOV, V. I.
Criteria used in simulation of the force exerted by a supersonic jet striking an obstacle A70-40515
POHLMANN, H. O.
JT9D engine operating experience [SAE PAPER 700288] A70-36807
POKORNY, V.
Trim changes A70-45436
Effect of changes in the aircraft geometry on the calculations of some flight characteristics A70-45437
POLGAR, P.
An on-line final data system for V/STOL wind tunnel testing A70-35494
POLHAMUS, E. C.
Variable sweep wing configuration Patent [NASA-CASE-XLA-00230] N70-33255
Variable sweep aircraft wing Patent [NASA-CASE-XLA-00350] N70-38011
POLLARD, F. B.
Commercial and military aircraft emergency egress systems A70-44466
PONSFORD, P. J.
Some wind-pressure measurements on a model of a group of closely-spaced cylindrical silos [NPL-AERO-NOTE-1088] N70-34941
PONZI, U.
Design criteria and characteristics of the blowdown wind tunnels of the Centro Ricerche Aerospaziali N70-37016
POOL, A.
The data collection system for the prototype flight tests of the Fokker F-28 Fellowship A70-38546
POOLE, D. B.
Defining the flow field of an open-jet wind tunnel [AD-709158] N70-41001
POPESCU, P.
Some aspects of the quality control of turbojet fuels A70-36550
POPOV, G. L.
Central aviaschedule as a part of air traffic control system

A70-36397
PORITZKY, S. B.
Seeking a new precision approach and landing system - A test of maturity
[AIAA PAPER 70-937] A70-35846
Satellite aid to airplanes - An overview
[AIAA PAPER 70-1301] A70-45922
POROCHNICKI, J.
Influence of flow turbulence on the efficiency of heat turbine blade systems
[NASA-TT-F-13180] N70-37524
PORT, W. G. A.
Low speed flight tests on a tailless delta wing aircraft /Avro 707B/. Part 2 - Longitudinal stability and control
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PORTER, B.
Synthesis of helicopter stabilization systems using modal control theory
[AIAA PAPER 70-1036] A70-39501
PORTER, R. F.
The gust-alleviation characteristics and handling qualities of a free-wing aircraft
[AIAA PAPER 70-947] A70-39580
PORTERFIELD, J. D.
Measurement and evaluation of helicopter flight loads spectra data
A70-35955
PORTIG, H.
Whirl of shaft-rotor systems supported by ball bearings
N70-43036
POSINGIES, W. M.
Hydrofluidic flight controls
[SAE PAPER 700793] A70-45854
POTOCKI, G.
Certain problems in the analysis and optimization of airtransport operations
A70-43532
POWELL, B. J.
The prediction of aerofoil pressure distributions for sub-critical viscous flows
A70-40924
POWERS, J. O.
Aircraft engine noise and sonic boom Technical evaluation report on AGARD specialists' meeting
[AGARD-AR-26-70] N70-38782
POWERS, S. R.
Nonlinear actuator disk theory and flow field calculations, including nonuniform loading
[NASA-CR-1672] N70-38435
PRASAD, K. S. R. K.
Complicated nodal patterns on a thin elastic circular plate vibrating in flexure
A70-38245
PREDTECHENSKII, A. N.
Pilot influence on the dynamic design of aircraft
[ICAS PAPER 70-37] A70-44134
PREISSER, J. S.
Effect of suspension line elasticity on parachute loads
A70-44531
PRENTICE, C. J.
Subsonic flow visualization using steam
A70-36460
PRESCOTT, A. T.
An assessment of the aircrew equipment assemblies and the type 9 ejection seat for the Harrier aircraft
[FPRC/MEMO-248] N70-36581
PRESSER, A.
S-band cw power module for phased arrays
A70-36674
PRICE, L. R.
Programmed engine maintenance - C5A Malfunction Detection Analysis and Recording System /MADARS/
[SAE PAPER 700820] A70-45898
PRIEBEE, E.
Technology of data handling and display for planning control
A70-38646
PRISEKIN, V. L.
Calculation of low aspect ratio wings under conditions of creep
A70-37244
PRISNIAKOV, V. F.
Aftereffect momentum of liquid-fuel jet engines
A70-37249
PRIVARNIKOV, O. A.
Approximate methods of calculating the distribution of velocity with altitude during the braking of bodies in the atmosphere
[AD-706171] N70-38655
PROMISEL, N. E.
A70-34351
PRUE, D. A.
Advanced control system considerations for small shaft-type aircraft gas turbines
[ASME PAPER 70-GT-132] A70-36858
PRUYN, R. R.
Prediction of the stability derivatives of large flexible prop/rotors by a simplified analysis
A70-34701
PRZIREMBEL, C. E. G.
The turbulent near wake of an axisymmetric body at subsonic speeds
A70-34463
PRZIREMBEL, E. G.
The turbulent near-wake of an axisymmetric body at subsonic speeds
[AD-705687] N70-34978
PUGLISI, S.
Airfield arresting gear exploratory development Final report
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PUTHOFF, R.
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[NASA-TM-X-52847] N70-34152
PYTLEWSKI, Z.
Fighting mud and water on runway surfaces
A70-34692

R

RAABE, H. P.
Instrument landing systems for the space shuttle
N70-39607
RABB, J. W.
Automation in air traffic control
A70-37914
RADNOFSKY, M. I.
New materials for manned spacecraft, aircraft and other applications
A70-42295
New materials for manned spacecraft, aircraft, and other applications
A70-44610
RAINEY, R. W.
High speed flight vehicle control Patent Application
[NASA-CASE-XLA-89670] N70-36056
RAMAMOORTHY, P.
Spline approximation as applied to aeronautical problems
[NAL-TN-20] N70-41882
A modified Multhopp's lifting surface theory as programmed for the NAL Sirius computer
[NAL-TN-17] N70-41883
RAMAN, K. K.
A method for calculation of frequencies and modes using an improved inertia matrix
[AE-276-S] N70-33607
RAMAPRIAN, B. R.
Flow development in conical diffusers with annular injection at inlet
[RR-14] N70-40472
RAMASASTRY, J.
The L-band air-traffic control satellite simulation experiment using balloons
[NASA-TM-X-65348] N70-41942
RAMBY, K. W.
A practical solution to automatic landings using digital flight control computers
[AIAA PAPER 70-1032] A70-39505
RAMNATH, R. V.
Transition dynamics of VTOL aircraft
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RAMSEY, V. B.
Aircraft electrical system multiplexing
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RANSONE, R. K.
STOL definition and field length criteria
[AIAA PAPER 70-1240] A70-45960
RAO, B. M.
Diffraction and reflection of sonic boom waves
A70-45266

RATZ, A. G.
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RAUMBARGER, J. H.
Survey of the state-of-the-art for the design of high speed rolling element bearings used in gas turbine engines - Volume 1 Final report [AD-705127] N70-32265
RAVISHANKAR, T. J.
Simulation of random load fatigue in laboratory testing [UTIAS-29] N70-33724
REA, F. G.
Generalized navigation error analysis [AIAA PAPER 70-1004] A70-39527
READER, D. C.
An assessment of the aircrew equipment assemblies and the type 9 ejection seat for the Harrier aircraft [FPRC/MEMO-248] N70-36581
REDING, J. P.
Dynamic stall of helicopter blades A70-34718
Dynamic stall simulation problems [AIAA PAPER 70-945] A70-39582
Boundary-layer transition and dynamic sting interference A70-44581
REDLICH, R. W.
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REED, E. A., JR.
Operational experience with the C-5A flight test computer controlled data processing system A70-37917
REED, T. O.
USAF experience with polyurethane foam inerting material N70-42754
REEHER, D. H.
The Washington-Baltimore regional air freight transport system [AD-708623] N70-40542
REGI, P.
ATCAS, the new Italian completely automatic air traffic control system A70-40911
REIMANN, H.
Automatic test equipment - Hardware and software examples, possible classification N70-32171
REINHEIMER, C. J.
Holographic subsonic flow visualization A70-40809
REITMAN, J.
Exploratory study into the development of an air traffic control computer simulation model [AIAA PAPER 70-1316] A70-45945
REMPFER, P. S.
Aircraft control system Patent Application [NASA-CASE-ERC-10439] N70-36052
RESTIVO, J. S.
The value of static and trend persistence in the one-hour prediction of ceiling and visibility [AD-703305] N70-35342
REULAND, W. B.
Forces and moment on a prolate spheroid accelerating with a constant angle of attack under a free surface [UCRL-50843] N70-36183
REYNOLDS, D. R.
Airborne data acquisition on high density computer tape A70-35499
REYNOLDS, D. T.
Stress analysis of spacecraft parachutes using finite elements and large deformation theory [AIAA PAPER 70-1195] A70-41821
REZNIKOV, G. B.
Stub and frame antennas for flight vehicles [JPRS-50690] N70-32902
RHOADS, D. W.
In-flight evaluation of selected pilot's controllers [AIAA PAPER 70-925] A70-35836
RIAZANOV, IU. A.
Relation between invariance conditions and the characteristics of a multidimensional control system for a turboramjet engine A70-39847
RIBAUD, Y.
Starting of low-drag supersonic blade cascades A70-41405
RICCIUS, R.
Designer's view on structural problems N70-40712
RICE, E. V.
Reliability of in-flight escape systems and survival equipments in U.S. Navy ejections - Successful and unsuccessful A70-44460
RICE, G. E.
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RICE, R. S., JR.
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RICEMAN, J. P.
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RICH, M. J.
Design considerations in selecting alloys for aircraft structures A70-39414
RICHARDE, H. M., JR.
A study of an adaptive aircraft control system in a self-organizing configuration [AD-703656] N70-32921
RICHARDS, B. E.
Methods for determining conditions in real nitrogen expanding flows [VKI-TN-58] N70-42586
RICHARDSON, A. S., JR.
Simulation study of NASA/ERC optical pilot warning indicator in terminal area traffic N70-40928
RICHARDSON, D. A.
The application of hingeless rotors to tilting prop/rotor aircraft A70-34719
RICHARDSON, D. J.
A short static probe with good incidence characteristics at supersonic speed [ARC-CP-1099] N70-37072
RICHARDSON, D. W.
A technique for establishing the cost-effectiveness of avionics system testing concepts N70-32156
What price on-board testing - Impact on tactical aircraft avionics N70-32166
RICHTER, G.
Investigations regarding the reduction of the noise from jets [ICAS PAPER 70-21] A70-44112
RIDER, D. C.
Results of the ATA CAS flight test program A70-38240
RIEBE, J. M.
Landing arrangement for aerial vehicles Patent [NASA-CASE-XLA-00142] N70-33286
Jet aircraft configuration Patent [NASA-CASE-XLA-00087] N70-33332
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RIESTER, E.
Hybrid-combustion in acceleration-ram rocket drives [ICAS PAPER 70-50] A70-44147
RIGNOT, D.
Climatology of the Tontouta Airfield N70-38299
RIMMER, R. J.
A method for guiding efflux air from a fan-in-wing model into a discharge duct [NRC-11446] N70-40470
RIMSKII-KORSAKOV, A. V.
Physics of aerodynamic noise A70-38651

Study of the discrete components in the noise spectrum of an axial compressor
A70-38652
The influence of air-intake wall design in an axial compressor on the propagation of sound
A70-38653
Experimental study of the effect of the surface roughness of a rod on the intensity and frequency of eddying sound
A70-38654
The supersonic air jet as a source of sound
A70-38659

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[AIAA PAPER 70-1209] A70-41809

ROBB, C. F.
The advances of testing and promulgation of information of safety, survival and life support equipment
A70-44488

ROBERTS, B. W.
The shape and stresses in an arbitrarily shaped gore parachute under an arbitrary pressure distribution
[AIAA PAPER 70-1197] A70-41819

ROBERTS, E.
Digital controlsystems self-check
N70-32168

ROBERTS, M. L.
Transitional flow separation upstream of a compression corner
[AIAA PAPER 70-764] A70-34487
Newtonian aerodynamic coefficients for an arbitrary body, including all 'shadowed' areas
A70-41866

ROBERTS, S. C.
The American approach to the solution of current flight test problems
A70-38530

ROBERTSON, A. J.
Aircraft control system Patent Application
[NASA-CASE-ERC-10439] N70-36052

ROBINS, A. W.
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[AIAA PAPER 68-1018] A70-42701

ROBINSON, A. C.
Optimal longitudinal control for obstacle clearance on takeoff
[AIAA PAPER 70-963] A70-39566

ROBINSON, F.
Increasing tail rotor thrust and comments on other yaw control devices
A70-44324

ROBINSON, G. H.
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N70-40912

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RODDEN W. P.
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N70-35873

RODERICK, W. E. B.
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ROGALLO, F. M.
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ROGERS, F. M.
Development planning and operational capabilities
N70-40720

ROGOZHIN, B. A.
Turbulence in the zone of interaction between a jet and a flow
A70-41773

ROIZMAN, V. P.
Vibration and balancing of aircraft engine rotors
A70-37237

ROLAND, J. R.
Transient behavior of charring ablators
[AIAA PAPER 70-1143] A70-40280

ROLFE, A. J.
Markov chain analysis of a situation where cannibalization is the only repair activity
[AD-707041] N70-37824

ROM, J.
Effect of a spike on the drag and on the aerodynamic stability of blunt bodies in supersonic flow
A70-39702
The IIT 40cm x 50cm intermittent, single jack, flexible nozzle supersonic wind tunnel-calibration at Mach numbers 1.5 to 3.0
[TAE-110] N70-36965

ROMERE, P. O.
Computer program to predict the Newtonian aerodynamics of general bodies approximated by flat plates
[NASA-TM-X-64431] N70-35621

RONALD, T. M.
Structural alloys - Favorites retain their lead
A70-34675

ROOKER, J. L.
Instrumentation for the extraction of V/STOL stability derivatives
A70-35502

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ROSCOE, S. N.
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A70-38234

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ROUX, B.
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A70-44207
ROWE, W. S.
On the unsteady aerodynamic loading of wings with control surfaces
A70-44761
RUBNER, K.
Measurement of spatial flow and of the blade pressures in an axial compressor, taking into consideration the flow close to the wall, with the aid of digital data processing and test guidance
A70-45093
RUBTSOV, I. F.
Pilot, attention - Birds
A70-44099
RUCKLE, D. L.
High strength titanium alloys for aircraft gas turbine application
A70-34436
RUDIN, A. M.
Two methods for cross wind compensation in an automatic aircraft stabilization system
A70-39842
RUETENIK, J. R.
Simulation study of NASA/ERC optical pilot warning indicator in terminal area traffic
N70-40928
RUGG, H. R.
A definition of the aircraft stretch efficiency factor
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RUMBARGER, J. H.
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RUMBAUGH, M. G.
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RUSS, D. G.
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RYLE, D. M., JR.
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N70-37758

S

SACHEK, V. I.
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A70-44742
SAGE, W.
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A70-35600
SAKATA, H.
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A70-42284
SALABA, J.
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A70-43116
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SALOMON, M.
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A70-41260
SANDERS, K. L.
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[SAWE PAPER 840] A70-40380
SANDERS, N. D.
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SANDERS, W. D.
Air conditioning in aircraft
A70-37975
SANDIN, S.
Viggen is tested - Evaluation
A70-46229
SANFILIPPO, F. A.
Sensitivity optimization - A lateral- directional flight control case study
[AIAA PAPER 70-962] A70-39567
SAPIRO, D. N.
Assembling and testing aircraft electrical and radio systems
A70-37405
SARAVANAMUTTOO, H. I. H.
Simulation of gas turbine dynamic performance
[ASME PAPER 70-GT-23] A70-36830
SARKISYAN, S. A.
Certain aspects of methodology of economic investigations in the appraisal of aircraft systems
[AD-703162] N70-36309
SARTO, J. M.
Area navigation charting
A70-38231
SATO, T.
A consideration on recirculating jet curtain flow
A70-42278
SAWADA, T.
Analytical investigation of radial inflow turbine design geometry
A70-46012
SAWYER, R. F.
Applications of aerospace technology to air pollution problems
[AIAA PAPER 70-815] A70-35194
The role of chemistry in gas turbine emissions
[ASME PAPER 70-GT-81] A70-36883
SCAGNELLI, H. J.
Design study of a transportable earth station for satellite communications systems
A70-41344

SCANLAN, J. V.
Forgings in titanium alloys
A70-34357
SCANLON, J. H.
Air pollution by airports
A70-35177
SCHADOW, K.
Hybrid-combustion in acceleration-ram rocket drives
[ICAS PAPER 70-50] A70-44147
SCHAEFER, G. W.
An airport bird detection radar for reducing bird hazards to aircraft
A70-35998
SCHAEFER, R. K.
Operational constraints for STOL aircraft
[AIAA PAPER 70-1283] A70-45972
SCHAEFER, R. K., JR.
Expected technical and economic characteristics of 1975 STOL systems
[SAE PAPER 700311] A70-36812
SCHAICH, J.
A four-seat STOL passenger aircraft - A new German design
A70-37371
SCHAUB, U. W.
A method for guiding efflux air from a fan-in-wing model into a discharge duct
[NRC-11446] N70-40470
SCHEPERS, H.-J.
The H2 hypersonic wind tunnel of the DFVLR at Porz-Wahn
[DFVLR-SONDDR-19] A70-44799
SCHIJVE, J.
Cumulative damage problems in aircraft structures and materials
A70-34924
Load sequences for fatigue testing of components and full-scale aircraft structures
[ICAS PAPER 70-32] A70-44101
SCHIRMER, R. M.
Morphology of deposits in aircraft and engine fuel systems
[SAE PAPER 700258] A70-36823
SCHLADER, A. F.
Steam film cooling in combustion chambers of aircraft propulsion units
A70-43199
SCHLOTT, B.
Steam film cooling in combustion chambers of aircraft propulsion units
A70-43199
SCHMIDT, G.
A V/STOL guidance and control system with bad weather landing capability
A70-44843
SCHMIEDLIN, R. F.
Acoustic and aerodynamic performance of a 6-foot-diameter fan for turbofan engines. 1 - Design of facility and QF-1 fan
[NASA-TN-D-5877] N70-32721
SCHMIEGE, R. A.
Holographic subsonic flow visualization
A70-40809
SCHMITZ, F. H.
Optimal takeoff trajectories of a heavily loaded helicopter
A70-35841
SCHMITZ, F. W.
Aerodynamics of the model airplane. Part 1 - Airfoil measurements
[NASA-TM-X-60976] N70-39001
SCHNEIDERMAN, A. M.
Laser planogram measurements of turbulent mixing statistics in the near wake of a supersonic cone
A70-37529
SCHNELL, W. C.
An experimental evaluation of exhaust nozzle airframe interference
[AIAA PAPER 69-430] A70-42702
SCHOEN, A. H.
Honeycomb core structures of minimal surface tubule sections Patent Application
[NASA-CASE-ERC-10363] N70-40071
SCHOFIELD, B. L.
Experience with unpowered terminal-area instrument approaches
N70-40960
SCHOFIELD, G.
A reliable high temperature transducer for engine vibration measurement
A70-38527
SCHOOLS, R. S.
Holographic head-up display Final technical report, 4 Jun. 1968 - 27 Mar. 1970
[AD-703683] N70-36298
SCHULMAN, S.
Fabrics for gliding decelerators
[AIAA PAPER 70-1180] A70-41833
SCHULTZ, D. F.
Tests of a full-scale annular ram-induction combustor for a Mach 3 cruise turbojet engine
[NASA-TN-D-6041] N70-41975
SCHULZ, R. B.
Interference characteristics of streamer discharges
A70-38179
SCHULZ, R. W.
Air cargo faces many new problems
A70-43268
SCHUMANN, H.-G.
Flight simulation as a design tool especially with respect to the German activities in this field
[ICAS PAPER 70-41] A70-44139
SCHUREK, O.
Application of a method of flow visualization in combustion chambers to an annular combustion chamber
A70-45444
Calculation of the pressure loss of a combustion chamber
A70-45446
SCHWAAR, P. G.
Design optimization of a V/STOL 5000 hp engine
A70-34709
SCHWARTZ, H. S.
Applications of reinforced plastics in aircraft
A70-40028
SCHWEIKHARD, W. G.
Flight evaluation of ground effect on several low-aspect-ratio airplanes
[NASA-TN-D-6053] N70-42738
SCHWEIZER, G.
A V/STOL guidance and control system with bad weather landing capability
A70-44843
SCHWERING, W.
Design of cascades for incompressible plane potential flows with prescribed velocity distribution
[ASME PAPER 70-GT-87] A70-36880
SCORER, R. S.
Contrails and aircraft downwash
A70-42684
SCOTT, J.
Air traffic demanding more accurate controls
A70-43486
SCOTT, R. B.
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SEAMAN, E. A.
U.S. Air Force problems in bird/aircraft strikes
A70-35984
SECKEL, E.
The stability deprivatives of the Navion aircraft estimated by various methods and derived from flight test data
N70-39253
SECOMB, D. A.
Performance at transonic speeds of an attitude sensing head using short protruding tubes
[ARL/A-321] N70-39023
Performance of an 0.81 inch diameter hemisphere-cylinder yawmeter at transonic speeds and varying Reynolds number
[ARL/A-320] N70-39031
SEDELNIKOV, T. KH.
The noise frequency spectrum of a supersonic jet
A70-38660
The discrete components of the noise frequency spectrum of a free supersonic jet
A70-38661
The dispersion equation of a 2-dimensional ejector
A70-38662
Dispersion equations for multi-layered jets and several jets

A70-38663
SEECAMP, R. G.
Calculation of radar reflecting properties of jet engine intakes using a waveguide model
A70-43584
SELEZNEV, K. P.
The shape of interblade channels in the impellers of stationary compressors
[NLL-RTS-5564] N70-34769
SELIG, E.
A method for assessing a system's operational effectiveness
A70-38837
SELTZER, S. M.
Parameter plane stability analysis of a flight vehicle
[AIAA PAPER 70-983] A70-39546
SEN, W. J.
Integrated communication, navigation and identification
A70-41132
SENSBURG, O.
Flutter induced by aerodynamic interference between wing and tail
A70-36445
SEREBRENY, S.
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[NASA-CR-1570] N70-34253
SEROVY, G. K.
Experimental performance in annular cascade of variable trailing-edge flap, axial-flow compressor inlet guide vanes
[ASME PAPER 70-GT-106] A70-36845
Utilization of cascade data in axial-flow compressor design and analysis - A critical review
A70-36846
SESEMAN, J.
Digital extraction of primary and secondary radar data
A70-38644
SHAFER, C. C.
An airline pilot's view of airline flying versus STOL flying
[AIAA PAPER 70-1282] A70-45971
SHAFFER, D. G.
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[AIAA PAPER 70-765] A70-34486
SHALAEV, G. M.
Turbulence in the zone of interaction between a jet and a flow
A70-41773
SHANEBROOK, J. R.
Entrainment theory for axisymmetric, turbulent, incompressible boundary layers
A70-44400
SHANK, M. E.
The development of columnar grain and single crystal high temperature materials through directional solidification
A70-44857
SHANKS, G. T.
Manoeuvre demand control for aircraft
A70-46203
SHANKS, R. E.
VTOL instrument flight research relating to aircraft requirements and operating characteristics for the terminal area
[AIAA PAPER 70-1333] A70-45935
SHAPELY, J. J., JR.
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SHAPIRO, N.
Model study of high bypass jet noise
A70-44394
SHAW, G. W.
Aerodynamic characteristics of thick sharp edged cropped delta and gothic wings giving low lift-dependent drag
A70-38615
SHAW, H.
An improved blade root design for axial flow compressors /and turbines/
A70-38616
SHEER, R. E., JR.
Flow and acoustic characteristics of subsonic and supersonic jets from convergent nozzle
A70-34460
Heat transfer on a flat plate in helium at Mach numbers 67.3 and 87.6 and in hypersonic corner flow with air at Mach number of 19
[NASA-CR-114257] N70-42365
SHEPHERD, J. T.
Airborne computers - Is the special-purpose machine economically effective
A70-41920
SHERBERT, A. T., JR.
An investigation of the need for improved displays in heavy-lift helicopters
A70-34731
SHERLING, W. G.
Critical height phenomenon for vertical jets mounted in flat surfaces
A70-36709
SHERSHER, E. A.
Pilot, attention - Birds
A70-44099
SHIBATA, T.
Porous wall interference in transonic wind tunnel
A70-42337
SHIELDS, J. E.
Hijack detection programs
A70-44496
SHIFRIN, K. S.
The terrestrial thermal radio-emission field
A70-45192
SHIPLEY, P.
Stabilization and control of the space shuttle orbiter during entry/pitchdown maneuvers
N70-40963
SHIPMAN, K. W.
A theoretical method for rotor blade flutter in forward flight
A70-34727
SHIRAISHI, S.
Aircraft inspection by Ir-192 and Tm-170 gamma-ray radiography
A70-45725
SHIRLEY, W. A.
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SHOEMAKER, H. E.
Techniques for reducing sand and dust erosion in small gas turbine engines
[SAE PAPER 700706] A70-42672
SHOOK, R. W.
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SHOOK, S.
Catalytic combustion fuel tank inerting techniques
A70-44485
SHOR, L. A.
Calculation of initial deflections in naturally twisted turbine engine blades
A70-45505
SHORE, C. P.
Flutter design charts for biaxially loaded isotropic panels
A70-36446
SHRAGER, J. J.
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SHTENNIKOV, YU.
Parachute packing
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SHULDINER, P. W.
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[PB-190929] N70-34648
SHULTEN, C.
STOL port safety
N70-41084
SHUMATE, C. P.
Techniques for reducing sand and dust erosion in small gas turbine engines
[SAE PAPER 700706] A70-42672
SHUTLER, A. G.
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[ASME PAPER 70-GT-40] A70-36870

SHVETS, IU. I.
Comparison of different methods for calculating velocity fields in turbine stages A70-44735
SIDOROV, IU. I.
Pilot influence on the dynamic design of aircraft [ICAS PAPER 70-37] A70-44134
SIGAUD, B. J.
Evolution of the test installation and the systems of data treatment of Jaguar A70-38537
SIKORSKI, M.
Some problems associated with the service life of technological aviation systems. II A70-34686
SILHANEK, V.
On aircraft longitudinal motion after boundary layer control system failure during take-off and landing A70-45448
SIMKIN, M. S.
On equations of three-dimensional laminar boundary layer of bodies of revolution A70-43323
SIMONS, I. A.
Some objectives and problems associated with model testing A70-38610
SIMPSON, M. A.
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SIMPSON, R. W.
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SIMS, C. T.
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SINACORI, J. B.
Validation of ground based simulation A70-35954
SINAISKII, B. N.
Fatique strength testing of turbine blade simulators in a gas flow A70-38459
SINCERBOX, G. T.
Holographic head-up display Final technical report, 4 Jun. 1968 - 27 Mar. 1970 [AD-703683] N70-36298
SIRAZETDINOV, T. K.
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SIRKIS, J. A.
Anticollision lights for the supersonic transport /SST/ [FAA-AM-70-9] N70-42404
SISTO, F.
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SIVASEGARAM, S.
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SIZOVA, R. N.
Statistical estimation of heat-resistance characteristics of materials for gas-turbine engines A70-43940
SJOEDIN, L.
Viggen is tested - Methods of measurement A70-46228
SKELTON, G. B.
Wind gusts - 0-300 ft altitude - Homogeneous terrain A70-40784
SKINNER, R. W.
Evaluation of lower ILS minimums for light aircraft [AD-708294] N70-41156
SKODA, Z.
A calculation of generalized aerodynamic forces acting on a wing in a subsonic flow A70-43118
Forces and torque acting on an aerofoil in a potential jet A70-45438
Effect of mixing of a jet with the ambient air on an aerofoil with a jet flap A70-45439
SLATER, A.
The use of fire tunnel test techniques in the design of Concorde powerplant [ASME PAPER 70-GT-128] A70-36854
SLEEMAN, W. C., JR.
Glide performance of advanced parawings [AIAA PAPER 70-1186] A70-41829
Wind tunnel studies of effects of construction methods, design details, and canopy slots on the aerodynamic characteristics of small-scale all-flexible parawings [NASA-TN-D-5974] N70-40751
SMALL, W. J.
Aerodynamic characteristics of a hypersonic transport configuration at Mach 6.86 [NASA-TN-D-5885] N70-34876
SMITH, D. H.
New developments in fluidics for aircraft high-pressure hydraulic system applications [SAE PAPER 700784] A70-45860
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SMITH, D. L.
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SMITH, D. P. J.
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SMITH, D. W.
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SMITH, E. H.
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SMITH, F. H.
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SMITH, G. E.
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SMITH, H. G.
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SMITH, J. H. B.
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SMITH, K. W.
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SMITH, M. C. G.
The use of a runway vehicle for testing lifting rotors in simulated forward flight A70-38611
SMITH, M. J. T.
Minimum noise pod design [SAE PAPER 700805] A70-45877
SMITH, R. E.
Development of a flying qualities criterion for the design of fighter flight control systems [AIAA PAPER 70-927] A70-35837
SMITH, R. T.
Hypersonic flow diagnostic studies in a large arc-heated wind tunnel A70-40270
SMITH, T. B., III
Determination of the optimum resolution element for a pilot warning indicator [NASA-CR-113808] N70-41040
SMITH, T. W.
TRANSOP model methodology Final report [PB-190936] N70-34622
HSGT mode service analysis in the Northeast Corridor Final report [PB-190934] N70-34644
SMITH, V. J.
A review of the design practice and technology of

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[ASME PAPER 70-GT-116] A70-36850
SMITHSON, H. K.
Supersonic combustion tests with a double-oblique-shock SCRAMjet in a shock tunnel
[AIAA PAPER 69-827] A70-41752
SNYDER, C. T.
A piloted simulator investigation of ground effect on the landing maneuver of a large, tailless, delta-wing airplane
[NASA-TN-D-6046] N70-42810
SOBCZAK, J.
Hi-glide personnel canopies - Efforts toward identification of requirements
[AIAA PAPER 70-1194] A70-41822
SOLMAN, V. E. F.
Airport design and management to reduce bird problems
A70-35991
SOLOMON, H. L.
Case studies of Short Haul Air Transportation in the Western Region
[AIAA PAPER 70-888] A70-37394
SOMASHEKAR, B. R.
Flutter of skew panels by the matrix displacement approach
A70-40586
SOMMER, R. W.
Evaluation of a moving-graph instrument display for landing approaches with a helicopter
[NASA-TN-D-6025] N70-41183
SOMMERS, A. N.
Intercity V/STOL service and the businessman traveler
[AIAA PAPER 70-1241] A70-45961
SOROKIN, V. G.
Study of the short-term creep of the OT-4 alloy in high-speed air flows under aerodynamic vibrations
A70-45826
SOSNITSKII, S. P.
Behavior of solutions to the equations of a spatial gyrohorizon compass
A70-35344
SOUILLARD, G. J.
Lubricants and hydraulic fluids
N70-39641
SOULE, T. L.
Advanced control system considerations for small shaft-type aircraft gas turbines
[ASME PAPER 70-GT-132] A70-36858
SPANGLER, S. B.
Theoretical investigation of the aerodynamic characteristics of all-flexible parawings
[AIAA PAPER 70-1188] A70-41827
SPATUZZA, G.
Radiobeacons in space for aerial navigation
A70-42652
SPAULDING, W. G.
Current ferrite phase shifter technology for array antennas
A70-37864
SPEELMAN, R. J., III
Hi-glide personnel canopies - Efforts toward identification of requirements
[AIAA PAPER 70-1194] A70-41822
A review of para-foil applications
A70-42706
SPENCER, B. W.
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[NASA-TN-D-5944] N70-39377
SPENCER, R. H.
Application of vortex visualization test techniques to rotor noise research
A70-34712
SPINCOURT, J.
Developments in helicopter rotor technology
A70-35550
SPITKO, R. J.
The development of a fiberglass main rotor blade for the CH-47C helicopter
A70-34702
SPIVEY, W. A.
New insights into the design of swept-tip rotor blades
A70-34736
SPOONER, P. J.
An analysis of safety
A70-35860
SPRAGUE, R. A.
High strength titanium alloys for aircraft gas turbine application
A70-34436
SPRATT, N.
Development of flight line tool box for use at A and AEE
[A/AEE-NOTE-9001] N70-42525
SPREITER, J. R.
Aerodynamics of slender bodies and wing-body combinations at a free-stream Mach number equal to one - Theory and experimental evaluation
[AIAA PAPER 70-798] A70-39900
Flow with M/infinity/equals 1 past thin airfoils
A70-44583
SPRINGER, W. E.
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[AD-703268] N70-32338
SPROUFFSKE, J. F.
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A70-44456
SRIDHARA, K.
Performance of conical jet nozzles in terms of discharge coefficient
A70-38243
STAFIEJ, W.
Influence of water ballast on glider loads
A70-36253
Water ballast loadings on sailplanes
A70-42962
STAHARA, S. S.
Aerodynamics of slender bodies and wing-body combinations at a free-stream Mach number equal to one - Theory and experimental evaluation
[AIAA PAPER 70-798] A70-39900
Flow with M/infinity/equals 1 past thin airfoils
A70-44583
STAKOLICH, E. G.
Acoustic and aerodynamic performance of a 6-foot-diameter fan for turbofan engines. 1 - Design of facility and QF-1 fan
[NASA-TN-D-5877] N70-32721
STALDER, J. P.
Propulsion system impact on military/commercial STOL transport commonality
[SAE PAPER 700269] A70-36819
The attitude control system as an integral part of the V/STOL propulsion system installation
[ASME PAPER 70-GT-31] A70-36832
STANDLEY, D.
Aircraft noise and airport neighbors - A study of Logan International Airport
[PB-190118] N70-37337
STANOIU, L.
Factors affecting fuel consumption and economy from the standpoint of different aircraft
A70-42602
STAPLES, J. C.
Operational evaluation of STOL aircraft and related STOL developments
N70-40777
Operational research related to STOL ports
N70-41085
STARIKOVA, M. V.
Application of the method of harmonic linearization to nonlinear automatic systems with finite automata
A70-42836
STARKEN, H.
Some experimental results of two-dimensional compressor cascades at supersonic inlet velocities
[ASME PAPER 70-GT-7] A70-36829
STARKMAN, E. S.
The role of chemistry in gas turbine emissions
[ASME PAPER 70-GT-81] A70-36883
STARR, S. H.
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[AIAA PAPER 70-966] A70-39563

STEARMAN, R. O.
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[AD-708485] N70-40297
STEFFEN, F. W.
Performance of an auxiliary inlet ejector nozzle with fixed inlet doors and triple-hinge trailing-edge flap
[NASA-TM-X-2034] N70-32047
Performance of a 10 deg conical plug nozzle with a stowed thrust reverser at Mach numbers from 0 to 2.0
[NASA-TM-X-2116] N70-42437
STEGALL, J. F.
Aircraft simulation of lunar landing approach trajectories
[NASA-TM-X-64433] N70-35662
STEGEN, G. R.
A technique for phase speed measurements in turbulent flow
A70-38019
STEINER, J. E.
Aircraft development and world aviation growth
A70-34915
STEINER, R.
A simplified method of estimating the response of light aircraft to continuous atmospheric turbulence
[AIAA PAPER 69-766] A70-42703
STEINERT, A. G.
Cost estimating techniques for advanced technology engines
[SAE PAPER 700271] A70-36818
STEINLEIN, F. R.
The design of composite compression tubes
[AIAA PAPER 70-898] A70-35809
STEINMANN, H. H.
The CH-47 cruise guide indicator
A70-34705
STENGEL, R. F.
Altitude stability in supersonic cruising flight
[AIAA PAPER 69-813] A70-42712
Space shuttle transition to cruising flight
A70-44623
STENTON, T. E.
Theoretical frequency response functions and power spectra of the XB-70 response to atmospheric turbulence
[NASA-CR-1621] N70-35659
STEPHENSON, C. D.
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[ASME PAPER 70-GT-97] A70-36844
STEPKA, F. S.
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[NASA-TN-D-5928] N70-34015
STERNBERG, E.
Load transfer and load diffusion in elastostatics
[AD-703641] N70-35374
STERNIN, L. E.
Method of characteristics for calculating supersonic gas flows with foreign particles in plane and axisymmetric nozzles
A70-37228
STEVENS, G. W. H.
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[AIAA PAPER 70-1169] A70-41844
STEVENS, J. R.
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A70-42709
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A70-36674
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A70-43272
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Multistage multiple-reentry turbine Patent
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STEWARTSON, K.
Trailing-edge stall
A70-36194
STICKNEY, T. M.
Thermal recovery and the accuracy of air total temperature sensors
A70-37882
STITES, J. D.
Air cargo terminal analysis
A70-40127
STOBBE, H.
The effects of uniform profile changes on the degree of efficiency, the incline, and the mass flow in multiple step axial turbines
N70-39449
STOLZE, K.
Problem of orthogonality of the eigenmodes of aircraft vibrations
A70-44766
STONE, J. W.
Mid-air retrieval - Optimizing performance and weight of the aircraft-borne and descent systems
[AIAA PAPER 70-1201] A70-41805
STORY, A. W.
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STOUT, W. M.
Future advances in the aerodynamics of military strike aircraft
N70-40708
STRAIGHT, D. M.
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[NASA-TM-X-52897] N70-42174
STRAUB, J.
Shot peening wing panels for the 747
A70-38498
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STUDD, A. G.
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N70-32165
STUEBER, B.
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A70-38722
STUEMKE, H.
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STURGES, D. C., JR.
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SUKHARNIKOV, V. N.
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SUKHININ, V. P.
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SUZUKI, T.
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A70-36647
SZUSTAK, L. S.
Control of large crane helicopters
A70-34723

T

TAGANOV, G. I.
A mathematical model for a theoretical study of three-dimensional separated flows
A70-36438
TAGIROV, R. K.
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A70-36261
TAILLET, J.
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A70-45192
TUDOR, A. J.
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A70-35995
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A70-34710
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A70-39140
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N70-36198
UDILOV, V. V.
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A70-39845
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A70-40182
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A70-38232
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V

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N70-39251
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N70-35137
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Instrumentation in the aerospace industry. Volume 15 - Instrument Society of America, International Aerospace Instrumentation Symposium, 15th, Las Vegas, Nev., May 5-7, 1969, Proceedings
A70-35476
Instrumentation in the aerospace industry. Volume 16 - Instrument Society of America, International Aerospace Instrumentation Symposium, 16th, Seattle, Wash., May 11-13, 1970, Proceedings
A70-37873
WATANABE, K.
On the characteristics of two-dimensional slide plate of ground effect machines with small attack angle
A70-39140
Aircraft inspection by Ir-192 and Tm-170 gamma-ray radiography
A70-45725
WATANABE, Y.
High enthalpy nozzle flow with heat exchange
A70-35238
WATERS, M. H.
Hypersonic transport preliminary performance estimates for an all-body configuration
[AIAA PAPER 70-1224] A70-45957
WATSON, H. A., JR.
Structural and environmental studies of acoustical duct-lining materials
A70-42531
WATSON, J. D. L.
The effects of tinted Plexiglas on visibility in the AH-1G Cobra aircraft
[AD-709405] N70-41229
WATSON, R. D.
Laminar heating in interior corners at Mach 19
A70-39700
WATSON, R. G.
Computer optimization of water-augmented turbofan concept and development of a test facility for two-phase flow
[AD-708044] N70-40023
WAUNG, F.
L-1011 on-board weight and balance system
[SAWE PAPER 837] A70-40359
WEAR, J. D.
Tests of a full-scale annular ram-induction combustor for a Mach 3 cruise turbojet engine
[NASA-TN-D-6041] N70-41975
WEBB, R. C.
Aerospace sciences - Terminal forecast verification
[AD-707498] N70-37703
WEBB, W. H.
Wake stability and transition studies at Mach 4.5
A70-34465

WEDAN, R. W.
Flight evaluation of radar-inertial systems
A70-42651
WEEKS, T. M.
Effects of flow unsteadiness on hypersonic wind tunnel spectroscopic diagnostics
A70-40271
WEETMAN, R. J.
Ducted propellers - A review and description of current investigation
[AD-705524] N70-33670
WEINSTEIN, L. M.
Influence of measured freestream disturbances on hypersonic boundary-layer transition
[AIAA PAPER 69-704] A70-41744
WEIR, D. H.
A pilot-vehicle systems approach to longitudinal flight director design
[AIAA PAPER 70-1001] A70-39530
WEISS, H. G.
General research Quarterly technical summary report, 1 Nov. 1969 - 31 Jan. 1970
[AD-704573] N70-36488
Air traffic control Quarterly technical summary report, 1 Feb. - 30 Apr. 1970
[AD-707137] N70-38709
WEISSMAN, C. C.
Introductory remarks on preliminary airplane design
N70-40702
WEISSMAN, J.
Tradeoffs for real-time computer configurations
A70-35510
Modular computer system architecture
N70-39496
WEISSMAN, S.
Avionics designer's view of the systems intergration problem
N70-40719
WELDON, W. J.
Nondestructive testing - A condition monitored maintenance tool
A70-38830
WELK, H. B., JR.
Naval fluidic applications - Present and future
A70-45428
WELLS, C. H.
Information requirements for supersonic transport operation Final report
[NASA-CR-1570] N70-34253
WELLS, G. R.
Development of a hybrid fluidic damper control for an aircraft yaw axis
[SAE PAPER 700794] A70-45853
WELLS, H. M., JR.
Air Force aircraft structural integrity program - Airplane requirements
[AD-707884] N70-39664
WENHAM, R. J.
Computerized air combat simulation - A digital approach and its application
A70-36453
WENNERSTROM, A. J.
Axial compressor airfoils for supersonic Mach numbers Final report
[AD-707144] N70-37673
WERLE, H.
Ground effect visualization at low speeds around aircraft models
[NASA-TT-F-13254] N70-39296
WERLE, J. E.
Reactor for nuclear extended range aircraft
A70-43188
WERLE, M. J.
Jet-interaction-induced separation of supersonic turbulent boundary layers - The two-dimensional problem
[AIAA PAPER 70-765] A70-34486
WERNER, J.
Reflection and focusing of sonic booms by two-dimensional curved surfaces
[NASA-CR-110727] N70-32893
WERNICKE, R. K.
Recent advances in helicopter vibration control
A70-34735
WEST, R. N.
Positron annihilation in quenched cadmium metal
A70-46257
WESTCOTT, V. C.
Helicopter lift-margin system, volume 1 Final report
[AD-704601] N70-36384
WETHORE, J. W.
Aircraft instrument Patent
[NASA-CASE-XLA-00487] N70-40157
WETZLAR, K. E.
A new method for wall thickness measurements down to 0.2 mm with an accuracy of better than 10 micrometers
A70-45681
WEYL, C. J.
A design approach to provide satisfactory spin characteristics for a modern fighter aircraft
[AIAA PAPER 70-928] A70-35838
WHALLON, H. D.
Economic analysis of the use of gelled fuels in jet transport aircraft Final report
[FAA-NA-70-45] N70-34002
WHEATCROFT, S.
The influence of operational and technical factors on air transport regulation
A70-40579
WHEELER, J. D.
Area navigation systems for STOL operation
A70-36513
WHINERY, D. G.
Composite airframe design
[AIAA PAPER 70-919] A70-35813
WHISMAN, M. L.
Storage stability of high temperature fuels. Part 3 - The effect of storage upon thermally induced deposition of selected fuel components and additives Technical report, Mar. 1969 - Mar. 1970
[AD-707524] N70-38458
WHITE, F. C.
Satellite aid to airplanes - An overview
[AIAA PAPER 70-1301] A70-45922
WHITE, R. J.
Improving the airplane efficiency by use of wing maneuver load alleviation
[AIAA PAPER 70-877] A70-34813
WHITEHEAD, A. M.
Hybrid computer programme for parameter optimisation of flight control systems
[RAE-TR-70043] N70-42386
WHITELEY, M. C.
Airborne Integrated Data Systems /AIDS/ for aircraft management
N70-32157
WHITLA, J.
An engineering treatment of continuous-flow requirements in aircraft passenger oxygen systems using the phased dilution principle
A70-44483
WHITTLE, P.
Reduction of a class of stochastic control problems
A70-35973
WHITTLEY, D. C.
Some experimental research on a new aircraft configuration incorporating ejector-type thrust augmentors for VTOL
[ICAS PAPER 70-56] A70-44152
The evolutionary development and current status of the augmentor wing concept
[SAE PAPER 700812] A70-45903
WIDMER, H.
Utilization of nondestructive testing as a means of extending aircraft service life
A70-45719
WIETING, A. R.
Experimental investigation of heat-transfer distributions in deep cavities in hypersonic separated flow
[NASA-TN-D-5908] N70-37168
WIGGERS, G. F.
A preliminary report on the Cleveland Before and After Study Interim technical report
[PB-184060] N70-41400
WIGNOT, J. E.
Aircraft dynamic wheel load effects on airport pavements Final report, May 1969 - May 1970
[FAA-RD-70-19] N70-32560
WILAND, E.
Unsteady aerodynamics of stationary elliptic cylinders in subcritical flow

[AIAA PAPER 69-745] A70-44564
WILBY, P. G.
The prediction of aerofoil pressure distributions for sub-critical viscous flows A70-40924
WILCOCK, D. F.
The hybrid boost bearing - A method of obtaining long life in rolling contact bearing applications
[ASME PAPER 69-LUB-16] A70-37605
WILCOX, D. E.
A fundamental approach to aircraft manufacturing cost estimating in the conceptual design phase
[SAWE PAPER 865] A70-40371
WILDE, K. K.
Work of ICAO in the field of bird hazard reduction A70-35997
International challenge to airports A70-37748
WILEY, E.
Problems of airport congestion by 1975 N70-41273
WILEY, J. R.
V/STOLport accessibility considerations
[AIAA PAPER 70-1311] A70-45947
WILEY, W. H.
Preliminary design and analysis of an advanced convertible fan/shaft engine for V/STOL tactical and transport aircraft A70-34710
WILLETTS, L. J., JR.
An investigation of the longitudinal handling qualities of a variable stability flight simulator
[AD-703225] N70-35288
WILLEY, O. S., JR.
Survival in foam A70-44465
WILLIAMS, D. C.
The theory and capabilities of magnetically driven flyers
[AD-708449] N70-41131
WILLIAMS, D. E.
Midair rescue using the pilot airborne recovery device /PARD/
[AIAA PAPER 70-1206] A70-41812
WILLIAMS, J.
Some fluid-dynamics considerations relating to the preliminary design of combat aircraft N70-40707
WILLIAMS, J. E. F.
Instability of a two-dimensional compressible jet
[AD-707257] N70-37667
WILLIAMS, J. P.
Some recent experimental studies on the aeroelastic stability of thin cylindrical shells. Part 1 - An experimental study of the supersonic flow field over an aeroelastic ogive cylinder model with boundary layer control
[AD-708485] N70-40297
WILLIAMS, J. R.
Technical approaches to aircraft data recording in civil and military aircraft A70-35515
WILLIAMS, R., JR.
The effects of nonlinear asymmetric supports on turbine engine rotor stability
[SAE PAPER 700320] A70-36799
WILLIAMS, S. B.
Helicopter lift-margin system, volume 1 Final report
[AD-704601] N70-36384
WILLIAMS, T. J.
STOL marking and lighting N70-41083
WILLIAMS, T. O.
Titanium hot forming A70-34444
WILLIAMS, W. W.
An advanced extensible wing flap system for modern airplanes
[AIAA PAPER 70-911] A70-35823
WILLIAMSON, R. G.
Experimental investigation of slotted engine intakes in the upper surface of a thick wing
[LR-526] N70-35142
WILLIHAN, A. O.
Through the central 'multiprocessor' avionics enters the computer era A70-34673
WILMOT, R. D.
Queueing requirements in an automatic radar target detection system operating with a narrow bandwidth data link A70-43489
WILSON, B. J.
An assessment of high-voltage dc electrical power in aircraft electrical systems Interim report
[AD-709079] N70-40339
WILSON, I. J.
A recombination ionization chamber system as a sensitive, three channel LET indicator for stratospheric use N70-32393
WILSON, K. H.
Influence of wing root shaping on the pressure distribution of swept-wing body configurations
[ARC-CP-1109] N70-43087
WILSON, K. R.
The use of stretch fabric materials in personnel escape parachutes A70-44482
WILSON, R.
System design study for an optimal remote oculometer for use in operational aircraft
[NASA-CR-1562] N70-33103
Analytical investigation of spinning behaviour and recovery from the developed spin of a 60 deg delta-wing aircraft configuration using a high-speed digital computer
[WRE-TN-HSA-137] N70-36966
WILSON, R. B.
Mobile lounges and airport productivity
[AIAA PAPER 70-918] A70-35830
WILSON, S. B. L.
Computer-aided production engineering at Rolls-Royce A70-45299
WILSON, W. F.
Recent advances in helicopter vibration control A70-34735
WINESTONE, R. L.
Northeast Corridor Transportation Project report
[PB-190929] N70-34648
WINKELMANN, A. E.
An experimental investigation of the flow field around a yawed cone A70-34485
WINN, L. W.
The hybrid boost bearing - A method of obtaining long life in rolling contact bearing applications
[ASME PAPER 69-LUB-16] A70-37605
WINTER, D. F.
Joule heating of a plate electrode in a free arc discharge
[AD-705645] N70-33442
WISE, F. D.
AIDS- Benefits and costs to users - Why use it A70-37894
WISEMAN, R. D., JR.
Helicopter personnel escape and survival system
[SAE PAPER 700832] A70-45890
WISER, G. L.
Glass/plastic composite windshields A70-41137
WISLER, L. S.
An investigation of oscillations in an adaptive aircraft control system under large input commands
[AD-705074] N70-36463
WISLICKI, B.
Investigations of kerosene fuels in small laboratory combustion chambers
[AD-708352] N70-39926
WISWALL, C. E.
Holographic subsonic flow visualization A70-40809
WITKOWSKI, R.
Some problems in piloting helicopters A70-43530
WITTLIN, G.
Aircraft dynamic wheel load effects on airport pavements Final report, May 1969 - May 1970
[FAA-RD-70-19] N70-32560
WOITSCH, W.
Airborne and ground resonance of hingeless rotors A70-34733

WOJCIECHOWSKI, C. J.
Study of convective heat transfer to cones and cylinders at angle of attack Final report
[NASA-CR-102824] N70-37466
WOLF, J. D.
Aircraft displays for steep-angle approaches
[AD-709475] N70-41477
WOLFE, J. A.
A digital data acquisition, processing and operations control system for the LTV high speed wind tunnel
A70-37923
WOLTOSZ, W. S.
Critical height phenomenon for vertical jets mounted in flat surfaces
A70-36709
WONG, N. D.
A two-dimensional mixed-compression inlet system designed to self-restart at a Mach number of 3.5
[AIAA PAPER 69-447] A70-42707
WOOD, E. R.
A theoretical method for rotor blade flutter in forward flight
A70-34727
WOOD, G. M.
An axial compressor end-wall boundary layer theory
[ASME PAPER 70-GT-80] A70-36884
WOOD, M. C.
Prototype cluster-parachute recovery system for a 50,000 pound unit load. Volume 1 - Design study Final report, May 1968 - Jan. 1969
[AD-701004] N70-33952
WOOD, R. M.
Aerodynamic parameters that affect compressor erosion in gas turbine engines
A70-34711
WOOD, W.
Maintenance recording applied to advanced aircraft
A70-35516
WOODFIELD, A. A.
Measurement of the moments and product of inertia of the Fairey Delta 2 aircraft
[ARC-R/M-3620] N70-37161
WOODMAN, L., JR.
Direct aircraft maintenance costs - Military and commercial
A70-40750
WOODS, B. A.
The design of compression surfaces for high supersonic speeds using conical flow fields
[ARC-R/M-3539] N70-40993
WORSHAM, J. E.
The design process
N70-40710
WRIGHT, R. H.
Wind-tunnel lift interference on sweptback wings in rectangular test sections with slotted side walls
[NASA-TR-R-344] N70-32610
WRIGLEY, B.
Engine performance considerations for the large subsonic transport
N70-37761
WUEST, W.
Experimental and theoretical investigations of different configurations of lifting re-entry vehicles in hypersonic low density flow
[ICAS PAPER 70-03] A70-44117
WYBORNY, W.
Comparison of hypersonic aerodynamic deceleration systems based on gun tunnel investigations
[AIAA PAPER 70-1174] A70-41839
WYKES, J. H.
XB-70 structural mode control system design and performance analyses
[NASA-CR-1557] N70-34004

Y

YAFFEE, M. L.
New versions of TF41 designed
A70-44596
YAKOVLEV, A. S.
Design handbooks for the Soviet Ministry of Aviation Industry
[AD-704280] N70-34862
YAMAMOTO, A.
Non-linear heaving motion of plenum-chamber- type air cushion vehicles
A70-42280
YAMAMOTO, K.
Drag measurement in nearly-free-molecule-flow regime
[NAL-TR-191] N70-40442
YANCEY, M. M.
An engineering investigation and analysis of crash-fire resistant fuel tanks Final report
[NA-69-43] N70-34001
YANG, H. S. D.
C-5A main landing gear bogie pitching control
[AIAA PAPER 70-914] A70-35826
YEFREMOV, I. I.
The problem of oscillations of a thin profile in a subsonic flow near a rigid boundary
[NASA-TT-F-12966] N70-34182
YERRY, B. R.
Thermal insulation for the Concorde engine bays
A70-36345
YINGLING, G. L.
An examination of the low visibility landing problem below 200 ft and the federal regulations governing operational approval
[AIAA PAPER 70-936] A70-35845
YOSHIHARA, H.
Flow over airfoils in the transonic regime. Volume 1 - Prediction of buffet onset Final technical report, 15 Nov. 1968 - 12 Dec. 1969
[AD-709377] N70-41732
YOST, J. D.
Structural design loads for strength and fatique, computed with a multi-variable load environment model
[AIAA PAPER 70-948] A70-39579
YOUNG, H.
The development of a fiberglass main rotor blade for the CH-47C helicopter
A70-34702
YOUNG, J. R.
Attenuation of aircraft noise by wood-sided and brick-veneered frame houses
[NASA-CR-1637] N70-35694
Judgment tests of flyover noise from various aircraft
[NASA-CR-1635] N70-35881
YOUNG, W. R.
Flight evaluation of ground effect on several low-aspect-ratio airplanes
[NASA-TN-D-6053] N70-42738
YUAN, S. W.
Jet circulation control airfoil for VTOL rotors
[AIAA PAPER 69-741] A70-42705

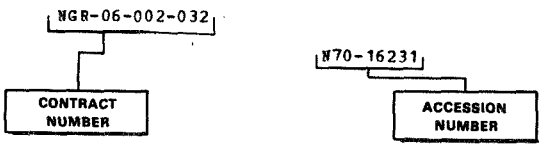
Z

ZAKHAROV, V.
Landing approach using the 'Svod' system
[JPRS-51258] N70-36101
ZAKHAROV, I. I.
Statistical estimation of heat-resistance characteristics of materials for gas-turbine engines
A70-43940
ZAPATA, R. N.
Determination of axial gradient effects in freejet flows
A70-44584
ZAVADA, E. J.
Frangible tube energy dissipation Patent
[NASA-CASE-XLA-00754] N70-34850
ZDORENKO, IU. N.
Comparison of different methods for calculating velocity fields in turbine stages
A70-44735
ZEBOOKER, J. L.
The 1970 study of general aviation flying occupant load factors. Based upon accident records for general aviation flying 1964 - 1968
[REPT-70-9] N70-40800
ZEBROWSKI, M.
Influence of the wind gradient on aircraft piloting
A70-43082
ZELL, H.
Computer program for system reliability
[AD-706827] N70-37871
ZELLER, A. F.
Aircraft accidents at night
A70-41489

ZEMLIANSKII, B. A.
Hypersonic flow around segmentally conical bodies at a large angle of attack
A70-36258
ZIEGER, D.
S-band cw power module for phased arrays
A70-36674
ZIEGLER, R.
An avionics system for a new fighter aircraft
A70-44413
ZIMI, W. P.
Thermal load of an aerodynamic reentry body and the resulting optimization and design criteria
[SC-T-70-4015] N70-33249
ZINBERG, H.
The development of an advanced composite tail rotor driveshaft
[AHS PREPRINT 451] A70-34703
ZIRNHELT, J.
The impact of NDT technology on military aircraft maintenance practices
A70-45678
ZIUZKO, M. P.
Calculation of initial deflections in naturally twisted turbine engine blades
A70-45505
ZOREA, C.
Effect of a spike on the drag and on the aerodynamic stability of blunt bodies in supersonic flow
A70-39702
ZOZULIA, N. V.
Influence of the turbulator element on the local heat transfer from a plate in a flow transition region
A70-44733
ZRELOV, V. N.
Jet engines and fuels
[AD-706167] N70-37640
ZUBRILOVA, V. A.
Statistical estimation of heat-resistance characteristics of materials for gas-turbine engines
A70-43940
ZUK, J.
Use of the computer in design of gas turbine mainshaft seals for operation to 500 ft/sec /122 m/sec/
[NASA-TM-X-52886] N70-40807
ZUMWALT, G. W.
Diffraction and reflection of sonic boom waves
A70-45266
ZVARA, J.
An automatic guidance concept for VTOL aircraft
[AIAA PAPER 70-1035] A70-39502
ZWAAN, R. J.
High subsonic and transonic effects on pressure distributions measured for a swept wing with oscillating control surface
A70-44763
ZWICK, J. W.
Sound transmission and suppression in turbomachinery ducts
[ASME PAPER 70-GT-58] A70-36873
ZWIERZYNSKI, J.
Automation of the service process in air transportation. II
A70-34688
ZYLICZ, M.
Profitableness of long-haul air transportation. I
A70-34689
Profitableness of long-haul air transportation
A70-34691

CONTRACT NUMBER INDEX

Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the *IAA* or *STAR* section.

AF 04/694/-67-C-0035
A70-34487

AF 04/694/-67-C-0051
A70-44566

AF 04/694/-389
A70-34487

AF 04/694/-516
A70-34487

AF 04/701/-69-C-0118
A70-34466

AF 04/701/-69-C-0122
A70-37529

AF 04/701/-70-C-0152
A70-34467

AF 19/604/-1706
A70-34496

AF 19/628/-69-C-0127
A70-43666

AF 19/628/-5167
N70-32481
N70-36488
N70-38709

AF 33/615/-67-C-1010
A70-36449

AF 33/615/-67-C-1157
A70-36443

AF 33/615/-67-C-1563
A70-40784

AF 33/615/-67-C-1672
A70-35814

AF 33/615/-68-C-1227
A70-41845

AF 33/615/-68-C-1720
A70-38179

AF 33/615/-69-C-1023
A70-35836

AF 33/615/-69-C-1121
A70-34722

AF 33/615/-69-C-1156
A70-36674

AF 33/615/-69-C-1488
A70-36674

AF 33/615/-69-C-1664
A70-35837

AF 33/615/-1470
N70-41721

AF 33/615/-2305
N70-38155

AF 33/615/-3294
A70-39529
A70-42711

AF 33/615/-3323
A70-40040

AF 33/615/-3508
A70-35813

AF 33/615/-3657
A70-36681

AF 33/615/-3736
N70-40002

AF 33/615/-5257
A70-40040

AF 33/615/-5389
N70-41152

AF 33/657/-70-C-0235
A70-41812

AF 33/657/-13403
A70-35159

AF 33/657/-14903
A70-34436

AF 40/600/-70-C-0001
A70-41752

AF 40/600/-1186
N70-33910

AF 44/620/-68-C-0010
A70-38019

AF 44/620/-68-C-0018
A70-34463

AF 44/620/-68-C-036
A70-44761

AF 49/638/-1433
N70-36489

AF-AFOSR-69-1744
A70-38304

AF-AFOSR-69-1798
A70-44584

AF-AFOSR-1062-67
A70-36195

AF-AFOSR-1234-67
N70-40297

AF-AFOSR-1502-68
N70-37666

ARPA ORDER 322
N70-40162

ARPA ORDER 529
N70-32870

AT/11-1/-2053
N70-40380

AT/30-1/-3673
N70-37120

AT/30-1/-3839
N70-40214

DA-AMC-28-043-64-G9
A70-34496

DA-AMC-28-043-65-G20
A70-34496

DA-01-021-AMC-13901/Z/
A70-42713

DA-28-043-AMC-02412/E/
A70-35841

DA-31-124-ARO/D/-247
N70-39885

DA-31-124-ARO/D/-459
N70-33274

DA-31-124-ARO/D/-464
A70-40110

DA-36-039-SC-80371
A70-34496

DA-44-177-AMC-200/T/
A70-42705

DAAF03-69-C-0014
N70-42747

DAAG17-68-C-0142
N70-33952

DAAH01-68-C-2086
A70-34465

DAAJ01-69-C-0215
N70-32069

DAAJ02-67-C-0055
A70-35955

DAAJ02-67-C-0072
A70-34702

DAAJ02-68-C-0041
A70-36858

DAAJ02-68-C-0048
A70-34734

DAAJ02-68-C-0076
A70-34706

DAHC04-67-C-0071
N70-41266

DAHC04-68-C-0004
N70-38173

DAHC04-68-C-0027
N70-43141

DAHC15-67-C-0011
N70-40037
N70-40109

DAJA37-69-C-1224
N70-42286

DASA01-68-C-0084
N70-41131

DOT-C-353-66
N70-34622
N70-34644

DOT-F-9-0017
N70-34741

DOT-FR-9-0017
N70-34691
N70-36810

DOT-OS-A9-009
N70-37337

DOT-UT-43 /IAA/
N70-40109

DOT-7-35248
N70-36811

DOT-7-35297
N70-35446
N70-36515

DRB-G-9501-02
N70-38116

DRB-G-9511-92
N70-38116

DRB-G-9550-40
N70-38116

DRB-G-9551-16
N70-38116

DRB-G-9551-17
N70-38116

DRB-0301-20
A70-44151

DRB-9550-38
A70-44564

E-207-69/N/
A70-40109

E-295-68/N/
A70-40109

F04701-69-C-0066
N70-40655

F19628-68-C-0365
N70-40276

F19628-69-C-0073
N70-37993

F33615-67-C-1065
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