AERONAUTICAL
ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 7

JULY 1971

PREVIOUS BIBLIOGRAPHIES IN THIS SERIES

Document	*Date*	*Coverage*
NASA SP-7037	September 1970	Jan.–Aug. 1970
NASA SP-7037 (01)	January 1971	Sept.–Dec. 1970
NASA SP-7037 (02)	February 1971	January 1971
NASA SP-7037 (03)	March 1971	February 1971
NASA SP-7037 (04)	April 1971	March 1971
NASA SP-7037 (05)	May 1971	April 1971
NASA SP-7037 (06)	June 1971	May 1971

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 7

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in June 1971 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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 466 reports, journal articles, and other documents originally announced in June 1971 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citations and abstracts are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes—subject, personal author, and contract number—are included. An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc., (AIAA), as follows: Paper copies are available at $5.00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche[1] are available at the rate of $1.00 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is $1.00. Please refer to the accession number, e.g., A71-10613, when requesting publications.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

SUBSCRIPTION AVAILABILITY

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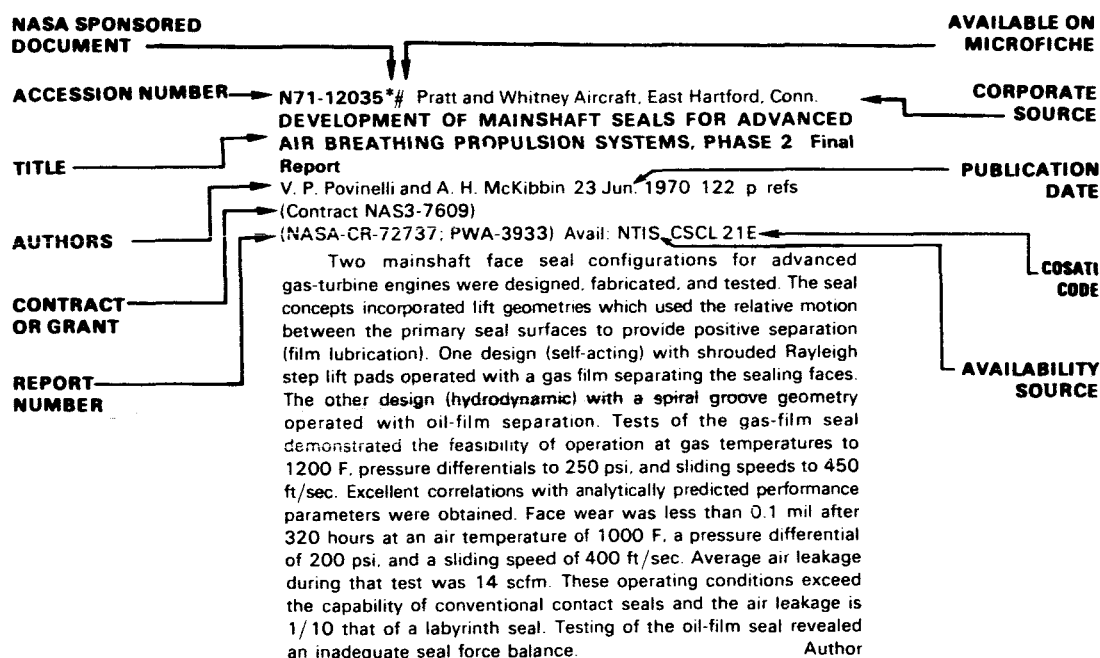Tylers Green
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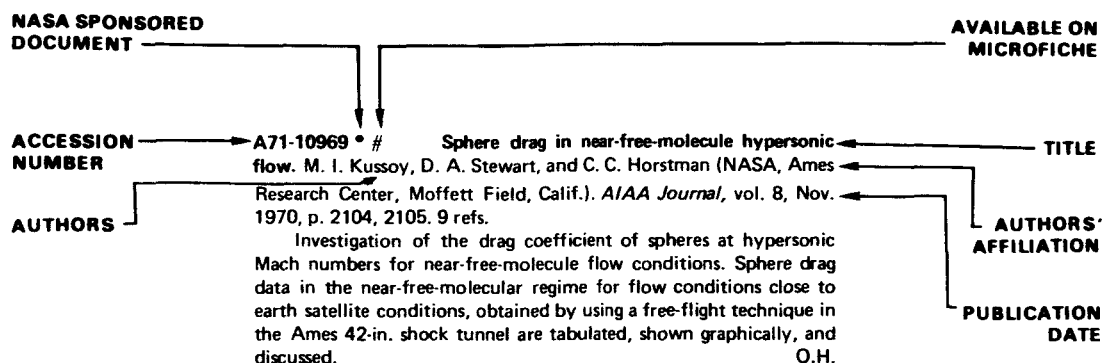8 München 86
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TYPICAL CITATION AND ABSTRACT FROM *STAR*

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ACCESSION NUMBER → N71-12035*# Pratt and Whitney Aircraft, East Hartford, Conn.

CORPORATE
SOURCE

DEVELOPMENT OF MAINSHAFT SEALS FOR ADVANCED
AIR BREATHING PROPULSION SYSTEMS, PHASE 2 Final

TITLE → Report

PUBLICATION
DATE

V. P. Povinelli and A. H. McKibbin 23 Jun. 1970 122 p refs
(Contract NAS3-7609)

AUTHORS → (NASA-CR-72737; PWA-3933) Avail: NTIS CSCL 21E

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REPORT
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Two mainshaft face seal configurations for advanced
gas-turbine engines were designed, fabricated, and tested. The seal
concepts incorporated lift geometries which used the relative motion
between the primary seal surfaces to provide positive separation
(film lubrication). One design (self-acting) with shrouded Rayleigh
step lift pads operated with a gas film separating the sealing faces.
The other design (hydrodynamic) with a spiral groove geometry
operated with oil-film separation. Tests of the gas-film seal
demonstrated the feasibility of operation at gas temperatures to
1200 F. pressure differentials to 250 psi, and sliding speeds to 450
ft/sec. Excellent correlations with analytically predicted performance
parameters were obtained. Face wear was less than 0.1 mil after
320 hours at an air temperature of 1000 F, a pressure differential
of 200 psi, and a sliding speed of 400 ft/sec. Average air leakage
during that test was 14 scfm. These operating conditions exceed
the capability of conventional contact seals and the air leakage is
1/10 that of a labyrinth seal. Testing of the oil-film seal revealed
an inadequate seal force balance.   Author

TYPICAL CITATION AND ABSTRACT FROM *IAA*

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AVAILABLE ON
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ACCESSION
NUMBER → A71-10969 * #   Sphere drag in near-free-molecule hypersonic
flow. M. I. Kussoy, D. A. Stewart, and C. C. Horstman (NASA, Ames

TITLE

AUTHORS → Research Center, Moffett Field, Calif.). *AIAA Journal,* vol. 8, Nov.
1970, p. 2104, 2105. 9 refs.

AUTHORS'
AFFILIATION

Investigation of the drag coefficient of spheres at hypersonic
Mach numbers for near-free-molecule flow conditions. Sphere drag
data in the near-free-molecular regime for flow conditions close to
earth satellite conditions, obtained by using a free-flight technique in
the Ames 42-in. shock tunnel are tabulated, shown graphically, and
discussed.   O.H.

PUBLICATION
DATE

IAA ENTRIES

A71-25144 #   **On two dimensional sound sources and sound waves.** Kaan Edis (Istanbul, Technical University, Istanbul, Turkey). *Istanbul Teknik Üniversitesi Bülteni,* vol. 23, no. 1, 1970, p. 13-26. 5 refs.

A solution of the two-dimensional wave equation is obtained in terms of the time-retarded argument, using asymptotic expansions of Bessel functions and the far field boundary condition. For the acoustic intensity and acoustic power of aeroacoustic noise sources, simple analytical expressions are derived, and a short analysis for the two-dimensional simple source is given.   M.V.E.

A71-25145   **Israel Annual Conference on Aviation and Astronautics, 13th, Tel Aviv and Haifa, Israel, March 3, 4, 1971, Proceedings.** Conference supported by the Israel Ministry of Transport; the Israel Ministry of Defence, Armament Development Authority; the Israel Ministry of Commerce and Industry; the Technion - Israel Institute of Technology; Tel Aviv University; the University of Negev; Aviation Services, Ltd.; and El-Al, Israel Airlines. *Israel Journal of Technology,* vol. 9, no. 1-2, 1971. 199 p.

The principal topics discussed are: the temperature distribution in a rotating sphere and in the ambient flow field; propagation and scattering of sound waves in moving media; application of flush-mounted electrostatic probes to flow diagnostics; compressibility correction for subsonic flows; methods and solutions in coupled thermoelasticity; laminar-turbulent transition in pipe flows; interaction between an axisymmetric jet and a coaxial oscillating stream; measurement of heat transfer coefficients between metal strips in contact; influence of in-plane boundary conditions on the buckling of clamped conical shells; mixing of homogeneous coaxial streams; flowfield analysis of plumes of underexpanded jets; lift and hinge moments of a delta control surface in a blunt-nosed canard configuration; and stable limit cycles and triggering limits of the first radial mode in unstable liquid rockets.
V.P.

A71-25149   **Compressibility correction for subsonic flows.** M. J. Cohen (Technion - Israel Institute of Technology, Haifa, Israel). *(Israel Annual Conference on Aviation and Astronautics, 13th, Tel Aviv and Haifa, Israel, Mar. 3, 4, 1971.) Israel Journal of Technology,* vol. 9, no. 1-2, 1971, p. 29-36.

Tables are presented which enable aerodynamics designers to estimate the effect of compressibility in flows whose incompressible

characteristics are known either from experimental data or from analysis. The order of accuracy is one higher than that of existing methods, and boundary distortion and pressure distribution shift can be taken into account. The procedure has been tested against existing test data and in the particular case of elliptic cylinders in a subsonic stream and agreement found to be very good.   (Author)

A71-25161   **Lift and hinge moments of a delta control surface in a blunt-nosed canard configuration.** J. Reichenthal and J. Rom (Technion - Israel Institute of Technology, Haifa, Israel). *(Israel Annual Conference on Aviation and Astronautics, 13th, Tel Aviv and Haifa, Israel, Mar. 3, 4, 1971.) Israel Journal of Technology,* vol. 9, no. 1-2, 1971, p. 165-175. 9 refs.

The aerodynamic forces and the hinge moments of a delta wing which is one surface of a cruciform control arrangement installed behind a blunt nose are investigated. In order to obtain effective aerodynamic control the delta wings used here are of moderate aspect ratio. The measurements of the forces and the moments acting on the control surface, which is installed on the cylindrical model behind the blunt nose, are obtained in subsonic, transonic and supersonic flows in the appropriate wind tunnels. These measurements are obtained over a wide range of angles of attack and control deflections. The results of these measurements are compared with the various theoretical calculations for lift on delta wings. It is found that the experimental data can be described by using the nonlinear delta wing analyses, including the effects of the wing-body interference parameters and the leading edge vortex contributions to the wing lift forces and moments. It is shown that the aerodynamic coefficients for the present configuration follow qualitatively those found for a delta wing alone, although in this case the nonlinear lift is significantly larger in the subsonic speed range.   (Author)

A71-25164   **Aircraft power-on polars corrected for propeller slipstream deflection.** Y. Eliraz (Israel Aircraft Industries, Ltd., Lod, Israel). *(Israel Annual Conference on Aviation and Astronautics, 13th, Tel Aviv and Haifa, Israel, Mar. 3, 4, 1971.) Israel Journal of Technology,* vol. 9, no. 1-2, 1971, p. 195-199.

A method for evaluating propeller power effect on lift and drag coefficients of a twin engine STOL aircraft is presented. This method is based on a theoretical approach which deals simultaneously with slipstream effect on lift and drag considering slipstream deflection by the wing flaps. This approach is applied to test flight data of the Arava STOL aircraft, yielding a unique polar based on corrected lift and drag coefficients (for each flap setting) valid for the whole available positive thrust levels at lift coefficients below the power-on stall. It is shown that this method can reduce the number of test flights required to cover the whole range of thrust and lift coefficients.   (Author)

A71-25180 *   **Performance of exhaust silencer components.** R. J. Alfredson (NASA, Langley Research Center, Hampton, Va.) and P. O. A. L. Davies (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 15, Mar. 22, 1971, p. 175-196. 18 refs. Research supported by the Ministry of Defence.

A71-25188

This paper describes part of a systematic investigation aimed at producing more accurate theoretical models for internal combustion engine exhaust silencers. The performance of a number of silencer components, e.g. area discontinuities, branched systems, was measured in a very noisy exhaust system. These results were then compared with those predicted by the one-dimensional linearized theory with mean gas flow. It was found that this one-dimensional theory was sufficiently accurate for silencer design purposes.

(Author)

A71-25188 # **A note on the T-tail flutter.** Kyuichiro Washizu, Teruo Ichikawa, and Takeshi Adachi. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Sept. 1970, p. 327-333. 17 refs. In Japanese, with abstract in English.

Demonstration that the dihedral effect of the horizontal tail has a significant effect on T-tail flutter and that the flutter speed is appreciably dependent on the angle of attack of the horizontal tail surface. The flutter characteristics of a simplified T-tail are analyzed. A quasi-steady aerodynamic force is used to represent the dihedral effect of the horizontal tail. Some references are made to experimental data on T-tail flutter which show a tendency similar to that observed by the authors. A.B.K.

A71-25189 # **Some effects of systematically varied location of one concentrated mass on transonic flutter characteristics of sweptback thin cantilever wing. II.** Eiichi Nakai, Toshiyuki Morita, and Toshiro Takagi. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, Sept. 1970, p. 333-340. 5 refs. In Japanese, with abstract in English.

Experimental investigation of the effects of longitudinal and vertical variation of the location of an engine-pod shaped concentrated mass on the transonic flutter characteristics of thin cantilever wings with a sweepback angle of 20 deg and a panel aspect ratio and taper ratio of 4.0 and 0.4, respectively. The investigation was carried out in a transonic blowdown wind tunnel for flutter testing at Mach numbers between 0.759 and 0.964. The results obtained are presented in the form of a comparison of the limits of flutter density and the flutter-velocity coefficients of the respective wing-pod configuration as a function of Mach number. Comparisons are also made with calculated results obtained by the matrix iteration method employing two-dimensional incompressible unsteady flow theory as the required oscillatory aerodynamic forces. A.B.K.

A71-25194 # **The effect of wind-gradient on the landing approach of an aeroplane.** Nirô Hira, Masao Inoue, and Éi Iti Takizawa. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, June 1970, p. 208-214. 6 refs. In Japanese, with abstract in English.

Consideration of the effect of a wind gradient on the flight characteristics of an aircraft during the final approach to landing. It is shown by numerical calculations that a wind gradient causes a considerable amount of path deviation of an aircraft during particular flight regimes. It is concluded that an aircraft during landing, being accelerated by the wind gradient, may touch the ground earlier than expected. A.B.K.

A71-25195 # **On the most feasible configuration for airplane gust-alleviation system.** Kenji Nakagawa, Yoshisada Muiotsu, Toshihiro Tsumura, and Naofumi Fujiwara. *Japan Society for Aeronautical and Space Sciences, Journal,* vol. 18, June 1970, p. 214-222. 21 refs. In Japanese, with abstract in English.

Consideration of a gust-alleviation system in which inertial sensors and feedback devices are employed and both wing flaps and elevators are operated to reduce gust-induced aircraft motions. Three possible configurations of such a system are proposed: linkage control, noninteracting control, and split control. Chang's (1961) frequency domain theory is applied to obtain an optimal control system which minimizes the gust response according to some criterion. Calculations of the alleviation capability of each system are

carried out on a sample aircraft in order to establish numerical evaluations of their relative merits. Among the three systems proposed, the split control system is simplest in its mechanization and is quite close to the optimal system in its alleviation capability. It is therefore concluded that the split control system is the most desirable one for inclusion in a future aircraft. A.B.K.

A71-25231 **NAMC C-1A - Japan's tactical transport (NAMC C-1A - Japanischer Kampfzonen-Transporter).** Hans Brenner. *Flugrevue/Flugwelt International,* Apr. 1971, p. 23-25. In German.

The technical specifications of a medium-weight tactical transport aircraft intended to replace the present Curtiss C-46 fleet are presented. The plane is powered by two Pratt & Whitney JP 8 D-9 turbofan engines with a takeoff thrust of 6575 kgf each. The span is 31.00 m, the length 29.00 m, the height 10.06 m, the wing area 120.70 sq m, the payload 11,800 kg, the takeoff weight 38,600 kg, the maximum speed 815 km at 7600 m, the cruising speed 704 km at 10,700 m, and the takeoff distance 671 m. The plane carries a crew of five. V.P.

A71-25232 **The SST and air traffic control (SST und Flugsicherung).** Frank W. Fischer. *Flugrevue/Flugwelt International,* Apr. 1971, p. 27-29. In German.

ATC considerations concerning the introduction of the Concorde to passenger transport service are presented. A review of the takeoff and landing characteristics of the Concorde shows that the present ATC regulations should be applicable also to this craft. It is suggested that priority treatments of the Concorde be reduced to a minimum. Straight-line acceleration paths from 100 to 170 n mi, starting as close as possible to the airport, are proposed together with flight sectors above FL 430 (to ensure longitudinal separation). Computerized ATC control over the entire flight path and rectilinear descent paths are suggested. V.P.

A71-25233 **The Viggen landing system (Das Viggen-Landesystem).** Roland Ziegler. *Flugrevue/Flugwelt International,* Apr. 1971, p. 36-38. In German.

The technical aspects of a tactical (all-weather) instrument landing system developed by Cutler-Hammer (USA) for the Swedish multipurpose STOL military aircraft Saab 37 Viggen are discussed. This microwave scanning-beam system consists essentially of a ground station located close to the landing runway and of an airborne receiver-encoder. The coverage of the system and the angle data transmission and scan cycle and encoding systems are diagrammed and discussed. V.P.

A71-25256 # **Experience gained in the operational preparation and putting into service of the IL-62 long-haul jet aircraft (Erfahrungen bei der Einsatzvorbereitung und Indienststellung des Langstrecken-Strahlflugzeuges IL-62).** Klaus Apel (Interflug Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 6, no. 9, 1970, p. 445-451. In German.

Description of the problems which arose in converting over from the use of the IL-18 and the Tu-134 to the IL-62 long-haul jet aircraft, noting the methods of solution adopted. Problems in retraining flight and maintenance personnel in the handling of the new aircraft in the shortest possible time without upsetting existing schedules are reviewed. It was decided to retrain all of the flight personnel and a small number of the engineering and technical personnel at the manufacturer's plant in the Soviet Union. It was also necessary to give passenger and baggage handling briefing regarding the IL-62 to the personnel at airports not familiar with this aircraft. The more exacting requirements of onboard passenger service are noted. A.B.K.

A71-25258 # **Formalities involving the Tu-154 at foreign airports in the case of three-man crews (Die Abfertigung der Tu-154**

340

A71-25307

Low-speed flutter model tests are described which were performed to determine such controlling parameters as wing sweep angle, wing bending to fuselage torsion frequency ratio, wing/horizontal tail longitudinal separation and tail dihedral angle, and their effects on flutter velocities. The results indicate that flutter velocities can be reduced by increasing wind sweep, that wing bending to fuselage torsion frequency ratios between 0.3 and 0.6 provide minimum flutter speeds, and that interference effects of wing on tail tend to enhance flutter.   V.P.

A71-25307 * #   Analysis of supersonic-hypersonic flutter of lifting surfaces at angle of attack. E. Carson Yates, Jr., and Robert M. Bennett (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-327.* 16 p. 35 refs. Members, $1.50; nonmembers, $2.00.

The features of supersonic-hypersonic flutter of lifting surfaces at angle of attack are studied analytically by three methods: a modified strip analysis, incorporating shock-expansion theory; a modified Newtonian-flow theory; and a local-flow piston theory. Flutter calculations for two pitching and translating rectangular wings with diamond airfoils indicate that a typical degradation of flutter speed index occurs with increasing angle of attack (which is most pronounced for thin sections at low angles of attack). For some airfoil shapes, however, a forward location of the center of gravity may mitigate the degradation at low to moderate angles of attack and essentially postpone it until shock-detachment conditions are approached. The vicinity of shock detachment is shown to be a critical region for supersonic-hypersonic flutter.   V.P.

A71-25308 #   Recent contributions to experiments on cylindrical shell panel flutter. W. Horn, G. Barr (Sandia Laboratories, Albuquerque, N. Mex.), L. Carter (Syracuse University Research Corp., Syracuse, N.Y.), and R. Stearman (Texas, University, Austin, Tex.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-328.* 16 p. 34 refs. Members, $1.50; nonmembers, $2.00. USAF-supported research.

The aeroelastic stability of cylindrical shell configurations was studied experimentally for various internal stress and supersonic flow conditions. It was found that the still-air buckling characteristics of the shells were hardly influenced by the supersonic (Mach number 1.2 to 3.5) air stream, so that still-air buckling data may be used to determine the buckling loads of cylindrical shells in a supersonic flow field. Two basic types of flutter instability were detected - one of a mild limited-amplitude motion, causing no persistent damage to the shell even after several minutes, and the other of a more explosive nature, which destroyed the shell a few seconds after onset. Both types of panel flutter instability are found to be closely associated with the fluid boundary layer characteristics.   V.P.

A71-25309 #   A collocation method for predicting oscillatory subsonic pressure distributions on interfering parallel lifting surfaces. A. M. Cunningham, Jr. (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-329.* 17 p. 19 refs. Members, $1.50; nonmembers, $2.00.

A method is presented which is an extension of the method developed by Hsu for isolated surfaces and improved by A. M. Cunningham. The integration scheme developed for non-planar interference effects properly converges to the Mangler formula as the surfaces become coplanar. The method and the criteria for choosing downwash point arrays a priori are verified by comparison with results from experiment and other theories on various multiple surface configurations. The method is also shown to be more economical than finite element methods for equivalent accuracy on identical problems.   (Author)

A71-25310 #   Optimization of a supersonic panel subject to a flutter constraint - A finite element solution. Roy R. Craig, Jr. (Texas, University, Austin, Tex.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-330.* 7 p. 7 refs. Members, $1.50; nonmembers, $2.00.

The equations of motion for a semi-infinite flat sandwich panel in supersonic flow are expressed in matrix form by use of a finite element model of the panel. The following aeroelastic optimization problem is posed. Minimize the total weight of the panel while keeping the dynamic pressure parameter constant at the value corresponding to flutter of a uniform panel. A first-order gradient procedure consisting of a 'weight-minimization mode' and a 'lambda-modification mode' is employed. For a panel divided into 5 elements and having 80% of the mass structural, a total weight reduction of 4% is obtained.   (Author)

A71-25317 #   Development of a torsional-flexural stability analysis of stiffened titanium panels for application to the U.S. Supersonic Transport. John G. Tawresey and James E. Lium (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-338.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00.

A solution for torsional-flexural buckling of stiffened skins, riveted or integral, is obtained by the use of small deflection energy methods. The effects of local distortions of the stiffener and skin cross sections and the effects of thermal gradient are directly accounted for in the buckling determinant. The order of the determinant is dependent on the number of distortion modes selected. The method is applicable to any open section stiffener attached to a skin. It has demonstrated good correlation with test data over a broad parameter range and has been extensively applied to the titanium compression panel design of the United States Supersonic Transport fuselage.   (Author)

A71-25319 #   Intermediate diagonal tension field shear beam development for the Boeing SST. Raymond M. Mello, Max D. Musgrove (Boeing Co., Seattle, Wash.), and Robert E. Sherrer (Washington, University, Seattle, Wash.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-340.* 14 p. 16 refs. Members, $1.50; nonmembers, $2.00.

This paper describes the comprehensive test and analysis program initiated for the development of titanium intermediate diagonal tension-field shear beam analysis and design methods necessary to support the Boeing SST. Existing semiempirical design and analysis procedures for aluminum beams have been extended for use with titanium beams. Detailed studies of the test results and current design methods show that major improvements of intermediate shear beam structural efficiency can be obtained through improved analytical procedures. A general theoretical analysis of post buckled stiffened plates, adaptable to the analysis of intermediate diagonal tension-field shear beams, was developed and is presented here. The theoretical formulation of this nonlinear problem was solved by the Rayleigh-Ritz method. Improvements available after the theoretical program becomes fully operational should constitute a second generation of shear beam designs that will provide improved and more efficient structure for the SST and other new vehicles. Areas for improvements to shear beams that have evolved during the program are indicated.   (Author)

A71-25321 #   Critical analysis of the methods used for predicting the response of large flexible aircraft to continuous atmospheric turbulence. Gabriel Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers,*

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Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-342. 8 p. 12 refs. Members, S1.50; nonmembers, S2.00.

Demonstration of a simple formula which makes it possible to determine the range of validity of two methods for predicting response to turbulence. The first method involves the assumption of a flight through cylindrical waves; the second assumes flight through an isotropic field of random vertical flow which is no longer uniform in span. It appears that the assumption of a turbulence uniform in span gives a good approximation in the range of frequency associated with flight mechanics, but in general is no longer valid once flexible modes are concerned. The power spectral densities of the response at different locations on the structure of the Concorde are discussed. These evaluations have been obtained both for isotropic turbulence and for turbulence uniform in span. The comparison of predictions is extended to the characteristic numbers of the responses, and consequences on fatigue life are emphasized.   F.R.L.

A71-25322 * #   **A critical wind-tunnel evaluation of a technique for predicting static aerodynamic characteristics for a highly flexible supersonic transport configuration.** Irving Abel (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-343.* 9 p. 8 refs. Members, S1.50; nonmembers, S2.00.

An experimental evaluation of an analytical approach for predicting the longitudinal stability characteristics of a large flexible aircraft is presented. An analytical method based on the modal approach is formulated for predicting the aerodynamic characteristics of a flexible airplane. This procedure is then applied to a flexibly scaled model of a supersonic transport configuration. Comparisons between wind-tunnel data, the modal approach, and calculations based on stiffness influence coefficients are presented over the Mach number range from M = 0.6 to 2.7. The results of this study show good agreement for most cases between analysis and experiment.   (Author)

A71-25325 * #   **The structural modeling of aircraft tires.** S. K. Clark, R. N. Dodge (Michigan, University, Ann Arbor, Mich.), J. I. Lackey, and G. H. Nybakken. *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-346.* 10 p. Members, S1.50; nonmembers, S2.00. Grant No. NsG-344.

Attempt to solve the difficulty of obtaining full size aircraft tire mechanical data by generating such data on small models. This has the advantage of allowing the necessary measurements to be made much more quickly and economically. It also allows measurements of aircraft tires under extreme conditions, which cannot be tolerated on full scale experiments for safety reasons. The theory of tire modelling is discussed in terms of tire mechanical properties, tire stresses, and tire temperatures. From this, it is shown that certain dimensionless variables must be the same for model and prototype. Data are presented which indicate that the concept of small scale modelling is both theoretically and practically achievable.   F.R.L.

A71-25340 #   **The impact of automated structural optimization on actual design.** James L. Tocher (Boeing Computer Services, Inc., Seattle, Wash.) and Richard N. Karnes (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-361.* 10 p. 6 refs. Members, S1.50; nonmembers, S2.00.

The organization of a large-scale structural optimization program and its application to practical aircraft problems is described. The program combines the matrix displacement method of structural analysis with mathematical programming to automatically design structures of minimum weight. Techniques used in developing efficient optimization and stress modules are described. A technique for finding a feasible ('safe') design is described and its application is demonstrated. Examples of the program's influence on actual design are presented. User experience and reaction with optimization in practical applications is discussed.   (Author)

A71-25347 #   **Natural frequencies of rotating, low aspect ratio, turbomachinery blades.** S. Rawtani (M. A. College of Technology, Bhopal, India) and M. A. Dokainish (McMaster University, Hamilton, Canada). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-374.* 12 p. 20 refs. Members, S1.50; nonmembers, S2.00.

A method based on the finite element technique is used to determine the vibration natural frequencies and mode shapes of rotating, low-aspect-ratio turbine blades. The centrifugal forces give rise to certain pseudostatic deformation, and the blade vibrations about the deformed configuration are studied. The initial stresses produced by the centrifugal forces increase the blade bending stiffness. The distributed d'Alembert forces due to rotation and vibration are converted to equivalent nodal forces, resulting in a consistent mass matrix and in a centrifugal mass matrix. The equilibrium equations provide the eigenvalue problem from which the natural frequencies are obtained. The effects of the following parameters on the pseudostatic deformation and the natural frequencies are described: the amount of pretwist, the speed of rotation, the disk radius, and the setting angle at which the blade is mounted on the disk.   T.M.

A71-25350 #   **Dynamic interactions of high speed tracked air cushion vehicles with their guideways - A parametric study.** S. B. Biggers (Kentucky, University, Lexington, Ky.) and J. F. Wilson (Duke University, Durham, N.C.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-386.* 13 p. 18 refs. Members, S1.50; nonmembers, S2.00.

The vehicle-guideway system is modeled as an arbitrary number of lumped, double-sprung vehicle masses travelling in tandem along simply supported beams. The vehicle load is transmitted to the guideway as a time-varying uniform pressure compatible with vehicle motion. Effects of system parameters on the vehicle heave accelerations and on the guideway deflections and bending moments are evaluated for high vehicle speeds. By proper choice of parameters, the passenger-compartment heave accelerations can be minimized, although very stiff and costly guideways, soft vehicle suspension systems, and high damping are required to keep this acceleration below 0.1 g for vehicles travelling from 100 to 300 mph.   T.M.

A71-25351 * #   **Comparison of two stochastic models for threshold crossing studies of rotor blade flapping vibrations.** G. H. Gaonkar and K. H. Hohenemser (Washington University, St. Louis, Mo.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-389.* 10 p. 8 refs. Members, S1.50; nonmembers, S2.00. Contract No. NAS 2-4151.

An earlier stochastic model which assumed that the vertical turbulence velocity is uniform over the rotor disk is compared with a loss restrictive model which considers the correlation between vertical turbulence velocities across the rotor disk in the longitudinal direction. Both models are limited to low-lift high-advance-ratio rotor operation where, however, turbulence excited blade vibrations are severe. Comparison for a typical example shows that the earlier and simpler model is adequate down to ratios of turbulence scale length over rotor radius of about five - a region covering all foreseeable operational conditions. The analytical data are supplemented by statistical data from analog studies.   T.M.

A71-25352 # **Techniques for stability analysis and design optimization with dynamic constraints of nonconservative linear systems.** Richard L. Bielawa (United Aircraft Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-388.* 14 p. 15 refs. Members, $1.50; nonmembers, $2.00.

The dynamics and aeroelastics of rotating machinery are characterized as highly nonconservative systems whose matrix dynamic equations are typically linear and nonsymmetrical. Three complimentary techniques are presented for improved analysis and design of such systems. The first technique systematizes the identification of destabilizing forces; the second analytically evaluates partial derivatives of complex (flutter) eigenvalues with respect to system parameters; and the third provides a method for optimizing designs of such systems constrained by dynamic considerations. These techniques are exemplified in a minimum weight design of a helicopter rotor blade constrained by bending-torsion flutter stability and favorable frequency placements. (Author)

A71-25355 # **The deformation and instability of a suddenly accelerated liquid drop.** E. Y. Harper, G. W. Grube (Bell Telephone Laboratories, Inc., Whippany, N.J.), and I-Dee Chang (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures, Structural Dynamics and Materials Conference, 12th, Anaheim, Calif., Apr. 19-21, 1971, AIAA Paper 71-393.* 7 p. 16 refs. Members, $1.50; nonmembers, $2.00.

Physical interpretation of mathematical results for the transient response of an initially spherical liquid droplet subject to the action of surface tension and to sudden acceleration by a flow of external gas with uniform upstream velocity. The vibration, distortion, instability, and disintegration of the droplet are described as functions of gas velocity and the Bond and Weber numbers. T.M.

A71-25400 **Boron and graphite fiber market competition.** William M. Powers (General Technologies Corp., Reston, Va.). In: Society of the Plastics Industry, Annual Technical Conference, 26th, Washington, D.C., February 9-12, 1971, Proceedings.
New York, Society of the Plastics Industry, Inc., 1971, p. 8-G1 to 8-G6. 19 refs.

There currently exists a demand for boron filament but competition from graphite fiber could begin to affect this market in the near future. Boron was the first material to develop an important place for itself in advanced composites. Its first big area of application was in aerospace and within a short period of time was being tested as structural material for selected aircraft components. As a result, there exists a considerable knowledge of design data and information on boron filament for use in military aircraft hardware. It will take approximately two years to develop comparable design data on graphite fibers. The degree to which boron will retain its market share will depend on the relative prices of the two fibers. Graphite and boron are at present about the same price (approximately $300/lb.) but graphite has the potential to approach $25/lb. Boron on the other hand is apparently restricted to a minimum of $50/lb. due to the complex manufacturing process. The near term markets will be mostly boron, but thereafter it is difficult to predict the individual market shares as it will depend on the progress of graphite fiber developments and innovations in boron manufacture. (Author)

A71-25420 **First boron composite structural production part.** G. Lubin and S. Dastin (Grumman Aerospace Corp., Bethpage, N.Y.). In: Society of the Plastics Industry, Annual Technical Conference, 26th, Washington, D.C., February 9-12, 1971, Proceedings. New York, Society of the Plastics Industry, Inc., 1971, p. 17-C1 to 17-C10.

Design of boron-epoxy (B/E) skins for the production F-14 full depth honeycomb horizontal stabilizer. The skins were optimized

utilizing a previously developed computer program. Once established, several verification subcomponents were fabricated and tested. At the conclusion of the tests, production type steel tooling was fabricated. Utilizing the mylar lay-up method and titanium inserts for penetration, the required four B/E skins were molded. Destructive and nondestructive evaluations of these skins indicated structural soundness. Simultaneously with skin manufacture, two honeycomb-beam-rib subassemblies were built. The skins were adhesively bonded to the substructure and the two stabilizers were available for static and fatigue tests. One stabilizer was successfully tested for all mission profiles and taken to destruction at 300 F. Failure occurred at 109% of design ultimate load, and the fatigue tests on the other stabilizer more than satisfied the F-14 loading spectrum after two lives (12,000 effective flight hours). F.R.L.

A71-25427 **Composites development, fabrication and characterization.** H. F. Volk and I. C. Lewis (Union Carbide Corp., Parma Technical Center, Cleveland, Ohio). In: Society of the Plastics Industry, Annual Technical Conference, 26th, Washington, D.C., February 9-12, 1971, Proceedings. New York, Society of the Plastics Industry, Inc., 1971, p. 20-B1 to 20-B6. Contracts No. AF 33(615)-3110; No. AF 33(615)-68-C-1077.

This paper describes two activities which constitute a portion of a much larger ARPA sponsored combined Industry/University Research Program: the repair of a representative 'Thornel' fiber, epoxy matrix aircraft fuselage component and the fabrication and evaluation of 'Thornel' fiber, polysulfone and polyamide-imide composites. Defects developed in the fuselage component during the last stage of fabrication consisted primarily of debonding of longitudinal stringers and circumferential stiffeners from the skin and were characterized by a variety of nondestructive tests. Experimental and analytical studies indicated that the defects resulted primarily from thermal degradation of the adhesive and from thermal stresses incurred during the final heat cure of attachments to the component. Novel repair techniques were established, and the component was successfully repaired. Fabrication techniques for 'Thornel' fiber, polysulfone, and polyamide-imide composites were established. The shear strength of these composites was found to be identical to that of the same yarns in epoxy resins. However, the epoxy and polyamide-imide composites failed catastrophically in shear, whereas the polysulfone composites did not. Polysulfone composites also showed no notch sensitivity. (Author)

A71-25428 **Design and test of a prototype graphite fiber/plastic fuselage component.** Dennis P. Hanley and S. L. Cross (Bell Aerospace Co., Buffalo, N.Y.). In: Society of the Plastics Industry, Annual Technical Conference, 26th, Washington, D.C., February 9-12, 1971, Proceedings. New York, Society of the Plastics Industry, Inc., 1971, p. 20-C1 to 20-C8. Contracts No. AF 33(615)-3110; No. AF 33(615)-68-C-1077.

Objectives of the effort described in this paper were two-fold: to demonstrate performance advantages of graphite fiber composite material in a representative subscale airframe fuselage structure and to develop and apply advanced structural analysis methods. This approach consisted of preliminary design studies to select the configuration, followed by integrated studies of material characterization and structural element tests leading to final design of the fuselage section. Discrete element analyses were extensively employed. The fuselage structure was fabricated by Union Carbide Corporation and tested at Bell Aerospace Co., Division of Textron. The test program included a series of response tests under various load conditions and combinations prior to a destruct test under bending and shear loads. On a bending stiffness-to-density basis, the composite shell outperformed the aluminum design by a factor of almost 3. Stiffness predictions, strains, and deflections correlated reasonably well with measurements. Failure of the shell in the destruct test occurred at a load 110% of the design requirement. The test demonstrated a 27% lighter weight shell than an aluminum structure designed for the same ultimate load. Performance projections for the fuselage indicate a 49% potential weight savings with use of presently available 'Thornel' 50S. (Author)

A71-25445 Tensile instability of initially spherical balloons. Harold Alexander (Stevens Institute of Technology, Hoboken, N.J.). *International Journal of Engineering Science,* vol. 9, Jan. 1971, p. 151-162. 14 refs. Contracts No. AF 19(628)-4990; No. AF 19(628)-67-C-0241.

Using a new elastic constitutive relation for rubber-like materials previously proposed by the author, a large deformation analysis of the inflation of rotationally symmetric balloons is developed and specialized to the inflation of an initially spherical balloon. An investigation of the pressure vs radius characteristic reveals the existence of a local maximum indicating the occurrence of a tensile instability. Observing the form of the total potential energy function at various equilibrium positions yields much insight into the tensile instability phenomenon. An analogy to snap-through buckling is recognized and discussed in detail. Inflation experiments performed with neoprene balloons are found to verify the analytically obtained results. Bifurcations to nonspherical modes in the unstable region, previously investigated by V. I. Feodos'ev by performing a perturbation on the homogeneously deformed nonlinear state, are experimentally observed and verified. (Author)

A71-25453 * # Coupled nongray radiating flows about long blunt bodies. Linwood B. Callis (NASA, Langley Research Center, Hypersonic Vehicles Div., Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Thermophysics Conference, 5th, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-865.) AIAA Journal,* vol. 9, Apr. 1971, p. 553-559. 22 refs.

Second-order time asymptotic solutions, extending far downstream, are presented for hypervelocity blunt-body flow fields including coupled nongray radiation. Shapes considered are parabolas, sphere-cones, and blunted conical shapes with continuous curvature. Numerical calculations treat the shock as a discrete surface and it is assumed that the flow is inviscid, nonconducting, and axisymmetric. Thermochemical equilibrium is assumed. Radiation is accounted for with an eight-step model absorption coefficient including line, band, and continuum radiation. Results include shock shapes, radiative heating distributions, and profiles through the shock layer of pertinent thermodynamic and flow quantities. A parametric analysis is made of radiating flows over sphere-cones. Comparisons with other investigators are made, where possible. (Author)

A71-25469 # Evolution of the laminar wake behind a flat plate and its upstream influence. L. I. Schneider (North American Rockwell Corp., Space Div., Downey, Calif.) and V. E. Denny (California, University, Los Angeles, Calif.). *AIAA Journal,* vol. 9, Apr. 1971, p. 655-660. 21 refs.

Analysis of laminar, two-dimensional, viscous flow of an incompressible fluid over the trailing edge of a vanishingly thin flat plate. A coordinate transformation is introduced which admits sufficient scaling of the problem to enable detailed study of the separating flow and its interactions with the inviscid stream, as well as with a presumed boundary-layer flow in an intermediate region. Second-order boundary-layer theory is applied in an iterative manner to extract a first approximation to the displacement thickness and associated induced pressure distribution. It is found that the near-wake region is nonisobaric, the classical isobaric result of Blasius-Goldstein for displacement thickness being slightly high just prior to the trailing edge and about 10% low downstream. Local corrections to the velocity and pressure distributions are obtained by numerically solving the full Navier-Stokes equations, using the second-order boundary-layer results to establish Dirichlet boundary conditions over a rectangular region enclosing the trailing edge point. It is found that the physical extent of this region is of order R to the minus 3/4. Within the region, shear at the plate increases with x and becomes very large at the trailing edge. No significant correction to the displacement thickness was found on resolving the second-order boundary-layer problem, using the Navier-Stokes results as inner boundary conditions. (Author)

A71-25471 * # Breakup of liquid sheets and jets in a supersonic gas stream. Allan Sherman (NASA, Goddard Space Flight Center, Engineering Physics Div., Greenbelt, Md.) and Joseph Schetz (Virginia Polytechnic Institute, Blacksburg, Va.). *AIAA Journal,* vol. 9, Apr. 1971, p. 666-673. 24 refs. Grant No. AF AFOSR 1228-67.

Experimental and analytical results are presented with the objective of defining the mechanism of liquid sheet and jet breakup when subjected to a supersonic gas stream. Liquid sheets are studied with photomicrographs and high-speed movies of the activity of a liquid layer maintained upon a porous plate test model in a parallel Mach 2.2 freestream. Tests with several different liquids show wave motion, with droplet and ligament shedding across the liquid surface. Numerical results from a liquid surface stability analysis are used to explain these observations. Liquid jets are studied with spark shadowgraphs, high-speed movies and photomicrographs of the normal injection of various liquids into a Mach 2.1 freestream. The results show that the breakup mechanism is characterized by gross jet fracture, as opposed to surface disintegration. The degree of breakup at a given streamwise location and jet spread after injection are found to be related to injection diameter and dynamic pressure, and certain liquid properties. (Author)

A71-25472 # An experimental investigation of the interaction between a transverse sonic jet and a hypersonic stream. V. Zakkay, W. Calarese, and L. Sakell (New York University, Bronx, N.Y.). *AIAA Journal,* vol. 9, Apr. 1971, p. 674-682. 14 refs. Contract No. AF 33(615)-68-C-1184.

Study of the interaction of an underexpanded jet with a hypersonic stream. The investigation includes an experimental study of a finite-span sonic jet on a 7 deg semivertex angle sharp cone in a Mach number 5.8 stream. A range of unit Reynolds numbers of 2,000,000 to 40,000,000/ft is covered in the experiments, producing laminar, transitional, and fully turbulent boundary layers on the conical surface. The models are instrumented with 60-surface pressure taps from which data on normal force coefficients are derived. In addition, the resultant forces are checked with a strain balance. Shock-wave and streamwise patterns in the plane of symmetry of the flowfield are obtained from schlieren photographs. The experimental study is primarily intended to provide quantitative data on interaction forces due to the three-dimensional effects of a finite-span jet. It is observed in these experiments that the crossflow can produce a favorable net interaction with the mainstream, thereby providing an induced normal force coefficient equal to or possibly exceeding the two-dimensional values, at the same Mach number and jet mass flux ratio. The experimental data show that a positive normal force (lift) contribution can be obtained from the flow downstream of the jet slot. Finite span fences have been tested for comparison with jet controls. It is found that the total normal force coefficient produced by the jet for which the Mach disk penetrates the flowfield to the same height as the fence is much larger than that produced by the fence. (Author)

A71-25474 * # A lifting-surface solution for vortex-induced airloads. Wayne Johnson (U.S. Army, Aeronautical Research Laboratory, Ames Research Center, Moffett Field, Calif.). *AIAA Journal,* vol. 9, Apr. 1971, p. 689-695. 13 refs. Grant No. NGR-22-009-303.

Planar lifting-surface theory is applied to the problem of the loads induced on an infinite aspect-ratio wing by a straight infinite, free vortex in a subsonic, compressible, freestream; the vortex lies in a plane parallel to the plane of the wing, at a given distance below it, and at an arbitrary angle with the wing centerline. The solution is obtained in the form of an aerodynamic influence function for an infinite aspect-ratio wing in an oblique, sinusoidal gust. The lifting-surface theory kernel function for this wing is presented. This kernel includes as limits the linear, aerodynamic kernel functions for the problems of steady, three-dimensional flow and unsteady, two-dimensional flow, and for the problems of incompressible, two-dimensional flow and transonic, three-dimensional flow. An approximate analytic expression is given for the lift influence function, suitable for practical use in the routine calculation of vortex-induced airloads. (Author)

A71-25475 # **Experimental investigation of the stability of the laminar supersonic cone wake.** Dennis K. McLaughlin (Oklahoma State University, Stillwater, Okla.). *AIAA Journal*, vol. 9, Apr. 1971, p. 696-702. 18 refs. Contract No. AF 44(620)-C-0013.

Investigation of the instability occurring in the wake of a 7 deg half-angle, sharp cone suspended magnetically. Hot-wire fluctuation measurements were made in the wake for a range of Reynolds numbers and at a Mach number 4.3. These measurements indicated a completely stable near wake at a freestream Reynolds number of 51,600 and large amplification of small disturbances at a freestream Reynolds number of 61,900. The amplified waves were highly concentrated with respect to frequency, with a number of pronounced harmonics being present. Amplitude and phase measurements of the spectral components indicated that the instability process fits within the framework of linear stability theory as formulated by Gold, with each mode having a wavefront shaped like a circular helix. It appears that each succeeding mode has an additional thread in the helical wavefront. However, the measured fundamental oscillation has a larger amplification rate and a much lower frequency than predicted by Gold's theory. In addition, weak nonlinear interactions were observed, which grow stronger with downstream position. (Author)

A71-25476 # **Results of a strong interaction, wake-like model of supersonic separated and reattaching turbulent flows.** Louis G. Hunter, Jr. (Avco Corp., Avco Systems Div., Wilmington, Mass.) and Barry L. Reeves. *(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-128.)* AIAA Journal, vol. 9, Apr. 1971, p. 703-712. 30 refs.

Results of an interaction theory for supersonic separated and reattaching turbulent boundary layers are presented and compared with recent experiments for flow past a compression ramp. Effects of ramp angle, Mach number, Reynolds number, and upstream pressure gradient are considered for situations where the critical point is located upstream of the trailing edge. When the critical point falls downstream of the trailing edge the whole region of separated flow is influenced by ramp length. In these 'short ramp' flows the peak ramp pressure attains a maximum at a critical ramp angle and then decreases with increasing angle. It is shown that this effect is responsible for the spanwise pressure distributions measured by Whitehead and Keyes for flow over a delta wing with a trailing edge flap. Results are also presented for a turbulent boundary layer-shock wave interaction. (Author)

A71-25477 # **Aerodynamic characteristics of a slender body traveling in a tube.** Theodore R. Goodman (Oceanics, Inc., Plainview, N.Y.). *AIAA Journal*, vol. 9, Apr. 1971, p. 712-717. 6 refs. Research supported by the U.S. Department of Commerce.

Incompressible inviscid slender-body theory is applied to determine the flow about a slender body of revolution traveling in a tube. Formulas for all the static and dynamic stability derivatives are derived for an arbitrary body of revolution in terms of its cross sectional area distribution. These formulas are specialized to that of an ellipsoid of revolution as an illustrative example and plots of the results are presented as a function of the ratio of the maximum cross-sectional area of the body to the area of the tube. For the body whose diameter is a large per cent of the tube diameter, the stability derivatives become an order of magnitude greater than they are for the same body in free air. Furthermore, a statically unstable force of attraction to the wall caused by proximity to the wall is present which does not exist at all for the body in free air. The inherent aerodynamic instability of a body in free air without controls is thus increased by the presence of the tube walls, and the walls may be said to exert a large effect on the aerodynamic characteristics of the body. (Author)

A71-25482 # **Curvature effects in the laminar and turbulent freejet boundary.** James C. Williams, III, Eddy H. Cheng, and Kun H. Kim (North Carolina State University, Raleigh, N.C.). *AIAA Journal*,

vol. 9, Apr. 1971, p. 733-736. Grant No. DA-HC-04-69-C-0084.

Investigation of the effects of curvature on the freejet boundary between a curved irrotational flow and a stagnant fluid. It is shown that similar solutions are possible in both the laminar and turbulent cases for certain variations of jet curvature, provided the curvature is moderate. In fact, for both the laminar and turbulent cases, the equations of motion can be reduced to a single ordinary differential equation, the solution of which is given. The results of this solution indicate that the velocity profile within the freejet boundary is, for all practical purposes, independent of the curvature. The effects of the pressure across the freejet boundary on the curvature and on the entrainment are determined. M.M.

A71-25487 # **Lift and drag of a wing-cone configuration in hypersonic flow.** Adolfo Reggiori (New York University, New York, N.Y.). *AIAA Journal*, vol. 9, Apr. 1971, p. 744, 745.

Measurement of the pressure distribution and total forces on a reentry-vehicle configuration consisting of a 20-deg cone with wings located at 60 deg from the plane of symmetry and a sweep-back angle of 75 deg. Measurements were taken at Mach 5.8 for several angles of attack between -16 and +20 deg. The leading edge of the wing was subsonic. Lift and drag coefficients determined from the pressure distribution and directly from balance measurements are compared to those obtained with an isolated cone. A large increase in lift is obtained with a negative dihedral configuration, while a positive dihedral configuration gives only a small increase in lift as compared to the isolated cone. T.M.

A71-25490 # **Inclination of pressure orifices in low-density flow.** K. Kienappel (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *AIAA Journal*, vol. 9, Apr. 1971, p. 749, 750. 7 refs.

The inclination of the orifice venting a cavity to surface rarefied gas flow is shown to affect the pressure in the cavity. Experiments were performed with a cooled flat plate model in a hypersonic low-density wind tunnel. Holes were drilled perpendicular to the model surface and at angles between 30 and 80 deg to the leading edge. Graphs show measured pressures (normalized with local reference pressures) as a function of the angle of inclination and the gas density. T.M.

A71-25492 # **Safety factors and the probability of failure in fatigue.** M. P. Bieniek (Columbia University, New York, N.Y.) and J. C. Joanides (North American Rockwell Corp., Downey, Calif.). *AIAA Journal*, vol. 9, Apr. 1971, p. 753, 754. 5 refs.

A probabilistic model of fatigue failure under variable-amplitude loading is used to establish a relation between the safety factor K and the fatigue failure probability. The relation appears to be of definite significance in selecting rational values of the safety factor. It may also be useful in planning the inspection, maintenance, and replacement for a fleet of aircraft. T.M.

A71-25494 * # **Laminar incompressible flow past a circulation-controlled circular lifting rotor.** Allen Plotkin (Maryland, University, College Park, Md.). *AIAA Journal*, vol. 9, Apr. 1971, p. 756-758. 8 refs. Grants No. NsG-398; No. NGR-21-002-266.

Prandtl's first-order boundary layer equations for two-dimensional, laminar, incompressible flow past a circulation-controlled circular lifting rotor are solved numerically using the implicit finite difference scheme of Blottner and Flugge Lotz (1963). The laminar theory shows that the momentum coefficient is an appropriate jet parameter for moderate values of h/R, where h is the slot height and R is the cylinder radius. For large values of h/R, the ratio of the speeds of the uniform stream and the jet becomes the appropriate parameter. T.M.

A71-25521 # **Disintegration of a supersonic jet impinging normally on a flat plate.** T. Nakatogawa, M. Hirata (Tokyo, University, Tokyo, Japan), and Y. Kukita. *Journal of Spacecraft and*

Rockets, vol. 8, Apr. 1971, p. 410, 411.

Previous studies of the structure of a supersonic freejet in relation to jet noise revealed that in the case of a highly underexpanded freejet, very strong directional sound called screech is generated and that disintegration of the jet occurs at the same time. It is proved that, for the case of a supersonic jet of almost correct expansion impinging normally on a flat surface, similar disintegration also occurs with strong screech when the normal shock wave in front of the flat surface is in a decelerating region of the jet.   O.H.

A71-25525 * # **Performance of disk-gap-band, ringsail, and cross parachutes at low earth altitudes.** 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.) Journal of Spacecraft and Rockets,* vol. 8, Apr. 1971, p. 418-420. 6 refs.

Evaluation of the performance of the Attached Inflatable Decelerator (AID) - i.e., a low-mass, ram-air inflatable fabric canopy configured to the payload - designed for decelerating interplanetary vehicles during their entry into low-density atmospheres, such as that of Mars. Wind tunnel data for models 5 ft in diameter attached to a 120 deg conical aeroshell, which utilize mechanically deployed ram-air inlets to initiate canopy inflation, are examined. Four models were successfully deployed at supersonic speeds. The models were very stable throughout the Mach number range 2.0 to 4.75 and at angles of attack through 10 deg and had a high drag coefficient. Calculated canopy inflation rates which account for permeability of the material are shown to be in good agreement with experimental values. A mission study performed demonstrated the advantage of the AID as the first stage of a two-stage deceleration system. Calculation indicates that the AID relaxes stringent deployment conditions on the terminal parachute.   O.H.

A71-25527 * # **Ground and flight test results for a decelerator towline energy absorber.** Ross L. Goble and Earl L. Councill, Jr. (NASA, Langley Research Center, Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1202.) Journal of Spacecraft and Rockets,* vol. 8, Apr. 1971, p. 423-425. 5 refs.

A test program was conducted to verify the shock attenuation characteristics of a decelerator towline energy absorber for the Supersonic High Altitude Planetary Entry Program (SHAPE). Ground-based drop tests were performed to simulate opening parachute shock load and sustained aerodynamic load subsequent to opening shock. The absorber, although constrained in size by payload canister packaging volume, was found to be effective in limiting shock load through energy dissipation by the damper constituents. Helicopter drop-test data and actual flight-decelerator load time histories with the absorber in the system are provided.
(Author)

A71-25528 * # **A shielded fine-wire probe for rapid measurement of total temperature in high-speed flows.** Leonard M. Weinstein (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *Journal of Spacecraft and Rockets,* vol. 8, Apr. 1971, p. 425-428. 12 refs.

A probe developed to satisfy the test requirements for a hypersonic helium facility having a 4 to 6 sec run time is described. The probe can survey across a 1-in. hypersonic boundary layer in approximately 2 sec, generally gives better than 1/4% absolute accuracy in the reduced data, and is useful for freestream Mach numbers greater than 1, Knudsen numbers less or equal to 0.3, and for total temperature less than 700 R.   O.H.

A71-25534 # **A new guidance system for approach and landing. Volume 2.** Washington, D.C., Radio Technical Commission for Aeronautics (Document No. DO-148), 1970. 396 p. $20.

Description of the selection and development of recommended system concepts. Tentative requirements are derived from operational considerations pertaining to airports, aircraft, approach and landing paths, classes of service, failure protection, weather penetration, and physical interference. The technique assessment procedures used in the technical and economic reviewing of proposals and in reaching conclusions are outlined, and the description of the selected and proposed concept dwells particularly on the capabilities of the system with respect to rollout, missed approach, departure guidance, obstacle clearance, identification, status data transmission, modulation techniques, and approach and landing guidance. The provisional standard signal formats recommended are covered in great detail.
M.V.E.

A71-25555 * # **A status review of Lewis Research Center supported protection system development.** S. J. Grisaffe, J. P. Merutka (NASA, Lewis Research Center, Cleveland, Ohio), and S. R. Levine (NASA, Lewis Research Center; U.S. Army, Air Mobility Research and Development Laboratory, Cleveland, Ohio). *NASA and U.S. Air Force, Refractory Composite Working Group Meeting, 18th, Marshall Space Flight Center, Huntsville, Ala., Mar. 16-18, 1971, Paper.* 12 p.

Lewis Research Center - sponsored coating development for superalloys has produced several promising systems including vapor deposited CoCrAlY coatings, alumina enriched aluminide coatings and metallic claddings. Efforts to minimize the interdiffusion of dispersion strengthened materials and protection systems have shown only modest success. Fused slurry silicide coatings for columbium reentry hardware are being optimized while process development and scale-up are underway. Several promising fused slurry silicide coatings have been developed for tantalum reentry hardware.
(Author)

A71-25652 **Aerospace applications.** M. A. Denney (British Aircraft Corp., Ltd., Weybridge, Surrey, England). In: Glass reinforced plastics. Edited by Brian Parkyn. London, Iliffe Books, Ltd., 1970, p. 94-105.

Applications of GRP in single-skin, wall, and sandwich radomes, dielectric panels, and aircraft ducting are reviewed. Production techniques for radomes of various designs are described with Hycar sandwich structures, fluted-core radomes of Bristol Aircraft, the Concorde radome, the Avro Shackleton radome, and Vickers Vanguard and Valiant radomes referred to as examples. The secondary structures in which GRP are used are listed as fairings, electrical distribution panels, propeller spinners, tank platings, passenger cabin furnishings, and freight bay linings. The less frequent applications in molding and tooling are also covered.   V.Z.

A71-25661 **Effect of changing wing sweep on the dynamics of the controlled processes.** 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.) Engineering Cybernetics,* vol. 8, May-June 1970, p. 604-609. Translation.

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.

A71-25802 # **Determination of three-dimensional density fields from holographic interferograms.** Robert D. Matulka and Daniel J. Collins (U.S. Naval Postgraduate School, Monterey, Calif.).

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A71-25847

Journal of Applied Physics, vol. 42, Mar. 1, 1971, p. 1109-1119. 12 refs. Navy-supported research.

The successful application of holographic interferometry, and an associated mathematical reduction process, to the determination of an asymmetric three-dimensional density field of an aerodynamic phenomenon is reported. An integral inversion method from the field of plasma physics has been extensively evaluated by applying it to the determination of functions, both axisymmetric and asymmetric, which simulate aerodynamic density fields. The application of holographic interferometry has been extended to provide multiple holograms about a test region, with sufficient coverage to provide interferometric data for the successful solution of the density field. The analytical and experimental methods developed were applied to an experimental axisymmetric test field, the supersonic flow from a free jet, and shown to be comparable to a previous solution obtained by the Abel inversion method. Further, the free jet was tilted to provide a test field which was asymmetric in the plane of solution. Comparison of the resulting asymmetric solution was shown to be consistent with the previously obtained axisymmetric solution.

(Author)

A71-25847   **Application of a hybrid computer to the development of a pilotless captive helicopter (Einsatz eines Hybridrechners bei der Entwicklung eines unbemannten, gefesselten Hubschraubers).** G. Schmidt, R. Swik, W. Dusold, and A. Kuechle (Dornier AG, Friedrichshafen, West Germany). In: Association Internationale pour le Calcul Analogique and International Federation for Information Processing, Conference on Hybrid Computation, Munich, West Germany, August 31-September 4, 1970, Proceedings.   Brussels, Presses Académiques Européennes, 1970, p. 280-289. In German.

A complex real-time simulator is described which was developed for solving dynamic problems of a captive two-blade rotor platform (termed DO 32-K) intended for reconnaissance purposes. Of particular interest was the determination of the influence of the mooring cable (which also served for fuel supply and data transmission), the rotor, and the turbine unit on the dynamic characteristics of the entire system and whether satisfactory stabilization could be accomplished with standard flight control equipment. The mathematical model, block diagram, and signal flow diagrams of the simulator are presented and discussed.   V.P.

A71-25852   **An application of hybrid computing to design and training.** Frank E. Oldfield and Philip J. Wall (Teledyne Ryan Aeronautical Co., San Diego, Calif.). In: Association Internationale pour le Calcul Analogique and International Federation for Information Processing, Conference on Hybrid Computation, Munich, West Germany, August 31-September 4, 1970, Proceedings.   Brussels, Presses Académiques Européennes, 1970, p. 628-636.

Description of a six-degree-of-freedom digital computer program written to evaluate a complex flight control system and associated control mode logic. Air launch separations from the launch aircraft were successful, and ground launch was demonstrated successfully, as well as supersonic flight. All flight control modes were successfully engaged and flown. To date, six radio control operators (RCOs) were trained on the simulator, and all have conducted successful flights.

F.R.L.

A71-25948 #   **An analysis of flow through a mixed flow impeller.** Yasutoshi Senoo and Yoshiyuki Nakase (Kyushu University, Fukuoka, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-2.* 8 p. 9 refs. Members, $1.00; nonmembers, $2.00.

In this report, a method of analyzing steady, three-dimensional, subsonic, nonviscous flow through a turbomachine with arbitrary hub and shroud shapes and a finite number of blades is presented. In order to make the analysis manageable, the stream surfaces are assumed to be axisymmetric. Position and shape of these surfaces, which depend upon the work of blades, are obtained by a

meridional plane solution using a quasi-orthogonal coordinate system. The flow condition on these surfaces of revolution and the result. The agreement appears to be very good. Some preliminary results are presented for a flow containing an oblique shock and its reflection. The computed results compare satisfactorily with the exact solution.   (Author)

A71-25950 #   **The radiation of sound from an airfoil immersed in a laminar flow.** L. T. Clark (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-4.* 11 p. 7 refs. Members, $1.00; nonmembers, $2.00.

The results of an experimental and analytical investigation of sound generation by single airfoils are presented. Airfoil sections studied were representative of those used in modern axial compressors; included were modified 65 series and double circular arc profiles. The radiation of sound from the airfoil immersed in the potential core of a free jet discharging through an acoustic chamber was measured. Acoustic data were obtained for the velocity range 200 through 800 ft/sec. Measurements of wake correlation volumes and turbulence velocity components were used in an analytical model to predict the spectrum of the sound radiated by the airfoil. Sound generation was found to be dependent upon the square of the component of turbulent velocity normal to the airfoil chord. In the velocity range 300 to 800 ft/sec, the overall sound pressure level was found to be dependent upon free stream velocity to the sixth power. A correlation of the normal component of turbulent velocity was found to exist with the momentum thickness of the wake. (Author)

A71-25953 #   **Shock wave behavior in transonic compressor noise generation.** M. R. Fink. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-7.* 7 p. 12 refs. Members, $1.00; nonmembers, $2.00.

Compressor noise at transonic tip speeds contains strong tones at multiples of shaft rotation frequency as well as harmonics of blade passage frequency. These multiple pure tones or combination tones are caused by rotor blade nonuniformities which result in pronounced irregularities in the shock pattern attached to the rotor. Nonlinear first-order theory, similar to that used in analysis of sonic boom strength, is utilized to determine shock wave decay with upstream distance. In the extreme near field of the rotor, shock strength varies inversely as the square root of upstream distance from the blade leading edge as with an isolated airfoil. Somewhat further upstream, the expansion region from the neighboring blade in the cascade interacts with the shock so that shock strength varies as the inverse first power of distance. These aerodynamic results are used to infer some characteristics of transonic compressor noise which in turn are compared with experimental results.   (Author)

A71-25958 #   **Discrete frequency noise from lifting fans.** A. N. Abdelhamid (Carleton University, Ottawa, Canada). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-12.* 10 p. 10 refs. Members, $1.00; nonmembers, $2.00. Research supported by the National Research Council of Canada.

Discrete frequency noise characteristics of a research lifting fan are investigated analytically. Based on steady aerodynamic data of the fan, unsteady aerodynamic forces acting on the rotor and stator blades were calculated using the results of previous investigators and an analysis which determines the effect of fluctuating velocity disturbance parallel to blade chord on the unsteady lift of cambered thin airfoils. The calculated unsteady forces were then used to determine the characteristics of discrete frequency noise emission from the fan. For the fan under consideration it is shown that the rotor interaction noise dominates the fan noise. Comparison between the predicted sound pressure levels and experimental observations shows good agreement. Based on the calculated detailed contributions of the different force harmonics acting on the blades to the fan noise, possible means of reducing lifting fan noise are discussed.

(Author)

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A71-25959 # **Performance of compressor blade rows in a sloping flowpath.** H. A. Harmon, A. A. Mikolajczak, and D. Marchant (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-13.* 8 p. 15 refs. Members, $1.00; nonmembers, $2.00. Research sponsored by the United Aircraft Corp.

In an effort to reduce engine length and weight it is desirable in some applications, such as high bypass ratio turbofan engines, to introduce compressor stages into a downward sloping flowpath. In this 'mixed flow' compressor the airfoil orientation with respect to the flowpath becomes important to ensure good performance. The performance of cascades and compressor stages with sloping walls is presented. Three methods of introducing blading into the flowpath were evaluated. It is shown that by canting the blading to be normal to the flow direction, no penalty in performance is incurred compared to the performance of a typical axial compressor with cylindrical flowpath. Test results are compared with predictions based on intrablade analysis and a wall boundary layer calculation. Qualitatively good agreement is obtained except for the case when the blading is swept with respect to the flow direction. Need for further investigation of three dimensional internal viscous flows is indicated. (Author)

A71-25960 # **Experimental investigation of methods for improving the dynamic response of a twin-spool turbojet engine.** A. J. Fawke (Gas Council, Newcastle, England) and H. I. H. Saravanamuttoo (Carleton University, Ottawa, Canada). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-14.* 7 p. Members, $1.00; nonmembers, $2.00. Research supported by the Science Research Council.

This paper describes experimental tests carried out on a twin-spool turbojet to confirm earlier simulator predictions of methods of improving the dynamic response. The engine was controlled by a digital computer, permitting ready changes of control schedules. It was verified that dynamic response could be improved by trading HP surge margin for LP surge margin by suitable variation of the nozzle area. Operating trajectories were obtained on both compressor characteristics during both accelerations and decelerations and excellent agreement with simulator results was obtained. (Author)

A71-25961 # **Measured and predicted flow near the exit of a radial-flow impeller.** G. B. McDonald, J. H. G. Howard (Waterloo, University, Waterloo, Ontario, Canada), and E. Lennemann (IBM Deutschland, Böblingen, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-15.* 6 p. 12 refs. Members, $1.00; nonmembers, $2.00. Defence Research Board of Canada Grant No. 9550-19.

Experimental measurements are presented of the velocity field near the exit of a radial impeller with backward-curved blades. The flow pattern, and its variation with changes in the flow coefficient are compared with numerical predictions on a blade-to-blade plane. The theoretical flow prediction method assumes inviscid flow, is essentially two-dimensional and is based on the streamline curvature approach. It does not specifically require the condition of zero absolute vorticity. The comparison with experiment indicates that the principal feature of the flow not accounted for in the inviscid model is the region of low velocity near mid-blade height on the suction surface, especially for higher blade loadings. (Author)

A71-25962 # **A blade theory of an impeller with an arbitrary surface of revolution.** Yasutoshi Senoo and Yoshiyuki Nakase (Kyushu University, Fukuoka, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-17.* 7 p. 14 refs. Members, $1.00; nonmembers, $2.00.

In this report a method of analyzing subsonic inviscid flow between blades on a stream surface of revolution of a turbomachine, which may be an axial, a radial, or a mixed-flow type, is presented. There may be a change in thickness of stream surface of revolution in the through flow direction. The stream surface of revolution is mapped onto a plane. In this picture plane the influence of rotation of the system is not always represented by uniformly distributed vorticity. Instead, the distribution of vorticity varies with radius. For the calculation of velocity distribution in the picture plane, an available rotating annular cascade theory is modified so that the variation of vorticity with respect to radius is properly considered. Numerical examples for a mixed flow type compressor rotor are included. (Author)

A71-25963 # **Heat transfer to an airfoil in oscillating flow.** J. A. Miller and P. F. Pucci (U.S. Naval Postgraduate School, Monterey, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-18.* 8 p. 7 refs. Members, $1.00; nonmembers, $2.00. Navy-supported research.

Local heat transfer coefficients to an airfoil in an oscillating stream have been measured for a range of frequencies and oscillation amplitudes. Results at moderate angles of attack are in agreement with previously reported findings. However, at large angles of attack, including those associated with stall in steady flow, a strong periodic starting vortex shed from the leading edge leads to a dramatic reattachment of the flow and consequent increase in local Nusselt numbers of as much as five-fold. These effects are shown to be amplified by increasing oscillation frequency and amplitude. (Author)

A71-25964 # **Analytical and experimental studies of two-dimensional flows in a radial bladed impeller.** R. S. Benson, W. G. Cartwright, and M. J. Hill (Manchester, University, Manchester, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-20.* 12 p. 16 refs. Members, $1.00; nonmembers, $2.00.

Numerical direct solutions are derived on the basis of the potential theory to determine two-dimensional flows in radial turbomachines under both on- and off-design conditions. A rotating cascade rig with a horizontal rotor mounted in an open circular water tank is used in experiments to obtain water circulation with radial inflow or outflow by the motion of the rotor at rates up to 300 rpm. A camera with a 12-channel flash unit is used for flow visualization by photographic observations of polystyrene particles suspended in the flow. The experimental and analytical results for a straight vaned constant-area rotor are compared. V.Z.

A71-25965 # **Design considerations in inertia welding of turbocharger and gas turbine components.** C. D. Weiss, L. J. Moen, and W. M. Hallett (Caterpillar Tractor Co., Peoria, Ill.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-21.* 7 p. Members, $1.00; nonmembers, $2.00.

The welding of low alloy steels and wrought superalloys to cast superalloys of special relevance to the gas turbine field is discussed. The inertia welding process is described, and it is shown that its applicability extends to many combinations of iron, nickel, and cobalt base superalloys and steels for gas turbine and supercharger construction. Weldable combinations are listed, and mathematical formulas are given that make it possible to calculate the parameters required for inertia welds. The tensile and stress rupture properties of inertia welds at various temperatures are tabulated, and their microstructure is illustrated and discussed. Various prerequisites to sound welds are reviewed and precautions to be observed set forth. M.V.E.

A71-25966 # **A turbine-speed, main-engine fuel pump.** H. T. Johnson (Battelle Columbus Laboratories, Columbus, Ohio).

American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-24. 8 p. Members, $1.00; nonmembers, $2.00. Grant No. DA-AJ-02-69-C-0072.

This paper describes the design and experimental evaluation of a vane-type fuel pump that has operated successfully at speeds up to 49,500 rpm and outlet pressures up to 900 psig. The objective of the research was to produce a main-engine fuel pump for small gas-turbine engines capable of operating at engine shaft speed in order to reduce the bulk and complexity of the required gear drive train. The pump has a design JP-4 turbine-fuel flow rate of 2000 lb/hr at 650 psig. The successful completion of a 200-hr endurance run has verified that the high-speed capabilities have been achieved without sacrificing pump endurance life. (Author)

A71-25967 # **Effects of Reynolds number on performance characteristics of a centrifugal compressor.** Toshio Mashimo, Ichiro Ariga, Ichiro Watanabe (Keio University, Tokyo, Japan), and Hiroshi Suefusa. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-25.* 12 p. 16 refs. Members, $1.00; nonmembers, $2.00. Research supported by the Mitsui Shipbuilding and Engineering Co.

The pressure was varied from 0.25 to 1 atm in the surge tank by a vacuum pump to vary the Reynolds number in a closed system used in a study of the performance of a centrifugal compressor with a single-shroud impeller having straight radial blades and a parallel-walled vaneless diffuser. The power losses in the compressor, impeller and diffuser stages of the system were determined and the adiabatic efficiency of the compressor vs the flow rates was analyzed. The critical Reynolds numbers were from 0.09M to 0.13M for the compressor stage, from 0.09M to 0.12M for the impeller, and from 0.09M to 0.15M for the diffuser. V.Z.

A71-25970 # **Inertia welded jet engine components.** K. W. Stalker and L. P. Jahnke (GE Material and Process Technology Laboratories, Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-33.* 9 p. Members, $1.00; nonmembers, $2.00.

The inertia welding process is discussed as a technique providing both a low weight-cost advantage and completely reproducible excellent mechanical properties when used for joining simple disk and ring shapes in the fabrication of jet engine rotors. This process is characterized as one of solid state joining which forges the two parts together under automatically controlled conditions. The inertia welding parameters for jet engine nickel and titanium alloys and the cost and weight advantages due to the elimination of mechanical joints and a better utilization of material in this process are analyzed. Several typical applications of the process are described. V.Z.

A71-25971 # **A design method and the performance of two-dimensional turbine cascades for high subsonic flow.** A. Uenishi (Hitachi, Ltd., Research Laboratory, Ibaraki, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-34.* 12 p. 7 refs. Members, $1.00; nonmembers, $2.00.

Description of an approximate hodograph method for designing turbine cascades for high subsonic flow of compressible fluid whose specific heat ratio gamma = -1 and gamma greater than 1. This method, which was established by Cantrell and Fowler (1959), is suitable for profiles with large deflection angles and thickness. Numerical examples are given, and theoretical and measured pressure distribution for profiles designed by this method are compared. A better design criterion for improving cascade efficiency is presented. M.M.

A71-25972 # **Liquid distributions of a low pressure drop injection system - Gas turbine 'vaporizer' design.** R. W. Alperi (New Hampshire, University, Durham, N.H.) and J. S. Hoffman (General

Electric Co., Lynn, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-38.* 6 p. Members, $1.00; nonmembers, $2.00.

Low pressure drop fuel injectors for jet engine combustors are currently being considered. In this respect, the general problem considered in this paper is the flow variables affecting the distribution of a low pressure drop, low velocity stream of liquid which is convected by a concentric airstream against a concave hemispherical cap similar to possible fuel injectors designs. Experimental results from a plexiglass model of the injection system are presented. The experimental results indicate that for a centrally located liquid stream injector (less than 1/16 in. from the true center), the momentum ratio between the liquid and airstreams is the predominant factor which influences uniform fuel distributions. More uniform distributions are obtained with higher liquid-to-air momentum ratios. For larger injector eccentricities, the liquid distributions exhibit variable tendencies depending on the range of the momentum ratio. (Author)

A71-25973 # **Investigation concerning the fluid flow in the mixed-flow diffuser.** Shinji Honami, Toshimichi Sakai (Tokyo Institute of Science, Tokyo, Japan), Ichiro Watanabe (Keio University, Tokyo, Japan), and Keizo Tsukagoshi. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-40.* 9 p. 13 refs. Members, $1.00; nonmembers, $2.00.

Velocity profile measurements were performed on the flow in a mixed-flow diffuser with walls having equal cone angles. The aim of the present study is to understand the flow behavior and the relation between the flow patterns and the diffuser losses. The boundary layer flow accompanied by separation on the inner wall and the velocity normal to the diffuser walls were measured in detail to examine the three-dimensional flow behavior in the mixed-flow diffuser. Comparing with the radial diffuser, the mixed-flow diffuser had a more complicated flow mechanism as it had the pressure gradients of transverse and normal directions. (Author)

A71-25974 # **A study on the flow pattern within the centrifugal and mixed-flow impellers.** Shinpei Mizuki, Toshimichi Sakai (Tokyo Institute of Science, Tokyo, Japan), and Ichiro Watanabe (Keio University, Tokyo, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-41.* 13 p. 10 refs. Members, $1.00; nonmembers, $2.00.

An investigation of the flow patterns within the centrifugal and mixed-flow impeller channel was performed. The velocity distributions within the impeller channel and blade surface pressure of the centrifugal and mixed-flow impellers were closely examined by experiment and the flow behavior within these impellers were clarified. The incompressible and inviscid flows within the impellers having straight radial blades were also derived analytically. The present authors assumed an outermost boundary of the relative eddy at the impeller exit periphery and corrected the analytical results. The corrected analytical results thus obtained showed good coincidence with the experimental data. (Author)

A71-25975 # **A numerical technique for the calculation of transonic flows in turbomachinery cascades.** S. Gopalarkrishnan and R. Bozzola (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-42.* 10 p. 16 refs. Members, $1.00; nonmembers, $2.00.

A numerical technique is presented for the calculation of steady inviscid transonic flows in turbomachinery cascades, wherein both subsonic and supersonic regions co-exist. The problem is posed in the time-dependent form and the asymptotic solution at large times provides the solution of the steady physical problems. The solutions for a hyperbolic nozzle cascade and two turbine cascades are compared with other analytical solutions and with an experimental

result. The agreement appears to be very good. Some preliminary results are presented for a flow containing an oblique shock and its reflection. The computed results compare satisfactorily with the exact solution. (Author)

A71-25976 = **The jet fuel starter goes operational.** R. A. Quick and F. D. Miller (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-43.* 10 p. Members, $1.00; nonmembers, $2.00.

The starter described is a compact, lightweight gas turbine consisting of a gas generator module, a power turbine module, and an accessory module. The complete unit is attached to the engine accessory gearbox by means of quick-disconnect coupling. The gas generator operates on aircraft fuel to generate a high-temperature gas stream output. The output is directed to the power turbine where the gas energy is converted to mechanical energy or torque for rotating the aircraft engine fast enough to start it. The advantages of this starting system are reviewed, together with development history and early service experience. Z.W.

A71-25977 # **A fluidic fuel control valve for turbine engines.** R. L. Wilcox (Delavan Manufacturing Co., Inc., West Des Moines, Iowa) and J. H. Shadowen (United Aircraft Florida Research and Development Center, West Palm Beach, Fla.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-44.* 4 p. Members, $1.00; nonmembers, $2.00.

A fluidic valve, consisting of a swirl chamber with tangential and radial inlets and a single outlet, has been used to provide uniform fuel distribution to the nozzles in an annular combustor designed for a small turbine engine. The fuel nozzles were of the air atomizing type, with large flow passages for contamination tolerance. Pressure drop across the nozzles was too small at low fuel flows to overcome hydraulic heat effects and uniformly distribute the fuel to the nozzles. A fluidic valve installed in series with each nozzle provided sufficient pressure drop to distribute the fuel at low flow rates without requiring exceptionally high fuel pressures at large flow rates. The fluidic valves were fed by a dual manifold fuel system. Fuel flow was divided between the two manifolds, which were connected separately to the tangential and radial inlets of the fluidic valves, by a pressure relief valve. The flow schedule of the system was similar to that of a dual orifice pressure atomizing fuel system. Turn-down requirements of the system were 40:1. (Author)

A71-25978 # **Cleaner fuel through nitrogen inerting.** W. Q. Brookley (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-45.* 3 p. Members, $1.00; nonmembers, $2.00.

Additional advantages associated with aircraft fuel tank nitrogen inerting are discussed. In addition to fire and explosion suppression, nitrogen inerting makes it possible to remove oxygen and water from aviation fuels, reduce foreign particles in fuel tanks, and possibly reduce sludge and lacquering. Malfunctions of components due to contaminates were found to be greatly reduced. If oxygen removal is found to improve thermal stability sufficiently the necessity of using expensive fuels for supersonic aircraft can also be eliminated. Z.W.

A71-25979 # **Metal matrix composite fabrication procedures for gas turbine engine blades.** J. A. Alexander, E. G. Parks, Jr., and P. Melnyk (TRW, Inc., Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-46.* 7 p. Members, $1.00; nonmembers, $2.00.

Application of the diffusion bonding process to the formation of gas turbine engine fan blades from titanium or aluminum matrix composites. Emphasis is placed on the susceptibility of this process

to the volume producibility of the blades. The use of a titanium matrix and B-SiC filaments yields evaluational quantities of composite blades, but analysis of the process indicates that substantial progress must be made before cost effect production could be contemplated. Raw materials are expensive, and cost reduction is directly associated with market volume. The hand labor and wastage associated with the formation of filament and foil lamellae were reduced by hot stretch forming of thick packages of foils to lengths and widths which more closely approximate the required ultimate size. Further economization of the foil and filament lamellae forming procedures is examined, and expected developments in this area are outlined. T.M.

A71-25980 # **Manufacturing approaches to resin matrix composite airfoils for gas turbine engines.** R. A. Whitaker, W. H. Reinhart, and C. H. Castle (TRW, Inc., Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-47.* 8 p. Members, $1.00; nonmembers, $2.00.

Performance and cost are considered to assess the prospects of the use of resin matrix composites in gas turbine airfoils. Graphite-fiber and resin-impregnated-graphite-sheet (prepreg) prices are surveyed to determine their contribution to the total cost of the resin matrix composites used. Anticipated high-volume production methods, such as computerized ply development with graphic plotting, broadgoods collimation, impregnation and consolidation, and computerized multiaxis tape-laying machining, are described. The highly automated fabrication techniques required for a cost-effective composite airfoil production with labor and in-process material waste minimization are expected to yield graphite yarn and tow at costs of $25 to $40/lb after the mid 70s. V.Z.

A71-25981 # **Effects of polyurethane foam on fuel system contamination.** T. O. Reed (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-54.* 10 p. 14 refs. Members, $1.00; nonmembers, $2.00.

The successful implementation of 10-pore/in. foam for aircraft fuel system fire and explosion protection is described with special reference to fuel contamination. Cleanliness requirements associated with the foam installation require that the level of particulate matter does not exceed 1 mg/gal over that serviced to the aircraft. It was verified that the foam installation has not increased the overall system contamination level and, in some uses, may have reduced it. Requirements for foam cleanliness were enacted through the manufacturing, fabrication, installation, and testing phases of the modification. Periodic maintenance checks are also recommended in the service. Z.W.

A71-25982 # **A new method for the calculations of blade loadings in a radial flow compressor.** M. P. Boyce (Texas A & M University, College Station, Tex.) and Y. S. Bale. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-60.* 10 p. 10 refs. Members, $1.00; nonmembers, $2.00.

The paper outlines a quasi-three-dimensional approach based on the solution of the entire inviscid momentum and energy equations in the meridional and blade-to-blade plane to calculate the blade loading in a radial flow turbomachine. The method is outlined in detail so as to enable the reader to adapt it for use on his computer. The flow in the compressor is considered to be nonhomentropic with variations of thermodynamic properties at the inlet. A comparison of various inlet distributions is shown and this illustrates the usefulness of this method. Calculation of the velocity on the trailing and driving faces of the blades is obtained. Pressure and temperature distribution throughout the flow passage considering an actual process is also outlined. (Author)

A71-25983 # **Advanced regenerative gas turbine designs for lightweight and high performance.** C. F. McDonald (AiResearch

Manufacturing Co., Los Angeles, Calif.) and R. A. Langworthy (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-67.* 25 p. 6 refs. Members, $1.00; nonmembers, $2.00.

Two integrated gas-turbine concepts for aircraft applications are described in which annular recuperators of tubular construction are wrapped around the turbomachinery to give compact lightweight engine packages. The recuperator is the prime structure, forming the backbone of the assembly. Designed for minimum mechanical complexity, the engine assembly can be quickly split by a single tool into the three basic modules (gas generator, recuperator, and power turbine) for routine inspection and maintenance. Direct performance, weight, and cost comparisons are made (at the same power level) with a nonrecuperative engine designed for the same cycle data. Sensitivity curves demonstrate the effects of small changes in basic parameters on optimum recuperator criteria for given mission times. Compressor, turbine, and combustor details are briefly outlined.   T.M.

A71-25984 # **Low cost short life gas turbine design.** D. L. Murray and W. E. Kidd (Teledyne, Inc., Toledo, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-69.* 7 p. Members, $1.00; nonmembers, $2.00.

Results of low cost gas turbine engine design studies are presented. System requirements are discussed and their effects on engine design and cost are analyzed. Parametric performance data are presented and the use of these data in engine build cost trades is discussed. The evolution of specific component fabrication techniques on selected components is discussed, and the overall effect on the engine cost is analyzed and described. The technique of achieving low manufacturing costs by the use of innovative design, keyed to operational requirements rather than new processes, is described. The accessory problem is discussed and a potentially low cost fuel control concept described. A cross section drawing of a simple production turbojet is shown and the use of a technique for a low cost design is outlined.   (Author)

A71-25985 # **Designing rotor burst protection.** A. A. Martino (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-70.* 13 p. Members, $1.00; nonmembers, $2.00.

Research on optimum-weight protective systems against uncontained rotor failure where fragments pass radially through the turbine engine casing leading to additional damage. A spin-chamber test facility was used for high-speed photographic study of the fragment impact on protective rings. Experimental data are given for such factors as fragment types, blade effects, plastic growth of protective rings, ring restraint, fragment energy distribution, ring cross section, and radial clearance. Ring materials evaluated included steel, aluminum, ballistic nylon, and filament wound E-glass. TRIP (Transformation Induced Plasticity) steels exhibited the highest ratios of attack energy to ring weight. Transient ring computer codes for predicting the transient response of fragment impacted containment systems are described.   T.M.

A71-25987 # **A dynamic model of gas turbine engine main combustor instability.** F. F. Ehrich (General Electric Co., Group Engineering Div., West Lynn, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-73.* 6 p. Members, $1.00; nonmembers, $2.00.

A gas turbine combustor model comprising a premixing (or vaporizing) chamber (1) and a combustion chamber (2), both designed as Helmholtz resonators, is described. The model is used to derive a stability criterion for obtaining the critical combustor temperature ratio as a function of the combustor geometry incorporating the chamber volumes and the effective perimeters and areas of the chamber orifices. An analysis suggests that stability of a

combustor represented by this model can be maintained when the ratio between natural frequencies in (1) and (2) is larger than unity.   V.Z.

A71-25988 * # **Holographic characterization of aerospace components.** R. K. Erf and J. P. Waters (United Aircraft Research Laboratories, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-74.* 15 p. 10 refs. Members, $1.00; nonmembers, $2.00. Contract No. NAS 1-9926.

Several adaptations of the basic holographic process to specific aerospace problems are described, including pulsed laser holography, interferometric holography, and pulsed schlieren holography. Specific applications of interest to the aerospace engineer include studies of fuel nozzle spray characteristics, vibration analysis techniques, and helicopter rotor flow visualization methods. Nondestructive testing of aerospace components and materials is illustrated by examples of the inspection of electron beam welds, characterization of bond defects in composite materials and honeycomb panels, and identification of internal structural flaws.   T.M.

A71-25989 # **Lift jet engine, JR100.** Masakatsu Matsuki, Tadao Torisaki (National Aerospace Laboratory, Tokyo, Japan), Kaneichiro Imai, and Kiyoto Miyazawa (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-75.* 12 p. Members, $1.00; nonmembers, $2.00.

The development of a vertical straight lift turbojet engine with a six-stage axial-flow compressor, an annular combustor, atomizing fuel injectors, and two ball and roller bearings is described. At a total weight of 342 lbs it delivers 3390 lbs of thrust. The design emphasizes low cost and ready component exchangeability for the sake of easy maintenance and prompt incorporation of further technology advances. Its suitability for use as a lift power plant for compound-type VTOL aircraft has been demonstrated by the preliminary endurance tests the engine has undergone as a main propulsion or booster engine. Engine component materials and weights and performance data are tabulated and design details illustrated in photographs and diagrams.   M.V.E.

A71-25990 # **The supersonic turbine - A design and cascade study.** Irving Fruchtman (General Applied Science Laboratories, Inc., Westbury, N.Y.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-76.* 12 p. 29 refs. Members, $1.00; nonmembers, $2.00.

Fundamental concepts are given for the design of a turbine stage with supersonic gas velocities relative to the blading. Minimum-length nozzles (stators) and free-vortex-type rotor blades are specified and a correlation of their published performance is given. A blade selection chart is given to provide a method for obtaining appropriate low-loss rotor blade configurations. A series of two-dimensional cascade experiments is described in which the performance of film-cooled, blunted leading-edge rotor blades were measured. Blade performance is given over a range of inlet Mach numbers and cooling flows.   (Author)

A71-25991 # **'Flying test cell' evaluation and applications.** J. R. Esser (Emerson Electric Co., St. Louis, Mo.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-77.* 9 p. 14 refs. Members, $1.00; nonmembers, $2.00.

Study of a flight test completed on an on-board real-time engine performance monitoring system that demonstrated the technical feasibility of the baseline comparison technique of jet engine thermodynamic health analysis. The decision to concentrate on the thermodynamic analysis technique is a result of its ability to detect major component deterioration, thereby reducing unscheduled engine removals and delayed flights. By providing a computer-controlled analysis tool (flight line or on-board) results are im-

mediately available. The basic system can be expanded to include other useful real-time monitoring techniques as they evolve.   F.R.L.

A71-25992 # **Holographic analysis of turbine blades.** J. P. Waters and H. G. Aas (United Aircraft Research Laboratories, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-84.* 11 p. Members, $1.00; nonmembers, $2.00. Contract No. N 00019-69-C-0271.

The applicability of holographic interferometry to measurements of surface strains in turbine blades is reviewed. It is shown that strains can be measured at the surface of a turbine blade, excited in dynamic flexure, using interferometric holographic fringe information. Interferometric holography offers possibilities in the detection of turbine blade flaws, especially using an internal pressurization technique. Turbine blade stress analysis can be performed at elevated as well as at room temperature, but requires the use of pulsed holographic techniques for best results. A review of the resonant modes present in turbine blades and an analysis of both the resulting time-average and double pulsed holographic fringe patterns are made.   M.V.E.

A71-25993 # **Design and development of a boron-glass-epoxy lightweight composite gear case.** W. N. Holcomb (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-85.* 9 p. Members, $1.00; nonmembers, $2.00.

The design and development of a composite material front housing for the reduction gear of the T56 engine are discussed. The program was undertaken to advance the state-of-the-art in engine structures by making a material available that is capable of replacing aluminum and magnesium. The selected boron-glass-epoxy material exhibits high strength and specific stiffness, light weight, good corrosion resistance, and suitability for molding. The design, molding, machining, and testing phases of the programs are described.
(Author)

A71-25994 # **Aircraft gas turbine condition analysis instrumentation - Its use for the status diagnosis of naval turbine engines.** H. K. Ziebarth and J. D. Chang (AiResearch Manufacturing Co., Los Angeles, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-86.* 12 p. 7 refs. Members, $1.00; nonmembers, $2.00.

The feasibility of current verification of the mechanical and performance status of gas turbines for naval use beyond that realized today in other turbine engine use areas is examined. It is shown that direct mechanical status determination of critical components appears to be feasible today in view of recent developments in the sensor and electronic data interpretation areas. This can be achieved by automatic checkout systems which functionally integrate different diagnostic techniques in a manner addressing specific use-mode related engine degradation and malfunction phenomena. O.H.

A71-25995 # **Standard measurement of aircraft gas turbine engine exhaust smoke.** D. L. Champagne (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-88.* 11 p. 19 refs. Members, $1.00; nonmembers, $2.00.

A standard system (equipment and procedures) for measuring smoke emitted by aircraft turbine engines has been developed. It has been adopted by several federal government agencies. In this paper, the system is explained and its accuracy defined. An experimentally determined relationship between the system's parameters and true smoke density (weight of solids per unit volume) is presented and theoretically examined. The definition of smoke plume visibility in terms of the system's parameters is also developed. This work led to the conclusion that aircraft turbine engine exhaust smoke is

composed of two groups of particles: the very small, which are primarily responsible for visible obscuration, and larger particles, which may constitute as much as half of the total by weight, but do not appreciably contribute to plume visibility.   (Author)

A71-25996 # **The computation of transonic flow through two-dimensional gas turbine cascades.** P. W. McDonald (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-89.* 7 p. Members, $1.00; nonmembers, $2.00.

Steady transonic flow through two-dimensional gas turbine cascades is efficiently predicted using a time-dependent formulation of the equations of motion. An integral representation of the equations has been used in which subsonic and supersonic regions of the flow field receive identical treatment. Mild shock structures are permitted to develop naturally without prior knowledge of their exact strength or position. Although the solutions yield a complete definition of the flow field, the primary aim is to produce airfoil surface pressure distributions for the design of aerodynamically efficient turbine blade contours. In order to demonstrate the accuracy of this method, computed airfoil pressure distributions have been compared to experimental results.   (Author)

A71-25997 # **Development of Borsic-aluminum composite fan blades for supersonic turbofan engines.** W. J. Schulz (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), J. A. Mangiapane, and H. Stargardter (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, Houston, Tex., Mar. 28-Apr. 1, 1971, Paper 71-GT-90.* 13 p. 26 refs. Members, $1.00; nonmembers, $2.00. Contract No. AF 33(615)-69-C-1651.

The design and fabrication of a new type of fan blades is described and their performance is evaluated. The blades are over 40% lighter than the titanium blades currently in use. In addition, the blades can be designed without partspan shrouds which results in a 1% increase in fan efficiency. A successful aeromechanical rig test is described which demonstrates that the blades can be designed for a 430 F application without encountering any severe vibratory stress problem. The condition of the blades after testing was good with no visible cracks and negligible root distortion. Changes in blade twist angle after testing were also considered insignificant. Moreover, the test results indicate that extending the operational limits of the blades to 600 F is possible.   O.H.

A71-26054 **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 Florida Research and Development Center, West Palm Beach, Fla.). *American Helicopter Society, Journal,* vol. 16, Apr. 1971, p. 34-42.

This paper describes the mechanical arrangement and performance of the Pratt & Whitney Aircraft STF/S351 convertible engine concept. The STF/S351 is a combined fan/shaft engine which can provide the multimode power required by V/STOL aircraft by delivering 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. Compared to a system using separate engines for cruise and takeoff, the STF/S351 offers lower installed weight, lower propulsion system cost, decreased complexity, decreased frontal area, and eliminates the need for in-flight starting and stopping of engines during mode-to-mode transition.   (Author)

A71-26192

A71-26192 # **Shock-shock reflection.** B. W. Skews (McMaster University, Hamilton, Ontario, Canada). *CASI Transactions*, vol. 4, Mar. 1971, p. 16-19. 5 refs. Research sponsored by the National Research Council.

This paper examines the trajectory described by the triple point of a Mach reflection when reflected off a plane wall. The incident triple point was obtained from the Mach reflection of shock waves, with Mach numbers of 1.2, 1.5, and 2.0, off wedges of various angles. The theoretical predictions were based on the simple three-shock theory, an examination of the interactions in the wave train following the reflection, and Whitham's theory. The three-shock theory and the interaction analysis give similar results for small corner angles but differ considerably from the results of Whitham's theory. The experimental values lie between these two predictions with the shape of the final curves being similar to those predicted from three-shock theory. The experimental values tend towards the theoretical prediction for the limiting case of zero wall angle.

(Author)

A71-26194 # **Reattachment of the supersonic laminar boundary layer (Recollement de la couche limite laminaire en supersonique).** C. Bourque (Université Laval, Quebec, Canada). *CASI Transactions*, vol. 4, Mar. 1971, p. 25-31. 7 refs. In French.

Measurements of the reattachment angle of a laminar mixed layer by means of a model of symmetrical revolution for a negligible initial boundary layer. The important parameters are the Mach number, the Reynolds number, and the angle of the cone upon which the layer reattaches. The reattachment angles obtained are from two to three times larger than are predicted by the Chapman criterion, which furthermore does not take Reynolds number into account. A new criterion is proposed which includes the effect of Reynolds number and the geometry of the model. This criterion is in quite good agreement with experimental measurements. F.R.L.

A71-26196 # **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, Joint Meeting, Toronto, Canada, July 9, 10, 1970.)* *CASI Transactions*, vol. 4, Mar. 1971, p. 39-46. 16 refs. National Research Council of Canada Grant No. A-4308.

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. 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 criterion 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)

A71-26197 # **Effect of small surface curvature on unsteady hypersonic flow over an oscillating thin wedge.** P. Mandl (Carleton University, Ottawa, Canada). *CASI Transactions*, vol. 4, Mar. 1971, p. 47-57. 12 refs.

Consideration of the effect of curvature on the aerodynamic characteristics of a thin, slightly curved, two-dimensional airfoil oscillating harmonically with small amplitude in a uniform hypersonic flow. The method employed is a perturbation of the equations of small-disturbance theory, considering relative amplitude of oscillation and airfoil curvature at the leading edge as independent perturbation parameters. It is shown that oscillating convex surfaces are dynamically less stable than oscillating wedges for all values of the relevant parameters; concave surfaces have the opposite effect.

F.R.L.

A71-26201 # **Classification of flexible runway surfaces by the LCN method (Klasyfikacja podatnych nawierzchni lotniskowych metodą LCN).** Franciszek Kaźmierczyk. *Technika Lotnicza i Astronautyczna*, vol. 26, Feb. 1971, p. 21-26. 6 refs. In Polish.

The use of the ICAO-recommended LCN (Load Classification Number) method of determining the load capacity of flexible and composite runway surfaces is demonstrated. Examples of LCN calculations are given for Iliushin-14 and Iliushin-18 aircraft. T.M.

A71-26258 **The profile couple method for studying the flow of an ideal fluid around a fixed arbitrary obstacle in the presence of a rectilinear wall (Sur la méthode du couple des profils pour l'étude de l'écoulement d'un fluide idéal autour d'un obstacle arbitraire fixe, en présence d'une paroi rectiligne).** Titus Petrila (Cluj, Universitatea, Facultatea de Matematică şi Mecanică, Cluj, Rumania). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques*, vol. 272, no. 13, Mar. 29, 1971, p. 908-910. 5 refs. In French.

Study of the plane motion of an ideal incompressible fluid around a fixed profile in the presence of an infinite rectilinear wall. Petrila's (1971) so-called profile couple method is used for this purpose, as well as Jacob's (1968) circular ring theorems. An explicit expression is derived for the complex potential in the particular case of a circular profile. This expression is the same as that obtained in the so-called 'dual' problem with a translational term added. A.B.K.

A71-26304 # **Laser beam probing of jet exhaust turbulence.** C. B. Hogge and W. L. Visinsky (USAF, Weapons Laboratory, Kirtland AFB, N. Mex.). *Applied Optics*, vol. 10, Apr. 1971, p. 889-892. 9 refs. ARPA-supported research.

Description of an experiment in which a He-Ne (6328-A) laser beam was passed through the highly turbulent region in the exhaust of a jet engine (J-57 with afterburner). Estimates of a structure constant that would characterize the turbulence in the exhaust are made from the beam spread of focused and collimated beams. The structure constant obtained in this manner is then compared with that determined from scintillation measurements of a (10.6-micron) beam and with the results of hot-wire anemometer readings taken in the exhaust. The various methods yield results for the structure constant that are in good agreement (typically a structure constant of the order of .00003 per meter to the 1/3 power). (Author)

A71-26308 **Aircraft maintenance.** J. W. Norberg (Air Canada, Montreal, Canada). *Aeronautical Journal*, vol. 75, Mar. 1971, p. 153-158.

The philosophy underlying the achievement and sustaining of the airworthiness standard throughout the life of aircraft is outlined and the principal tasks in this field are specified. The respective prime processes involved are discussed. Determination, provisioning, and utilization of maintenance resources are examined. Basic elements of maintenance which constitute a system through which the maintenance task is accomplished are summarized. Finally, future maintenance requirements are briefly considered. O.H.

A71-26309 **A design study for a freight-carrying airship.** E. Mowforth (Surrey, University, Guildford, Surrey, England). *Aeronautical Journal*, vol. 75, Mar. 1971, p. 166-174.

Some areas of the overall transport spectrum which might be expected to favor airship operation are discussed, and some of the problems associated with different modes of operation are examined. Particular reference is made to the project that is underway at Airfloat Transport, Ltd., which is a vessel with a gas capacity of 30 million cu ft (849,510 cu m) intended for the carriage of large indivisible loads over moderate distances. O.H.

A71-26310 **Local avoidance of sonic boom from an aircraft.** W. F. Hilton. *Aeronautical Journal*, vol. 75, Mar. 1971, p. 179-181.

Acoustic consequences of a curved supersonic flight path are examined. It is shown that such a flight path causes a local focus of shock waves and accentuated boom and, more particularly, produces a 'no-boom' zone in other localities closer to the center of curvature of the flight path than the M = 1 radius. Practical aspects of this effect are discussed and rules for curved supersonic flight are outlined.   O.H.

A71-26311   **Analysis of taxiing induced vibrations in aircraft by the power spectral density method.** C. L. Kirk (Cranfield Institute of Technology, Cranfield, Beds., England) and P. J. Perry (RAF, London, England). *Aeronautical Journal,* vol. 75, Mar. 1971, p. 182-194. 22 refs.

A method was developed for determining the response to stationary random vibrations of a flexible aircraft, taking into account nonlinearities in the oleo-pneumatic landing gear in the form of orifice damping and Coulomb friction. Results of a separate investigation are also presented in which the response of the aircraft in the coupled rigid body and first elastic mode was determined using an analog computer.   O.H.

A71-26314   **A theory on effect of entrainment, due to jet flap which hits the ground, for an aerofoil with separation.** T. Kida and Y. Miyai (Osaka Prefecture, University, Osaka, Japan). *Aeronautical Journal,* vol. 75, Mar. 1971, p. 199-201. 11 refs.

A simple approximate method is presented which is effective in calculating the flow around a jet flapped airfoil irrespective of whether or not the jet entrainment exists. The numerical results show that the increment in lift coefficient due to jet reaction is more significant than the changes in pressure forces on the airfoil. The effect of jet entrainment on lift coefficient is not large except when the jet sheet is almost touching the ground.   O.H.

A71-26315.   **A flight test establishment - Its function and a suggested composition.** J. M. Lewendon (Hawker Siddeley Aviation, Ltd., Dunsfold, England). *Aeronautical Journal,* vol. 75, Mar. 1971, p. 207-212.

The objectives of flight testing of aircraft are detailed, and the major features of the individual but interdependent test programs which have to be carried out to achieve these objectives, are broadly explained. Particular attention is given to the responsibilities and organization of the Flight Test Establishment which provides the execution of this operation.   O.H.

A71-26316   **The manufacture of glass fibre rotor blades with pressure tappings.** D. G. Gregory-Smith and H. Marsh (Cambridge University, Cambridge, England). *Aeronautical Journal,* vol. 75, Mar. 1971, p. 213-215. Research supported by Rolls-Royce, Ltd.

A set of rotor blades from glass fiber and epoxy resin was designed and manufactured for a large rotating cascade wind tunnel used for research on the flow through turbomachines. Design characteristics of blade root fixing and a description of blade manufacture are presented. Particular attention is given to a cheap and simple newly developed method for making 30 pressure channels running the full length of the blade surface.   O.H.

A71-26325   **Air and cosmic space common law as the only solution of the problem of determining the boundaries of these spaces (Le régime juridique commun de l'espace aérien et cosmique comme la seule solution du problème de la délimitation de ces espaces).** Michel Smirnoff. *Revue Française de Droit Aérien,* vol. 25, Jan.-Mar. 1971, p. 27-34. 20 refs. In French.

Study of the problem of air and space boundaries which is implied in the principle of the freedom of the cosmos and the incapability of states to appropriate parts of the cosmos. However, it is recognized that states can and do exercise sovereignty in the air

space over their territories. With the future development of space travel it will be necessary to establish a universally recognized system of jurisprudence.   F.R.L.

A71-26364   **Wind shear on the approach.** W. W. Melvin (Delta Air Lines, Inc., Atlanta, Ga.). *Shell Aviation News,* no. 393, 1971, p. 16-20. 6 refs.

Some representative examples of low altitude vertical wind shears resulting from variations in wind levels with altitude and their general characteristics are presented. The effects of the gradients and magnitudes of wind shears on aircraft flying on approach are examined. Necessary thrust corrections in the presence of a wind shear and countercorrections in case the wind shear ceases are discussed. Thrust requirements for aircraft flying a glide slope with a tailwind that decreases to a no-wind condition just above the ground are also considered. Several concealed hazards for the pilot due to wind shears are reviewed. Particular attention is given to the situation that can occur owing to the combined effect of a shear and the characteristic method of flight control utilized by the approach coupler - i.e., control of glide path position by pitch corrections, with resultant excursions in airspeed controlled by thrust corrections. Finally, several rules are suggested which might be helpful in correcting for wind shears.   O.H.

A71-26401 #   **Theory and calculation of aircraft bladed machines (Teoriia i raschet aviatsionnykh lopatochnykh mashin).** K. V. Kholshchevnikov. Moscow, Izdatel'stvo Mashinostroenie, 1970. 613 p. 67 refs. In Russian.

The fundamentals of the theory of bladed machines are explained, with emphasis on the design and principles of operation of bladed machines of various types - namely, axial-flow, centrifugal, and composite compressors, and axial-flow turbines. The basic equations of the theory of these machines are derived, the thermodynamic processes occurring in the machines are represented in p-v, T-s, and i-s diagrams, and the determination of the efficiencies of these machines is demonstrated. Special attention is given to the characteristics and control of turbines and compressors, and to the problem of matching the parameters of the turbine and compressor in a gas turbine engine system.   A.B.K.

A71-26403   **Automation of aircraft and rocket power plants (Avtomatika aviatsionnykh i raketnykh silovykh ustanovok) (3rd revised and enlarged edition).** A. A. Sheviakov. Moscow, Izdatel'stvo Mashinostroenie, 1970. 670 p. 45 refs. In Russian.

This third edition extends the theoretical treatment of automatic aircraft and rocket engine control to include automatic control systems of hybrid and nuclear-powered engines. The theoretical considerations are limited to problems associated with the determination of the dynamic characteristics of the controlled plants, the calculation of system dynamics, and to the study of possible control and fuel system design. A special chapter is devoted to the dynamics of heat exchangers employed in power plants. Particular attention is given to control systems of gas turbine engines, ramjet engines, and rocket engines. The reader is assumed to be acquainted with the fundamentals of automatic control theory, engine theory, and methods of control-system simulation. The textbook should be also of interest to engineers and scientist dealing with automatic engine control.   V.P.

A71-26409   **Quasi-optimum proportional navigation.** Elliot I. Axelband and Frederick W. Hardy (Hughes Aircraft Co., Culver City, Calif.). *IEEE Transactions on Automatic Control,* vol. AC-15, Dec. 1970, p. 620-626. 6 refs.

The problem of deriving feedback guidance laws for interceptor type aerodynamically controlled missiles which seek to engage moving targets is considered. These missiles contain target trackers which provide angular information about the relative interceptor-to-target geometry. The performance criterion for this problem is

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quadratic, but the system equations are nonlinear. Suitable guidance mechanizations are obtained by applying the technique of quasi-optimum control. The efficiency of the resulting guidance system, relative to a linear optimum guidance system and a proportional navigation system, is demonstrated by simulations of attack situations in which the interceptor missile launch conditions depart from the nominal attack geometry. (Author)

A71-26418   **Property of the equation-error approach to parameter identification.** Jerry M. Mendel (McDonnell Douglas Astronautics Co., West Huntington Beach, Calif.). *IEEE Transactions on Automatic Control,* vol. AC-15, Dec. 1970, p. 676-678. 7 refs.

An unusual property associated with the equation-error approach to parameter identification is demonstrated. This property, which is usually a liability of the equation-error formulation, is shown to be an asset for a specific application involving third-order pitch-plane dynamics for a typical high-performance aerodynamically controlled aerospace vehicle. M.V.E.

A71-26443 #   **Calculation of three-dimensional turbulent boundary layers.** P. Bradshaw (Ministry of Technology, National Physics Laboratory, Teddington, Middx., England). *Journal of Fluid Mechanics,* vol. 46, Apr. 13, 1971, p. 417-445. 35 refs.

The two dimensional prediction method of Bradshaw, Ferriss and Atwell (1967), which was based on the empirical conversion of the turbulent energy equation into a 'transport' equation for shear stress, is extended to three-dimensional flows satisfying the boundary-layer approximation (which excludes flows near bluff obstacles or streamwise corners). Predictions, using exactly the same empirical data as in two-dimensional flow, agree to within the likely experimental error with a variety of experiments on 'infinite' swept wings. (Author)

A71-26447 #   **Viscous tails in Hele-Shaw flow.** C. J. Wood (Oxford University, Oxford, England). *Journal of Fluid Mechanics,* vol. 46, Apr. 13, 1971, p. 569-576.

An experiment has been performed, using pulsed dye injection on an aerofoil in a Hele-Shaw cell. The purpose was to observe the form of the trailing-edge flow when the Reynolds number was high enough to permit separation and the initiation of a Kutta condition. The experiment provides a successful confirmation of the existence of a 'viscous tail' as predicted by Buckmaster (1970) although there is an unexplained quantitative discrepancy. (Author)

A71-26448 #   **On the scattering of aerodynamic noise.** D. G. Crighton and F. G. Leppington (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 46, Apr. 13, 1971, p. 577-597. 10 refs. Research supported by the Ministry of Technology.

The extent to which scattering bodies situated near Lighthill's multipoles can convert some of their intense near-field energy into the form of sound waves (whose intensity is greater than the incident field) is analyzed for hard and soft bodies of various shape. The reciprocal theorem is used to reduce the problem to finding the field, near the obstacle, induced by an incident plane wave. For the situation where the scatterer is large compared with the wavelength, the prototype problem of a wedge of exterior angle (p/q)pi is shown to yield an intensity law I proportional to U to the (4 + 2q/p) power (where I is the far-field intensity, and U the turbulence velocity) for both hard and soft surfaces. This result is shown to hold for more general wedge-like surfaces whose dimensions are large scale and whose edges may be smoothed out on a small scale compared with the wavelength. V.P.

A71-26449 #   **Wake characteristics of two-dimensional perforated plates normal to an air-stream.** I. P. Castro (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 46, Apr. 13, 1971, p. 599-609. 15 refs.

Investigation of the flow in the wakes behind two-dimensional perforated plates in the Reynolds number range from 25,000 to 90,000. Measurements of drag and shedding frequency were made and a pulsed hot-wire anemometer was used to measure the mean velocity and turbulent intensity variations in the highly turbulent regions immediately behind the plates. The results indicate the existence of two distinct types of flows: one appropriate to high and the other to low values of plate porosity. (Author)

A71-26486   **A 'static' evaluation of the manoeuvring tail load for instantaneous unchecked longitudinal manoeuvres of sailplanes.** Piero Morelli (Torino, Politecnico, Turin, Italy). *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.)* Aero-Revue, Apr. 1971, p. 183-185.

The sailplane in the equilibrium condition corresponding to a point on the n-V maneuver envelope is considered. Relations regarding the equilibrium of forces in the vertical direction and of moments about the pitching axis are examined. The effects of an instantaneous upward deflection of the elevator are investigated, and aerodynamic responses of the aircraft are discussed. Conditions for a sailplane are considered giving attention to the aperiodic dynamic response. G.R.

A71-26487   **Elevator-induced manoeuvring loads from the standpoint of airworthiness requirements for sailplanes.** Piero Morelli (Torino, Politecnico, Turin, Italy). *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.)* Aero-Revue, Apr. 1971, p. 185.

An expression for the incremental aerodynamic load on the horizontal tail, produced by an instantaneous elevator deflection, is considered. A proposal to use the incremental tail loads thus calculated for a replacement of the maneuvering incremental loads specified by the OSTIV Airworthiness Requirements is examined, and an investigation of the tail loads due to abrupt longitudinal maneuvers is discussed. G.R.

A71-26667 *   **A facelifting for NASA's reliability requirements.** David S. Liberman (NASA, Reliability and Quality Assurance Office, Washington, D.C.). In: Institute of Electrical and Electronics Engineers, Annual Symposium on Reliability, Washington, D.C., January 12-14, 1971, Proceedings.   Symposium co-sponsored by the Institute of Environmental Sciences and the American Society for Quality Control. New York, Institute of Electrical and Electronics Engineers, Inc. (Annals of Assurance Sciences. Volume 4, No. 1), 1971, p. 121-128.

Brief review of the evolution process which led to supersession of NPC 250-1 by NHB 5300.4(1A) 'Reliability Program Provisions for Aeronautical and Space System Contractors'. The resulting changes in the requirements are described. Experience with NPC 250-1 led to significant evolution in capabilities of NASA and contractor reliability organizations, acceptance of the assurance role of reliability, and the needs of NASA and its projects. It is considered that the revision has successfully responded in large measure to these changed requirements. F.R.L.

A71-26671   **Effects of the Pan American reliability program on airline maintenance.** F. H. Moxley, Jr. (Pan American World Airways, Inc., John F. Kennedy International Airport, N.Y.). In: Institute of Electrical and Electronics Engineers, Annual Symposium on Reliability, Washington, D.C., January 12-14, 1971, Proceedings.   Symposium co-sponsored by the Institute of Environmental Sciences and the American Society for Quality Control. New York, Institute of Electrical and Electronics Engineers, Inc. (Annals of Assurance Sciences. Volume 4, No. 1), 1971, p. 163-166.

Review of the substance and application results of a reliability program designed to reduce maintenance cost and downtime for modern commercial jet aircraft. A brief outline of the background of

cost-effective maintenance management in commercial aviation is followed by a discussion of the reliability program's aircraft performance report parameters, data collection and analysis techniques, functions, and responsibilities. The results so far show that the program has been very effective in reducing aircraft maintenance downtime and costs. The theoretical reliability techniques have proven to be very useful in practice. M.V.E.

A71-26679 Helicopter auxiliary power unit cost of ownership. B. M. Gallagher and W. H. Knobloch (International Harvester Co., San Diego, Calif.). In: Institute of Electrical and Electronics Engineers, Annual Symposium on Reliability, Washington, D.C., January 12-14, 1971, Proceedings. Symposium co-sponsored by the Institute of Environmental Sciences and the American Society for Quality Control. New York, Institute of Electrical and Electronics Engineers, Inc. (Annals of Assurance Sciences. Volume 4, No. 1), 1971, p. 285-291.

The methodology used to compute life cycle costs for the current model of an auxiliary power unit (APU) is explained, and the costs for four different APU concepts are estimated. The various cost factors for the four new concepts are described briefly. Comparisons are made between current model costs and anticipated decreases or increases in the new concepts. It is shown that for the current APU model, support expenditures far exceed the initial acquisition cost. By incorporating design changes which are aimed at increased reliability, improved maintenance, and the reduction of spare parts stocked in the field, it is found that life cycle costs can be reduced even when initial acquisition cost is increased. Z.W.

A71-26683 Screening for reliability growth. Robert W. Fink (General Electric Co., Utica, N.Y.). In: Institute of Electrical and Electronics Engineers, Annual Symposium on Reliability, Washington, D.C., January 12-14, 1971, Proceedings. Symposium co-sponsored by the Institute of Environmental Sciences and the American Society for Quality Control. New York, Institute of Electrical and Electronics Engineers, Inc. (Annals of Assurance Sciences. Volume 4, No. 1), 1971, p. 316-320.

The effectiveness of a screening program from parts procurement through system test is examined on the basis of experience obtained with the AN-APQ-113 attack radar system for the F-111 aircraft. It is shown how screening at all levels affects both reliability performance and profit levels. A Duane Growth Model, constructed to relate the impact of screening on system MTBF growth, is discussed. V.P.

A71-26702 Sound radiation from a point force in circular motion. C. L. Morfey and H. K. Tanna (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 15, Apr. 8, 1971, p. 325-351. 14 refs.

This paper is a theoretical study of sound radiation from a time-varying point force in accelerative motion, where the acceleration arises from steady rotation in a circle. The study is prompted by the question of whether such effects are significant in fan or helicopter rotor noise at subsonic tip speeds. Closed-form expressions are found for the overall radiation at a point in the far field, and for the radiated sound power, showing the acceleration effect as an additive term in each case. The effect of rotation on the broad-band far-field spectrum is demonstrated by a series expansion for rotational frequencies small compared with the radiated frequency. (Author)

A71-26704 Effects of louvres on the noise of an axial flow fan. P. E. Doak and D. N. May (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 15, Apr. 8, 1971, p. 421-424.

Experimental investigation of the effect on the sound field of axial flow fans of louvers positioned across their intakes, performed with the aid of a rig configuration typical of many practical situations (e.g., lift fans for VTOL aircraft and ventilation systems).

Findings include the observation that the overall noise field is roughly nondirectional for all louver angles. M.V.E.

A71-26714 Adaptive systems; Moskovskii Aviatsionnyi Institut, Iubileinaia Nauchno-Tekhnicheskaia Konferentsiia, Moscow, USSR, Mar. 26, 27, 1970, Transactions (Adaptivnye sistemy; Moskovskii Aviatsionnyi Institut, Iubileinaia Nauchno-Tekhnicheskaia Konferentsiia, Moscow, USSR, Mar. 26, 27, 1970, Trudy). *Informatsionnye Materialy*, no. 7 (44), 1970. 144 p. In Russian.

Includes the realization of adaptive control algorithms, elements of adaptive control systems, self-adjusting control systems for an aeroelastic aircraft, adaptive control of flight vehicle roll, flight vehicle control during atmospheric reentry, parametrically invariant control systems, statistical estimation in monitoring and control problems, choosing the transfer function of a standard model of a self-adjusting control system, the equations of motion of bodies of variable mass, the synthesis of nonsearching self-adjusting control systems, the development of a criterion for comparing adaptive control systems, the structure of a digital self-adjusting system with a model, the synthesis of a self-adjusting autopilot, and the special features of fixed-adjustment control systems. A.B.K.

A71-26716 # Prospective automatic flight-control systems (Perspektivnye sistemy avtomaticheskogo upravleniia poletom). A. D. Aleksandrov. *(Moskovskii Aviatsionnyi Institut, Iubileinaia Nauchno-Tekhnicheskaia Konferentsiia, Moscow, USSR, Mar. 26, 27, 1970.) Informatsionnye Materialy, no. 7 (44), 1970, p. 20-29.* In Russian.

Description of nonlinear self-adjusting and variable-structure automatic control systems for piloted and pilotless flight vehicles. Control problems considered include load stabilization, limitation of critical regimes, and control of yaw, pitch, and roll angles. Emphasis is placed on the extension of stability ranges by appropriate switching of the controller structure. The additional use of adaptive loops is demonstrated, and oscillations arising from intrinsic nonlinear characteristics of electric servo systems (dead zones and time lags) are examined. T.M.

A71-26718 # Self-adjusting automatic control systems for an aeroelastic aircraft (Samonastraivaiushchiesia sistemy avtomaticheskogo upravleniia aerouprugogo samoleta). G. I. Fedorenko, V. A. Vishnevetskaia, V. I. Glukhov, and L. R. L'vov. *(Moskovskii Aviatsionnyi Institut, Iubileinaia Nauchno-Tekhnicheskaia Konferentsiia, Moscow, USSR, Mar. 26, 27, 1970.) Informatsionnye Materialy, no. 7 (44), 1970, p. 36-43. 7 refs.* In Russian.

High-quality control of an aircraft as a rigid body can be achieved (with allowance for the nonlinearity and inertia of the actuator) by using appropriate compensating devices and by placing adaptive filters in the angular-velocity sensor circuits to eliminate noise caused by high- and low-frequency elastic oscillations. The primary low-frequency components of flexural vibrations in the wings and fuselage can be damped by special control surfaces on the wings and fuselage. This damping should be steered from accelerometer sensors positioned in selected points. The required phase relationships are obtained with compensating mechanisms and either phase-lead or phase-lag filters. Automatic control of optimal gain in the stabilization loops is accomplished with the aid of spectrum analyzers. The synthesis of controller structure and parameters should be based on graph-theory methods.

A71-26766 # Flutter of clamped skew panels with mid-plane forces in supersonic flow. S. Durvasula (Indian Institute of Science, Bangalore, India). *(Aeronautical Society of India, Annual General Meeting, 21st, Indian Institute of Technology, Madras, India, Apr. 4-6, 1969.) Indian Institute of Science, Journal*, vol. 52, Oct. 1970, p. 192-208. 31 refs.

The flutter problem of uniform, thin, flat, isotropic, skew panels clamped on all the edges and under the action of mid-plane forces is

formulated on the basis of the classical small deflection thin plate theory. For the aerodynamic loading, the two-dimensional static approximation is used. Approximate flutter analysis is made by using the Galerkin method employing a double series of beam characteristic functions to represent the deflection surface. Results of numerical calculation for the critical dynamic pressure for a few configurations of rhombic panel under direct stress in the stream-wise direction are presented. (Author)

A71-26870 Subsonic and supersonic operations in the years ahead (Sir Charles E. Kingsford-Smith Memorial Lecture). James Andrew (British Overseas Airways Corp., London Airport, Hounslow, Middx., England). *Aeronautical Journal*, vol. 75, Apr. 1971, p. 269-279.

Consideration of various restraints which hinder aircraft operations and which threaten further growth. Community reaction to noise and pollution causes one set of constraints, but at the same time fast and efficient transport is desired. Another set of constraints concerns the adequacy of facilities at airports on certain routes. Aspects of radio and other aids needed for safe and regular operation are extensively discussed. Some simulated Concorde flights are described, including a complete London-New York mission. F.R.L.

A71-26878 # The growth of avionics. L. F. E. Coombs. *Aircraft Engineering*, vol. 43, Apr. 1971, p. 4-6, 22. 8 refs.

Account of the application of electronics to aircraft systems and of the latest advances in this field. It is considered that the rate of growth for the next decade will be less than previously, since civil aviation has reached a point in its development where avionic advances are becoming marginal. However, there will be increased use of digital computers, solid state transducers, integrated circuits, electronic flight instruments, area navigation, and collision avoidance systems. F.R.L.

A71-26879 # The RNAV thing. Mark Lambert (Elliott Flight Automation, Ltd., Rochester, Kent, England). *Aircraft Engineering*, vol. 43, Apr. 1971, p. 8-10.

Examination of the various solutions to the problem of providing an area navigation facility. In area navigation, all routes are defined as bearings from the beacons, not as tracks. In a system developed by Decca Navigator Co. and Ambac there are three control and display units by which the crew operates and receives information from the navigation computers. Marconi offers a computer-driven projection map display. Some aspects of Aeronautical Radio, Inc. (ARINC) standards for area navigation are discussed. F.R.L.

A71-26880 # Airborne communications systems. B. H. L. Blake (Marconi-Elliott Avionic Systems, Ltd., Chelmsford, Essex, England). *Aircraft Engineering*, vol. 43, Apr. 1971, p. 11, 12.

Description of the development of aeronautical radio communications and the different systems in use. Of the three basic systems, VHF, HF, and UHF, VHF is the most universal, while the HF system is used for long range communications. Reliability is emphasized as the keystone of equipment design. F.R.L.

A71-26881 # The development of terrain following radar. R. J. Starling and C. M. Stewart (Ferranti, Ltd., Hollinwood, Lancs., England). *Aircraft Engineering*, vol. 43, Apr. 1971, p. 13-15.

Account of the progress made with an airborne guidance system for low flying military aircraft. The penalty which must be paid for the advantage of low-level attack is the danger of the aircraft striking the ground, particularly at night or in bad weather. A radar device is described which when mounted in the nose of a low flying aircraft scans the terrain ahead and determines the path in elevation which the aircraft must follow to clear the ground by the required height. This height, selectable by the pilot, can be anywhere between 200 and 1000 ft. F.R.L.

A71-26882 # Concorde structural features. *Aircraft Engineering*, vol. 43, Apr. 1971, p. 16-19, 22.

Description of the methods of construction and materials used in the production of the Anglo-French SST. Hiduminium RR 58 (AU2GN), a heat- and creep-resistant alloy available in the form of sheets, forgings, prestretched plates and extrusions, was chosen as the basic structural material. Structural details of many components such as the wing leading edge, main wing ribs, and many others are given and line drawings of them are presented. F.R.L.

A71-26883 # The challenge of the supersonic era. Thomas G. Foxworthy. *Aircraft Engineering*, vol. 43, Apr. 1971, p. 23-26.

Assessment of some of the problems that face the pilot of the SST. Adequate instrumentation is one of the greatest concerns. Pilots expect to see much more information presented in digital form only for reasons of space and duplication. Angle of attack and sideslip indicators would be extremely useful. Aspects of supersonic cruise are discussed. It is considered that the problem of rendering fuel tanks immune to explosion is of primary concern, since the fuel is used as a heat sink. Better on-board radar is needed. F.R.L.

A71-26884 # Powered flying controls on the VAK 191B. *Aircraft Engineering*, vol. 43, Apr. 1971, p. 27, 28.

Description of the development of advanced powered flying controls for the VFW-Fokker V/STOL fighter prototype. Five duplex input servos are fitted to the aircraft, each one being an electrically signaled, twin channel, high resolution input servo with manual reversion, hydraulically powered. Its function is to power the input linkage from the pilot's controls to the operating servo valves of the surface power control, and also to operate the pneumatically stabilizing puff-pipes which function continuously during the VTOL flight mode. F.R.L.

A71-26921 In 18 months - First flight of the European Airbus. *Interavia*, vol. 26, Apr. 1971, p. 371-376.

The present status of the European Airbus is discussed giving attention to the flight trials of the first prototype of the A.300B high capacity transport aircraft which are to begin in about 18 months time. Approximately one year later the first A.300B aircraft could be making their debut in scheduled service at European airports. It is pointed out that the Airbus program has entered a new phase since Airbus Industrie was founded by French and German partners in December 1970. A standard and a long distance version of the aircraft are to be manufactured. Questions of development phase financing and expenditure are considered, some design data are presented, and sale prospects of the aircraft are evaluated. G.R.

A71-26939 An application of the method of dimensional perturbations to compressible flow. Stefan Nadir (Northrop Corp., Hawthorne, Calif.). *Zeitschrift für angewandte Mathematik und Physik*, vol. 22, Mar. 25, 1971, p. 257-266. 6 refs.

The Taylor-Maccoll problem - i.e., the problem of steady, supersonic, isoenergetic flow of a thermally and calorically perfect gas past circular cones at zero angle of attack - is investigated using the perturbation series approach developed by Garabedian (1956) for the study of axisymmetric free jet problems. The solution of the problem is obtained by perturbing its counterpart in plane flow - namely, supersonic flow past wedges. It is found to agree well with the exact numerical solution by Sims (1964). O.H.

A71-26946 High-speed methods for testing reliability and fatigue life of airplane structures. I. V. Iakobson (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR). (*Problemy Prochnosti*, vol. 2, Apr. 1970, p. 30-35.) *Strength of Materials*, Apr. 1970, p. 325-330. 5 refs. Translation.

Examination of the principles underlying methods for planning, realization, and evaluation of accelerated tests of passenger aircraft

under operational conditions. Topics discussed include (1) selection of the number of aircraft subjected to testing under operational conditions, (2) evaluation of data obtained by means of approximate formulas, (3) determination of damage accumulation in the tested aircraft, and (4) selection of the overhaul time for aircraft under current operation on the basis of failures observed in selected aircraft.
Z.W.

A71-26952 ≠ **Structural-endurance problems for rotor disks in turbine engines** (Zagadnienia konstrukcyjno-wytrzymałościowe tarcz nośnych wirników silników turbinowych). Stefan Szczeciński. *Technika Lotnicza i Astronautyczna*, vol. 26, Mar. 1971, p. 7-11, 21. 9 refs. In Polish.
Analysis of loads imposed on compressor, ventilator, and turbine rotor disks having large central holes (up to 0.7 times the outer diameter of the disk). Formulas are given for stress distributions in such disks as a function of hole radius, material density, rotational speed, blade loading, and heating uniformity. Permissible permanent deformations are defined.
T.M.

A71-26953 ≠ **Determination of the mutual aerodynamic effects of SM-1 helicopters during takeoff and landing** (Ustalenie wzajemnego oddziaływania aerodynamicznego śmigłowców SM-1 podczas startu i lądowania). Mieczysław Lekowski and Józef Petulski. *Technika Lotnicza i Astronautyczna*, vol. 26, Mar. 1971, p. 12-15. In Polish.
Aerodynamic measurements and calculations were performed on SM-1 helicopters to determine minimum runway distances for safe simultaneous landing and takeoff operations. Gust velocities in the rotor wake around the helicopter are given as functions of distance from the craft both on the ground and at different hover heights. Rotor blade rigidity was measured, and deflection amplitudes are given as functions of gust velocities from a combination of wind and adjacent-helicopter effects.
T.M.

A71-26954 ≠ **Fundamental problems in the production of laminated aircraft structures** (Podstawowe problemy wytwarzania laminatowych konstrukcji lotniczych). Hieronim Ołtarzewski. *Technika Lotnicza i Astronautyczna*, vol. 26, Mar. 1971, p. 16-18, 21. In Polish.
Discussion of the relative importance of initial material properties, impregnation, shaping, hardening, and structural design in the efficient mass production of reinforced laminates for the aircraft industry. Problems arising from ingrained traditional concepts of design and production are defined, and some specific causes are listed for the relatively stagnant state of laminate fabrication in Poland.
T.M.

A71-26991 **Thrust measurement of great accuracy of aeronautical propulsion systems giving particular attention to a hydraulic device for measuring the force. I** (Schubmessung grosser Genauigkeit an Flugtriebwerken unter besonderer Berücksichtigung einer hydraulischen Kraftmesseinrichtung. I). Joachim Fruböse. *Archiv für technisches Messen und industrielle Messtechnik*, Apr. 1971, p. 69-72. In German.
Requirements regarding test installations for measuring the thrust of propulsion systems are discussed and approaches for meeting these requirements are considered. Cost and characteristics of mechanical, electrical and hydraulic systems for the measurement of force are compared. The hydraulic systems combine accuracy of about 0.1% with a superior degree of insensitivity against shock. A device consisting of a cylinder and a piston in which friction effects in the direction of the force are practically eliminated is described. A change in the force to be measured causes a change in the position of the piston. This change in piston position causes a change in the oil pressure, which is measured, because of changes in the width of the opening for the passage of the oil due to an appropriate design. G.R.

A71-27016 **Microwave applications of reinforced plastics.** J. A. G. Thomas. *Composites*, vol. 2, Mar. 1971, p. 46-48.
Brief description of the use of reinforced plastics components in radar systems, particularly radomes and antennas. Large numbers of reinforced plastic radomes have been produced for the Thunderbird missile program, and nose radomes for the prototype Concorde SST have been developed and produced. The Concorde radomes are constructed by the method of molding between matched metal tools. The plastics molding of an antenna is made to reflect by coating the concave side with metal. The surface of the mold is prepared and a thin coating of resin mix is applied and allowed to almost gel. Zinc or aluminum is then sprayed onto the mold surface gel coat and allowed to gel. The component is then layed-up by hand in the normal way.
M.M.

A71-27040 **Performance testing of fluorosilicone hydraulic fluid in high temperature aircraft piston pumps.** George J. Quaal and Harry M. Schiefer (Dow Corning Corp., Midland, Mich.). *(American Society of Lubrication Engineers, Annual Meeting, 25th, Chicago, Ill., May 4-8, 1970.)* Lubrication Engineering, vol. 27, Apr. 1971, p. 115-122. 6 refs.
The properties and functional aircraft hydraulic pump testing of a structurally modified fluorosilicone fluid are described. The fluorosilicone hydraulic fluid, designed primarily for SST and other future high performance aircraft, was subjected to three aircraft hydraulic piston pump tests. Included were a 200 hour test with a 160 F Off-Set Pump, a 170 hour test with a 275 F High Speed In-Line Pump, and a 1300 hour High Temperature Test with a 400 F In-Line Pump. Testing was conducted at a maximum fluid temperature of 460 F. Fluid properties, which were monitored during each test, showed no significant changes after a combined total time of 1470 hours of pumping and no fluid make-up. Inspection of the pumps at the end of the tests indicated that each pump could be operated successfully with the fluid above the design temperatures of the pumps.
(Author)

A71-27051 **On the accuracy of Merk's method for solution of laminar boundary-layer equations.** G. Abad and W. R. Schowalter (Princeton University, Princeton, N.J.). *Applied Scientific Research*, vol. 23, Mar. 1971, p. 426-430. 8 refs.
Results for the local drag coefficient, computed by a one- and two-term Merk expansion (1959), were compared with drag coefficients computed for more accurate solutions. From the results, a simple correction procedure was developed which should permit rapid and accurate estimation of drag coefficients from the Merk expansion in regions upstream of the stagnation point of shapes with surface profiles likely to be of physical interest.
O.H.

A71-27063 ≠ **Aerodynamically induced noise or condenser microphones** (Das Windgeräusch von Kondensatormikrophonen). P. Költzsch (VEB RFT Messelektronik, Dresden, East Germany) and H.-J. Bauer (Dresden, Technische Universität, Dresden, East Germany). *Hochfrequenztechnik und Elektroakustik*, vol. 79, Dec. 1970, p. 225-234. 21 refs. In German.
It is pointed out that sound generated aerodynamically determines a lower limit for the measurement of acoustic pressure levels. The dependence of this limit on the velocity and the turbulence of air flow is investigated taking into consideration conditions in a condenser microphone. It is found that the aerodynamic sound depends on the flow direction and that the energy spectrum of the flow turbulence determines the aerodynamic sound spectrum. Aspects of a standardization of aerodynamically induced noise are discussed, and questions regarding a practical application of the obtained results are considered.
G.R.

A71-27100 ≠ **Statistical methods of determining the dimensions and concentrations of various inhomogeneities from satellite and aircraft measurement data** (Statisticheskie metody opredeleniia razmerov i kontsentratsii razlichnykh neodnorodnostei po dannym izmerenii so sputnikov i samoletov). N. I. Vul'bson (Glavnoe

Upravlenie Gidrometeorologicheskoi Sluzhby SSSR, Institut Prikladnoi Geofiziki, Moscow, USSR). *Akademiia Nauk SSSR, Izvestiia, Fizika Atmosfery i Okeana*, vol. 7, Feb. 1971, p. 151-163. In Russian.

A method is proposed for determining the distribution of circles randomly situated on a plane, or of spheres in space, with respect to their diameters. The distributions and concentrations are determined from the distribution of the largest cross sections obtained by intersecting the circles by an arbitrarily directed strip or intersecting the spheres by an arbitrarily directed cylindrical tube. Tables are presented, using which the distribution with respect to dimensions of circles in a plane can be easily determined for various widths of the intersecting strip. The technique proposed is useful for improving the interpretation accuracy of aerial photographs, cloud characteristics, and similar applications. V.P.

A71-27123 Inherent vibration damping of helicopter blades. Wilfred E. Baker (Southwest Research Institute, San Antonio, Tex.). *International Journal of Mechanical Sciences*, vol. 13, Feb. 1971, p. 157-170. Contract No. DA-31-124-ARO(D)-356.

Comparison of the results of extensive experiments on damping of vibrations in helicopter main rotor blades with those obtained by theoretical and semiempirical methods of predicting blade damping. The feasibility of numerical solution of blade vibration equations which include complicated damping effects is also demonstrated. Nonlinear air damping is shown to be relatively unimportant for all but the fundamental bending vibration mode. Damping for higher modes is essentially independent of amplitude but varies significantly with frequency. For much of the experimental data, internal damping of the blade material is apparently the primary source of damping. (Author)

A71-27141 # Problems and aspects of elaboration of weather minimum conditions for INTERFLUG aircraft (Probleme und Aspekte der Erarbeitung von Wettermindestbedingungen für die Luftfahrzeugtypen der INTERFLUG). Erwin Langrock (Hauptverwaltung der Zivilen Luftfahrt, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 2, 1971, p. 76-87. 6 refs. In German.

The methodology necessary for determining weather minima is discussed. Factors affecting this determination are reviewed and qualitatively estimated. Requirements are presented which must be included in the methodology. Finally, possible approaches to the methodology preparation are examined. O.H.

A71-27142 # Crane and external load flight with helicopters (Kran- und Aussenlastflug mit Hubschraubern). Michael Caspari. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 2, 1971, p. 88-99. In German.

Problems involved in using helicopters as a material handling equipment for transport and crane operations are discussed. Specific features of these operations performed by helicopters are outlined. Factors for assessing the applicability of helicopters to perform such operations are examined. Finally, the economic effectiveness of these operations is calculated. O.H.

A71-27143 # Examination of operational aspects of motion sequences on airways (Betriebstechnologische Untersuchungen von Bewegungsabläufen auf Luftstrassen). Rolf Küttner. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 2, 1971, p. 100-105. In German.

Actual and scheduled motion sequences are described by means of mathematical-statistical methods. Equations are derived for calculating the so-called 'advance times' by means of which, provided that a prescribed altitude-path diagram is observed, flight motions can be exactly adapted to an airway so that the shortest possible flight sequence is achieved. O.H.

A71-27144 # Planning of transportation operations at AEROFLOT (Die Planung der Beförderungsleistungen bei der AEROFLOT). O. Ovchinnikov (Aeroflot, Soviet State Airlines, Moscow, USSR). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 2, 1971, p. 106-111. In German.

A new planning methodology introduced in Soviet civil aviation and adapted to the new system of economic planning is described. Principal objectives of this methodology and new planning criteria and parameters are discussed. Organizational principles adopted for plan preparation and fulfillment are outlined. O.H.

A71-27150 Analogue recursive computer. R. J. Lamden, J. Archer, and A. Maybanks (Ultra Electronics, Ltd., London, England). *Institution of Electrical Engineers, Proceedings*, vol. 118, Mar.-Apr. 1971, p. 486-492. Research supported by the Ministry of Technology.

Description of a control computer which uses a serial digital program to control an arithmetic unit and storage system working entirely in the analog mode. Storage is capacitive, using field-effect-transistor switches for data selection. Using conventional techniques, speeds of 20 microsec per arithmetic operation are readily obtainable. The first application of this computer is to aircraft-gas-turbine control. A control program, for example, of a Rolls Royce Olympus 593B engine occupies 120 instructions, and the computation has a recursion time of 3 msec. An accuracy of within 0.1% is obtainable. (Author)

A71-27169 # Theory of an inertial navigation system constructed on the basis of a gyrohorizon compass (K teorii inertsial'noi sistemy navigatsii, postroennoi na baze girogorizontkompasa). O. F. Boichuk and V. N. Kalinovich. *Matematicheskaia Fizika*, no. 8, 1970, p. 46-53. 10 refs. In Russian.

Detailed study of the errors of an inertial system consisting of a gyrohorizon compass, a directional gyro, and a computer due to vibrations of the compass, with allowance for side moments applied to the compass, drift of the directional gyro, and inaccurate input of the initial conditions into the computer. The vibrations of a compass subjected to the action of side moments are considered. It is shown that the resulting system of differential equations has the same form as the corresponding system characterizing the vibrations of a gyroinertial platform. The errors in determining the position coordinates of an object are calculated. This problem is also found to be equivalent to the analogous problem for an inertial system with a gyrostabilized platform, although it has certain special features. A.B.K.

A71-27174 # Motion of a wing of solid profile near a screen (Dvizhenie kryla telesnogo profilia vblizi ekrana). V. N. Kravets. *Matematicheskaia Fizika*, no. 8, 1970, p. 102-107. 6 refs. In Russian.

Solution of the problem of the motion of a wing of solid profile near a solid wall or a free surface by employing the acceleration potential method. A solution to the singular integral equation for this problem is found by an approximate method involving the use of a small parameter. As a result, a formula is obtained for the lift coefficient of the wing profile, on the basis of which a calculation is made for a specific case. A.B.K.

A71-27217 # An asymptotic theory of the jet flap in three dimensions. Naoyuki Tokuda (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics*, vol. 46, Apr. 27, 1971, p. 705-726. 18 refs.

A uniformly valid asymptotic solution is constructed for three-dimensional jet-flapped wings by the method of matched asymptotic expansions for high aspect ratios. The flow is assumed to be inviscid and incompressible and is formulated on the thin airfoil theory in accordance with the two-dimensional Spence (1961) theory. Using this formulation, a physical picture is presented that not only illuminates the basic structure of the flow field, but also greatly facilitates the analysis. The asymptotic solution obtained is

consistent with this picture. After deriving the formula for aerodynamic forces on wings, the result of the analysis is applied to flat wings of various wing plan forms such as cusped, elliptic, and rectangular wings.   M.V.E.

A71-27220 # **Vortex shedding from circular cylinders at low Reynolds numbers.** M. Gaster (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *Journal of Fluid Mechanics,* vol. 46, Apr. 27, 1971, p. 749-756. 6 refs.

Experiments on slightly tapered models of circular cross-section have shown that the vortex wake structure exists in a number of discrete cells having different shedding frequencies. Within each cell shedding is regular and periodic, the frequency being somewhat lower than that from a parallel cylinder of the same diameter. A similar type of wake behavior has also been observed on a parallel model in a nonuniform mean flow. These results suggest that the discontinuities in the shedding law observed by Tritton could arise through nonuniformities in the flow.   (Author)

A71-27247 # **Let's do away with fog.** William H. Best, Jr. *Defense Management Journal,* vol. 7, Spring 1971, p. 41-47.

Discussion of fog dissipation techniques and the cost of fog dissipation. Both cold and warm fog are considered. The existing fog dissipation techniques and their efficiency are briefly described. Particular emphasis is placed on the economic problem of whether fog dissipation can compete in the field of benefits and cost avoidance. By several examples illustrating the problem, it is demonstrated that fog costs resources, and that dissipation of fog can recover these resources for use in a more productive manner.   O.H.

A71-27277   **High temperature aerodynamics with electromagnetic radiation.** John D. Anderson, Jr. and Eva M. Winkler (U.S. Navy, Naval Ordnance Laboratory, White Oak, Md.). *IEEE, Proceedings,* vol. 59, Apr. 1971, p. 651-658. 39 refs.

In recent years, the basic study and concepts of the interaction between radiation and matter have found application in aerodynamic problems of engineering interest. This paper discusses three such problems actively being examined at the Naval Ordnance Laboratory (NOL): (1) thermally radiating high-temperature shock layers, (2) electric arc-driven wind tunnels, and (3) gasdynamic lasers. Special emphasis is given to the area of gasdynamic lasers. New research results recently obtained at NOL are presented and discussed. Moreover, in the same context, an overview is made of each subject in order to whet the enthusiasm of the reader to look more thoroughly into these interesting areas, whether he be an aerodynamicist, electrical engineer, plasma physicist, or any physical scientist or engineer interested in radiation and matter.   (Author)

A71-27312 # **Holographic detection of microcracks.** C. M. Vest (Michigan, University, Ann Arbor, Mich.), E. L. McKague (General Dynamics Corp., Fort Worth, Tex.), and A. A. Friesem (Radiation, Inc., Advanced Optics Center, Ann Arbor, Mich.). American Society of Mechanical Engineers, Paper no. 71-Met-C, 1971. 5 p. 10 refs. Members, $1.00; nonmembers, $2.00. Research sponsored by the General Dynamics Corp.; Grant No. DA-AG-46-69-C-0017.

This paper describes the application of optical holographic interferometry to the detection of microcracks in metals. In particular, detection of radial cracks extending from bolt holes in high strength aircraft steel was studied. The method was found to have several advantages over currently used detection methods. The results of the holographic study compared favorably with independent results obtained by magnaflux, eddy current, and X-ray inspection. Some evidence of a possible ability to detect untempered martensite deposits was also noted.   (Author)

A71-27323 # **Advanced composites efforts - A status report of Air Force programs with graphite reinforced composites.** F. J.

Fechek (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Design Engineering Conference and Show, New York, N.Y., Apr. 19-22, 1971, Paper 71-DE-13.* 9 p. Members, $1.00; nonmembers, $2.00.

Review of progress in advanced composites, which in five years have come from a laboratory curiosity to a material used in the production of primary aircraft structures. Graphite composites now compete with boron composites on an equal basis. Efforts to combine graphite filaments into structures have utilized both organic and inorganic matrix materials, with most of the effort being applied to the epoxy systems. The costs of graphite composites have been continually decreasing, and weight savings for components such as speedbrakes, horizontal stabilizers, and spacer beams range from 18 to 60%.   F.R.L.

A71-27324 # **Applications of self-organizing and learning control to aeronautical and industrial systems.** R. L. Barron (Adaptronics, Inc., McLean, Va.) and C. W. Gwinn (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Design Engineering Conference and Show, New York, N.Y., Apr. 19-22, 1971, Paper 71-DE-22.* 13 p. 16 refs. Members, $1.00; nonmembers, $2.00. USAF-sponsored research.

This paper describes a broad area of development in adaptive control systems, emphasizing several recent applications. Two principal lines along which development has occurred since 1961 are: those systems that use short-term memory retention, and those systems that use long-term memory retention. Both employ logic random searches to find appropriate parameter values within the controller. Self-organizing systems use a probability state variable algorithm, continually up-dating internal probability distribution functions by which successive control actions are governed. Results of two recent applications are presented. Learning control systems use multimodal guided random searches to adjust parameters of the system, given only a representative data set as the basis for training. Two representative applications of state-estimation networks are discussed to illustrate the power of the learning control system method.   (Author)

A71-27325 # **Controlling structural fatigue through adhesive bonding.** M. A. Melcon and V. D. Moss (Lockheed-California Co., Burbank, Calif.). *American Society of Mechanical Engineers, Design Engineering Conference and Show, New York, N.Y., Apr. 19-22, 1971, Paper 71-DE-27.* 17 p. Members, $1.00; nonmembers, $2.00.

Review of fatigue improvement potential through bonding in the Lockheed L-1011 TriStar, utilizing analysis of joint variables and test data. Bonding in the fuselage is discussed with reference to joints, doublers at cutouts, and fail-safe straps. The integration of the bonding process with the structural arrangement is described, as well as the results of full-scale component development tests. Both fatigue test and fail-safe test data are presented. Structural requirements pertinent to metal-to-metal bonding in a relatively large aircraft are discussed, together with past experience that indicates the necessity of these requirements. The usefulness of adhesive peel strength as a parameter for the design of bonded structures incorporating the relatively thick elements of large aircraft is shown.   F.R.L.

A71-27327 # **The design and application of the Traversing Infrared Inspection System (TIRIS).** S. E. Cohen (Lockheed-Georgia Co., Marietta, Ga.). *American Society of Mechanical Engineers, Design Engineering Conference and Show, New York, N.Y., Apr. 19-22, 1971, Paper 71-DE-37.* 10 p. 11 refs. Members, $1.00; nonmembers, $2.00.

Description of a Traversing Infrared Inspection System designed primarily for high-volume production inspection of C-5 aircraft fail-safe strap panels. These panels are bonded laminates of 0.020 in. thick titanium and 0.125 in. thick aluminum. The system is flexible enough to be used for the development of special techniques such as the detection of entrapped water in aluminum honeycomb and the inspection of advanced structural composites. The system injects heat into the panels by means of hot air guns. Imperfections as small

as 0.30 in. in diam are displayed on an 8 x 10 in. cathode ray tube in real time. The inspection scanning rate is 4.3 sq ft/min. A Polaroid camera is used to produce thermograms which define the size and shape of voids, disbonds, and delaminations which are located directly on the panels with a unique marking device. Principles of operation are explained in detail with the aid of representative thermograms made with the system. A blackbody calibration device and special facilities were also designed for the system. It was found that no emissivity costing is required for the inspection of the fail-safe panels because of the surface characteristics of titanium.

(Author)

A71-27330 # **Hypersonic flow around a thin three-dimensional body (Giperzvukove obtikannia tonkogo prostorovogo tila).** L. I. Dzvonik (Kiivs'kii Derzhavnii Universitet, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 33, Mar. 1971, p. 220-223. In Ukrainian.

Theoretical analysis of hypersonic inviscid flow around a thin delta wing at small angles of attack. Equations of motion and boundary conditions for a general class of disturbances are derived within the framework of the asymptotic hypersonic theory of small perturbations. Flow around the body is divided into an outer region of uniform flow and a central region of conical flow. The outer region is studied in a cross-sectional plane, and numerical calculations are performed for finite values of the hypersonic similarity parameter and for an infinite freestream Mach number in the limiting case. A qualitative pattern of streamline behavior is constructed, together with the distribution of the transverse velocity component along these lines. Analysis of the results confirms the presence of a singularity region near the central symmetry plane where additional studies of the flow are required.

A71-27339 # **Generalized conditions for the absolute invariance of an aircraft's longitudinal-motion coordinates relative to atmospheric disturbances (Mzagal'neni umovi absoliutnoi invariantnosti koordinat pozdovzhn'ogo rukhu litaka vidnosno atmosfernikh zburen').** V. S. Mechetnii. *Avtomatika,* vol. 16, Jan.-Feb. 1971, p. 10-15. 5 refs. In Ukrainian.

A previously described concept of the physical reducibility of control systems is used to derive generalized invariance conditions for the coordinates of longitudinal motion. Simultaneous thrust-variation, rudder-deflection, and flap-deflection control rules are given for counteracting vertical and horizontal wind gusts. Conditions for longitudinal-coordinate invariance relative to vertical wind gusts are also defined for an aircraft without horizontal control surfaces. Various technical considerations associated with practical realization of the theoretical control laws are evaluated. T.M.

A71-27410 # **Rapid analysis methods for the design and optimization of wing pivot systems for variable geometry aircraft.** Ken Schwartz (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), Stanley Mellin, and Leonard Ascani (North American Rockwell Corp., Los Angeles, Calif.). *American Astronautical Society and American Institute of Aeronautics and Astronautics, Variable Geometry and Expandable Structures Conference, Anaheim, Calif., Apr. 21-23, 1971, AIAA Paper 71-404.* 48 p. 11 refs. Members, $1.50; nonmembers, $2.00.

The problem of developing rapid, low-cost analysis techniques to assess the efficiency of advanced or existing variable geometry applications to aircraft design is investigated. In particular, a program is discussed which is concerned with the structural-mechanical design of a wing pivot system. Included in the program are all critical variables existing between the points of basic aircraft definition through to the final and complete design of the wing pivoting system itself. Such items as load analysis, stress determination, deflected shapes, fatigue analysis, thermal stresses, bearing wear and performance, and structural optimization constitute the output of the program. Additional areas also included are follow-on detailed design methods utilizing refined two-dimensional and expanded three-dimensional finite element techniques. A discussion of the correla-

tion between experimental variable geometry test data and calculated value based on the present program is also included. Results have shown that a wing pivot system can indeed be designed with much greater efficiency and speed. O.H.

A71-27412 **Flame-retardant silicone elastomers for aircraft.** T. L. Laur and L. B. Guy (Dow Corning Corp., Midland, Mich.) *SAMPE Journal,* vol. 7, Apr.-May 1971, p. 21-24, 31. 7 refs.

A new rubber technology was developed and new silicone rubber stocks are produced that consistently exceed aircraft flame specifications. The sensitivity of the new materials to moisture was minimized, and they are also easier to fabricate and significantly lower in cost than the early flame retardant silicone rubbers. The new stocks have much improved resiliency over the early high-phenyl content materials because they react better to low cure temperatures. The new materials are not subject to heat aging and have excellent weatherability. Z.W.

A71-27413 **Graphite epoxy flight spoiler - Design/analysis/fabrication.** Leo C. Jensen (Hercules, Inc., Magna, Utah). *SAMPE Journal,* vol. 7, Apr.-May 1971, p. 25-28.

Presented are discussions on the design, analysis and fabrication of a commercial aircraft flight spoiler utilizing graphite/epoxy composite skins. The unit is designed so that the fibers within a given ply lamina are multidirectional to provide a greater stiffness/skin weight ratio than available with conventional unidirectional layups. The success of this multiangle ply technique is demonstrated by test results and comparison with conventional ply skin designs and aluminum skins. (Author)

A71-27437 **Performance analysis of the modulation cancellation altimeter.** Sol Rauch and Howard A. Grant (Canadian Marconi Co., Montreal, Canada). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-7, Mar. 1971, p. 367-378. 6 refs.

The performance of the modulation cancellation altimeter is investigated. Several sources of error are considered, specifically: (1) terrain averaging error; (2) output noise fluctuations; (3) errors due to phase shifts; and (4) acquisition ambiguities. The predominant parameters affecting these errors are investigated with a view towards optimizing the performance of the altimeter. (Author)

A71-27450 # **Flow of a two-phase medium with solid particles around a thin profile (Obtekanie tonkogo profilia dvukhfaznoi sredoi s tverdymi chastitsami).** N. A. Mamadaliev and Kh. A. Rakhmatulin. In: Waves in nonelastic media (Volny v neuprugikh sredakh). Edited by N. Z. Dmitrenko. Kishinev, Akademiia Nauk Moldavskoi SSR, 1970, p. 146-152. 7 refs. In Russian.

The two-dimensional linearized problem for the flow of a two-phase, supersonic, barotropic medium with solid particles around a thin profile is studied with allowance for elastic collisions of the particles against the profile surface. The boundary condition imposed on the gas velocity is the same as that for the case of a perfect continuous medium. This condition is not valid for the particle velocity which has a component normal to the solid surface, giving rise to a third type of reflected flow. As a result, a region of three-velocity flow arises between the shock wave and the solid body. This region is separated by a dividing line from the region of two-velocity flow. If the position of the solid profile is specified, the location of this dividing line can be obtained by solving the flow problem, and inversely, the position of the body can be determined for a specified location of the dividing line. The problem is solved for large and small concentrations of solid particles in the flow. T.M.

A71-27467 # **Review of testing techniques for transonic airfoils. I - Apparatus for commercial tests at S3MA. II - Experimental study of wall corrections at R1 Ch. (Critique des techniques d'essais de profils transsoniques. I - Dispositif d'essais industriels à S3MA. II - Etude expérimentale des corrections de parois à R1 Ch.).**

M. Bazin (ONERA, Modane, Savoie, France), J. Ponteziere, and R. Bernard-Guelle (ONERA, Meudon, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 35 p. 10 refs. In French.

Discussion of the testing of transonic airfoils in two-dimensional flow in the ONERA S3MA and R1 Ch. wind tunnels. The S3MA apparatus is directed toward developments of a practical character. It makes it possible to carry out tests on large models over a wide range of Reynolds numbers. The study of helicopter blade elements with chords identical to those of rotor blades tested in the S1MA wind tunnel makes comparisons possible. The systematic study of wall interactions, indispensable for understanding of aerodynamic coefficients, is carried out in the R1 Ch. wind tunnel, which is particularly well adapted for basic research at high Reynolds numbers. Preliminary results indicated corrections which are applicable to test conditions in the latter wind tunnel. F.R.L.

A71-27468 # Measurement of unsteady aerodynamic forces and propagation of perturbations during rapid variations of the angle of attack of an airfoil (Mesure des efforts aérodynamiques instationnaires et propagation des perturbations lors de variations rapides de l'incidence d'un profil). A. Damongeot (Société Nationale Industrielle Aérospatiale, Châtillon, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 64 p. 9 refs. In French.

Measurement of the unsteady flow around wing sections, particularly for the case of helicopter blades. The analytic interpretation is due to the previous work of Wagner and his successors. In this linear theory the viscosity forces of the fluid do not intervene; thus the vortex elements released downstream of the airfoil during a variation of the circulation are activated by a velocity Vo in relation to the airfoil. In order to take account of the essentials of the viscosity effects the distribution of vortex elements must be defined. Experimental comparison with the theory was made in the St. Cyr No. 2 wind tunnel, using a mounting permitting a rapid variation of the angle of attack. Comparisons are also made with results obtained by Boeing-Vertol and ONERA. In the second part of the paper experiments concerning the distribution of vortex elements of the wake are described.

A71-27469 # Measurement of unsteady pressures on stator blades of the S2.MA compressor (Mesure des pressions instationnaires sur aubes fixes du compresseur S2.MA). G. Fasso and R. Larguier. *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 13 p. 13 refs. In French.

Demonstration that it is possible to obtain mean periodic values of pressures on flow straightening blades of a large-sized axial compressor. Four contiguous blades located in the lower part of the flow straightener were fitted with short response time pressure detectors. The results showed that a preliminary idea of the magnitude of the vibration-exciting forces could be obtained, as well as of the behavior of wakes of the rotating wheel and their action on the flow straightening blades. F.R.L.

A71-27470 # Influence of a sinusoidal wall perturbation on transition (Influence d'une perturbation sinusoidale de paroi sur la transition). P. Gougat (CNRS, Laboratoire d'Aérothermique, Meudon, Hauts-de-Seine, France) and J. J. Perrin (Société Nationale Industrielle Aérospatiale, Châtillon, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 38 p. 10 refs. In French.

Attempt to show that the testing of medium speed airfoils in a laminar boundary layer does not permit distinguishing the onset of transition. A study of airfoils at different levels of speed fluctuation provides a sufficiently selective transition criterion. The development of the instantaneous signal and the observation of the power spectral density make it possible to better understand the concept of instability, amplification of perturbations within the laminar boundary layer, and the appearance of turbulent gusts. An extensive appendix considers the possibility of accurately predicting the turbulent behavior of a wing at high Reynolds number. F.R.L.

A71-27471 # Lateral control of high-speed aircraft with lift devices (Controle lateral des avions rapides fortement hypersustentes). R. Guiot (Breguet Aviation, Velizy-Villacoublay, Yvelines, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 35 p. In French.

The criteria for wing design imposed by the requirement of high speed for short takeoff aircraft are examined and a relatively thin sweptback wing with small aspect ratio is considered. The disadvantages of such a design are also investigated. An appropriate design for a fuselage is described and the position for the tail assemblies is shown. It is found that an aircraft of the design considered has very bad takeoff characteristics. It is therefore necessary to employ lift devices. Designs for a flap and a spoiler are shown. Problems of lateral control are discussed giving attention to the effects of spoiler position and form and to aerodynamic modifications of the wing. The lateral behavior of the aircraft is analyzed taking into consideration problems of side-slipping at low and high speeds. Inertia effects are considered, and the particular problems of the approach are investigated. G.R.

A71-27473 # Study of the effect of the marginal vortex from a helicopter blade on the aerodynamic flow around the following blade (Etude de l'influence du tourbillon marginal issu d'une pale d'hélicoptère sur l'écoulement aérodynamique autour de la pale suivante). B. Monnerie and A. Tognet (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 20 p. 5 refs. In French.

The basic characteristics of marginal vortices from wings with limited span are investigated, and the effect which these vortices can have on the aerodynamics of lifting surfaces in their neighborhood is explored. The effects of the presence of a vortex in the flow upstream of a blade are discussed, and effects of the blade form are considered. Velocity measurements are described, and a method for calculating the effect of a vortex on a wing is presented. A photograph is provided showing the marginal vortices in a hydrodynamic tunnel. The noise spectrum for a rectangular blade tip and for a trapezoidal blade tip is shown. G.R.

A71-27475 # Theoretical and experimental study of blade cascades in supersonic flows (Etude théorique et expérimentale de profils de grilles en écoulement supersonique). A. Papon and G. Inglesakis (IMFM, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 34 p. In French.

Comparison of theoretical and experimental wave configurations upstream from a simple initial blade cascade contour in a supersonic flow. An attempt is made to obtain a blade cascade with an entropy which is as uniform as possible in the flow downstream from the cascade and to determine the range of variation of the counterpressure for which this uniformity can be maintained. A.B.K.

A71-27476

A71-27476 # The high-lift wing - Remarks on the prediction of characteristics (L'aile aux portances élevées - Remarques sur la prévision des caractéristiques). Y. Semezis and J. Gombert. *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 82 p. 42 refs. In French.

Examination of some problems encountered in predicting the characteristics of high-lift wings with or without additional high-lift devices. Compromises must be made between the qualities desired at high speeds and those desired at takeoff speeds. Attention is given to existing means of controlling lift or distributing the load on a wing by detachment. Particular emphasis is placed on the processes of prediction of maximum lift coefficient and its increase by means of high-lift devices; these are compared for the case of a moderately long and moderately swept-back wing equipped with conventional high lift devices. It is considered that improvement in prediction is related to a better understanding of detachment phenomena. Results of current studies are briefly reviewed, and various procedures to increase lift by blowing are described. F.R.L.

A71-27477 # Elements of calculation for three-dimensional aerodynamics in a perfect fluid (Eléments de calcul d'aérodynamique tridimensionnelle en fluide parfait). P. Perrier and W. Vitte (Avions Marcel Dassault, Vaucresson, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970, Paper.* 39 p. 5 refs. In French.

The problems presented by the calculation of three-dimensional flows involving an aircraft are examined giving attention to the important effect of the vortex field on the flow. The three-dimensional incompressible flow about a slender foil is investigated making use of a numerical iterative method. Nonlinear effects due to rolling up at the wing tip appear in the results obtained for the lift coefficient. Problems of the interaction of the vortex sheet with the surfaces are investigated. The geometry of the vortex sheet is determined, and the velocity field at the surface is considered. G.R.

A71-27481 * The transient response of a coupled plate-acoustic system using plate and acoustic finite elements. A. Craggs (Alberta, University, Edmonton, Alberta, Canada). *Journal of Sound and Vibration,* vol. 15, Apr. 22, 1971, p. 509-528. 9 refs. Grant No. NGR-52-025-003.

Plate and acoustic finite elements are used to simulate the behavior of a window-room system. The first part of the paper is concerned with the general formulation of the equations of motion and a mixed formulation is used: displacements for the plate and pressures for the room acoustics. In the final part, the equations are solved for a simple window-room system being excited by a sonic boom. The results show that the room response is dominated by the volume displacing and plane wave depth modes. However, at points near the window, the effects of nonpropagating cut-off modes are significant. The effect of the room on the window is small except for rooms with a small volume. (Author)

A71-27491 # Calculation of the lifting force of a wing with a rotating flap (Raschet pod'emnoi sily kryla s vrashchaiushchimsia zakrylkom). T. S. Patel'. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 10-15. 6 refs. In Russian.

Crabtree's (1957) two-dimensional theory of wing with rotating flap is extended to include an asymmetric Zhukovskii profile with a rotating flap. An equation describing the circulation distribution over a slender profile of small curvature is derived within the framework of slender profile theory. Two approaches to the solution of this equation are proposed. It is shown that, in addition to providing supplementary lift at the flap itself, a rotating flap increases the lift of the wing by redistributing the circulation on its surface. V.P.

A71-27493 # Thermal behavior of aircraft structural elements under conditions of aerodynamic heating (Temperaturnyi rezhim elementov konstruktsii letatel'nykh apparatov v usloviiakh aerodinamicheskogo nagreva). V. V. Salomatov. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 22-30. 6 refs. In Russian.

An approximate analytical method of solving the aerodynamic heating problem in general formulation is proposed. The method is used to determine temperature-field characteristics which can be used in engineering calculations of the thermal behavior of aircraft elements. It is shown that the heat transfer problem can be reduced to the solution of a functional equation containing a term for the surface temperature. Good convergence of the method of successive approximations for this equation is established. This equation yields a Volterra integral equation of the second kind for the temperature in an arbitrary cross section of a structural element. An analysis of the integral equation reveals a linear dependence of the temperature field on the initial temperature, which can be used as a basis for plotting engineering nomograms. V.P.

A71-27494 # Determination of the optimal dimensions of the fuselage of a supersonic transport in the preliminary design stage (Opredelenie optimal'nykh razmerov fiuzeliazha sverkhzvukovogo passazhirskogo samoleta na etape predvaritel'nogo proektirovaniia). O. K. Iugov. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 31-37. In Russian.

A formula for calculating the cruising flight range as a function of the geometrical parameters of the fuselage is derived. An expression defining the drag coefficient as a function of the same parameters is also obtained. A procedure, based on these formulas, for determining the optimal fuselage parameters (for supersonic and subsonic transports) from the prescribed volume of the fuselage is proposed. V.P.

A71-27501 # Influence of some design parameters of gas-turbine-engine combustion chamber on the circumferential nonuniformity of the gas temperature field (Vliianie nekotorykh konstruktivnykh parametrov kamery sgoraniia GTD na okruzhnuiu neravnomernost' temperaturnogo polia gaza). Iu. A. Spiridonov and A. V. Talantov. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 80-86. In Russian.

Approximate expressions are derived which describe the gas field nonuniformity as a function of the total area of the holes in the flame tube, the equivalent diameter, and the spacing between the holes along the tube circumference. It is shown that to each value of the total hole area there corresponds an optimal value of the equivalent diameter which minimizes the circumferential nonuniformity of the field. The minimum value of this nonuniformity decreases with a decrease in the total hole area. Recommendations for designing the mixing zone of gas-turbine-engine combustion chambers are proposed. V.P.

A71-27502 # Calculation of boundary layer separation from an arbitrary curvilinear rotating plate (K raschetu otryva pogranichnogo sloia na proizvol'noi krivolineinoi vrashchaiushcheisia plastine). I. M. Korshin. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 87-92. 6 refs. In Russian.

The laminar boundary layer equations for a rotating plate with a surface of arbitrary curvilinear shape are analyzed. The external-flow pressure gradient leading to boundary layer separation is determined by a method proposed by Bam-Zelikovich (1954). The parameters leading to separation at a rotating and a stationary blade are calculated as an example. V.P.

A71-27504 # Determination of the optimal parameters of an ejector nozzle under supersonic flight conditions (Opredelenie optimal'nykh parametrov ezhektornogo sopla v usloviiakh sverkhzvukovogo poleta). E. D. Nesterov and V. M. Shishkin. *Aviatsionnaia Tekhnika,* vol. 13, no. 4, 1970, p. 101-110. 7 refs. In Russian.

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The parameters of a propelling nozzle that are optimal for obtaining a maximum thrust coefficient at Mach numbers between 1 and 2.5 are analyzed. Formulas for calculating the optimal parameters are obtained on the basis of a theory of a cylindrical ejector supersonic propelling nozzle proposed by Pearson et al. (1958). Problems associated with the control of ejector nozzles are examined. The results of the analysis make it possible to evaluate the efficiency of ejector nozzles in the Mach number range under consideration.
V.P.

A71-27505 # **Expansion of a turbulent-jet boundary layer in a slipstream (O rasshirenii pogranichnogo sloia turbulentnoi strui v sputnom potoke).** V. K. Temnov. *Aviatsionnaia Tekhnika*, vol. 13, no. 4, 1970, p. 111-115. 6 refs. In Russian.

A formula derived by Abramovich (1960) for the expansion of a boundary layer is checked experimentally, using circular and plane jets. A new formula for calculating the boundaries of the flow core is proposed which, in combination with the momentum equation, can be used to calculate the bounds of a jet boundary layer at the initial portion of the jet. An analytical expression describing the behavior of the axial velocity of the jet beyond its initial portion is obtained.
V.P.

A71-27531 **Effects of temporal and spectral combinations on the judged noisiness of aircraft sounds.** Karl S. Pearsons and Ricarda L. Bennett (Bolt Beranek and Newman, Inc., Canoga Park, Calif.). *Acoustical Society of America, Journal*, vol. 49, Apr. 1971, pt. 1, p. 1076-1082. 7 refs.

The effects on perceived noisiness of spectral and temporal combinations of stimuli at varying durations were determined by 20 college students in an anechoic chamber. Several recordings of turboprop, turbofan, turbojet, and helicopter flyovers were also included in the list of stimuli. The results indicated that the most accurate predictor of the judged noisiness was perceived noise level with tone and duration corrections as outlined by the Federal Aviation Administration (1968) aircraft certification procedure. To illustrate the responsiveness of effective perceived noise level (EPNL) over perceived noise level (PNL) in predicting the noisiness of stimuli, the results of the duration test revealed that, at judged equal noisiness, 75% of the data were within 4 dB of the standard signal for EPNL with the FAA tone and integrated duration measure as compared to 11 dB for PNL.
(Author)

A71-27536 **The PT6 after 5 million hours.** F. R. Cowley (United Aircraft of Canada, Ltd., Montreal, Canada). *Society of Automotive Engineers, National Business Aircraft Meeting, Wichita, Kan., Mar. 24-26, 1971, Paper 710385.* 9 p. Members, $1.00; nonmembers, $1.50.

The first PT6A-6 turboprop engine, rated at 500 shp, was delivered in December 1963 with an initial life of 600 hr between overhauls. By early 1971, over 4000 engines had been delivered, the output had grown to 900 shp, and times between overhaul in excess of 5000 hr had been reached. The technology spawned by the PT6 has resulted in the development, by UACL, of a host of turboprop, turboshaft, and turbofan engines, along with industrial derivatives. In over 5 million hr of operation, the PT6 has clearly demonstrated how sound technology by persistent development can meet the exciting challenges of the 1970s.
(Author)

A71-27537 **Geodetic control for airports.** Willard A. Kuncis (NOAA, Div. of Photogrammetry, Rockville, Md.). In: American Congress on Surveying and Mapping, Annual Meeting, 31st, Washington, D.C., March 7-12, 1971, Technical Papers. Washington, D.C., American Congress on Surveying and Mapping, 1971, p. 489-493.

Approximately 2500 geodetic control stations have been established on about 750 airports in the United States and its possessions in addition to regular networks. They were established in connection with an airport obstruction charting program and have been tied, by approximate third-order accuracy methods, to the national network of horizontal and vertical geodetic control.
O.H.

A71-27542 **Economics of propulsion systems for air transport. I.** David Huddie. *Esso Air World*, vol. 23, no. 4, 1971, p. 91-96.

Outline of reasons for producing new powerplants and the contributions made by powerplant efficiency and size to aircraft operating economics. The continued growth in aircraft size obliges the engine constructor to develop larger engines. At the same time the need for lower weight and lower fuel consumption to stave off square-cube effects, and social pressures for less nuisance from aircraft (noise and air pollution) demand more advanced designs. Provided that the advance in technology continues to allow this process to occur with each new generation of aircraft there seems to be no reason why transport aircraft should not continue to increase in size since there is no intrinsic natural limit to the size of turbomachinery.
F.R.L.

A71-27551 # **Survey of viscous interactions associated with high Mach number flight.** 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.) AIAA Journal*, vol. 9, May 1971, p. 771-784. 76 refs.

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)

A71-27552 * # **Theoretical analysis of vortex shedding from bodies of revolution in coning motion.** G. D. Kuhn, S. B. Spangler, and J. N. Nielsen (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-52.) AIAA Journal*, vol. 9, May 1971, p. 784-790. 11 refs. Contract No. NAS 2-4765.

A theoretical flow model for the steady asymmetric vortex system shed from a slender body in coning motion is described. The model was developed using potential flow methods and slender-body theory, and provides for the calculation of the strengths and positions of two unequal concentrated vortices and the resulting force distribution induced on the body. The vortex motion is determined in the flow field which consists of a portion described by a velocity potential plus a portion due to rotation. The method of determining the initial conditions for the vortex motions is discussed. Comparisons are made between predicted and experimental values of side forces and side moments for slender cones and ogive-cylinder combinations in lunar coning motion.
(Author)

A71-27554 # **Supersonic boundary-layer transition - Effects of roughness and freestream disturbances.** S. R. Pate (ARO, Inc., Arnold Air Force Station, Tenn.). *(American Institute of Aeronautics and Astronautics, Aerodynamics Testing Conference, 5th, Tullahoma, Tenn., May 18-20, 1970, Paper 70-586.) AIAA Journal*, vol. 9, May 1971, p. 797-803. 15 refs.

Boundary-layer transition experiments were conducted in the AEDC-VKF 12- and 40-in. supersonic wind tunnels at Mach numbers 3 and 4 on an adiabatic wall, 10-deg total-angle sharp cone. The effects of spherical roughness elements and free-stream disturbances (radiated aerodynamic noise) on transition were investigated. The large variation in smooth wall transition locations which exists on models in supersonic wind tunnels of different sizes is shown to

influence trip performance. These studies have also indicated that the 'effective point' location proposed by van Driest, et al. is relatively independent of the smooth wall transition location (or free-stream disturbance and tunnel size) at supersonic speeds. The correlation parameters developed by van Driest-Blummer and Potter-Whitfield are examined, and their ability to predict the tripped transition location is discussed. (Author)

A71-27555 * # Electron-beam studies of viscous flow in supersonic nozzles. Dietmar E. Rothe (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). (American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 3rd, Los Angeles, Calif., June 29-July 1, 1970, Paper 70-810.) AIAA Journal, vol. 9, May 1971, p. 804-811. 20 refs. Contract No. NASw-1668.

Experimental investigation of the internal and external flow for nozzle Reynolds numbers in the general range between 100 and 1000 with nitrogen as the test gas. Electron-beam techniques are used for measuring gas density and rotational temperatures at selected points throughout the flow. Discharge coefficients are also measured. In addition, some effects of ambient pressure on the external flow structure are studied by flow visualization experiments. At the lower Reynolds numbers studied, experimentally determined temperatures indicate the existence of a supersonic bubble inside the nozzle expansion-cone, with a subsequent shock-free viscous transition to subsonic flow. These results substantiate the theoretical prediction of this phenomenon, first made by Rae (1969) in an earlier phase of this program. (Author)

A71-27556 * # Some numerical results on viscous low-density nozzle flows in the slender-channel approximation. William J. Rae (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). (American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-654.) AIAA Journal, vol. 9, May 1971, p. 811-820. 35 refs. Contract No. NASw-1668.

Calculated results for converging-diverging nozzle flows in which viscous effects are important across the entire nozzle cross section. The slender-channel equations are used, with slip boundary conditions at the walls. The solution is started upstream at the throat, using asymptotic results for slow viscous flow in a converging cone. An implicit finite-difference scheme is then used to calculate the pressure and profiles of velocity and enthalpy at successive stations along the channel. The cases chosen for presentation show the effects of varying the nozzle geometry, the Reynolds number, and the thermal condition of the nozzle wall. The results suggest that specific impulse is improved by a throat whose longitudinal radius of curvature is small, and that area ratios as low as 10 can be used without serious loss of performance. It is shown that, at sufficiently low Reynolds numbers and low exit-cone angles, there is no solution of the slender-channel equations in which the flow can expand to supersonic conditions. Instead, the boundary layer closes, and the solution resembles a viscous subsonic pipe flow. The implications of this finding on the upstream influence of the exit-plane conditions and on the limits of validity of the slender-channel equations are discussed. (Author)

A71-27557 # Extension of Emmons' spot theory to flows on blunt bodies. Karl K. Chen and Noel A. Thyson (Avco Corp., Avco Systems Div., Wilmington, Mass.). AIAA Journal, vol. 9, May 1971, p. 821-825. 27 refs. Contract No. AF 04(701)-69-C-0117.

The transition region is considered to be characterized by the intermittent appearance of turbulent spots, which grow as they move downstream until they finally merge into one another to form the turbulent boundary layer. The intermittency factor for arbitrary axisymmetric body with zero angle of attack has been derived in an expression which can be reduced to the form of universal intermittency distribution of Dhawan and Narasimha in the case of straight tube or flat plate. A key factor to control flow conditions in the transition zone appears to be the spot formation rate, which has been deduced from the available data of the extent of transition zone. It was found that the spot formation rate depends not only on

the transition Reynolds number but also on the Mach number. A comparison of the deduced spot formation rate with the neutral stability curves indicated that the neutral stability curves can be used as a guide to relate the spot formation rate to the transitional Reynolds number. Calculations of the transitional heat-transfer rate on a sphere in supersonic flow agree well with the experimental results. (Author)

A71-27559 * # Generalized aerodynamic forces on a flexible plate undergoing transient motion in a shear flow with an application to panel flutter. E. H. Dowell (Princeton University, Princeton, N.J.). AIAA Journal, vol. 9, May 1971, p. 834-841. 21 refs. Grants No. NGR-31-001-146; No. NGR-31-001-197.

A theoretical solution to the title problem is obtained. Unlike previous solutions in the literature, the present method allows for finite plate dimensions and continuously varying mean velocity and temperature profiles. A computer program has been developed to calculate the required aerodynamic forces for boundary-layer profiles. These forces are then employed in a nonlinear flutter analysis previously developed by the author. The theoretical flutter results are compared with the experimental data of Muhlstein, Gaspers, and Riddle and generally good agreement is obtained. Other physical problems to which the present aerodynamic analysis is relevant include: (1) stabilization of viscous boundary layers by flexible walls, (2) sound wave propagation through shear layers, and (3) shear layer effects on control surface aerodynamics at supersonic speeds. (Author)

A71-27560 * # Jet aircraft air pollutant production and dispersion. John B. Heywood, James A. Fay (MIT, Cambridge, Mass.), and Lawrence H. Linden. (American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-115.) AIAA Journal, vol. 9, May 1971, p. 841-850. 44 refs. Grant No. NGR-22-009-378.

In this paper two aspects of pollution from jet engines are considered in detail. Firstly, it is shown from reported exhaust gas measurements that the most important air pollutants are nitric oxide and soot, and the production processes of these two pollutants are then discussed. A kinetic analysis shows that nitric oxide is formed mainly in the combustor primary zone, in regions of the flow where the equivalence ratio is greater than about 0.8, and that freezing occurs as the gas is diluted and cooled in the secondary zone. Calculated results for nitric oxide concentrations in the combustion products are presented and compared with existing experimental data. The mechanisms important in the formation of carbon in the fuel-rich regions of the primary zone are reviewed. The oxidation of this carbon in the remainder of the combustor is then considered, and the oxidation rates attainable within the combustor are computed from existing rate data. Secondly, the dispersion of the exhaust plume in the atmosphere is analyzed, the two effects considered being the entrainment of surrounding air due to turbulent motion of the jet and the motion induced by the buoyancy of the trail. For short times, mixing proceeds as in ordinary wakes; for longer times, mixing is dominated by motion induced by buoyancy. Typical pollutant dilutions behind the aircraft are presented. (Author)

A71-27561 # Experimental stability studies in wakes of two-dimensional slender bodies at hypersonic speeds. Wilhelm Behrens (California Institute of Technology, Pasadena, Calif.) and Denny R. S. Ko (TRW Systems Group, Redondo Beach, Calif.). AIAA Journal, vol. 9, May 1971, p. 851-857. 25 refs. Contract No. DA-31-124-ARO(D)-33.

Experimental study of the stability in the transition region from laminar to turbulent flow in wakes of slender wedges and a flat plate at Mach number 6. As in low-speed flat plate wakes, transition from laminar to turbulent flow may be divided into a linear and a nonlinear instability region. Inviscid linear stability theory predicts well the growth of fluctuations and amplitude distribution in the linear region. In the nonlinear region similarities with low-speed

wakes exist. Characteristic persisting peaks in the power spectra are observed. Based on these peak frequencies a nearly universal Strouhal number is found for both incompressible and hypersonic wake flows. A theoretical approach to predict the development of mean flow and flow fluctuations in the nonlinear region as employed by Ko, Kubota, and Lees (1970) in slender body low-speed wakes appears equally applicable for hypersonic wakes. (Author)

A71-27577 # **Connection between lift and particle displacement.** Kenji Inouye (National Aerospace Laboratory, Tokyo, Japan). *AIAA Journal*, vol. 9, May 1971, p. 945, 946.

Demonstration that Corrsin's (1968) conjecture between the lift and particle displacement around a lifting body can be proved without his assumption. The assumption was that the changes of y-coordinates of the fluid particles can be neglected. The conjecture can be proved by the use of the stream function as an integral of the equations of motion of the fluid particle. A similar formulation can be found in the analyses of drift in the flow with no circulation around a circular cylinder by Darwin (1953) and around a sphere by Lighthill (1956, 1957). M.M.

A71-27582 # **Three-dimensional stagnation-point heat transfer in equilibrium air flows.** Andrzej Wortman (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 70-809.) AIAA Journal*, vol. 9, May 1971, p. 955-957. 8 refs.

A parametric study was made of equilibrium air boundary-layer flows at general three dimensional stagnation points, ranging in shape from spheres, through cylinders, to saddle points with equal magnitudes of adverse and favorable pressure gradients. The gas properties used in the computations corresponded to free-stream speeds ranging up to 29,000 ft/sec in the earth's atmosphere. The parameter of wall-to-total enthalpy ratio was varied between 0.01 and 0.9, with the higher value used at lower airspeeds. The rapidity and ease of the present calculations are shown to be due to the use of a semi-analytical method for exact solutions of boundary-layer flows. Characteristics of the flow are discussed in detail, and explanations are given in terms of the known behavior of two-dimensional flows. It is shown that real-gas heat transfer parameters can be correlated with highly idealized gas data over the full range of shapes. Several engineering relations are obtained for rapid estimates of heat transfer to general stagnation points. (Author)

A71-27584 * # **Flutter of a buckled plate exposed to a static pressure differential.** C. S. Ventres (Princeton University, Princeton, N.J.). *AIAA Journal*, vol. 9, May 1971, p. 958-960. 8 refs. Grant No. NGR-31-001-146.

Experimental results on the stability boundary for a panel exposed simultaneously to a static pressure differential and to a streamwise applied in-plane load, obtained by Hess (1970), are compared with author's own theoretical stability boundary calculations. Flutter boundaries for plates with both zero and complete in-plane edge restraint were calculated. The experimental data lie closest to the stability boundary for zero restraint. The calculated flutter frequencies are not in as good agreement with the experimental results as are the flutter boundaries. O.H.

A71-27592 # **Computation of Chebycheff optimal control.** Gerald J. Michael (United Aircraft Research Laboratories, East Hartford, Conn.). *AIAA Journal*, vol. 9, May 1971, p. 973-975. 6 refs.

Demonstration of a general method for the efficient computation of Chebyshev optimal control for nonlinear systems. The Chebyshev algorithm is used to determine a Chebyshev optimal controller for the minimim flight path angle climb to station of an airbreathing vehicle whose thrust and fuel flow rate are characterized by a thrust coefficient and a specific impulse both of which are given

as tabular functions of Mach number. Advantages of the proposed algorithm are pointed out as well as potential pitfalls which may be encountered in its implementation. M.M.

A71-27598 * # **Shock interaction effect on a flapped delta wing at M = 8.2.** Dhanvada Madhava Rao (NASA, Langley Research Center, Hypersonic Vehicles Div., Hampton, Va.). *AIAA Journal*, vol. 9, May 1971, p. 985, 986. 8 refs. Research supported by the Ministry of Technology.

Description of a simple method for estimating the impingement boundary of the reflected expansion arising from shock interaction on a flapped delta wing. The resulting hypersonic aerodynamic coefficients are presented. The method uses a simple flow model. It is suggested that, as a consequence of the three-dimensional shock interaction, the outboard portions of the trailing-edge flap on a delta wing are relatively less effective since they derive the least benefit from the compression field of the wing. M.M.

A71-27599 # **A method for predicting the number of near mid-air collisions in a defined airspace.** G. T. A. May. *Institute of Navigation, Journal*, vol. 24, Apr. 1971, p. 204-218.

A simple analytical method was developed for the solution of some main air traffic control problems in connection with a proposed integration of civil and military air traffic control services in Sweden. Assumptions and principles underlying the method are presented. The method was used practically for determining the amount of control required for a particular off-airways area and to help determine the optimum control procedures for air traffic planning in that area. Preliminary results indicate that when developed further, it may provide a useful guide for studying en-route traffic structures. O.H.

A71-27600 # **The simple logic of radar avoidance action.** J. V. Inglesby. *Institute of Navigation, Journal*, vol. 24, Apr. 1971, p. 219-232.

Basic principles of avoidance action are developed. It is shown that a unique, completely logical set of rules exists which will guarantee the safe passage of converging aircraft. When two aircraft are involved, if either, or both simultaneously, act according to these rules, it is impossible to have an accident whatever the situation. The proposed rules are consistent with the Rules of the Air. Past attempts to formulate rules are compared. O.H.

A71-27601 * # **The promise of aeronautics.** Leonard Roberts (NASA, Ames Research Center, Moffett Field, Calif.). *Astronautics and Aeronautics*, vol. 9, May 1971, p. 24-31. 12 refs.

Socioeconomic changes to be expected for the future are examined. It is pointed out that the industrially developed nations will have a greater and ever-increasing proportion of the public educated to the use of air travel and that this proportion will increasingly have the means to use it. The need for the development of faster long-range aircraft for travel to the developing continents of Asia, Africa, and South America and transportation requirements within these areas are considered. Factors mitigating against the full realization of potential growth are reviewed, including concern about undesirable side effects of air transportation, problems of airport access, and lack of profitability for new technological advances. Joint industry and government action of a few clearly defined goals is recommended, giving attention to problems of short-haul transportation and to vastly improved international long-haul transportation. G.R.

A71-27602 * # **Turbofan STOL research at NASA.** Bradford H. Wick (NASA, Ames Research Center, Full-Scale and Systems Research Div., Moffett Field, Calif.) and Richard E. Kuhn (NASA, Langley Research Center, Low-Speed Aircraft Div., Hampton, Va.). *Astronautics and Aeronautics*, vol. 9, May 1971, p. 32-50. 10 refs.

Problems of congestion in the present air-transportation system are discussed. The problems are mainly the result of a shortage of runways and airways. The role of STOL technology in significantly changing the magnitude of these problems is considered, and the principal requirements of STOL transport to provide the required service are examined. The principal factors conditioning landing-field length are explored, and navigational and control problems are investigated. Research on turbofan-powered STOL transport is reported, focusing attention mainly on two promising jet-flap concepts: the externally blown flap and the augmentor wing. Planned cooperative efforts on STOL transports and avionics systems are discussed, and a brief outline of limited exploratory investigations of other STOL aircraft concepts and avionic-system components is presented. G.R.

A71-27608 **Methods utilized in tests of the flying qualities of the Concorde** (Méthodes utilisées dans les essais de qualités de vol de Concorde). Jean Pinet (Société Nationale Industrielle Aérospatiales; Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 27, 1971, p. 37-42. In French.

Pragmatic use of numerous methods and combinations of methods used to study the flying qualities of the Concorde. This procedure gives great flexibility in testing, and greatly reduces flying time. Simulation is intensively used, notably in the Blagnac flight simulator, which features a mobile cabin with a visualization scheme, a monitoring post, a pilot's post, an analog computer, a color television terrain model, and recording apparatus. The data processing is automated. F.R.L.

A71-27609 **Unsteady stall of an airfoil** (Le décrochage instationnaire d'un profil). Jean-Jacques Philippe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Colloque d'Aérodynamique Appliquée, 7th, Modane, Savoie and Ecole Centrale Lyonnaise, Ecully, Rhône, France, Nov. 4-6, 1970.)* L'Aéronautique et l'Astronautique, no. 27, 1971, p. 51-57. 8 refs. In French.

Investigation of the unsteady stall of airfoils by testing a two-dimensional model in harmonic pitching oscillation. The processes involved in such a stall are reviewed, followed by examination of its effects on unsteady pressure, overall performance, and aerodynamic stability as functions of mean incidence, Mach number, and reduced frequency. The unsteady qualities which must be possessed by airfoils intended for helicopter blades are described. In this field knowledge of unsteady aerodynamics is basic. F.R.L.

A71-27662 # **Effect of the deoxygenation of jet fuels on their antiwear properties** (Vliianie obeskislorozhivaniia reaktivnykh topliv na ikh protivoiznosnye svoistva). A. F. Aksenov, A. A. Litvinov, A. E. Borodin, V. P. Belianskii, V. P. Logviniuk, and V. V. Malyshev. *Khimiia i Tekhnologiia Topliv i Masel*, vol. 16, no. 2, 1971, p. 42-44. 5 refs. In Russian.

Samples of the ShKh-15 steel were subjected to vibrational and gliding friction in industrial T-7 fuel at temperatures of 20 and 60 C. A series of tests was carried out in a fuel from which oxygen was removed by means of argon or CO_2 scrubbing. It is shown that the wear of steel in a CO_2-scrubbed fuel decreased about three times and the critical load increased about twice with respect to results obtained in the unscrubbed fuel. For an argon-scrubbed fuel these values are 1.5 and 2, respectively. Z.W.

A71-27665 # **Interaction of particles with a wedge surface in a supersonic two-phase flow** (Vzaimodeistvie chastits s poverkhnost'iu klina v sverkhzvukovom dvukhfaznom potoke). G. A. Saltanov. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport*, Jan.-Feb. 1971, p. 141-149. 5 refs. In Russian.

The analysis is carried out by means of equations of motion for a drop behind an oblique shockwave derived by Saltanov et al.

(1970). Expressions are derived for determining the coordinates of particle incidence on the wedge surface and the collision frequency as a function of initial conditions. The local increase in pressure at the moment of impact is also estimated. It is found that during a two-phase flow past a wedge with rebounding particles, there exists a surface which limits the escape of rebounded particles into the external flow. Z.W.

A71-27676 **How to get there from here with new materials - A designer's viewpoint.** W. T. Shuler (Lockheed-Georgia Co., Marietta, Ga.). *SAMPE Quarterly*, vol. 2, Apr. 1971, p. 12-14.

The possibility of application of advanced materials to aircraft design is discussed. In particular, titanium, and boron and graphite fiber composites are considered. Their outstanding mechanical properties are outlined and the problem of making them competitive with current materials in terms of manufacturing efficiency, increased performance, lower cost, improved schedules, or a combination, is examined. Several examples of successful applications are presented. O.H.

A71-27677 **Materials for Air Force - 1980: An industry commentary.** William J. Harris, Jr. (Association of American Railroads, Washington, D.C.). *(Air Force Materials Symposium, Miami Beach, Fla., May 18-22, 1970.)* SAMPE Quarterly, vol. 2, Apr. 1971, p. 22-26.

A brief review is presented of the development in the past years in the field of new metals and alloys, composites, and ceramic materials which were of primary importance to weapon systems. The various problems involved in using advanced materials in aircraft industry as replacements for more traditional materials and, in particular, the problem of reluctance in their acceptance, are examined. Innovations necessary in management of governmental programs, in procurement specifications, and in the contracting procedures of the Department of Defense are discussed. O.H.

A71-27688 # **Equipment UIT-1200/50 for determining the heat resistance of sealing materials** (Ustanovka UIT-1200/50 dlia opredelenia termostoikosti uplotnitel'nykh materialov). N. L. Golego, M. E. Belitskii, E, I. Kuznetsov, G. A. Volosovich, and A. P. Voidenov (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR; Gosudarstvennyi Trest Predpriiatii po Izgotovleniiu Izmeritel'nykh Priborov, Leningrad, USSR). *Problemy Prochnosti*, vol. 3, Mar. 1971, p. 92-96. 6 refs. In Russian.

The requirements posed to sealing materials of modern aircraft power plants are reviewed, with particular reference to the heat resistance of porous metal ceramic seals under thermal cyclic loads. An automatic equipment that will study the thermal behavior of materials at temperatures ranging from 200 to 1200 C in such media as nitrogen, argon, air, and exhaust gases, and will record simultaneously the changes in the mass of the materials, is described. V.P.

A71-27697 # **Method for determining unsteady flow downwash behind a finite-span wing during a supersonic motion** (Metod opredeleniia nestatsionarnogo skosa potoka za krylom konechnogo razmakha pri sverkhzvukovom dvizhenii). R. A. Mezhlumian and R. Sh. Solomonian (Erevanskii Politekhnicheskii Institut, Kirovakan, Armenian SSR). *Akademiia Nauk Armianskoi SSR, Izvestiia, Mekhanika*, vol. 23, no. 6, 1970, p. 50-63. 10 refs. In Russian.

A procedure is given for solving the problem of unsteady flow downwash at finite Strouhal numbers in a linear formulation. Essential in this procedure is the representation of the perturbation potential through the coefficients of downwash rotational derivatives according to Belotserkovskii (1955) and Kishagin (1961). The supersonic motion of a slender slightly curved wing in an ideal fluid at a small angle of attack in the absence of external forces is discussed. V.Z

A71-27714 # Structure of vortex flows in axial-flow turbomachines (Sur la structure des écoulements tourbillonnaires dans les turbomachines axiales). Jean-Pierre Guiraud and Radyadour Kh. Zeytounian. *La Recherche Aérospatiale*, Mar.-Apr. 1971, p. 65-87. 12 refs. In French.

The axial flow in a turbomachine is analyzed by means of an asymptotic method assuming infinite mutual blade proximity and ideal incompressible flow. A twofold structure is observed: a quasi-axisymmetric mean flow and a thereon superposed fine, fluctuating structure. The latter makes it possible to take into account the effect, outside the blade rows, of the vortex sheets issuing from the trailing edges of the blades. The equations governing the mean flow and the fluctuations inside and outside the blade rows are obtained. M.V.E.

A71-27715 # Calculation of the mean flow in an axial-flow turbomachine (Calcul de l'écoulement moyen dans une turbomachine axiale). Jean-Pierre Veuillot. *La Recherche Aérospatiale*, Mar.-Apr. 1971, p. 89-97. 9 refs. In French.

A determination is attempted of the velocity field induced by a wheel in an axial-flow turbomachine for the flow of an incompressible ideal fluid uniform at infinity upstream by way of solving an inverse problem under abandonment of the classical hypothesis of absence of any radial velocity component but retaining some simplifying assumptions. An iterative numerical algorithm permits solving this nonlinear limit problem for various values of rotation velocity and circulation. Some calculation results are presented. M.V.E.

A71-27716 # Influence of a given conical fuselage on the problem of optimizing a delta wing in supersonic flow (L'influence d'un fuselage conique donné sur le problème de l'optimisation d'une aile delta en courant supersonique). Adriana Nastase (Academia Romănă, Institutul de Mecanica Fluidelor, Bucharest, Rumania). *La Recherche Aérospatiale*, Mar.-Apr. 1971, p. 99-107. 7 refs. In French.

The surface shape is determined of a thick delta wing integrated with a conical fuselage and generating minimum drag for a given cruising speed. Under the linearized theory applied, it is possible to separate the load-carrying effect from the thickness effect, as well as from the effect of the symmetrical axial flow around the circular cone at zero angle of incidence. The expressions for the axial velocities of the perturbations are determined, and solutions are obtained for the variational problems pertaining to the optimization of either a thin delta wing attached to a conical fuselage at some angle of incidence, or a delta wing of symmetrical thickness attached to a conical fuselage at zero angle of incidence. M.V.E.

A71-27717 # Wind tunnel visualization arrangements for fixed or rotating annular cascades (Dispositifs de visualisation pour souffleries de grilles annulaires fixes ou tournantes). Michel Philbert and Guy Fertin. *La Recherche Aérospatiale*, Mar.-Apr. 1971, p. 109-118. In French.

Review of the nature and work of two experimental installations using schlieren techniques: (1) a supersonic annular fixed cascade wind tunnel, and (2) a supersonic freon compressor. In both of these installations, the gas flow test section is confined to an annular space of slight thickness which imparts a largely two-dimensional character to the flow. This makes for superior schlieren pictures in terms of afforded interpretation thoroughness. However, the presence of vane-holding cylinders creates certain problems that are met by an application of techniques and devices described in detail. M.V.E.

A71-27719 # Accelerometric circuits for the measurement of modal characteristics (Chaînes accélérométriques pour la mesure des caractéristiques modales). Jean-Francois Boisseau and André Duchêne. *La Recherche Aérospatiale*, Mar.-Apr. 1971, p. 121-124. In French.

Description of a modal-characteristic pick-up system for vibration tests of rockets or aircraft on the ground using small-size inexpensive accelerometers each of which is provided with its own electronic circuit. Several hundreds of these devices have been successfully applied to individual rockets on the ground for modal measurements over the 5 to 500 Hz range. M.V.E.

A71-27738 Experimental determination of the momentum thickness of a circular cylinder in a cross flow (Experimentelle Bestimmung der Impulsverlustdicke beim querangeströmten Kreiszylinder). E. Achenbach (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). *Wärme- und Stoffübertragung*, vol. 4, no. 1, 1971, p. 18-24. 14 refs. In German.

Measurement of the local static pressure and skin friction distribution around circular cylinders in a cross flow in the range of Reynolds numbers from 15,000 to 260,000. The experimental data have been used to determine the momentum thickness of the boundary layer as a function of the angle of circumference. If the results are presented in a suitable dimensionless form, it can be shown that the experimental results fit the theoretical curve with a scattering of about plus or minus 5%. (Author)

STAR ENTRIES

N71-21855   Pennsylvania Univ., Philadelphia.
A STUDY OF MULTIPLE ACCESS COMMUNICATION SYSTEM
Edmond Yu-shang Ho (Ph.D. Thesis) 1969 89 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00   Order No. 70-7807
A digital communication system to be used among low-flying aircraft which, individually, require the transmission channel infrequently is analyzed. To make more efficient use of the transmission medium without the need for intervening switching centers, a form of random access is planned. Transmission is largely along line-of-sight; multipath propagation is assumed to be involved.   Dissert. Abstr.

N71-21874#   Speas (R. Dixon) Associates, Palo Alto, Calif.
NORCALSTOL: A REPORT ON THE NORCALSTOL DEMONSTRATION, 13 – 15 MAY 1970
1970 80 p Prepared in cooperation with Chamber of Commerce, San Francisco
Avail: NTIS
Demonstration flights of several short takeoff aircraft were conducted at San Francisco, California. The purpose of the flights was to promote the use of such aircraft as commercial transportation system to improve access to the city. Aircraft which participated in the demonstration were: (1) Britten – Norman Islander, (2) Helio H-550A Stallion, (3) Helio H-295 Super Courier, (4) De Havilland Twin Otter, (5) Fairchild Hiller Heliporter, and (6) Cessna Super Skymaster.   P.N.F.

N71-21882*   North American Aviation, Inc., Downey, Calif.
OPTICAL PROJECTOR SYSTEM Patent
Robert A. Beam, inventor (to NASA) Issued 26 Dec. 1967 (Filed 9 Sep. 1966) 10 p Cl. 88-24 Sponsored by NASA
(NASA-Case-XNP-03853; US-Patent-3,359,855; US-Patent-Appl-SN-578931) Avail: US Patent Office CSCL 20F
The device comprises an optical projector system which projects an image for each eye, and which may take into consideration peripheral vision, as well as color, symbol and word recognition. The projector system also includes provisions to simulate vertical and horizontal eye movement, together with vertical, horizontal and angular head movement. The system does not require the cooperation of an actual observer. The image projector system includes the ability to provide for particular visual characteristics of individual observers. For instance, an instrument display may be arranged which provides for reductions and changes in normal visual limits from such factors as pressure unit visor restrictions, lack of sufficient oxygen, G forces, light versus dark adapted eyes, and moving the eyes farther away or near to the display panel.
Official Gazette of the U.S. Patent Office

N71-21885#   Royal Aircraft Establishment, Farnborough (England).
ON THE MEASUREMENT OF THE NOISE IN THE NEIGHBOURHOOD OF BODIES IN SUBSONIC WIND TUNNELS, PART 2 [UEBER DIE GERAEUSCHMESSUNG AN UMSTROEMTEN OERPERN IN

UNTERSCHALLWINDKANALEN TEIL 2]
G. Schulz Oct. 1970 37 p refs Transl. into ENGLISH of German report DLR-FB-69-86
(RAE-Lib-Trans-1465; DLR-FB-69-86) Avail: NTIS
The construction, effects, and evaluation of sound damping elements are discussed. Measurements were made on the spatial distribution of the sound in the measuring jet as well as its dependence on the speed of rotation of the fan and on the blowing speed. By a suitable theoretical procedure it is possible to separate the characteristic noise of the tunnel into its two parts, the fan noise and the free jet noise.   Author

N71-21898   Colorado Univ., Boulder.
THEORY OF THE SOLID ROTOR INDUCTION MACHINE
James Clayton Wilson (Ph.D. Thesis) 1969 429 p
Avail: Univ. Microfilms: HC $19.35/Microfilm $5.50   Order No. 70-5907
Extremely high-speed polyphase induction motors for aerospace applications must be designed with solid rotors because windings cannot withstand rotation stresses. The high performance expected calls for an analysis that takes into account the nonlinearity of the rotor iron and the finite length of the motor, complexities not considered in an acceptable form by former researchers. This type of analysis is applied to predetermine the characteristic of a 5 h.p., 145 volt, 3200 Hz, three-phase, wye-connected solid rotor induction motor. After a historical review, a developed mathematical model is described. The partial differential equation and the boundary conditions, considering fully the motion of the rotor, are developed from Maxwell's equations. The relationship of the terminal voltage and of a current sheet representing the stator slot currents is developed. The torque of the induction motor as a function of the slip is developed from Poynting's theorem.   Dissert. Abstr.

N71-21915#   Tennessee Univ., Knoxville.
SIMPLIFIED GUIDANCE AND CONTROL
J. M. Bailey 1 Apr. 1970 73 p refs
(Contract DAAH01-69-C-1264)
(AD-717567) Avail: NTIS CSCL 17/7
While formulating the optimum trajectory one must at the same time synthesize some form of corrective control action along the way. Economic considerations also dictate that this control scheme be as simple as possible commensurate with the desired system accuracy. One approach to such a requirement is to design a linear controller that attempts to keep deviations of some or all the state variables from a standard trajectory small. Directional Control which acts to keep the steady state normal velocity due to cross winds essentially zero is such a scheme. This report summarizes the status of investigations into such simplified schemes at the University of Tennessee under the contract.   GRA

N71-21922#   Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
OPTIMAL FUEL SYSTEM ESTIMATION
Nelson R. Zagalsky 30 Oct. 1970 39 p refs
(Contract N00014-69-C-0101)
(AD-717640; Rept-12591-TR-1E1) Avail: NTIS CSCL 21/4
The application of Kalman (Linear Least Squares Recursive) filtering to the estimation of fuel quantity and fuel rate for fighter aircraft is discussed. Error analyses are presented for the resultant filter. The blending of quantity and rate information is shown to offer a tradeoff between required system accuracies and individual sensor accuracies.   Author (GRA)

N71-21927#   National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
ENGINE SNOW INGESTION IN THE BELL 206A JET RANGER HELICOPTER
J. R. Stallabrass Jan. 1971 20 p
(NRC-11893; MET-513) Avail: NTIS

To investigate reported cases of engine flameout occurring during flight in snow, tests were made on a ground-running helicopter, using a device for generating artificial snow. The tests showed that operation in snow could result in engine flameout, largely as a result of accumulations of ice being formed in the engine inlet plenum chamber. It is concluded that flight in any condition of snow is unsafe with the existing engine inlet configuration of this helicopter.   Author

N71-21961*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A WIND-TUNNEL INVESTIGATION OF SONIC-BOOM PRESSURE DISTRIBUTIONS OF BODIES OF REVOLUTION AT MACH 2.96, 3.83, AND 4.63
Barrett L. Shrout, Robert J. Mack, and Samuel M. Dollyhigh Washington Apr. 1971 33 p refs
(NASA-TN-D-6195; L-7398) Avail: NTIS CSCL 01A
Sonic-boom pressure signature measurements were made for a series of bodies of revolution at Mach numbers of 2.96, 3.83, and 4.63. Maximum overpressure and signature impulse tend to increase with increasing Mach number as predicted by a near-field modified linear theory applicable to smooth bodies. However, the measured signatures agree only qualitatively with near-field theory at the high Mach numbers. Inclusion in the theory of the effects of oblique-plane-surface forces and model boundary layer improved the correlation between theory and experiment. A nonsmooth-body theory produced better agreement for the trailing shock but with some reduction of the signature impulse.   Author

N71-21973*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CHARTS FOR PREDICTING THE SUBSONIC VORTEX-LIFT CHARACTERISTICS OF ARROW, DELTA, AND DIAMOND WINGS
Edward C. Polhamus Washington Apr. 1971 11 p refs
(NASA-TN-D-6243; L-7558) Avail: NTIS CSCL 01A
The leading edge suction analogy method of predicting the aerodynamic characteristics of slender delta wings was extended to cover arrow and diamond wing planforms. Charts for use in calculating the potential and vortex flow terms for the lift and drag are presented, and a subsonic compressibility correction procedure based on the Prandtl-Glauert transformation is outlined.   Author

N71-21976# Federal Aviation Administration, Washington, D.C.
SECOND MEETING OF THE SONIC BOOM PANEL, REPORT OF THE US DELEGATION
19 Nov. 1970 112 p Conf. held at Montreal, 12 21 Oct. 1970
(IGIA-17/4.8) Avail: NTIS
The second meeting of the ICAO Sonic Boom Panel convened at ICAO headquarters, Montreal, on October 12, 1970. On October 21, 1970, the panel concluded its meeting in Montreal by submitting to the Air Navigation Commission a report entitled, Report on the Sonic Boom Phenomenon, the Ranges of Sonic Boom Values Likely to be Produced by Planned SSTS and the Effects of Sonic Boom on Humans, Property, Animals and Terrain. This report had initially been developed at the Panel's First Meeting and has since been amended and expanded upon, both by correspondence between members and at an ad hoc meeting of panel members held in Paris during February 1970. Specific recommendations were made and it was considered that sufficient progress had been made by the panel within its initial terms of reference with reference to Stages 1 and 2 to allow transition to Stage 3 of the Council's Staged Plan of Action of Steps to be Taken to Facilitate Compliance with Resolution A16-4.   Author

N71-21977# Federal Aviation Administration, Washington, D.C.
Office of Management Systems.

AVIATION STATISTICS: AIRPORTS, AIR CARRIER FLEET, AIRCRAFT PRODUCTION, AND AIRMEN
Sep. 1970 23 p
Avail: NTIS
A summary of the statistics pertaining to various aspects of civil aviation is presented. Subjects discussed are: (1) number of joint-use landing facilities, (2) size of United States civil air fleet, (3) general aviation utilization, (4) airline operations, (5) civil aircraft production, and (6) trends in pilot training and licensing.   P.N.F.

N71-21978# Federal Aviation Administration, Washington, D.C. Bureau of National Capital Airports.
ANALYSIS OF BOEING 727-200 OPERATIONS AT WASHINGTON NATIONAL AIRPORT
Feb. 1971 25 p
Avail: NTIS
During the period April through October 1970, the Bureau of National Capital Airports conducted an analytical study of the operations of the Boeing 727-200 aircraft at Washington National Airport. The 727-200 is identical (same basic power plant and wing/flap geometry) to the 727-100 except for an extra 20-foot fuselage section which provides additional seating capacity. The 727-100 has operated at Washington National since it was opened to jet aircraft in 1966. The study included close observation for impact on environment, air and surface traffic management, passenger processing, passenger boarding trends, and scheduled and total operation trends. The effect of the current nationwide decline in airline business, evident at all three area airports, was also taken into account. Analysis of the data collected during the study period indicates that the 727-200 had no adverse impact on conditions at Washington National or on the growth and utilization of Dulles International Airport.   Author

N71-21979# Federal Aviation Administration, Washington, D.C. Office of Aviation Economics.
WASHINGTON NATIONAL AND DULLES INTERNATIONAL AIRPORT FORECASTS, FISCAL YEARS 1971 1982
Nov. 1970 51 p
Avail: NTIS
Forecasts for eight major traffic categories at both Washington National Airport and Dulles International Airport for fiscal years 1971 through 1982 are presented. These categories are passengers (air carrier and all others), cargo (express, freight and mail), and aircraft operations (air carrier, general aviation, and military). The study is a basis for planning the intermediate needs of the Bureau of National Capital Airports. It also supplies guidance for other Offices and Services of the Federal Aviation Administration which have a direct interest in the day-to-day operation of these two major commercial airports. These forecasts indicate probable aviation demand for the Washington Metropolitan Area. They do not imply that 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 their own specialized studies and recommendations on how best to meet this demand.   Author

N71-21980# Federal Aviation Administration, Washington, D.C. Office of Environmental Quality.
JET ENGINE NOISE DATA FROM SUBSONIC AIRCRAFT, MARCH -APRIL 1971
1971 42 p Presented at the Intern. Short Course on Aircraft Noise Theory and Appl., Knoxville, Tenn., 15 20 Mar. 1971 and at Aachen, 29 Mar.- 3 Apr. 1971
Avail: NTIS

The acoustic considerations of aircraft noise have led to the development of several basic descriptors of that noise. The first descriptor of an aircraft sound is its representation as a sound level spectrum. A sound level spectrum presents the intensity of the sound in decibels as a function of the frequency in hertz. Sound level spectra may be developed by the use of weighting functions to give perceived noisiness and then factored for discrete frequency and duration. The final descriptor for the description of noise in the vicinity of an airport is called the noise exposure forecast. The noise exposure forecast considers the daily operations in the airport environment. It uses the effective perceived noise level which is combined ultimately with the number of operations weighted for the type of aircraft, including the flight profile of each aircraft with additional weighting factors for the night and daytime operations.
Author

N71-21995*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF COMPRESSOR BLADING WITH SLOTS AND WALL FLOW FENCES
R. W. Rockenbach and J. A. Brent 1 Apr. 1971 174 p refs
(Contract NAS3-10481)
(NASA-CR-72635; PWA-FR-3597) Avail: NTIS CSCL 20D
A highly loaded 0 8 hub-tip ratio single stage axial flow compressor was tested with two rows of slots in both the rotor and stator blades and with wall mounted intrablade row flow fences. These devices were intended to reduce the migration of wall boundary layer flow onto the blade surfaces and to prevent flow separation on the blade suction surfaces. The devices were found to be ineffective in achieving this goal and the poor performance of the stage was largely a result of stall in the wall region. It was concluded that the latter mechanism is limiting the permissible loading and, therefore, that future means of increasing permissible loading be concentrated on the wall stall problem.   Author

N71-21996*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
SELECTION OF LANDING AIRFIELDS FOR SHUTTLE ORBITERS WITH VARIOUS CROSSRANGES Landing and Recovery Division Internal Note
Jonny E. Ferguson 25 Sep. 1970 112 p refs
(NASA-TM-X-67080; MSC-02666) Avail: NTIS CSCL 01E
The findings and recommendations resulting from a study designed to select specific airfields to support landings of example space shuttle orbiters with various hypersonic crossranges are reported. The orbiter is a single unit vehicle similar to a large jet transport in size, appearance, and landing characteristics. The airfields were selected from those currently available in the free world. Based upon the analysis of all the generated data associated with these airfield selections, it is recommended that the shuttle orbiter should be designed for a hypersonic crossrange not less than 200 n. mi. to optimize the number of support airfields required and the duration of in-orbit waits required. It is also recommended that the orbiter be designed to land on runways of not more than 10,000 feet in length and with support capability for 100-psi tire pressure and an equivalent single-wheel load of about 50,000 lb. Consideration should be given to the cost of the number of airfields required, the cost of modifying the airfields as required, the in-orbit waits required, and the hypersonic crossrange desired in all shuttle program design efforts.   Author

N71-22011# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LUBRICATING OILS FOR JET ENGINES [SMAZOCHNYE MASLA DLYA REAKTIVNYKH DVIGATALEI]
E. N. Kalaitan 23 Dec. 1970 237 p refs Transl. into ENGLISH from the Russian
(AD-717835; FTD-HC-23-1296-68) Avail: NTIS CSCL 11/8

The report describes briefly the construction and principles of operation of aviation gas turbine engines, their assemblies and friction points, and also the oil systems. Operating conditions of lubricants in these engines are discussed, as are the functions of oils as lubricating materials, the functions of operating liquids and cooling agents; technical specifications required of lubricants are discussed. Questions are discussed related to the assortment and quality of oils currently employed for aviation gas turbine engines and the requirements for oils of the near future. Methods are described for obtaining from petroleum and synthetics high-quality oils which possess high anti-oxidation, viscosity-temperature, anti-wear and other properties. Information is presented concerning additives which improve the operational properties of oils for aviation gas turbine engines. Domestic and foreign methods of investigating and testing oils under laboratory conditions, and also in special stands and devices are systematized and described.
GRA

N71-22068*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALYSIS OF EFFECTS OF SPANWISE VARIATIONS OF GUST VELOCITY ON A VANE-CONTROLLED GUST-ALLEVIATION SYSTEM
L. Keith Barker and Gene W. Sparrow Washington Apr. 1971 28 p refs
(NASA-TN-D-6126; L-7442) Avail: NTIS CSCL 01A
An analysis was made of the effects of spanwise variations of gust velocity in isotropic turbulence on a gust-alleviation system which employs an angle-of-attack vane mounted ahead of the wing to sense the vertical gust velocity. The wing flaps were moved in response to the vane deflection by a linear second-order servosystem to produce a lift opposite to that produced by the gust. Consideration of spanwise variation of gusts has indicated design parameters (gain and natural frequency of flap servosystem and vane location) that give substantial reduction of the lift due to gusts.
Author

N71-22069*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT INVESTIGATION OF A V/STOL TRANSPORT MODEL HAVING SIX WING-MOUNTED LIFT FANS
William A. Newsom, Jr. and Sue B. Grafton Washington Apr. 1971 29 p refs
(NASA-TN-D-6198; L-7560) Avail: NTIS CSCL 01C
The investigation consisted of free-flight model tests in hovering and forward flight through the transition speed range up to the speed where conversion would be made to wing-borne flight. Dynamic lateral-directional stability characteristics of the model were also calculated to explain the flight-test results. The model was flyable without artificial stabilization but, in general, angular rate damping was required to make the flight characteristics satisfactory.   Author

N71-22070# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin (West Germany). Abteilung Aeroakustik und Instabilitaet.
A WAVE MODEL FOR SOUND GENERATION IN CIRCULAR JETS
Alfons Michalke Nov. 1970 33 p refs
(DLR-FB-70-57) Avail: NTIS; ZLDI Munich: 9,30 DM
A wave model is used for the investigation of sound generation in circular jets. The source term of the Lighthill equation is expressed by a Fourier series in the azimuthal angle, is Fourier-transformed with respect to time, and each component is assumed to be of wave-type in jet direction. A far-field solution for the sound pressure is derived for single azimuth-frequency components. It is found that the sound field depends strongly on a convection parameter and on a jet thickness parameter. The influence of

axisymmetric and azimuthal source components is discussed. For a special source term with arbitrarily chosen amplitude distributions the convection factor and the jet thickness factor of sound intensity are calculated and discussed. The influence of the amplitude distribution of the source components is found to be of minor importance. Author (ESRO)

N71-22072# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Heterogene Stroemungen.
MASS TRANSFER INVESTIGATIONS AT A FLAT STATIC LIQUID SURFACE IN PARALLEL AIR FLOW FORMING A LAMINAR BOUNDARY LAYER [UNTERSUCHUNG DES STOFFUEBERGANGS AN EINER EBENEN RUHENDEN FLUESSIGKEITSOBERFLAECHE BEI PARALLELER ANSTROEMUNG UND LAMINARER GRENZSCHICHT]
Klaus-Juergen Schultz Jul. 1970 46 p refs In GERMAN; ENGLISH summary Sponsored by Deut. Forschungsgemeinschaft
(DLR-FB-70-58) Avail: NTIS; ZLDI Munich: 12,30 DM
Some results of the current experimental work which is being done for the determination of the velocity of evaporation of a flat hydrocarbon film in parallel flow, whereby a laminar boundary layer is formed over the liquid surface, are reported. The test layout and performance are described. The dependence of the evaporating mass per unit time and area, averaged over the liquid surface from the velocity and temperature of the flow is presented by means of diagrams for the hydrocarbon benzol and compared with the results of two simplified computation methods. Author (ESRO)

N71-22076*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FATIGUE OF FOUR STAINLESS STEELS, FOUR TITANIUM ALLOYS, AND TWO ALUMINUM ALLOYS BEFORE AND AFTER EXPOSURE TO ELEVATED TEMPERATURES FOR UP TO THREE YEARS
Walter Illg and L. A. Imig Washington Apr. 1971 66 p refs
(NASA-TN-D-6145; L-7613) Avail: NTIS CSCL 11F
Tensile specimens and unnotched, notched, spotwelded, and fusion-welded fatigue specimens from sheets of four stainless steels, four titanium alloys, and two aluminum alloys were tested at room temperature before and after exposure to elevated temperatures for up to 3 years. The steels and titanium alloys were exposed at 560 K (550 F) and the aluminum alloys were exposed at 390 K and 420 K (250 F and 300 F). Fatigue data covering a range of fatigue lives from 1,000 to 10 to the 7th power cycles were obtained before and after 3 years of exposure. The fatigue strengths after exposure were essentially the same as those before exposure Author

N71-22087# Politecnico di Torino (Italy). Istituto di Meccanica Applicata Aerodinamica e Gasdinamica.
LOW PRANDTL NUMBER STAGNATION HEAT FLUX CALCULATIONS FOR A BLUNT AXISYMMETRIC BODY IN HYPERSONIC FLOW
Aldo Muggia Jul 1970 10 p refs
(Contract EOOAR-0049-68)
(AD-717418; AFOSR-70-3009TR; TN-63; SR-9) Avail NTIS CSCL 20/4
Calculations are performed of the enthalpy behaviour and of the wall heat flux in the stagnation region past a blunt axisymmetric body in hypersonic axial flow. The case of high free steam Mach number and consequently high temperature and low Prandtl number in the stagnation region is considered. By supposing equilibrium flow, two numerical examples are presented for Peclet number. Author (GRA)

N71-22098# Naval Ship Research and Development Center, Washington, D.C. Dept. of Aerodynamics.
APPLICATION OF THE METHOD OF INTEGRAL

RELATIONS (MIR) TO TRANSONIC AIRFOIL PROBLEMS. PART 1: INVISCID SUPERCRITICAL FLOW OVER SYMMETRIC AIRFOILS AT ZERO ANGLE OF ATTACK
Tsze C. Tai Sep. 1970 42 p refs
(AD-717339; NSRDC-3424; Aero-1176) Avail: NTIS CSCL 20/4
The feasibility of applying the method of integral relations (MIR) to transonic flows over symmetric airfoils was studied. In order to take account of the severe transversal flow variation and still retain simplicity in computation, the method is modified so that the number of strips used may be considerably higher than the order of the polynomial which approximates the integrand. An important feature of this modification, however, is its capability to extend the free-stream boundary to infinity. Using one-strip and two-strip approximations, flow equations are reduced to a set of ordinary differential equations in a cartesian coordinate system Numerical procedures, including the treatment of the sonic point and the determination of shock location, are also formulated. The fourth-order Runge-Kutta method was used in numerical computation The advantage of small computer capacity and time required by the method is evidenced by exploratory calculations for a symmetric circular-arc airfoil and an NACA 0012 airfoil, traveling at supercritical speeds. It is also found that in transonic airfoil problems using a cartesian coordinate system, the order of polynomial approximating the integrand in the method of integral relations should be at least second-order or higher. Author (GRA)

N71-22129# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Abteilung Trans- und Ueberschallwindkanaele.
EXPERIMENTAL INVESTIGATIONS ON SUPERSONIC COMBUSTION IN THE FLOW FIELDS OF BODIES OF REVOLUTION AND NEAR A FLAT PLATE IN TANGENTIAL FLOW [EXPERIMENTELLE UNTERSUCHUNGEN ZUR WAERMEZUFUHR IM UEBERSCHALL-STROEMUNGSFELD AN ROTATIONSKOERPERN UND AN DER TANGENTIAL ANGESTROEMTEN PLATTE]
Franz Maurer, Franz-Joachim Niezgodka, and Helmut Post Dec. 1970 77 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung
(DLR-FB-70-64) Avail: NTIS; ZLDI Munich: 19,70 DM
Supersonic combustion of hydrogen in the flow field of a flat plate in tangential flow and near bodies of revolution was studied in the Mach number range from 1.8 to 3.2. In the flat plate experiments a secondary air jet from a crosswise slot was used to stabilize the flame. Hydrogen was injected upstream of the slot. Flame stabilization on bodies of revolution was obtained due to a small annular cavity near the thickness maximum. In all cases spark ignition was used. The changes of pressure distribution near the flat plate as well as changes of drag of the bodies of revolution due to heat addition were considerable. Author (ESRO)

N71-22135*# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
SIX CHANNEL PHOTOMETRIC OBSERVATIONS FROM THE CV990 AIRCRAFT Final Report
S. B. Mende and R. H. Eather 26 Jun. 1970 36 p refs
(Contract NASw-1997)
(NASA-CR-117466; LMSC/N-AR-70-1) Avail: NTIS CSCL 14E
An investigation of the spatial extent of aurorae was undertaken from College, Alaska, by the ground based television two channel (5577A and 4278A) image intensifier system and with a multichannel boresighted tilting filter photometer. The measurements indicate that even on clear nights the extinction due to scattering in the 4278A is significant unless the measurements are taken at small zenith angles. To confirm the results and to avoid the low altitude scattering problem, measurements were made on a quite arc with the 6 channel tilting filter zenith photometer during the NASA CV 990 expedition. These results show that in the cases observed there was no significant difference between the latitude profiles of O(5577) and N2(4278) emissions. Author

N71-22136# Naval Postgraduate School, Monterey, Calif.
INTERFACE OF MATERIALS AND STRUCTURES ON AIRFRAMES. PART 2: OUTLINE OF DECISION PROCESS IN STRUCTURAL DESIGN
Ulrich Haupt Dec. 1970 57 p refs
(AD-717576; NPS-57HP0121A-Pt-2) Avail: NTIS CSCL 1/3

The decision process in structural design becomes increasingly important with the introduction of new materials. Starting from a consideration of present problems in structural design, an outline is developed for the decision process with particular emphasis on interaction between materials, structures, and design. This outline, however, still lacks the details which are required for an analytical model of the decision process. These missing details are identified and a practical approach toward their solution is shown.
Author (GRA)

N71-22147# National Aerospace Lab., Tokyo (Japan).
MODEL TEST ON DEFLECTED JET PIPES OF THE NAL FLYING TEST BED
Yoshikazu Tanabe Oct. 1970 10 p refs In JAPANESE; ENGLISH summary
(NAL-TR-209) Avail: NTIS

Problems associated with VTOL operations of a lift-type aircraft are evaluated in order to improve flight safety. Deflecting jet pipes with different deflecting angles are tested to obtain the relationships between the real deflection angle and the geometrical deflection angle, the jet pipe thrust coefficient, etc. for suppression of pitching moment caused by one engine failure. It is concluded that the real deflection angle is nearly 90% of the geometrical deflection angle and that the thrust coefficient of the deflecting jet pipes is not less than 86% regardless of the geometrical deflection angle.
Author

N71-22149# McGill Univ., Montreal (Quebec). Dept. of Mechanical Engineering.
COMPUTER GRAPHICS ON JOUKOWSKI AIRFOILS
J. H. T. Wu and P. P. Ostrowski [1970] 11 p refs
(TN-71-2) Avail: NTIS

Steady, incompressible flow about a Joukowski airfoil section is simulated using an IBM 360-75 digital computer and a Calcomp plotter. The effect of various transformation parameters as well as the streamline pattern and pressure distribution about the airfoil is illustrated. The values of the simulation technique as a teaching tool are demonstrated. The method is shown to be particularly useful for flow visualization as all the basic features of the Joukowski transformation and the potential flow streamline patterns are clearly depicted.
Author

N71-22156# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE EFFECT OF EDGE BLUNTNESS OF A FLAT PLATE ON HEAT TRANSFER IN A SUPERSONIC FLOW
L. V. Kozlov 2 Dec. 1970 15 p refs Transl. into ENGLISH from the book "Issled. Teploobmena v Potokakh Zhidkosti i Gaza" Moscow, Izd-Vo Mashinostr., 1965 p 103 - 109
(AD-717825; FTD-MT-24-274-70) Avail: NTIS CSCL 20/4

The effect of edge bluntness of a flat plate on heat transfer is experimentally investigated in the region where anisotropic conditions do not exist on the limit of the boundary layer. The experiments were carried out by means of a wind tunnel having a 110 x 110 mm test section with nozzle velocities in the Mach range from 2 to 4 M. Heat transfer was evaluated on a flat plate with cylindrical bluntness in a range of a given relative bluntness. The dependence of the nondimensional heat-transfer coefficient on the Reynolds number is illustrated in a graph. The data obtained with a blunt-edged flat plate are compared with those obtained on a sharp-edged flat plate. The distribution of local heat fluxes on both plates is presented in graphical form and shows that at given large ratios the local value of the heat flux on a blunt-edged plate is always smaller than on a sharp-edged plate, but in a given

vicinity the boundary layer builds up faster. An analysis of the results shows that the effect of bluntness increases with the Mach number.
Author (GRA)

N71-22158# Cornell Aeronautical Lab., Inc., Buffalo, N.Y. Aerodynamic Research Dept.
RESEARCH ON ADVANCED GASDYNAMIC TEST FACILITIES. PART 1: STUDIES OF THE ISENTROPIC COMPRESSION TUBE AS A MEANS FOR PRODUCING HYPERVELOCITY TEST FLOWS Final Technical Report, 1 Jul. 1966 - 30 Jun. 1970
Frank J. Stoddard Jan. 1970 77 p refs
(Contract AF 33(615)-5389)
(AD-717727; CAL-AD-2297-A-3-Pt-1; ARL-70-0235-Pt-1) Avail: NTIS CSCL 14/2

The report summarizes research conducted on the use of isentropic-compression techniques for producing hypervelocity test flows. The results of experiments in the pilot isentropic-compression tube are reported and compared with theoretical predictions. It is shown that the experimental results are, in general, in agreement with the theoretical performance predictions for both the isentropic-flow and the free-piston shock-tube mode of operation. Theoretical estimates of the performance of a large-scale high-pressure facility are given which indicate that such a facility would be extremely versatile and capable of performance far exceeding that of existing short-duration high-speed test facilities. The report provides a complete documentation of the research conducted including previously unpublished work recently completed. Author (GRA)

N71-22159# National Aerospace Lab., Tokyo (Japan).
CYLINDRICAL BOUNDARY INTERFERENCE ON VIRTUAL MASS OF A SPHERE
Nagamasa Kono Nov. 1970 17 p refs In JAPANESE; ENGLISH summary
(NAL-TR-223) Avail: NTIS

In order to clarify the virtual mass increment by cylindrical wall interference the flow field induced by a single doublet located at an arbitrary point in a cylinder and having its axis oriented parallel to the axial and radial direction and normal to both directions was solved, and closed surfaces were sought by transforming the field to an uniformly translating system. The virtual mass was calculated from the kinetic energy and results were compared with the case of a free field. When a body is placed on the cylinder axis, boundary interference appears both as surface distortion and virtual mass increase; the former is not serious unless the radius ratio of the body to the cylinder does not exceed 0.5, but the latter is remarkable. Results when the body is off-centered at 0.3 radius from the cylinder axis showed complex behavior depending on the orientation of motion.
Author

N71-22160# National Aerospace Lab., Tokyo (Japan).
AERODYNAMIC CHARACTERISTICS OF A FLARED BODY WITH BLUNT NOSE
Takashi Tani, Iwao Kawamoto, Seizo Sakakibara, Junichi Noda, and Hiroshi Higuchi Oct. 1970 17 p refs In JAPANESE; ENGLISH summary
(NAL-TR-221) Avail: NTIS

The aerodynamic characteristics of a flared body with blunt nose were investigated theoretically and compared with the result of experiments conducted in a supersonic wind tunnel at Mach numbers 2 and 3. Measurements of the static pressure, as well as the total pressure, around the blunt nosed body immediately revealed that the blunt nose caused a strong shear flow field in the vicinity of the body surface and that the pressure distribution measured on the flare of the blunt body was markedly different from that of a similar body with sharp nose. Analysis based on the concept of two parallel layers which approximated the shear region showed the pressure distribution to be quite acceptable in simulating the experimental distribution for the flare due to a blunt nosed body.
Author

N71-22166# Cornell Univ., Ithaca, N.Y. Lab. of Plasma Studies.
LABORATORY STUDY OF HIGH-BETA PLASMA SHOCK WAVES
David L. Morse and William W. Destler Jul. 1970 34 p refs
(Contract N00014-67-A-0077-0002)
(AD-717397; LPS-53) Avail: NTIS CSCL 20/9
    A plasma wind tunnel has been used to generate shock waves at rest in the laboratory reference frame. The upstream pressure ratio beta is in the range 1 to 3, and the Mach number based on the fast magnetosonic wave speed is 3 to 5. The shock wave is formed by letting the plasma wind impinge on the field of a magnetic obstacle. The resulting shock is primarily transverse, and exhibits a thickness of 1 to 1 1/2 times the ion inertial length (c/omega sub pi). The shock thickness decreases with increasing Mach number, and increases as the ion mass is increased. Magnetic fluctuations in the shock front are observed, with frequencies near the ion gyral frequency. Comparisons of these results with those of other experiments, and with the earths bow shock, are made.
Author (GRA)

N71-22168# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATIONS OF STRAINS AND STRESSES BY MEANS OF MOIRE PATTERNS [ISSLEDOVANIYA DEFORMATSII I NAPR YAZHENII METODOM MUAROVYKH POLOS]
I. P. Sukharev et al 9 Dec 1970 182 p refs Transl. into ENGLISH from the Russian
(AD-717826; FTD-HC-23 614-70) Avail: NTIS CSCL 20/11
    The report contains a discussion of the theoretical principles, experimental procedure and the application of a new experimental method for studying strains and stresses of machine parts and structural elements in which the moire effect is used. The method permits experimental solution of a broad class of problems. It has a number of advantages over other techniques and is distinguished by simplicity of the experimental procedure and equipment. Application of the method for studying plates and membranes is discussed in greatest detail. Examples are presented from machine and aircraft building and construction practice.   Author (GRA)

N71-22169# Catholic Univ. of America, Washington, D.C. Inst. of Ocean Science and Engineering.
WIND INDUCED VIBRATIONS OF SKEWED CIRCULAR CYLINDERS
Gary H. Koopmann Sep. 1970 26 p refs
(Contract N00014-68-A-0506-0001)
(AD-717739; Rept-70-11) Avail: NTIS CSCL 20/4
    A general discussion of the various techniques used to measure the oscillating lift coefficients of wind-induced vibrations of circular cylinders is presented. The discussion is summarized with a brief outline of the various categories of research efforts being conducted on fluid-induced vibrations. Each category is referenced to an appropriate group of papers which exist in the literature. A simple method for determining the oscillating lift coefficient for the wind-induced vibration of a circular cylinder is developed and applied to a typical problem where the longitudinal axis of the cylinder is skewed relative to the direction of the oncoming flow.
Author (GRA)

N71-22174# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
THE FEASIBILITY OF UTILIZING COLOR CATHODE RAY TUBES FOR AIRCRAFT CREW STATION DISPLAYS
Technical Report, Feb. May 1970
Ronald S. Vokits Nov. 1970 47 p refs
(AD-717655; ASD-TR-70-33) Avail: NTIS CSCL 1/4
    The report compiles the characteristics of various state-of-the-art color cathode ray tubes (CRTs). The structures, theory of operation, and technical advantages and disadvantages of the various color CRTs for use in aircraft display instruments are evaluated. The results of the study were that presently available types of color CRTs are not suitable for cockpit displays and the Penetron and other non-patterned screens could be used in low ambient light areas.   Author (GRA)

N71-22186# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany).
FUTURE COMMERCIAL FLIGHT TECHNIQUES [VERKEHRSFLUGTECHNIK DER ZUKUNFT]
Nov. 1970 239 p refs In GERMAN Proc. of the DGLR Symp., Hamburg, 29 Jan. 1970
(DLR-MITT-70-15) Avail: NTIS; ZLDI Munich: 50 DM

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    7. VARIABLES INFLUENCING THE DIRECT OPERATIONAL COSTS OF A V/STOL PASSENGER AIRCRAFT K.-A. Wendt (Ver. Flugtech. Werke-Fokker, Munich) p 121 - 132

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    9. INLET FLOW AND OUTLET JET INFLUENCE ON THE FLOW AROUND THE WINGS OF TWO LIFT FAN CONFIGURATIONS H. Neppert (Hamburger Flugzeugbau) p 170 - 218 refs

    10. CONSIDERATIONS REGARDING THE DESIGN OF THE COCKPIT FOR A V/STOL AIRCRAFT J. Lindemann (Hamburger Flugzeugbau) p 219 - 228
    11. AIR TRAFFIC SECURITY, TODAY AND TOMORROW H. Herb (DFVLR, Brunswick) p 229 - 237 refs

N71-22187# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
THE VTOL JET FOR A FUTURE V/STOL TRANSPORT SYSTEM [DAS SENKRECHTSTARTENDE STRAHLFLUGZEUG IM RAHMEN EINES ZUKUENFTIGEN VSTOL-TRANSPORTSYSTEMS]
B. Huinink and K. B. Brink In DGLR Future Com. Flight Tech. Nov. 1970 p 7 - 32 refs In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM
    In view of the future demand in civil VTOL aircraft the advantages offered by the development of the DO-31 aircraft provide a basis for further development. An analysis of the aerodynamic characteristics, the aircraft safety, and operating costs leads to the conclusion that the German aerospace industry has high chances in this field.   ESRO

N71-22188# Vereinigte Flugtechnische Werke - Fokker G.m.b.H., Munich (West Germany).

MARKET SITUATION FOR V/STOL AIRCRAFT
[MARKTSITUATION FUER V/STOL-FLUGZEUGE]
H. Hoeppner *In* DLGR Future Com. Flight Tech. Nov. 1970
p 33–52 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The market situation for V/STOL aircraft is assessed for
both the military and civil aviation fields. The design and testing of
prototypes, taking into account the special operational requirements
is discussed and a specific design is proposed; a tilt wing aircraft
with propeller drive in a tandem configuration. ESRO

N71-22189# United Aircraft International Inc., Cologne (West
Germany).
AIR SPACE CONGESTION AND THE COMPOUND
HELICOPTER [DIE LUFTRAUM-UEBERFUELLUNG UND DER
VERBUND-HUBSCHRAUBER]
S. I. Sikorsky *In* DLGR Future Com. Flight Tech. Nov. 1970
p 53–66 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

As the majority of civil air transport is over short haul
distances, and in view of air traffic control problems, a VTOL
solution to these problems is proposed. In particular, a compound
and a normal helicopter design are described meeting the
requirements derived from the above conditions. The use of advanced
composite materials and retractable rotors is briefly discussed.
ESRO

N71-22190# Hamburger Flugzeugbau G.m.b.H. (West Germany).
COMMERCIAL INTERPRETATION OF VTOL AIR LINERS
[MARKTGERECHTE AUSLEGUNG VON
VTOL-VERKEHRSFLUGZEUGEN]
H.-G. Klug *In* DGLR Future Com. Flight Tech. Nov. 1970
p 67–92 In GERMAN (
Avail: NTIS; ZLDI Munich: 50DM

The reliability and operational requirements of short haul
VTOL aircraft are discussed. A particular design is presented,
featuring lift- and lift/cruise fans, using a conventional jet engine
as a gas generator. The advantages of this design are outlined, in
particular low noise generation and a spacious compartment.
ESRO

N71-22191# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich
(West Germany)
PROPELLER-DRIVEN VTOL AIRCRAFT
[PROPELLERGETRAGENE VTOL-FLUGZEUGE]
U. Dornseifer *In* DGLR Future Com. Flight Tech. Nov. 1970
p 93–104 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The advantages of propeller-driven tilt-wing aircraft for intercity
transport are outlined. The advantages are in particular a lower
noise generation as compared to both conventional and V/STOL jet
engine powered aircraft, and the excellent STOL properties.
ESRO

N71-22192# Vereinigte Flugtechnische Werke - Fokker G.m.b.H.,
Bremen (West Germany).
APPLICATION ANALYSIS OF VTOL AIRCRAFT FOR
FUTURE INTEGRATED INTERCITY TRAFFIC SYSTEM
[EINSATZANALYTISCHE UNTERSUCHUNGEN EINES
ZUKUENFTIGEN INTERCITY-VERKEHRS-VERBUND-SYS-
TEMS MIT VTOL-FLUGZEUGEN]
H.-R. Buschhorn *In* DGLR Future Com. Flight Tech. Nov. 1970
p 105–120 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The operational problems of future integrated intercity VTOL
traffic are discussed. A model is developed taking into account
conventional ground transfer traffic to derive the optimum condi-
tions for integrating different means of transport to minimize travel
time. ESRO

N71-22193# Vereinigte Flugtechnische Werke - Fokker G.m.b.H.,
Munich (West Germany).
VARIABLES INFLUENCING THE DIRECT OPERATIONAL
COSTS OF A V/STOL PASSENGER AIRCRAFT
[EINFLUSSGROESSEN AUF DIE DIREKTEN
BETRIEBSKOSTEN EINES
V/STOL-PASSAGIERFLUGZEUGES]
K.-A. Wendt *In* DGLR Future Com. Flight Tech. Nov. 1970
p 121–132 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The aircraft under consideration is a tilt wing, propeller
driven tandem aircraft with a flight range of 800 km. The different
sources of operational costs are described and the influence of
changes in the parameters are discussed. Finally, the tradeoff
between increased cost versus overall travel time is mentioned.
ESRO

N71-22194# Motoren- und Turbinen-Union Muenchen G m b H
(West Germany).
LIFT FANS AND A FLEXIBLE SOLUTION FOR THE
DEVELOPMENT OF VTOL PASSENGER AIRCRAFT
[GEBLAESEANTRIEBE UND EINE IN JEDER WEISE FLEXIBLE
LOESUNG FUER DIE ENTWICKLUNG VON
VTOL-VERKEHRSFLUGZEUGEN]
A. Hartmann *In* DGLR Future Com. Flight Tech. Nov. 1970
p 153–170 refs In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The various design alternatives in VTOL aircraft thrust
generation are compared, and a design with separate gas generator
and thrust generator is discussed. The requirements imposed on
the connecting tube, the gas generator, the fans, and their
combination into a propulsion aggregate. Finally, the integration of
the propulsion system into the aircraft body is discussed. ESRO

N71-22195# Hamburger Flugzeugbau G.m.b.H. (West Germany).
INLET FLOW AND OUTLET JET INFLUENCE ON THE
FLOW AROUND THE WINGS OF TWO LIFT FAN
CONFIGURATIONS [ZULAUF- UND STRAHLEINFLUESSE
ZWEIER HUBGEBLAESEKONFIGURATIONEN AUF DIE
FLUEGELSTROEMUNG]
H. Neppert *In* DGLR Future Com. Flight Tech. Nov. 1970
p 170–218 refs In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

Two configurations of lift fans were investigated as to the
influence of the inlet and outlet flow on the aerodynamic forces
and moments. A half-model was placed into a wind tunnel to
measure the pressure distribution over several airfoil sections. The two
configurations under test were compared concerning longitudinal
stability, cruising flight drag, and tilting moments. ESRO

N71-22196# Hamburger Flugzeugbau G.m.b.H. (West Germany).
CONSIDERATIONS REGARDING THE DESIGN OF THE
COCKPIT FOR A V/STOL AIRCRAFT [UEBERLEGUNGEN
ZUR GESTALTUNG DES COCKPITS EINES
V/STOL-TRANSPORTERS]
J. Lindemann *In* DGLR Future Com. Flight Tech. Nov. 1970
p 219–228 In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

A mockup of a V/STOL aircraft cockpit is presented. The
requirements imposed on such a cockpit are outlined, and the
resulting design is described. ESRO

N71-22197# Deutsche Forschungs- und Versuchsanstalt fuer
Luft- und Raumfahrt, Brunswick (West Germany). Inst fuer
Flugmechanik.
AIR TRAFFIC SECURITY, TODAY AND TOMORROW [DIE
SICHERHEIT IM LUFTVERKEHR, HEUTE UND MORGEN]

H. Herb *In* DGLR Future Com. Flight Tech. Nov. 1970 p 229 237 refs In GERMAN
Avail: NTIS; ZLDI Munich: 50 DM

The development of accident figures in air traffic is discussed; the factors influencing them, human errors, technical failures, clear air turbulence, and cosmic radiation are described. ESRO

N71-22198# National Research Council of Canada, Ottawa (Ontario).
QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 OCTOBER - 31 DECEMBER 1970
31 Dec. 1970 84 p refs
(DME/NAE-1970/4/) Avail: NTIS

CONTENTS:
1. PRESENT STATUS OF ELECTRIC AUTOMOBILES J. J. Gottlieb p 1 - 38 refs
2. THE DEVELOPMENT AND TESTING OF A PYROTECHNIC SEEDING SYSTEM ON A MODIFIED T-33 G. K. Mather p 39 - 54 refs

N71-22200# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Lab.
THE DEVELOPMENT AND TESTING OF A PYROTECHNIC SEEDING SYSTEM ON A MODIFIED T-33
G. K. Mather *In* NRC of Can. Quart. Bull. of the Div. of Mech. Eng. and the Natl. Aeron. Estab., Oct. Dec. 1970 31 Dec. 1970 p 39 54 refs
Avail: NTIS

A T-33 aircraft was modified and instrumented to meet the requirements for a seeding aircraft in hail suppression experiments. All systems, including radar, flare fire control, and instrumentation, proved extremely reliable during field tests. The design of the flares proved optimum for the Alberta storms. The chaff flare was useful in gaining confidence in targetting accuracy. Author

N71-22221# Joint Publications Research Service, Washington, D.C.
EXPERIMENTAL INVESTIGATION OF FLUID FLOW ALONG A TRAVELING WAVE
V. I. Merkulov et al *In its* Hydrodyn. Probl. of Bionics 12 Mar. 1971 p 153 - 157
Avail: NTIS

Mathematical investigations of flow of a viscous fluid along a traveling wave utilize a system of coordinates linked with the wave crest. In such a system the region boundary becomes a constant undulating surface each point on which slips along the tangent toward the fundamental stream. Since the forces to which the body is subjected are independent of selection of inertial system of coordinates, a coordinate system linked to the wave crest was used in this investigation. The construction of the model, layout of measuring devices, and method of measurement are described. A.L.

N71-22232# Naval Research Lab., Washington, D.C.
STATIC ELECTRICITY MEASUREMENTS DURING REFUELER LOADING Interim Report
Joseph T. Leonard and Homer W. Carhart 5 Jan. 1971 26 p refs
(AD 717347; NRL-7203) Avail: NTIS CSCL 21/4

The generation of electrostatic charge by JP-5-type jet fuel was examined at a truck fill stand which has both a 30-second relaxation chamber and bottom-loading capability. The installation, which is located at Patuxent Naval Air Station in Patuxent,

Maryland, conforms to the latest NavFac design criteria except that a surge suppressor was not specified or provided. The objectives of the study were to examine the effect of hose diameter and length on the level of charge on fuel entering a refueler and to determine the effectiveness of the relaxation and bottom-loading facility in reducing the electrostatic hazard during refueler loading. Author (GRA)

N71-22241# Cornell Univ., Ithaca, N.Y. Graduate School of Aerospace Engineering.
BOUNDARY LAYER SEPARATION
Demetrios Pyrros Telionis (Ph.D. Thesis) Sep. 1970 147 p refs
(Contract F44620-69-C-0063)
(AD-717772; AFOSR-70-2404TR) Avail: NTIS CSCL 20/4

The phenomenon of separation is one of the most critical features of the flow of viscous fluids about rigid bodies. In the two-dimensional steady-state case, Prandtls criterion (vanishing of skin friction) appears to be successful in predicting separation. Numerical integrations have indicated that the boundary-layer equations behave singularly at separation, and Goldstein has suggested analytical formulas describing this situation. Prandtls criterion fails to predict meaningful separation for unsteady problems and this seems to have been mostly unnoticed. A general and formal definition of boundary-layer separation is given, based on the concept of Goldsteins singularity. It is demonstrated how from this definition one can deduce meaningful criteria for the unsteady problem as well as other complicated cases, such as three-dimensional or compressible separation flow. A simple formula is suggested for the component of the velocity in the direction parallel to the wall; and it is demonstrated that this is in agreement with Goldsteins results for small distance from separation along the wall. A differential equation is derived from the momentum equation which contains the velocity profile at separation. A few applications are included, demonstrating solutions of this equation, which, in the unsteady case, contains the velocity of the phenomenon of separation too. GRA

N71-22294# Cambridge Univ. (England). Dept. of Engineering.
THE OFF DESIGN ANALYSIS OF FLOW IN AXIAL COMPRESSORS
H. Daneshyar 1970 56 p refs
(CUED/A-Turbo/TR-19) Avail: NTIS

The existence and uniqueness of the solutions obtained from the streamline curvature method of calculating flow through turbomachines are examined for several operating points of a Rolls-Royce compressor. It is shown that under certain conditions the truncation errors in the numerical solution can become large and hence give rise to the violation of the uniqueness conditions. The computer program may then give wrong answers to the physical problem. The conditions for existence and uniqueness may be violated when the meridional velocities are small (e.g. near stall) or when there are regions of choked flow. Flow for an operating point in the stall region is computed by suitable modifications to minimize the truncation errors and hence to obtain a unique solution. This is compared with the results of the actuator disc theory and other experiments. Author

N71-22300# ARO, Inc., Arnold Air Force Station, Tenn.
INVESTIGATION OF BLUNT FIN-INDUCED FLOW SEPARATION REGION ON A FLAT PLATE AT MACH NUMBERS 2.5 TO 4.0 Final Report
Ernest J. Lucas AEDC Jan. 1971 25 p refs
(Contract F40600-71-C-0002)
(AD-717717; AEDC-TR-70-265) Avail: NTIS CSCL 20/4

Tests were conducted at Mach numbers 2.5 to 4.0 to investigate the effects of cylindrically blunted fins on the flow over a flat plate at zero angle of attack. The free-stream Reynolds number, based on the distance from the blunt fin to the flat plate

leading edge, ranged from 2,800,000 to 4,700,000. Pitot pressure profiles were obtained in the fin-induced flow separation region. Increasing the thickness of the fin was found to increase the size of the three dimensional separation area. Pressure distributions as well as examples of the oil flow and schlieren photographic coverage are presented.   Author (GRA)

N71-22331# National Aeronautical Lab., Bangalore (India).
ANNUAL REPORT OF THE NATIONAL AERONAUTICAL LABORATORY, 1969 - 1970
1970 91 p refs
Avail: NTIS

Summaries of research activities are presented. The laboratory's major project was the design, fabrication, commissioning, and calibration of a 4-ft trisonic wind tunnel. Other projects reported include the following areas of research: (1) aerodynamics, (2) structural sciences, (3) materials science, (4) propulsion, (5) electronics, (6) instrumentation, (7) mathematical sciences, (8) pilot plants, and (9) technical aid and assistance.   D.L.G.

N71-22339*# TRW Systems Group, Redondo Beach, Calif.
THE APPLICATIONS OF SATELLITES TO COMMUNICATIONS, NAVIGATION AND SURVEILLANCE FOR AIRCRAFT OPERATING OVER THE CONTIGUOUS UNITED STATES. VOLUME 1: Technical Report
J. H. Craigie, A. Garabedian, D. D. Morrison, I. Zipper et al Dec. 1970 314 p refs
(Contract NAS5-21535)
(NASA-CR-117760; TRW-14671-6007-R0-00-Vol-1) Avail: NTIS HC $6.00/MF $0.95 CSCL 17G

Satellite applications to communications, navigation, and surveillance requirements are discussed for aircraft operating beyond 1975 over the contiguous United States and adjacent oceanic transition regions. The highest priority satellite applications are surveillance and rapid collision warning communications and it is concluded that the necessary technology is available. A system concept based on the technology was synthesized. A satellite-based air traffic control concept is described which consists of satellites, ground stations, and electronic hardware, and provides support for a wide range of aircraft. All users have a Location/Identification Transmitter (LIT) and antenna for surveillance which permits identification and three-dimensional location of all airborne aircraft approximately every second; and most of these aircraft are also equipped with LIT backlink receivers providing short access time mid-air collision warning. In addition, higher cost aircraft can have an option of satellite navigation equipment which can provide highly accurate three-dimensional position and velocity information. The use of satellites for rapid and reliable data communication from any place in the country to an aircraft anywhere over the country also is discussed.   Author

N71-22340*# TRW Systems Group, Redondo Beach, Calif.
THE APPLICATIONS OF SATELLITES TO COMMUNICATIONS, NAVIGATION AND SURVEILLANCE FOR AIRCRAFT OPERATING OVER THE CONTIGUOUS UNITED STATES. VOLUME 2: APPENDICES
A. J. Mallinckrodt, C. S. Miller, C. S. Easley, G. E. Clark, R. J. Harte et al Dec. 1970 180 p refs
(Contract NAS5-21535)
(NASA-CR-117759; TRW-14671-6008-R0-00-Vol-2-App) Avail: NTIS CSCL 17G

Appendices of supporting information for the application of satellites to aircraft communication, navigation, and surveillance over the contiguous United States are presented including future air traffic control loads and air traffic system organization and management. Specific equipment studies are summarized including location/identification transmitter (LIT) pricing quotations; pulse

detection and false alarm rates due to thermal noise and crosstalk; biphase coding; ground multipath; satellite LIT antenna optimization; computation of satellite transmitter linear range requirements for LIT; alternate design approaches for the LIT; aircraft antenna pattern measurements; a multiple tap surface wave delay line; and a LIT surveillance computer program.   J.M.

N71-22345# Michigan Univ., Ann Arbor. Dept. of Naval Architecture and Marine Engineering.
THEORY OF HIGH ASPECT RATIO PLANING SURFACES
Technical Report, 1 May 1969 - 30 Apr. 1970
Young-Tsun Shen Nov. 1970 135 p refs
(Contract N00014-67-A-0181-0019)
(AD-717667; Rept-102) Avail: NTIS CSCL 13/10

A high-aspect-ratio planing surface gliding on a stream of an infinitely deep, incompressible, inviscid and gravity-free fluid is treated. This complicated problem is decomposed into two relatively simpler boundary-value problems: (1) The near-field boundary-value problem is valid only in the neighborhood of the planing surface. The problem is solved by the classical hodograph method. The second-order inner problem is also shown to be a plane, irrotational flow and the solution is obtained by following the same procedure as in the first-order inner solution. (2) The far-field boundary-value problem is valid only far away from the planing surface. The first-order outer solution is shown to be a trivial uniform flow. The outer velocity potential is defined in the whole space by harmonic continuation. The second-order solution is then shown to be similar to a lifting-line solution. The unknown strength of singularities is obtained by matching of the velocity potential. Then a matching of the free-surface deflection provides a height reference for the planing surface. The location of the planing surface with respect to the undisturbed free surface is uniquely defined. In order to obtain a unique second-order solution, it is necessary to solve the third-order outer solution. The detail of this solution is presented. A numerical solution for a planing plate of arbitrary angle of attack is presented. A downwash correction is also included. It is shown mathematically that the present theory can be applied to V-shape or general-shape planing surfaces with curvature in the spanwise direction.   Author (GRA)

N71-22374# Cambridge Univ. (England). Dept. of Engineering.
EXPERIMENTAL PRESSURE DISTRIBUTIONS ON AEROFOILS IN TRANSVERSE AND STREAMWISE GUSTS
D. W. Holmes 1970 38 p refs
(CUED/A-Turbo/TR-21) Avail: NTIS

Experiments are described in which measurements were made of the force and pressure fluctuations on an aerofoil in an unsteady flow. Two types of unsteady flow are studied: (1) a transverse gust flow and (2) a streamwise gust flow. In both cases the gust was non convective and had a propagation speed that was less than the mean flow velocity. All the experiments were performed with a low reduced frequency, the maximum value reached being 0.2 based upon the half chord. The streamwise gust results are presented to show separately the responses due to incidence and thickness. For the transverse gust flow a detailed picture is presented of the pressure fluctuation in the trailing edge region and results are also presented demonstrating the effect of incidence. It is further shown for both flows that the form of the lift fluctuation due to a harmonic gust is also harmonic to a small approximation.   Author

N71-22379# Polhemus Navigation Sciences, Inc., Burlington, Vt.
VERTICAL NAVIGATION STUDY FOR THE CONCORDE SST. VOLUME 1: SUMMARY, SIMULATION, ANALYSIS AND RECOMMENDATIONS Final Report
Mar. 1970 28 p
(Contract UKTSD-C-4539)

N71-22380# Polhemus Navigation Sciences, Inc., Burlington, Vt.
VERTICAL NAVIGATION STUDY FOR THE CONCORDE SST. VOLUME 2: TECHNICAL, SIMULATION, ANALYSIS AND RECOMMENDATIONS Final Report
Mar. 1970 217 p
(Contract UKTSD-C-4539)
(PNSI-TR-70-0301-2-Vol-2) Avail: NTIS
(PNSI-TR-70-0301-1-Vol-1) Avail: NTIS

An analysis of vertical navigation for the Concorde aircraft is presented. Subjects discussed are: (1) computer simulation of the Concorde and its interrelated guidance systems, (2) evaluation of several levels and combinations of guidance system, aircraft performance, and meteorological forecast errors on ability to predict and achieve planned profiles over a variety of airline routes, (3) evaluation of the effects of certain air traffic control initiated commands on crew workload, fuel, schedule reliability, and controlled time of arrival, and (4) synthesis of additional operational techniques and equipment requirements to assure that air traffic control and crew performance requirements can be met. 'Author

N71-22381# National Council for Civil Aviation, Tel Aviv (Israel).
CIVIL AVIATION IN THE 1970's
1969 303 p Presented at the Ann. Symp. on Current Probl. in Civil Aviation, Tel Aviv, Israel, 8 - 9 Oct. 1969
Avail: NTIS HC $6.00/MF $0.95

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N71-22382# Israel Ministry of Transport and Communications, Tel-Aviv.
ADDRESS BY THE MINISTER OF TRANSPORT
M. Carmel In Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 10 p
Avail: NTIS HC $6.00/MF $0.95

Planning and developments in civil aviation are outlined. Considered are future technological and economic trends, the operation of new transport aircraft, the production of transport aircraft in Israel, the planning of modern airports and other related problems. G.G.

N71-22383# Federal Aviation Administration, Washington, D.C.
TECHNOLOGICAL TRENDS AND FORECASTS FOR THE 1970's
Joseph D. Blatt In Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 13 p
Avail: NTIS HC $6.00/MF $0.95

Traffic generating potentials of air transportation and the problems that must be solved to insure increasing systems capacity are discussed by analyzing market forecasts of unconstrained growth for the U.S. air traffic. Large scale changes to employ 747 aircraft and SST aircraft demand sophisticated technology and high speeds. Improved air traffic control and navigation systems as well as passenger handling facilities are proposed that rely on automatic simulators to provide guidance for traffic optimization. Volumetric navigation, aided by scanning satellites, atomic clocks, ground to air and air to ground synchronization techniques, precise time and precise frequency standards provide the required flexibility in the use of air space and meet specific operational needs of air traffic developments. G.G.

N71-22384# Institute of Transport Aviation, Paris (France).
ECONOMIC ASPECTS OF THE EXPECTED DEVELOPMENT IN AIR TRANSPORT IN THE NEXT DECADE
Jean Mercier In Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 13 p
Avail: NTIS HC $6.00/MF $0.95

The main positive and negative economic aspects directly concerning commercial aviation development in the next decade are discussed: (1) financing appears to be one of the most complex problems to solve; (2) profitability, owing to heavier charges and labor costs, will perhaps not be able to maintain a good level, (3) vertical integration for extensions of transport activities at the level of tourism and customer facilities; (4) the uncertainty concerning the size of firms which will have to meet these commitments; (5) the consequences at the economic and organizational level of maintaining or increasing the flexibility in traffic; (6) adaptation to the changing market which is developing rapidly; and (7) the increasing importance of the operations preceding and following the actual transport process with regard to surface transport media. Author

N71-22385# EL AL Israel Airlines, Ltd., Tel Aviv.
PROBLEMS OF CIVIL AVIATION IN THE NEXT DECADE
M. Ben-Ari In Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 28 p
Avail: NTIS HC $6.00/MF $0.95

The main problems are listed that will become critical with the introduction of giant and supersonic aircraft into international civilian air transport: (1) financing; (2) economics of airline operations; (3) marketing and development of traffic; (4) security problems; (5) overland transportation and ground services; and (6) charter flights. Considerable emphasis is placed on expected air traffic developments in Israel. G.G.

N71-22386# Boeing Co., Seattle, Wash.
THE B-747 AND DEVELOPMENT OF THE SST
G. Snyder In Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 53 p
Avail: NTIS HC $6.00/MF $0.95

The 747 and SST airplanes are designed to meet the challenges of the expanding air travel market of the 1970's. Both airplanes are designed to operate from existing airports and to minimize noise at the airports. The SST will operate so as to preclude sonic boom problems en route by operating international routes at supersonic speeds, and domestic routes at transonic speeds. The 747 status reflects the confidence of the initial design. Development flight testing has been essentially completed, and the airplane characteristics have been proven to permit initiation of FAA certification demonstration. Analysis of flight data indicates the airplane performance is equal or better than predicted. The only remaining developmental area of significance relates to engine performance. Author

N71-22387# British Aircraft Corp., Filton (England).
CONTINUED PROGRESS ON CONCORDE
M. G. Wilde *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 29 p
Avail: NTIS HC $6.00/MF $0.95

Certification flight development for the Concorde is outlined; reported flight testing on two prototypes included 1500 hours of endurance flying and direct application on airline routes. Improvements during design progress are described and operating cost trends are analyzed. Revenue yields, costs and load factors for the Concorde and the remaining subsonic traffic clearly project a single class operation for the supersonic transport as the best economic choice. G.G.

N71-22388# EL AL Israel Airlines, Ltd., Tel Aviv.
EL-AL'S PLANNING FOR THE INTEGRATION OF THE B-747
S. Eshel *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 8 p
Avail: NTIS HC /6.00/MF $0.95

The airplane is only one component in a complex system consisting of man-power, equipment, structure, know-how, methods and procedures, all of which are required to enable the aircraft to perform its function: flying. Described are some planning activities and preparations for the integration of the 747 aircraft into Israel airline operations. Author

N71-22389# Port of New York Authority, N.Y. Aviation Technical Services Div.
THE AIRPLANE AND THE AIRPORT
Louis Achitoff *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 28 p
Avail: NTIS HC $6.00/MF $0.95

The parameters that require evaluation in the planning of an international airport intended to accommodate new generation, high capacity aircraft are discussed. The infrastructure of airport-airplane requirements includes runway/taxiway dimensional trends, taxiway-to-taxiway separation, holding space, noise reduction, recovery of disabled aircraft, and fire and rescue operations. Emphasis is placed on the necessity of including the airport operations area as part in a public transportation system. G.G.

N71-22390# British Airports Authority, London (England).
ACCOMMODATING PASSENGERS AND CARGO
D. C. Ramage *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 27 p
Avail: NTIS HC $6.00/MF $0.95

Airside and landside parts of the overall planning for supporting structures in expanding civil aviation traffic are discussed. The system is evaluated from the point where the payload leaves the airport and joins the external ground transport system to the centers of population and industry. Considered are passenger and cargo travel between the aircraft and the private car, public service vehicle, truck, railway train, etc., with application to Heathrow airport and its handling of larger and faster aircraft. The aircraft is considered the starting point of the systems approach followed by airline/airport administration and cooperation with government levels as well as a scheduling for concept integration. G.G.

N71-22391# Israel Ministry of Transport and Communications, Tel-Aviv.
DEVELOPMENT OF CIVIL AVIATION IN ISRAEL IN THE 1970's
R. Harel *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 21 p
Avail: NTIS HC $6.00/MF $0.95

Four main points are stressed in the development of civil aviation in Israel: (1) aviation is regarded as a leading branch of the national economy; (2) cargo, in terms of extent, may take precedence over passengers; (3) measures to improve the supporting infrastructure in handling expected growth in passenger and cargo traffics; and (4) emphasis on systems planning in reaching important decisions. A master-plan presently incorporates electronic low-approach aids and communications as well as the introduction of terminal radar equipment to meet the requirements for increased air traffic operations during the 1970's. G.G.

N71-22394*# National Aeronautics and Space Administration, Washington, D.C.
CONTRIBUTIONS OF THE SPACE PROGRAMME TO AVIATION
H. Cohen *In* Natl. Council for Civil Aviation Civil Aviation in the 1970's 1969 25 p
(NASA-TM-X-67073) Avail: NTIS CSCL 22A

Contributions to air transport safety resulting from developments conducted by space programs are discussed. Subjects presented are: (1) meteorological and navigation satellites, (2) communications satellites, (3) flight recorders, (4) structural analysis, (5) inertial guidance systems, (6) systems for monitoring physical condition of flying personnel, and (7) manufacturing processes under conditions of weightlessness and vacuum to produce new materials. Author

N71-22426# School of Aerospace Medicine, Brooks AFB, Tex.
COCKPIT NOISE WITHIN TRAINER AIRCRAFT Final Report, Feb. Oct. 1970
Donald C. Gasaway Dec. 1970 23 p refs
(AD-717852; SAM-TR-70-95) Avail: NTIS CSCL 20/1

Routine unprotected exposure to acoustic noise within cockpits of many trainer aircraft represents potentially hazardous stress. The character of the acoustic noise found within the cockpits of fixed- and ROTARY-wing aircraft used primarily for flying training is described and illustrated. The effect of various maneuvers commonly encountered in training flights on cockpit noise is evaluated, and factors of aeromedical significance associated with noise in trainer aircraft are identified and described. Author (GRA)

N71-22428# Cambridge Univ. (England). Dept. of Engineering.
THE UNSTEADY RESPONSE OF AN AXIAL FLOW COMPRESSOR WITH A DISTORTED INLET FLOW
H. Mokelke 1970 37 p refs Presented at the Turbomachinery Subcomm. of the ARC Meeting, 2 Oct. 1970
(CUED/A-Turbo/TR-20) Avail: NTIS

A 4-stage axial flow compressor with a hub/tip ratio of 0.8 is first investigated with a circumferential 60 deg-square wave inlet flow distortion at a high and a low flow rate. By measuring the total pressures, static pressures and yaw angle behind each stage, the development of the distortion is followed through the

compressor. It is found that some of the experimental results differ considerably from analytical results predicted by quasi-steady theories. These discrepencies are likely to be due to the unsteady response of the flow around the rotor blades while these are passing through a distorted region. The compressor was tested using two asymmetric inlet distortions which were mirror images of each other. For the case of a low flow rate, great differences in the profiles were recorded. It is believed that different types of short duration stall are responsible for this result. In the case of the higher flow the discrepancies are somewhat less and might conceivably be explained by unsteady potential flow theories. Author

N71-22431# Aeronautical Research Inst. of Sweden, Stockholm.
STUDY OF INSPECTION INTERVALS FOR FAIL SAFE STRUCTURES
Sigge Eggwertz and Goeran Lindsjoe Jan. 1970 59 p refs
(FFA-120) Avail: NTIS
Based on a method of evaluating the reliability of failsafe structures, a theoretical investigation, applicable to an aircraft wing, has been made of the influence of the length of inspection intervals which are both constant and varying. An optimum study shows that the least number of regular inspections during the service life is obtained by making especially the first interval considerably longer than the following ones. This result presupposes that all fatigue cracks occurring may be statistically anticipated. Unexpected cracks are likely to appear, however, during an initial "debugging period", and have to be considered when determining the first inspection intervals. Unscheduled inspections, randomly distributed in time, decrease the risk of total failure but are shown to be much less effective than regular inspections. Author

N71-22453# National Bureau of Standards, Washington, D.C.
PHOTOMETRIC CHARACTERISTICS OF SEMIFLUSH AIRPORT LIGHTS
A. C. Wall [1970] 57 p
(NBS-10121) Avail: NTIS
The intensity distribution characteristics of semiflush airport approach and runway lights are presented. As installed these lights project one-half or one inch above the pavement surface. The lights may be separated into two generic groups: (1) capsule-type lights using tubular halogen-cycle lamps with lens-type optical systems, and (2) prismatic-head lights using PAR-type sealed reflector lamps with their beam axes vertical, and with prisms to redirect the beams to near-horizontal directions. Intensity distribution data of at least one light of the principal sub types of each generic group are included. Author

N71-22455# National Bureau of Standards, Washington, D.C.
OPERATIONAL TESTS OF DUAL BASELINE TRANSMISSOMETER SYSTEMS
J. C. Wilkerson, J. W. Simeroth, and James E. Davis 15 Sep. 1970 14 p
(NBS-10339) Avail: NTIS
A Skopograph Duplex dual-baseline transmissometer system was installed and operated for four months to determine operational performance of the system. A system of standard transmissometers with similar baselines was placed beside the test system to provide data for comparison. The output data from both systems were recorded photographically by a special photo-pack. The Skopograph equipment operated through the test period with no failures. The most important maintenance requirement was the need for cleaning the windows of the field units approximately twice each week. Several features of the performance and records that could require special treatment in processing the data and evaluating the performance are discussed Author

N71-22456# National Bureau of Standards, Washington, D.C. Photometry Div.
DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS Consolidated Progress Report, 1 Jul. – 30 Sep. 1970
12 Jan. 1971 14 p
(NBS-10508) Avail: NTIS
Evaluations of several types of aircraft approach and landing systems are presented. Subjects discussed are: (1) aviation ground lighting, (2) development, testing, and evaluation of visual landing aids, (3) operational tests of Dual-Baseline Transmissometer sight, (4) photometric measurements of a deck-landing projector sight, and (5) DCA type lamp for Fresnel Optical Landing System. Author

N71-22467 Cornell Univ., Ithaca, N.Y.
AERODYNAMIC SOUND PRODUCTION AND THE METHOD OF MATCHED ASYMPTOTIC EXPANSIONS
Roy Keith Amiet (Ph.D. Thesis) 1969 113 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 70-5974
The method of matched asymptotic expansions is first applied to problems of sound generation by a body in an infinite fluid. The method is then extended to include a free stream flowing over the sound source. If the Mach number is less than one but is not small, slender body theory is assumed and the equations are linearized. The resulting modified wave equation is transformed to the usual wave equation by using a Lorentz and a Galilean transform, and the flow in this transformed plane is divided into an inner incompressible and an outer acoustic region. The effect of the shed vortices (for airfoil problems) on the order of the error is considered. The sound produced by a pulsating airfoil in a stream and the perturbation of a one dimensional sound wave by a moving elliptical airfoil are calculated as examples. In conclusion, the method of matched asymptotic expansions, when applicable, provides a simple method of determining acoustic sound fields. Dissert. Abstr.

N71-22469# National Aerospace Lab., Tokyo (Japan).
AERODYNAMIC NOISE OF A CIRCULAR DOUBLE JET
Nagamasa Kono Sep. 1970 18 p refs In JAPANESE; ENGLISH summary
(NAL-TR-212) Avail: NTIS
The noise characteristics of a jet issuing from a coaxial double nozzle, of diameters of 3 cm and 6 cm respectively, are compared with those of a single jet. The far field sound pressure levels and spectrum at the mesh points, 3 m from the nozzle exit and at 30, 45, 60 and 90 degrees from the jet axis, respectively, were measured under various conditions of by-pass ratio, jet pressure and Mach number. At subsonic speeds, the maximum noise reduction was 4 db, corresponding to a mass flow ratio of 1.2 at 75% thrust increase. The reduced sound levels are mainly due to high frequency compenents, while the Strouhal number remains 0.24. At sonic speeds, the maximum noise reduction was about 10 db which is due to delayed shock turbulence interaction. At the same flow conditions mean velocity profiles and velocity fluctuation in the axial direction are investigated to clarify the mutual relation between the reduced noise, mean shear rate, and the turbulence characteristics. The results were that the maximum velocity fluctuation in the double jet was reduced to 1/3 of the single jet, which causes considerable noise reduction with alleviation of mean shear. Author

N71-22472# National Aeronautical Lab., Bangalore (India).
SOME REMARKS ON MULTHOPP'S SUBSONIC LIFTING-SURFACE THEORY
P. Ramamoorthy Mar. 1970 12 p refs
(NAL-TN-24) Avail: NTIS
Multhopp's subsonic lifting surface theory, introducing

interpolation functions to facilitate the integration in the spanwise direction, is reviewed. The interpolation functions were derived, using the least square approximation.   Author

N71-22476# National Aeronautical Lab., Bangalore (India).
WIND TUNNEL PRESSURE REGULATING SYSTEMS
S. Balakrishna Feb. 1970 27 p refs
(NAL-TN-22) Avail: NTIS

The design aspects of the flow control system are discussed with reference to wind tunnels at the National Aeronautical Laboratory, Bangalore. A system model is obtained and the effects of various disturbances and their effects on the regulating accuracy are discussed.   Author

N71-22485# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
A KOITER TYPE METHOD FOR FINITE ELEMENT ANALYSIS OF NONLINEAR STRUCTURAL BEHAVIOR. VOLUME 1: THE MODIFIED STRUCTURE METHOD Final Report, 17 Oct. 1969 - 17 Oct. 1970
R. T. Haftka, R. H. Mallett, and W. Nachbar Wright-Patterson AFB, Ohio AFFDL Nov. 1970 259 p refs
(Contract F33615-69-C-1899)
(AD-717740; AFFDL-TR-70-130-Vol-1) Avail: NTIS CSCL 20/11

Koiters method for the asymptotic analysis of post-buckling behavior is reformulted in finite element notation for application to structures idealized by finite element models. Koiters method is herein adapted to a general class of structures exhibiting the common snap-through (limit point) type of buckling. This is referred to as the Modified Structure method. It is accomplished by modification of the actual energy functional to create a hypothetical modified structure having a strictly linear pre-buckling path along which buckling must be of the bifurcation type. The analysis of the actual structure is then accomplished by application of Koiters method through consideration of the actual structure as an imperfect version of the modified structure. The effects of pre-buckling nonlinearity are approximated asymptotically. The use of the Modified Structure method in conjunction with direct methods of nonlinear analysis is examined. A highly accurate finite element representation is employed in presenting a comprehensive numerical evaluation of the Modified Structure method of analysis on the basis of a number of planar frame problems.   Author (GRA)

N71-22494# Glasgow Univ. (Scotland). Dept. of Aeronautics and Fluid Mechanics.
THE ROLE OF HEAT CONDUCTION IN LEADING EDGE HEATING: THEORY AND EXPERIMENT
T. Nonweiler, H. Y. Wong, and S. R. Aggarwal Jun. 1969 62 p refs
(Rept-6901) Avail: NTIS

The effect of heat conduction of material on the temperature distribution in the vicinity of a wing leading edge in hypersonic flight is investigated. The theory is based on a conducting plate subjected to aerodynamic heating. It is found that the role played by the conductivity of the material and the leading edge thickness in moderating the nose temperature is very significant. Detailed discussions of the numerical solutions for various shapes of leading edge are given. An experimental technique was developed by which a number of models representing a wing leading edge can be tested and the results thus obtained are compared with those predicted by the theory.   Author

N71-22503# Aeronautical Research Labs., Melbourne (Australia).
THE GOBLIN Mk35 ENGINE: INVESTIGATION OF NOISE AND VIBRATION
J. E. Williams and D. H. Edwards Apr. 1970 87 p refs

(ARL/ME-127) Avail: NTIS

Some Goblin Mk 35 engines in R.A.A.F. service developed unusual noise and vibration in flight at altitudes above about 17,000 feet. An investigation showed that the noise and vibration were caused by unstable airflow in the engine, which resulted in pressure pulsations in the combustion system. The instability was found to originate in the compressor vaneless diffuser space under conditions of high internal Mach Number which occurs at high engine speed and low inlet air temperature. While the cause of the instability was not determined precisely, evidence indicated that it was probably caused by boundary layer flow separation on the rear wall of the vaneless diffuser space. The compressor modification which gave rise to the instability increased the radial depth of the vaneless space, potentially decreasing the stability of the boundary layer flow: the actual occurrence of instability depended upon the air flow distribution around the engine. The disturbance was shown to have no effect upon the mean performance, and to present no hazard to the safe operation of the engine. Some alleviation of the condition was shown to be possible by engine nozzle area modification to increase the engine airflow, and by modifications designed to improve the uniformity of airflow distribution around the engine.   Author

N71-22515# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
INSTITUTE FOR AEROSPACE STUDIES Annual Progress Report, 1970
Nov. 1970 225 p refs
Avail: NTIS

Research is summarized on the following topics: mechanics of rarefied gases; plasma dynamics; combustion, explosions, hypervelocity, and two-phase flows; MHD power generation and earth resource satellites; aerodynamic noise; subsonic aerodynamics; space dynamics; materials science and structures; rocket research; space simulation and surface interactions; high temperature gas dynamics and gas physics; laser excitation diagnostics and environmental sensing; flight and air cushion transportation; atmospheric trace gas studies; sonic boom; and industrial and architectural aerodynamics.   N.E.N.

N71-22527*# Battelle Memorial Inst., Columbus, Ohio.
ANALYSIS OF BRINELLING FAILURE OF BEARINGS FROM VIBRATION TESTED PLV FANS Summary Report
W. A. Glaeser, S. K. Batra, and R. H. Prause 8 Jun. 1970 51 p
Sponsored by NASA
(NASA-CR-117855) Avail: NTIS CSCL 13I

Brinelling damage was identified in PLV fan bearings as the cause for noisy running after exposure to a random-vibration environment. Assuming a maximum Hertz stress of 460,000 psi to produce brinelling, the maximum axial load for the fan bearing was calculated as 43 pounds. Dynamic analysis of the rotor-bearing-spring system revealed that with one preload spring, the maximum predicted axial load would be 297 pounds. It was determined that reduction in maximum bearing loads under vibration conditions could be achieved by reducing the rotor natural frequency and by increasing the damping through using a soft spring system. When a system of five springs at each end of the rotor was considered, the bearing load predicted was 58 pounds. Actual vibration tests using the 5-spring preload configuration resulted in reduction of bearing damage. A bearing load-capacity computer program was written so that, given the bearing parameters, inner race diameter, ball diameter, diametral clearance, total curvature of the race groove and number of balls, the limiting axial load can be determined using maximum Hertz stress.   Author

N71-22538*# Goodyear Aerospace Corp., Akron, Ohio.
DESIGN, FABRICATION, AND STATIC TESTING OF ATTACHED INFLATABLE DECELERATOR (AID) MODELS
G. L. Faurote 1 Mar. 1971 95 p refs

(Contract NAS1-9726)
(NASA-CR-111831; GER-14940) Avail: NTIS CSCL 01C
Three attached inflatable decelerator models were designed and fabricated for supersonic wind tunnel evaluation. The models incorporate four quick-release aeroshell inlets to accomplish deployment and four canopy inlets to effect final canopy pressurization. It was demonstrated by a rapid inflation test that the model's inlet release system and packaging and deployment system are workable.   E.M.C.

N71-22568*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTER PROGRAM DESCRIBING TURBINE AERODYNAMIC REQUIREMENTS, APPROXIMATE EXTERNAL BLADE GEOMETRIES, AND COOLANT FLOW REQUIREMENTS FOR A TWO STAGE AXIAL FLOW TURBINE
Keith A. Furgalus, David G. Evans, and Michael R. Vanco
Washington Apr. 1971 59 p refs
(NASA-TM-X-2229; E-6014) Avail: NTIS CSCL 21E
A computer code is described which generates aerodynamic and thermodynamic designs for a two-stage cooled or uncooled axial-flow turbine. A free vortex flow model is used to generate hub, mean, and tip velocity diagrams. From these diagrams, inner-stage temperatures and pressures, approximate external blade shapes, external blade surface areas, and turbine blade and wall coolant airflow requirements are computed. Inner-stage temperatures and turbine annulus areas are adjusted to include the effects of the mass flow and energy addition of the blade cooling air.   Author

N71-22589*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALOG ANALYSIS OF THE HEAVE RESPONSE AND CONTROL OF A PLENUM-TYPE AIR CUSHION VEHICLE
Jack D. Leatherwood Washington Apr. 1971 31 p refs
(NASA-TN-D-6257; L-7227) Avail: NTIS CSCL 01C
An analytical investigation was conducted to determine the basic heave response characteristics of a plenum-type tracked air-cushion vehicle as a function of vehicle operating parameters. In addition to determining basic characteristics, the effect of an active lip control system on the vehicle dynamic response was investigated. Nonlinear equations describing the dynamic and thermodynamic state of the air-cushion system were derived, and the response of the system to sinusoidal perturbations of the guideway was obtained with the use of an analog computer. Results are presented in terms of vehicle-to-guideway motions and vehicle accelerations experienced during fundamental and subharmonic oscillations.   Author

N71-22590*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DEVELOPMENT OF A SIMULATOR FOR STUDYING SIMPLIFIED LUNAR ESCAPE SYSTEMS
George J. Hurt, Jr., David B. Middleton, and Marion A. Wise
Washington Apr. 1971 46 p refs
(NASA-TN-D-6111; L-7364) Avail: NTIS CSCL 14B
A lunar-escape-system simulator was designed and fabricated to be used as a research tool to study problems related to lunar escape and simplified manual guidance and control. The design involved a two-man platform with instruments and controllers mounted on a strain-gage base. Most of the vehicle characteristics and control logic were contained in the computer program; thus a wide range of vehicles (including the lunar flying vehicles) and guidance and control systems could be studied. The computer program was compared with an independent computer program with good agreement. During checkout operations the subjects were able to adapt to the equipment with a minimum of training and instruction in the operation of the simulator.   Author

N71-22593# Cornell Aeronautical Lab., Inc., Buffalo, N.Y. Aerodynamic Research Dept.
RESEARCH ON ADVANCED GASDYNAMIC TEST FACILITIES. PART 2: LASER-FLUID INTERACTION STUDIES Final Technical Report, 1 Jul. 1966 30 Jun. 1970
John W. Daiber, Ronald G. Rehm, and Herbert M. Thompson
Wright-Patterson AFB, Ohio ARL Oct. 1970 41 p refs
(Contract AF 33(615)-5389)
(AD-717728; CAL-AD-2297-A-3-Pt-2; ARL-70-0236) Avail: NTIS CSCL 14/2
The report describes experimental and theoretical studies conducted on the application of lasers to aerodynamic facilities. The experimental program is concerned with the response of a gas to a high-intensity ruby laser beam. The primary diagnostic tools are high-speed streak cameras and x-ray emission monitors. Experiments were performed in both a spatially uniform gas and in a free-jet expansion. In the latter configuration, fast moving fronts of bright luminosity are propagated back into the high-density reservoir by the absorption of the laser energy. The theoretical effort was concerned with describing the types of fluid responses to laser energy addition through both analytical and numerical analysis.
Author (GRA)

N71-22614*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
AN INVESTIGATION OF TWO VARIATIONS OF THE GAS GENERATOR METHOD TO CALCULATE THE THRUST OF THE AFTERBURNING TURBOFAN ENGINES INSTALLED IN AN F-111A AIRPLANE
Frank W. Burcham, Jr. Washington Apr. 1971 30 p refs
(NASA-TN-D-6297; H-643) Avail: NTIS CSCL 21E
Two variations of the gas generator method for calculating the net thrust of the afterburning turbofan engines installed in an F-111A airplane are investigated. An influence coefficient study and two ground thrust tests were performed. It was found that the gas generator method can be successfully applied to an afterburning turbofan engine. At static conditions with two engines operating, + or − 2 percent accuracy can be achieved for most power settings using either the method based primarily on nozzle total pressure and area (PTA) or the method based primarily on nozzle total temperature and weight flow (TTW). For in-flight conditions the influence coefficient results indicated that the accuracy of the TTW method was about + or − 3 percent, whereas the accuracy of the PTA method was about + or 5 percent for a military power setting. With either calculation method, additional errors in calculated thrust of + or − 2 percent could result from high inlet flow distortion. If accurate thrust values are required, both thrust calculation methods should be used.   Author

N71-22620*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUMMARY OF CENTER-OF-GRAVITY ACCELERATIONS EXPERIENCED BY COMMERCIAL TRANSPORT AIRPLANES IN LANDING IMPACT AND GROUND OPERATIONS
Paul A. Hunter Washington Apr. 1971 66 p refs
(NASA-TN-D-6124; L-7483) Avail: NTIS CSCL 01C
Data are presented on incremental normal accelerations due to landing impacts and to ground operations associated with taxi, takeoff, and landing. NASA VGH recorders, installed in a total of 38 turbine-powered airplanes of both foreign and domestic airlines, were used to obtain the data. Limited data on longitudinal deceleration during landing are also presented   Author

N71-22622*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUBSONIC AERODYNAMIC CHARACTERISTICS OF A HIGHLY SWEPT FIXED WING CONFIGURATION WITH

VARIATION IN WING DIHEDRAL ANGLE
William P. Henderson Washington Apr. 1971 45 p refs
(NASA-TM-X-2261; L-7473) Avail: NTIS CSCL 01A

An investigation to determine the effects of wing-dihedral angle on the aerodynamic characteristics of a highly swept fixed-wing configuration was conducted. The tests were conducted at a Mach number of 0.168, at angles of attack of −5 deg to 22 deg, and at sideslip angles of 0 deg and + or − 5 deg. The effects of the addition of vertical tails, vertical-tail cant angle, and leading-edge flap deflection on the aerodynamic characteristics are also included.
Author

N71-22625*# AiResearch Mfg. Co., Los Angeles, Calif.
AN ANALYTICAL STUDY OF HYDROGEN COOLED PANELS FOR APPLICATION TO HYPERSONIC AIRCRAFT
W. G. Flieder, C. E. Richard, O. A. Buchmann, and F. M. Walters Washington NASA Apr. 1971 201 p refs
(Contract NAS1-5002-1)
(NASA-CR-1650; Rept-68-3667) Avail: NTIS CSCL 20M

Results of an engineering design study of flat, hydrogen-cooled, structural panels for heat fluxes up to 500 Btu/sec-sq ft and pressure loads up to 250 psi are presented. Three basic conceptual designs, with varying degrees of integration of the thermal protection and structural functions of the panel, are evolved; minimum panel weights are obtained; and the ranges of applicability of the various concepts are established. Detailed procedures used to analyze and optimize panel design are included.
Author

N71-22626 Advisory Group for Aerospace Research and Development, Paris, France).
NEW EXPERIMENTAL TECHNIQUES IN PROPULSION AND ENERGETICS RESEARCH
David Andrews and Jean Surugue, eds. Oct. 1970 637 p refs
Conf. held at Munich, 11 - 15 Sep. 1967
(AGARD-CP-38) Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks, Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave., Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The experimental techniques developed for diagnosing high velocity flows include shock tubes, optical methods, enthalpy probes, mass spectrometry, molecular beams, measurements using ionization, plasma flow measurements, and gas chromatography.

N71-22630 Sheffield Univ. (England).
COMBUSTION RESEARCH IN A SHOCK TUNNEL
J. Swithenbank and R. J. Parsons In AGARD New Exptl. Tech. in Propulsion and Energetics Res. Oct. 1970 p 91 - 122 refs
Sponsored in part by Min. of Technol.
Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks, Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave., Pelham, New York 10803 (Attn. Mr. A. L. Candido)

In addition to conventional pressure and shock speed instrumentation, the feasibility of the measurement of gas velocity by electromagnetic induction was studied and found to be a promising technique at the higher flight speeds. Radio frequency probes were used to indicate its magnitude. High speed gas sampling valves are used to measure the fuel concentration in the mixing region, however care must be taken with probe design. The proven value of flow visualization techniques are attained by high speed cine photography.
Author

N71-22633 AC Electronics-Defense Research Labs., Santa Barbara, Calif.
AEROPHYSICS RESEARCH BASED ON FREE FLIGHT RANGE MEASUREMENTS
A. Q. Eschenroeder, H. H. King, and K. S. Wen In AGARD New Exptl. Tech. in Propulsion and Energetics Res. Oct. 1970

p 165 - 188 refs
Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks, Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave., Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The recent advances in techniques which have significantly extended the application of free-flight ranges to the study of high temperature gas-dynamic phenomena are discussed with the improvements in the resolution of information available from laboratory scale flight investigations. Two approaches are followed in relating subscale and full scale observations: direct scaling and evolution of theoretical description. In the first approach, classical results of similitude are extended to include modeling of nonequilibrium chemistry. The second approach requires a detailed mathematical model that contains the essential physical features of interest. The model is refined using the experimental findings. Within the scope of this theoretical system observations of both small and large scale events are predictable. Evidently, the analytical approach is the more general of the two.
Author

N71-22635 Rolls-Royce, Ltd., Bristol (England). Engine Div.
THE USE OF A GUN TUNNEL FOR HYPERSONIC INTAKE CALIBRATION
R. Hawkins and E. Carlton In AGARD New Exptl. Tech. in Propulsion and Energetics Res. Oct. 1970 p 211 - 240 refs

Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks, Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave., Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The use of a gun tunnel as a low temperature test facility for hypersonic intake research was studied with the techniques suitable for calibrating intakes for both supersonic and subsonic combustion ramjet engines. One of the major advantages of the gun tunnel is the ability to establish supersonic throat flow within the intake, without recourse to variable geometry. This, coupled with the fact that the flow duration is short (typically 30 to 100 milliseconds), has led to great simplification and economy in intake model construction. In the case of an intake for a supersonic combustion engine where the blockage of multitube rakes would be unacceptable, a high speed pitot traverse technique was successfully developed. For the more difficult case of the subsonic combustion intake, it is necessary to cover a range of back pressures up to the critical value. This has been achieved by fitting a specified volume to the intake, in which the rate of pressure rise is slow enough to permit a transient calibration procedure to be adopted. Tests were made in a conventional wind tunnel facility to check the validity of the results obtained.
Author

N71-22637 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
VISUALIZATION OF LOW VOLUMETRIC MASS [VISUALISATION A FAIBLE MASSE VOLUMIQUE]
Claude Veret In AGARD New Exptl. Tech. in Propulsion and Energetics RES. Oct. 1970 p 257 269 refs In FRENCH; ENGLISH summary
Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks, Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave., Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The schlieren and phase contrast methods used for the visualization of supersonic flow are revised Both methods are described and their sensitivies are compared Examples of wind-tunnel hypersonic flow visualizations are given. The conditions for the application of these methods to the visualization of flows that are themselves luminous (plasmas and flames) are indicated.
Author

N71-22639 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany).
MEASUREMENTS WITH AERODYNAMIC PROBES IN PLASMA JETS PRODUCED BY ELECTROTHERMAL AND

HALL CURRENT ACCELERATORS
S. Krause *In* AGARD New Exptl. Tech. in Propulsion and
Energetics Res. Oct. 1970 p 301 – 335 refs

Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks,
Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave.,
Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The measurement of macroscopic aerodynamic quantities
in plasma jets which contribute largely in obtaining a better
understanding of the phenomena in electric plasma accelerators is
studied. A survey is given of early and recent experiments performed
at the Institut fur Plasmadynamik, D.V.L., Stuttgart, with common
and new types of aerodynamic probes. Radial distributions of Pitot
pressure, stagnation enthalpy, mass and energy fluxes and other
quantities in plasma jets emerging from electrothermal and Hall
current accelerators are presented. A graphical iteration method is
described for the determination of any thermodynamic values and
the plasma velocity from the measured quantities. An interesting ex-
ample shows the calculation of an unknown quantity by simultane-
ous use of aerodynamic and nonaerodynamic experimental results:
the axial velocity in a Hall current accelerator is derived from
aerodynamic yaw probe determination of the swirl angle and
spectroscopic Doppler effect measurement of the azimuthal velocity
Author

N71-22640 Centre National de la Recherche Scientifique,
Meudon (France). Lab. d'Aerothermique.
EXPERIMENTAL STUDY OF THE LAMINAR BOUNDARY
LAYER WITH CATALYTIC REACTION OF THE WALL
|ETUDE EXPERIMENTALE D'UNE COUCHE LIMITE
LAMINAIRE FIGEE AVEC REACTION CATALYTIQUE A LA
PAROI|
G. Lassau and E. A. Brun *In* AGARD New Exptl. Tech. in
Propulsion and Energetics Res. Oct. 1970 p 337 355 refs
In FRENCH; ENGLISH summary
Copyright. Avail: Technivision, Braywick House, Maidenhead, Berks,
Engl. US Distributor: Circa Publications Inc., 415 Fifth Ave.,
Pelham, New York 10803 (Attn. Mr. A. L. Candido)

The transformation of air components, due to the marked
increase in temperature, during reentry is studied in the shock
wave. It is assumed that there is an equilibrium flow in the shock
layer, but the temperature in the vicinity of the wall is lower;
chemical equilibrium no longer exists as the reaction time is too
long in comparison with the residence time in the boundary layer;
and the gas along the wall is in a metastable state. Experimental
evidence of the catalytic effect of the flat wall parallel to the flow
on the concentration in the boundary layer is given. The theory
shows that from the concentration profiles in the layer, the wall
concentration can be obtained. Concentration curves are obtained by
three different methods: (1) By means of an enthalpy probe giving
the activated nitrogen concentration in the boundary layer; (2) By
injecting a carbide in the activated nitrogen and studying the
luminosity; and (3) By mass spectrometry of cyanhydric acid. The
three methods give similar results. Author

N71-22666 Iowa State Univ. of Science and Technology, Ames.
NATURAL FREQUENCIES OF VIBRATION OF A
TRIANGULAR INFLATABLE WING MODEL
Lo-Ching Hua (Ph.D. Thesis) 1969 136 p
Avail: Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No.
70-7705

The influence coefficients, natural frequencies and mode
shapes of vibration of a triangular inflatable wing are computed.
The influence coefficients of the wing are computed by two
different methods. The first is an iterative method based on the
linear theory of inflatable plates and engineering beam theory. The
wing is treated conceptually as a composite structure made from
an edgeless inflatable plate and two semi-circular stiff edges. The
second approach is by means of the stiffness matrix method. In

this method, the wing is simulated physically by a system of spars
and ribs that are orthogonal to each other. In each case, the
natural frequencies and mode shapes of vibration are computed
from these influence coefficients by means of a lumped-parameter
method. All of the analytical results obtained in this study correlate
very well with experimental works. Dissert. Abstr.

N71-22667 Iowa State Univ. of Science and Technology, Ames.
APPLICATION OF SELECTED FINITE DIFFERENCE
TECHNIQUES TO THE SOLUTION OF CONICAL FLOW
PROBLEMS
Paul Kutler (Ph.D. Thesis) 1969 213 p
Avail: Univ. Microfilms: HC $9.70/Microfilm $3.00 Order No.
70-7713

The inviscid flow fields about a pointed circular cone and
a flat-top or conical wing-body configuration both at angle of
attack are determined by applying first and second order differencing
schemes to the gas-dynamic equations (in conservation-law form)
and by utilizing the self-similar or conical nature of the flow field.
A survey and analysis which includes an experimental and
theoretical stability study of these finite difference schemes is
performed. The purpose of the cone study is to develop a numerical
method which will predict the flow field when the angle of attack
is increased far enough such that embedded shock waves are
formed on the lee side of the cone as a result of the large
cross-flow velocities. Dissert. Abstr.

N71-22672*# Northrop Corp., Hawthorne, Calif. Aircraft Div.
FLOW FIELDS OVER SHARP EDGED DELTA WINGS WITH
ATTACHED SHOCKS
S. A. Powers and E. R. Beeman, Jr. Washington NASA Apr.
1971 67 p refs
(Contract NAS1-7850)
(NASA-CR-1738) Avail: NTIS CSCL 20D

The problem of supersonic and hypersonic flow of an inviscid
ideal gas over conical wings with sharp leading edges and attached
shock waves has been treated using the three-dimensional method of
characteristics. Solutions for both the expansion and compression
side have been developed and provided as highly automated
computer programs. These programs provide for wing cross sections
of flat plate, modified wedge, or general conic shapes. Since the
flow fields on upper and lower surfaces are independent the total
wing shape can be a combination of any two of these three
shapes. These solutions require from one to three minutes on a CDC
6600 computer and provide an accurate description of the flow
field between the body and the external boundary (the shock wave
on the compression side and the free stream on the expansion
side). Results from these programs are compared with experimental
and theoretical data. Author

N71-22674 New York Univ., N.Y. School of Engineering and
Science.
NUMERICAL SOLUTION OF SEVERAL STEADY WAKE
FLOWS OF THE MIXED SUPERSONIC/SUBSONIC TYPE BY
A TIME-DEPENDENT METHOD
John Istvan Erdos (Ph.D. Thesis) 1969 79 p
Avail: Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No.
70-9772

The analysis of steady, mixed supersonic/subsonic flow
fields involved difficulties associated with the elliptic character of
the differential equations governing the subsonic regime, and the
resulting interactions between the subsonic and supersonic regions.
The complexities of a mixed elliptic-hyperbolic problem can be
effectively circumvented by transforming it into a purely hyperbolic
problem through introduction of an additional, albeit artificial, time
variable. The present investigation considers the near wake of a
flat-based slender body at supersonic speeds in the context of this

type problem. Inviscid solutions are obtained by a finite-difference method known as the two-step Lax-Wendroff technique. This study demonstrates that an inviscid model of the closed near wake exhibits remarkable agreement with the available experimental data at even moderately low Reynolds numbers.   Dissert. Abstr.

N71-22680*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COOLING AIRFLOW THROUGH A STATIONARY TURBINE DISK AND BLADE
Frederick C. Yeh, David J. Poferl, Reeves P. Cochran, and Hadley T. Richards Washington Apr. 1971 44 p refs
(NASA-TM-X-2171; E-6006) Avail: NTIS CSCL 20D

The cooling-air pressure changes through a stationary turbine disk and blade assembly and the airflow distribution within a blade were determined experimentally. Tests were conducted with room-temperature air over a range of inlet pressures from 28 to 100 psia and flow rates from 0.12 to 0.45 lb/sec. Based on demonstrated agreement between measured and calculated rotor disk and blade pressures, an analytical procedure is proposed for predicting the cooling-air pressure changes through the rotor disk and blade during engine operation.   Author

N71-22699*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH TEMPERATURE TURBINES
Jack B. Esgar and R. A. Reynolds (Dept. of Ind., Trade, and Com., Ottawa) Paris AGARD Feb 1971 7 p refs Presented at the 36th Meeting of the Propulsion and Energetics Panel, Florence, 21 – 25 Sep. 1970
(NASA-TM-X-67123; AGARD-AR-29-71) Avail: NTIS CSCL 21E

State of the art review of high temperature turbine technology was provided at this conference. The following topics were covered by papers presented: problems involved in cooling small turbines, application of turbine blade cooling to engines, selection of high temperature and cooled turbine materials, heat transfer measurement techniques, and an evaluation of the techniques of film, convection, and transpiration cooling.   E.M.C.

N71-22702 South Carolina Univ., Columbia.
COMBINED FREE AND FORCED LAMINAR NON-NEWTONIAN CONVECTION IN A VERTICAL TUBE
Wilbur Joseph Marner (Ph.D. Thesis) 1969 116 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 70-9306

Heat transfer to a power law fluid flowing in a constant wall temperature vertical tube was studied. Except for a linear variation of density with temperature, all properties were assumed to be constants. An initially fully developed velocity profile was assumed for the analysis. Nondimensionalization of the governing equations showed the parameters controlling the problem to be: flow behavior index n, Prandtl number Pr, and the Grashof over Reynolds number ratio Gr/Re. The dimensionless groups are defined in the generalized sense for power law fluids. The governing equations were solved numerically for a range of the parameters. Mean Nusselt numbers, dimensionless pressure drop, and typical developing dimensionless velocity and temperature profiles are presented. Results show that distortion of the velocity profile due to free convection effects can increase the heat transfer and pressure drop significantly.   Dissert. Abstr.

N71-22712 Pennsylvania Univ., Philadelphia.
THE DYNAMIC RESPONSE OF AXIALLY COUPLED TURBOROTORS
Donald George Lemke (Ph.D. Thesis) 1969 124 p
Avail: Univ Microfilms: HC $6.00/Microfilm $3.00 Order No. 70-7821

An analytical investigation of the effect of coupling characteristics on the response of axially coupled sets of turborotors is presented. A digital computer program based on transfer matrix techniques and utilizing a coupling fixity matrix was developed. Gyroscopic effects and both shaft as well as coupling orthotropy were included in the program. Linear bearings were assumed and the motion was restricted to synchronous precession. An illustrative example, utilizing two axially coupled modified Prohl rotors, demonstrates that the nature of the coupling has a significant effect on the response characteristics of the rotor set. The coupling must be considered when writing balancing specifications and during actual balancing of the rotor set. It is shown that the axial coupling of turborotors can result in the unloading of particular bearings which may initiate journal instabilities that are known to be associated with light loading conditions.   Dissert. Abstr.

N71-22891 Purdue Univ., Lafayette, Ind.
THEORETICAL STUDY OF LANDING MAT BEHAVIOR
John Christopher Rosner (Ph.D. Thesis) 1969 198 p
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 70-8962

Mechanistic models are developed to help predict the behavior of landing mat systems. The first model, which is based upon elastic theory, is capable of duplicating the action of such systems under static loads. The associated assumptions are: (1) that an infinite beam is the structural equivalent of the mat; (2) that the subgrade is homogeneous; (3) that horizontal displacements within the subgrade are negligible; and (4) that the mat always remains in contact with the subgrade. The model parameters are established from simulations of full-scale experimental tests. These parameters are also correlated with prototype test variables. Results from prototype tests indicate that the model parameter k, the subgrade modulus, decreases as trafficking of the section progresses. Contrary to common belief the model behavior is found to be extremely sensitive to the magnitude of the subgrade modulus.   Dissert. Abstr.

N71-23007* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
METEOROLOGICAL BALLOON Patent
James R. Scoggins, inventor (to NASA) Issued 12 Sep. 1967 (Filed 7 Jan. 1965) 7 p Cl. 73-189
(NASA-Case-XMF-04163; US-Patent-3,340,732; US-Patent-Appl-SN-424156) Avail: US Patent Office CSCL 01C

A meteorological balloon is described having high aerodynamic stability. The balloon contains uniform conical surface protuberances to provide roughness and stable boundary layer separation.   E.C.

N71-23030* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MODEL LAUNCHER FOR WIND TUNNELS Patent
Harold P. Holway, inventor (to NASA) Issued 19 Sep. 1967 (Filed 2 Apr. 1965) 5 p Cl. 73-147 Sponsored by NASA
(NASA-Case-XNP-03578; US-Patent-3,342,066; US-Patent-Appl-SN-445292) Avail: US Patent Office CSCL 14B

This invention is employed for studying the performance of a body in a high speed wind tunnel. A model launcher is positioned within the wind tunnel adjacent a viewing window. The model launcher includes a chamber and a piston movable within said chamber. The piston ends in a rod having an end whereupon the body or model can be supported for a launching. The piston is held from moving while gas under pressure is introduced into the chamber. When the piston is released, the gas moves the piston and the rod until the piston is snubbed, whereupon the model can continue its movement into the wind in the chamber, and its operation in flight is studied through the window.   Official Gazette of the U.S. Patent Office

N71-23085* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
HEAT FLUX MEASURING SYSTEM Patent
Richard D. Baxter, inventor (to NASA) Issued 6 Feb. 1968 (Filed 2 Jun. 1965) 4 p Cl. 73-190
(NASA-Case-XFR-03802; US-Patent-3,367,182;
US-Patent-Appl-SN-460877) Avail: US Patent Office CSCL 20M

A heat flux sensor is described which is adapated for mounting on research aircraft for determining the aerodynamic heat flux inflow to the skin of an aircraft or space vehicle. The thermally symmetrical rod-shaped sensor is mounted flush with the aerodynamic surface and is well insulated from the surrounding environment. The sensor includes a heating circuit that detects thermal differentials between the skin and exposed end of the sensor and raises the exposed-end temperature to the skin temperature; a heating circuit that detects temperature differentials between the insulated and exposed ends of the sensor; and a heater power input monitoring device.   J.M.

N71-23091*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER SUPPRESSION USING ACTIVE CONTROLS BASED ON THE CONCEPT OF AERODYNAMIC ENERGY
E. Nissim Washington Mar. 1971 115 p refs
(NASA-TN-D-6199; L-7525) Avail: NTIS CSCL 01A

The problem of flutter suppression is treated from an energy point of view, whereby the energy dissipated per cycle of oscillations is reduced to a quadratic form involving a diagonal matrix of energy eigenvalues which are of aerodynamic origin only. A simplified binary bending-torsion flutter of a wing strip is investigated by several systems: leading edge control surface, trailing edge control surface, and combined leading edge trailing edge control surfaces. In each case the control surfaces are allowed to be driven by a linear sensor, a rotational sensor, and a combined linear rotational sensor system. The results show that the flutter of the wing strip can be suppressed, a single control law being used, over a wide range of reduced frequencies, irrespective of the mass of the system, its stiffness, center of gravity location, elastic axis, the mode of vibration, and the Mach number (in the subsonic range). Parameters affecting the implementation of the control law, such as power requirements, phase lags, and amplitude gains, are investigated. The extension of the results to three dimensional flow cases is discussed, and the use of the flutter suppressor as a gust alleviator is also considered.   Author

N71-23115*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC AND STATIC WIND TUNNEL TESTS OF A FLOW DIRECTION VANE
Norman R. Richardson Washington Apr. 1971 22 p refs
(NASA-TN-D-6193; L-7431) Avail: NTIS CSCL 14B

Dynamic and static wind tunnel tests of a low-inertia flow-direction vane are described. The vane was designed to provide good dynamic response characteristics and was used for the in-flight measurement of gust velocities. Both subsonic and supersonic tests were conducted. The data indicated that the natural frequency of the vane is about one-half times the square root of the dynamic pressure (measured in N/sq m) or about three times the square root of the dynamic pressure (measured in psf). The data also indicated that the damping ratio is between 0.80 and 0.65 critical at sea level and varies approximately as the square root of the air density.   Author

N71-23116*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL WINDAGE STUDIES FOR HIGH SPEED ALTERNATORS
S. H. Gorland and E. E. Kempke [1971] 12 p refs Proposed for Presentation at 1971 Intersoc Energy Eng. Conf., Boston, 3 6

Aug. 1971; sponsored by SAE
(NASA-TM-X-67809) Avail: NTIS CSCL 10B

Windage tests were conducted on two concentric rotor-stator configurations, in ambient air, producing Reynolds numbers as high as 100,000. A cylindrical 12 in. diameter rotor and an 8 in. diameter Lundell-type rotor were operated at speeds up to 36,000 rpm. Gap-to-radius ratios of 0.01 to 0.04 were incorporated. Tests were also conducted with axial slots machined on the stator surface of the Lundell configuration to simulate electrical winding slots. The stators were mounted on a reaction-torque device so that viscous drag from the surface of the rotor would be measured. Tests were also conducted to determine the pumping characteristics of the conical sections of the Lundell rotor. The results are presented and discussed.   Author

N71-23122*# Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.
DATA REDUCTION TECHNIQUES FOR USE WITH A WIND TUNNEL MAGNETIC SUSPENSION AND BALANCE SYSTEM Interim Technical Report, Nov. 1968 - Jun. 1970
George D. Gilliam Jun. 1970 70 p refs
(Contract NAS1-8658)
(NASA-CR-111844; TR-167) Avail: NTIS CSCL 14B

The equations relating the forces and moments exerted on a body by the magnetic fields produced by the MIT NASA prototype magnetic balance are presented. A computer program which will derive the aerodynamic coefficients for a body using these relations is listed along with a sample output. A preliminary procedure for aligning the axis of the magnetic suspension system with a reference axis is detailed. A procedure for determining dynamic-stability derivatives is outlined.   Author

N71-23124*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF ENGINE POSITION AND HIGH-LIFT DEVICES ON AERODYNAMIC CHARACTERISTICS OF AN EXTERNAL-FLOW JET-FLAP STOL MODEL
Charles C. Smith, Jr. Washington Mar. 1971 141 p refs
(NASA-TN-D-6222; L-7581) Avail: NTIS CSCL 01C

An investigation was conducted to provide some basic information on the aerodynamic design parameters of an external flow, jet flap configuration. Static force tests were included to determine the effects of engine vertical and longitudinal position, jet exhaust deflectors, flap size and type, leading edge slat chord and deflection, and gap and overlap of the slats and flaps. The force tests were made in full-scale tunnel with a model having an unswept untapered wing and powered by four simulated high-bypass-ratio turbofan engines.   Author

N71-23125*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND-TUNNEL INVESTIGATION OF SONIC-BOOM CHARACTERISTICS OF TWO SIMPLE WING MODELS AT MACH NUMBERS FROM 2.3 TO 4.63
David S. Miller, Odell A. Morris, and Harry W. Carlson Washington Apr. 1971 31 p refs
(NASA-TN-D-6201; L-7178) Avail: NTIS CSCL 01A

A wind tunnel investigation was undertaken to provide experimental data for use in studying lift-induced sonic boom characteristics at high supersonic Mach numbers. Pressure signatures below two simple wing models were measured at two separation distances for a range of lift coefficients at Mach numbers of 2.3, 2.96, 3.83 and 4.63. Comparisons of theoretical and experimental pressure signatures showed that the good agreement obtained for the lowest Mach number of this investigation does not persist into the higher Mach number range, particularly for high lift coefficients. In all instances, the overall signature correlation became worse

with increasing Mach number and with increasing lift coefficient. Impulse comparisons indicated that even at extremely large distances experimental and theoretical overpressures could differ by as much as 20 percent.   Author

N71-23126*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FORTRAN PROGRAM FOR QUASI-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND CHOKING FLOW FOR TURBOMACHINE BLADE ROWS
Theodore Katsanis Washington Apr. 1971 37 p refs
(NASA-TN-D-6177; E-5869) Avail: NTIS CSCL 20D
A quasi-three dimensional compressible flow analysis for axial flow turbines, was generalized to allow for mixed or radial flow and for nonuniform inlet conditions. The velocity gradient method is used, with one velocity gradient equation used for radial equilibrium and another velocity gradient equation for blade-to-blade variation.   Author

N71-23127*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE AERODYNAMIC CHARACTER-ISTICS OF A HYPERSONIC TRANSPORT MODEL AT MACH NUMBERS TO 6
James C. Ellison Washington Apr. 1971 80 p refs
(NASA-TN-D-6191; L-7478) Avail: NTIS CSCL 01C
A wind tunnel investigation was conducted at subsonic, supersonic, and hypersonic speeds to determine the aerodynamic characteristics of a blended wing-body configuration. Data were obtained for the configuration with a single vertical tail, a flow-through inlet, and elevons deflected from 5 deg to −20 deg. At a Mach number of 6 and a Reynolds number of 21.6 × 1 million, the configuration had a maximum lift-drag ratio of 5.0 with no trim penalty. Based on the selected center of gravity position of 56.4 percent of the model length, the configuration was stable in all directions over the Mach number range. Results of analytical methods agreed with the data at zero elevon deflection for the range of angle of attack from 0 deg to 6 deg at all Mach numbers.
                                              Author

N71-23131+ National Aerospace Lab., Amsterdam (Netherlands).
APPLICATION OF A METHOD FOR ESTIMATING PRESSURE DISTRIBUTIONS TO AN OSCILLATING T-TAIL
R. J. Zwaan 1 May 1968 55 p refs
(NLR-TR-68048-L) Avail: NTIS
A method proposed to estimate pressure distributions from theory and from measured distributions for one vibration mode, was applied to a T tail configuration at low speeds. The results indicate that the method may be used successfully.   Author

N71-23132*# General Motors Corp., Indianapolis, Ind.
DESIGN AND EXPERIMENTAL RESULTS OF A HIGHLY LOADED, LOW SOLIDITY TANDEM ROTOR
James L. Bettner Washington NASA Apr. 1971 68 p refs
(Contract NAS3-11164)
(NASA-CR-1803; EDR-6627) Avail: NTIS CSCL 01A
The overall performance of a single stage turbine with a low solidity tandem rotor blade assembly was tested over a range of equivalent speeds and expansion ratios. The rotor blades were designed with negative hub reaction and a mean line axial chord solidity of 1.092. The results of this investigation are compared with the performance of a modified tandem rotor blade which was designed to similar velocity diagrams but with a mean section axial chord solidity of 1.852. Both rotors were tested with the same stator.   Author

N71-23133*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
CALCULATIVE TECHNIQUES FOR TRANSONIC FLOWS

ABOUT CERTAIN CLASSES OF AIRFOILS AND SLENDER BODIES
J. R. Spreiter and S. S. Stahara Washington NASA Apr. 1971 144 p refs
(Contract NAS2-5410)
(NASA-CR-1722) Avail: NTIS CSCL 01A
Procedures based on the method of local linearization and transonic equivalence rule were developed for predicting properties of transonic flows about thin airfoils and slender bodies. The procedures are applicable to transonic flows with free stream Mach numbers near one, below the lower critical, and above the upper critical. Comparisons with experimental surface pressure distributions exhibit good agreement for all shapes considered, although discrepancies appear near the aft region, particularly for the slender bodies. Analysis of the discrepancies suggests substantial wind tunnel wall interference effects are present in the experimental results for the three dimensional shapes. Effects of shock wave boundary layer interaction and vortex induced separation are not included in the theory.   Author

N71-23134*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOW-SPEED JET NOISE FROM A 1.83 METER (6FT) FAN FOR TURBOFAN ENGINES
Gene L. Minner and Charles E. Feiler Washington Apr. 1971 16 p refs
(NASA-TN-D-6314; E-6124) Avail: NTIS CSCL 20D
The jet noise from a large fan model was determined for two simulated nacelle configurations. These were a hard wall nacelle and one having acoustic liners on the walls and on inlet splitter rings. The jet velocity range of the data was from 137 to 223 meters per second (450 to 730 ft/sec). The data show that internally generated low frequency noise is effectively removed by the acoustic liners. Data from the lined configurations show the classical eighth power dependence on jet velocity. Data from the hard wall configurations were higher in (NASA-TM-X-67809) and had a weaker velocity dependence due to the noise from internal sources. Several comparisons of the data were made with correlations of jet noise data from the literature.   Author

N71-23135*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SUBSONIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A TWIN-BODY SPACE-SHUTTLE BOOSTER CONFIGURATION
Bernard Spencer, Jr. and George M. Ware Washington Apr. 1971 60 p
(NASA-TM-X-2162; L-7417) Avail: NTIS CSCL 01A
An investigation was conducted in the low turbulence pressure tunnel with a model representative of a first stage booster space shuttle concept proposed by industry. The configuration consisted of twin body elements connected by fore and aft wings with each body having an outboard horizontal and a vertical stabilizer. The tests were made at angles of attack from about 4 deg to 20 deg at 0 deg sideslip. Tests were made over a range of Reynolds numbers (based on body length) from 4.34 million to 26 million at Mach numbers below 0.35.   Author

N71-23157+ National Aerospace Lab., Amsterdam (Netherlands)
DESCRIPTION OF THE EQUIPMENT FOR THE FATIGUE TEST ON THE WING OF THE FOKKER F28 FELLOWSHIP
R. Noback Nov. 1969 75 p refs
(NLR-TR-70008-L) Avail: NTIS
The wing of the Fokker F 28 Fellowship was fatigue tested. Before the actual testing started the equipment was tested on a dummy test rig. Different types of networks for stabilizing the systems were evaluated. Considerations which led to the choice of the loading systems are given together with a full description of the test equipment, including the protective system. The accuracy

of the wing test is discussed. An analysis is given of two loading systems, especially of the influence of the coupling between these systems.   Author

N71-23186*# Massachusetts Inst. of Tech., Cambridge. Measurement Systems Lab.
AN AIRSPACE UTILIZATION MODEL FOR V/STOL TERMINAL OPERATIONS
Dorian Albert De Maio (M.S. Thesis) Jan. 1971 95 p refs
(Contract NAS12-2081; Grant NGR-22-009-010; Contract DOT-TSC-5)
(NASA-CR-117887; TE-45) Avail: NTIS CSCL 01E
The computer processes inputs describing the terminal area and accompanying constraints and displays on a cathode ray tube the airspace utilization model, a three dimensional image representation of the constraints at a given altitude. Extensive machine/operator interaction is provided to select various constraint criteria, to plan approaches and departures and to check the results through viewing and teletype output. The program is general and may be applied to a number of terminal areas. The programs' applicability and usefulness is demonstrated in the analyses of several proposed V/STOL port sites in the Northeast Corridor. Approach and departure paths are developed for each site and observations are made regarding flight path characteristics. The computer display leads to drastic reductions in time and effort over a comparable manual task in terminal area studies.   Author

N71-23193# Lockheed Missiles and Space Co., Palo Alto, Calif.
ASYMPTOTIC SOLUTION OF THE PROBLEM OF OSCILLATIONS OF A SOLID PROFILE IN TRANSONIC GAS FLOW
G. F. Sigalov 1971 5 p refs Transl. into ENGLISH from Dopovidi Akad Nauk Ukr. RSR (Kiev), no. 1, 1971 p 80-84
Avail: NTIS. National Translations Center, John Crerar Library, Chicago, Ill. 60616
An asymptotic method of investigating nonlinear problems is developed on whose basis the problem of the oscillation of a solid profile in a transonic shockless adiabatic inviscid gas flow is investigated at Mach numbers somewhat less than the critical. Complete approximation is based on reflection of the physical space into a new auxiliary space, the space of the approximations, and is realized by means of a special deformation of the coordinates which converts the nonlinear differential equation in the physical space into a linear equation in the space of the approximations. The boundary value problem for a nonlinear differential equation which described the low-frequency oscillations of a solid profile in a transonic gas flow is given.   Author

N71-23210# Advisory Group for Aerospace Research and Development, Paris (France).
FREQUENCY RESPONSE FUNCTIONS AND HUMAN PILOT MODELLING
Mar. 1971 65 p refs Mostly in ENGLISH; partly in FRENCH
(AGARD-R-580-71) Avail: NTIS

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1. THE ART OF DETERMINING GUST FREQUENCY RESPONSE FUNCTIONS J. C. Houbolt (Aeron. Res. Associates of Princeton, Inc.) p 1-20 refs
2. THE EFFECT OF ACTIVE CONTROLS ON STRUCTURAL RESPONSES C. F. Newberry, J. I. Arnold, and G. J. Kass (Boeing Co., Wichita, Kans.) p 21-44 refs
3. TRANSFER FUNCTION OF FLEXIBLE AIRCRAFT TO AMOSPHERIC TURBULENCE G. Coupry (ONERA, Paris, France) p 45-58 refs
4. HUMAN PILOT MODELLING H. F. Huddleston (RAE, Farnborough, Engl.) p 59-65 refs

N71-23211# Aeronautical Research Associates of Princeton, Inc., N.J.
THE ART OF DETERMINING GUST FREQUENCY RESPONSE FUNCTION
John C. Houbolt In AGARD Freq. Response Functions and Human Pilot Modelling Mar. 1971 p 1-20 refs

Avail: NTIS
The art of determining the frequency response function for gust response, and of deriving the associated structural response parameters A and N sub o is discussed. Measured and computed values are compared to show the degree of success obtained. It is brought out that frequency response determination is a computationally large task and that simplified procedures are needed. Emphasis is also given to the fact that there is not a frequency response function for the airplane, but that there are many, depending on flight conditions. A procedure is suggested for helping to establish the appropriate frequency response functions, and the A and N sub o values, for use in design.   Author

N71-23212# Boeing Co., Wichita, Kans.
THE EFFECT OF ACTIVE CONTROLS ON STRUCTURAL RESPONSES
Clifford F. Newberry, James I. Arnold, and Gerald J. Kass In AGARD Freq. Response Functions and Human Pilot Modelling Mar. 1971 p 21-44 refs
Avail: NTIS
The use of an active control system on large flexible aircraft to improve flying qualities, ride qualities, and to alleviate loads require a good mathematical model. The number of modes to be included is treated from a standpoint of stability and for structural loads evaluation. The verification of the model during flight testing is discussed. Frequency response, transient response, and random response techniques are presented. Presented are two examples; one dealing with a lower structural mode frequency that affects the handling qualities and ride qualities of the aircraft and the other deals with a higher frequency mode that is a stability problem. Consideration for artificial damping of the flutter mode is also presented.   Author

N71-23213# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
TRANSFER FUNCTIONS OF FLEXIBLE AIRCRAFT TO ATMOSPHERIC TURUBLENCE [FONCTIONS DE TRANSFERT D'UN AVION SOUPLE A LA TURBULENCE]
G. Coupry In AGARD Freq. Response Functions and Human Pilot Modelling Mar. 1971 p 45-48 refs In FRENCH

Avail: NTIS
Computation and measurement of the transfer function of an aircraft flexible to atmospheric turbulence are reported. After a survey of the usable turbulence models, the computation of the transfer function for isotropic turbulence is discussed; it is shown that it is hardly more complicated than in the case of uniform turbulence. Finally, the methods for measuring the transfer function are described   Author

N71-23228# National Research Council of Canada, Ottawa (Ontario).
INITIAL STUDIES OF LOW TEMPERATURE ABLATION IN A HELIUM HYPERSONIC WIND TUNNEL
L. Elias, K. Orlik-Ruckemann, and D. L. Kohlman Albuquerque, N.Mex. Sandia Corp. Jan. 1971 61 p refs Prepared for Sandia Corp.
(SC-CR-69-3215) Avail: NTIS
Exploratory experiments were carried out at Mach 16.4 and at 600 psi stagnation pressure using (a) metal models at room temperature, (b) models with copper inserts, cooled to 140 C, and (c) models with carbon dioxide inserts. Surface temperature,

surface recession rates and pitot pressure profiles were determined. Suitable model fabrication and experimental techniques were developed. A simple theoretical method of predicting recession rates and surface temperatures was proposed. It was demonstrated that the ablation of carbon dioxide into an unheated Mach 16.4 helium flow at 600 psi stagnation pressure is significant enough to result in measurable flat plate recession rates and measurable changes in pitot pressure profiles. In addition it was shown that it is possible to distinguish between the effects on pitot pressure of reduction in surface temperature and of mass addition through sublimation of carbon dioxide. It was also found that the first order theoretical analysis predicts proper trends and correct approximate magnitude of sublimation rates.   Author

N71-23232#   Boeing Co., Renton, Wash.
FLAMMABILITY AND DESIGN CONSIDERATIONS FOR COMMERCIAL AIRPLANE INTERIOR MATERIALS
W. S. Perkowski and R. G. Cheatham [1971] 16 p refs
Avail: NTIS
   Plastic materials and textiles used for the interiors of commercial aircraft are discussed from the standpoint of flammability, cost, and weight. Design considerations which are used in the choice of materials are: (1) the materials must meet the FAA certification requirements, (2) the materials must provide a maximum of weight for functional use, (3) the materials must provide the lowest and most realistic cost, and (4) the materials must provide a pleasing and acceptable decor.   Author

N71-23233#   Department of Transportation, Washington, D.C. Air Traffic Service.
INDEX OF STANDARD INSTRUMENT APPROACH PROCEDURES
4 Feb. 1971 151 p
Avail: NTIS
   An index of standard instrument approach procedures is presented. The procedures are current up to and including 4 February, 1971. Information is presented for airports in the continental United States, Alaska, and the Caribbean area.   Author

N71-23234#   Air Line Pilots Association, International, Washington, D. C.
FACT SHEET ON THE AIR LINE PILOTS ASSOCIATION ANNUAL AIR SAFETY FORUM
21 Jul. 1970 49 p refs Presented at 17th ALPA Air Safety Forum, San Francisco, 20 -22 Jul. 1970
Avail: NTIS
   The Air Line Pilots Association Air Safety Forum is a meeting of all segments of the aviation community. It is devoted solely to air safety and has been sponsored by the Air Line Pilots Association in the public interest in every year since 1953. The reasons for the Forum are threefold: (1) to stimulate an interest in air safety; (2) to promote an exchange of safety information between pilots, and representatives of the aviation industry and government, and (3) to develop recommendations to improve the safety of air travel. Participants in the ALPA Forums are pilot and flight attendant safety experts from all air lines, plus safety representatives from the air line companies, aircraft manufacturers, government agencies concerned with aviation, airport operators, the military services and many other segments of the national and international aviation community. Subjects covered are those timely ones concerned with increasing the efficiency and safety of air line flying. They vary from year to year, but the stress is upon those associated with air safety problems considered to be currently the most critical. They are covered by various means, including panel presentation, technical papers, open discussion, guest speakers and field trips.   Author

N71-23245#   Massachusetts Inst. of Tech., Cambridge. Acoustics and Vibration Lab.
AN INVESTIGATION OF THE NEAR WAKE PROPERTIES ASSOCIATED WITH PERIODIC VORTEX SHEDDING FROM AIRFOILS
Carl E. Hanson Sep. 1970 82 p refs
(Contract Nonr-3963(26))
(AD-718893; A/V-76234-5) Avail: NTIS CSCL 20/1
   An investigation of the near wake of airfoils with various trailing edge configurations including splitter plates reveals properties which are conducive to wake periodicity. The frequency of the shedding process is found to scale with the near wake momentum thickness and a wake velocity simply related to the base pressure coefficient. Computer results suggest that the frequency and bandwidth of the vortex shedding process can be predicted by a solution of the complete Orr-Sommerfeld equation.   Author (GRA)

N71-23250*#   Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
HIGH TOTAL TEMPERATURE SENSING PROBE FOR THE X-15 HYPERSONIC AIRCRAFT
Ronald G. Bailey Sep. 1968 85 p refs
(Contract NAS4-1211)
(NASA-CR-116772; Rept-12080-FRI) Avail: NTIS CSCL 01D
   The results are presented of research aimed at applying the fluid oscillator concept to the development of a probe for measuring free stream total temperatures on hypersonic aircraft of the X-15 class. The probe generates an oscillating pressure signal in the form of a sonic pressure wave which is propagated and reflected within the device to cause an oscillation of the incoming fluid. The sensor oscillation frequency is dependent on the acoustical velocity of the wave within the fluid, and thus a function of the fluid temperature in the probe cavity. The probe utilizes a cooled sensor concept in which the probe body temperature is maintained below the material melting point with nitrogen gas coolant. The free-stream total temperature is arrived at through measurements of the oscillation frequency, body temperature and local pitot pressure. The frequency is measured with two conventional pressure transducers arranged to operate in push-pull, with either transducer capable of independent operation should the other fail. The time response of the instrument is dependent upon the purging time of the fluid within the sensor cavities which is about 10 milliseconds.
                     Author

N71-23268*   National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMBINED OPTICAL ATTITUDE AND ALTITUDE INDICATING INSTRUMENT Patent
Arthur W. Vogeley and Alfred J. Meintel, Jr., inventors (to NASA) Issued 31 Dec. 1968 (Filed 2 Jan. 1964) 7 p Cl. 356-72
(NASA-Case-XLA-01907; US-Patent-3,419,329; US-Patent-Appl-SN-335441) Avail: US Patent Office CSCL 14B
   Optical instrumentation to facilitate take off and landing of aircraft or space vehicles on planetary surfaces is described. The system serves as a primary or backup onboard instrumentation system to present vehicle altitude and attitude information on a screen located on the vehicle instrument panel and viewable by the pilot or other occupants of the vehicle.
                     Official Gazette of the U.S. Patent Office

N71-23278*#   Scientific Translation Service, Santa Barbara, Calif.
ACCELERATED SUPERSONIC MOTION OF A PLANE AT A FINITE ANGLE OF ATTACK [USKORENNOYE SVERKHZVUKOVYE DVIZHENIYE PLASTINY PRI KONECHNOM UGLE ATAKI]
O. G. Goman Washington NASA Apr. 1971 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza (Moscow), no. 4, Jul. - Aug. 1970 p 70 - 75

(Contract NASw-2035)

(NASA-TT-F-13525) Avail: NTIS CSCL 01A

Supersonic nonsteady motion of a plane in an ideal gas is considered. The plane with the attached shock wave moves at a finite (not infinitely small) angle of attack. The laws governing the change of velocity and the angle of inclination of the plane are assumed to be arbitrary, and the Struhal numbers are small. With the latter assumption, and with Mach numbers in the perturbed area not too close to unity, the motion can be characterized sufficiently well by instantaneous values of the nonsteady parameters and their derivatives. This fact provides the possibility of simplifying considerably the system of equations describing the perturbed nonsteady movement, and to obtain its analytical solution.   Author

N71-23283# ITT Research Inst., Chicago, Ill.
PRELIMINARY STUDY OF AN AUGMENTED RAM-WING VEHICLE CONCEPT Final Report, 1 Aug. 1967 - 18 May 1968
Imants Reba Jan. 1971 126 p refs
(Contract DOT-7-33512)
(PB-189425; IITRI-J6128-FR) Avail: NTIS CSCL 13F

A wind-tunnel study of a ram-wing-type vehicle with various blowing arrangements is reported. Two models were studied. One model represented a thick vehicle configuration with a blunted rear end. The second had a streamlined chord section. Blowing arrangements consisted of two two-dimensional Coanda nozzles, one placed near the leading edge and one near the midchord. Upward, downward, and mixed blowing arrangements were investigated. The results indicate that the downward blowing near the leading edge and upward blowing at midspan constitute the most promising of those arrangements investigated.   Author (GRA)

N71-23296*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN INVESTIGATION OF SONIC BOOM FOR STRAIGHT-AND DELTA-WING SPACE SHUTTLE ORBITERS
Raymond M. Hicks, Joel P. Mendoza, and Lionel L. Levy, Jr. Apr. 1971 26 p refs
(NASA-TM-X-62030) Avail: NTIS CSCL 20A

Wind tunnel tests were conducted to determine the sonic boom characteristics of straight wing and delta wing space shuttle orbiters during reentry into the earth's atmosphere. Two different trajectories were analyzed for the delta wing orbiter while one trajectory was considered for the straight wing orbiter. Both trajectory and angle of attack were found to have strong effects on the level of sonic boom overpressure under the flight path of the vehicle.
Author

N71-23297# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CENTRIFUGAL COMPRESSOR MACHINES
F. M. Chistyakov et al Dec. 1970 443 p refs Transl. into ENGLISH of the Book "Tsentrobezhn. Kompressornye Machiny" Moscow, Izd-vo Mashinostr., 1969 p 1 - 327
(AD-717878; FTD-MT-24-183-70) Avail: NTIS HC $6.00/MF $0.95 CSCL 13/7

The book discusses fundamentals of theory, calculation and design of centrifugal compressor machines. There are examined processes of flow and losses in elements of the stage and the effect of separate structural factors of the flow area on efficiency. There is substantiated the rational selection of elements of the flow area: rotor wheel, diffuser, return stator, and volute. There are provided calculations of compressor machines with cooling, calculations of disks for strength and of shaft for critical number of revolutions. There are examined systems of automatic control of compressor machines, and also questions of their testing.   Author (GRA)

N71-23306# Collins Radio Co., Cedar Rapids, Iowa.
INTEGRATED HIGH FREQUENCY ANTENNA SYSTEM   Final

Report, 13 Nov. 1969 - 9 Nov. 1970
David M. Jaksa and Jeffrey S. Yalowitz   Nov. 1970   259 p refs
(Contract N62269-70-C-0016)
(AD-718167; Rept-523-0763421-00111M) Avail: NTIS CSCL 9/5

The objective of the integrated high-frequency antenna system (IHFAS) program is to provide a simultaneous operation (SIMOP) capability for the P-3 hf communication system. This capability will be provided for the P-3C, which will incorporate the higher hf transmitter powers and Link 11 data capability of A-NEW. A technique was developed to optimize transmit filters. This technique enables analysis of system parameters to determine detailed requirements for an optimum high-level transmit filter. A series of tests were performed on the AN/ARC-132(V) hf transceiver to aid in evaluating it as a SIMOP radio. General performance tests were conducted in accordance with applicable portions of MIL-STD-449C. In addition, external intermodulation, spurious voltage, and spurious impedance measurements were made.   Author (GRA)

N71-23314# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
AN EXPERIMENTAL INVESTIGATION OF A TURBULENT JET IN A CROSS FLOW
David K. Mosher (Ph.D. Thesis) Dec. 1970 182 p refs
(Contract DAHC04-68-C-004; Proj. Themis)
(AD-718798; GIT-AER-70-715) Avail: NTIS CSCL 20/4

The interference phenomenon occurring when a subsonic turbulent jet exhausts normally from a large flat plate into a low speed crossflow was experimentally investigated in the Georgia Tech nine foot wind tunnel. Static pressures were measured on the surface around the jet. In the region off the surface, including the jet plume, wake and surrounding areas, the average total and static pressures and the average velocity magnitudes and directions were determined. Three jet exit configurations were studied, one circular and two slot-shaped with width to length ratios of 0.3 and 3.4. All have the same exit area. The effective jet to cross-flow velocity ratio was varied, for each of the exit configurations, over the range 4.0 to 12.0. Analysis of the data indicates that the pressure distributions induced on the surface are a combined result of the jets blocking and entraining effects on the cross flow with entrainment becoming the more dominant of the two as the effective velocity ratio is increased. This relative dominance brings about an attenuation of total interference lift loss (when computed as a fraction of gross thrust) primarily by causing a rise in the low pressures in the wake region as the effective velocity ratio increases. When the effective velocity ratio is held fixed, the total interference lift loss increases with increasing width to length ratio of the jet exit.
Author (GRA)

N71-23333# Catholic Univ. of America, Washington, D.C.
A POSITION PAPER ON VEHICLE SAFETY
Nicholas Perrone Sep. 1970 53 p refs
(AD-718397) Avail: NTIS CSCL 13/12

The problem of the air bag and its development standards and their significance is addressed. The auto safety standards are critically reviewed in detail especially those portions concerned with crashworthiness. Suggestions for specific new additions as well as modifications of existing standards are made. Special attention is focused on the instrument panel area, hard internal spots such as door posts, windshield headers, and main frame structural elements, and the front seat (which should be appreciably strengthened). The worth from a cost/benefit viewpoint of increasing vehicle safety is examined in some detail. The problem of general aviation crashworthiness is also examined in the same context and it is suggested there that immediate retrofitting of existing airplanes should take place in a manner comparable to automobiles (in other terms, similar standards should be invoked). The general question of resource allocation is also examined and it is suggested that greater and organized national attention be devoted to this critical problem.   Author (GRA)

N71-23356# Royal Aircraft Establishment, Farnborough (England).
RADIO ENVIRONMENT MONITORING FOR THE CATEGORY 3 INSTRUMENT LANDING SYSTEM
T. R. G. Lampard May 1970 74 p refs
(RAE-TR-70076) Copyright. Avail: NTIS

The need for integrity monitoring of the category 3 instrument landing system when used for automatic landing is discussed. A radio environment monitoring system is proposed, based on early experimental work carried out at Farnborough and London Airport. The practical results obtained support the theoretical work in such a way as to indicate that the method of monitoring is a viable proposition. Author (ESRO)

N71-23361# Royal Aircraft Establishment, Farnborough (England).
DETERMINATION OF CPILS LOCALISER BEAM NOISE
J. Benjamin Jul. 1970 41 p refs
(RAE-TR-70141) Copyright. Avail: NTIS

A method of estimating the magnitude of residual beam noise resulting from reflected interference is given for the CPILS localizer configuration. Author (ESRO)

N71-23387# Naval Ordnance Lab., White Oak, Md.
A NEW APPROACH TO THE DETERMINATION OF THE STEADY STATE INFLATED SHAPE AND INCLUDED VOLUME OF SEVERAL PARACHUTE TYPES IN 24 GORE AND 30 GORE CONFIGURATIONS
William P. Ludtke 3 Oct. 1970 56 p refs
(AD-718808; NOLTR-70-178) Avail: NTIS CSCL 1/3

N70-27898 documented a new method of determining the steady-state inflated shape and included volume of several types of parachutes in 12-gore and 16-gore configurations. This report uses the methods and technique of **N70-27898** to extend the data to 24-gore and 30-gore configurations of the flat circular, 10 percent extended skirt, 16 percent porous ring slot and 24 percent porous ribbon parachutes. The inflated elliptical shapes of the various canopies were obtained from photographic records of the wind-tunnel tests at various velocities from 17 mph to 200 mph using parachute models of approximately 40-inch flat diameter. The steady-state canopy volume includes the volume of the billowed gore panel and an air volume ahead of the canopy skirt hem. The results of this investigation are particularly applicable to studies of canopy stress analysis and determination of the volume of air which must be collected during canopy inflation process for use in the calculation of opening-shock force. Author (GRA)

N71-23410# Advisory Group for Aerospace Research and Development, Paris (France).
LESSONS WITH EMPHASIS ON FLIGHT MECHANICS FROM OPERATING EXPERIENCE, INCIDENTS AND ACCIDENTS
Mar. 1971 301 p refs Presented at the 37th Meeting of the Flight Mech. Panel of AGARD, Baden-Baden, 20 – 23 Oct. 1970
(AGARD-CP-76-71) Avail: NTIS HC $6.00/MF $0.95

Detailed accident and incident investigations, flight control systems developments and operational performance recordings are used to optimize aircraft flight mechanical parameters. Considerable emphasis is placed on human factors engineering for aircraft safety requirements.

N71-23411# Air Registration Board, London (England).
A BRIEF REVIEW OF SOME SAFETY STUDIES BASED ON OPERATIONAL FLIGHT RECORDING
J. C. Chaplin In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 26 p refs
Avail: NTIS HC $6.00/MF $0.95

In order that advances in aviation safety may continue to be made without unnecessarily adding to cost, it is essential to be able to study the effectiveness of current regulations to determine whether or not they are acting in the manner expected. Methods which have been developed to abstract and examine data of safety interest are outlined. The fields of operations and airworthiness are both considered and the relative places of statistical data on the one hand and the more detailed study of isolated events are discussed. Examples are given of some of the results which have been obtained. The importance of the close links which have been developed with the operator is emphasized. Author

N71-23412# National Aerospace Lab., Amsterdam (Netherlands).
OPERATIONAL FLIGHT RECORDING AND ITS IMPACT ON FLIGHT SAFETY AND AIRCRAFT DESIGN
T. Van Oosterom In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 19 p refs
Avail: NTIS HC $6.00/MF $0.95

Flight operational experience and results from incident and accident analyses are important sources of basic information for improving flight safety and aircraft design. These sources can be effectively explored by in-flight recording of data, which define the flight condition, the navigational environment and the technical functioning of the aircraft. Present aircraft integrated data systems (AIDS) provide an extensive data acquisition capability and allow for automatic data processing. The main technical features of these systems and the relevant data processing equipment are reviewed from a users' point of view. A survey is given of present and possible future applications of AIDS with emphasis on flight safety and aircraft design data recording. Some specific examples are discussed which illustrate the usefulness of flight recording. Author

N71-23413# General Dynamics/Fort Worth, Tex.
PROVING THE OPERATIONAL CAPABILITY OF A HIGH PERFORMANCE FLIGHT CONTROL SYSTEM
E. C. Livingston, Jr. In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 12 p
Avail: NTIS HC $6.00/MF $0.95

Two generalized approaches to the development and proof of a high performance flight control system are examined. The first approach is conventional in that no more than minimal simulation is utilized to confirm the system analysis and design. In the second approach, extensive use is made of complete closed-loop simulation, including an accurate dynamic model of the airframe, to confirm analysis and design. Examples encountered in the utilization of these two approaches are provided in order to illustrate the benefits of one approach over the other. Experience gained from the utilization of both of these approaches has shown the latter to be the best. The extensive use of flight simulators and an airframe test stand assures that the system will meet requirements after minimal retrofit and flight test. Author

N71-23414# Smiths Industries, Ltd., London (England).
THE OPERATIONAL PROVING OF AUTOMATIC FLIGHT CONTROL SYSTEMS IN THE APPROACH AND LANDING PHASE
R. H. Ashforth In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incident and Accidents Mar. 1971 10 p
Avail: NTIS HC $6.00/MF $0.95

The Hawker Siddeley Trident aircraft equipped with a flight control system that covers both automatic approaches and automatic landings is studied. The flight control system comprises the SEP 5 autopilot which is triplex in the pitch and roll axis and duplex in yaw. The lessons learnt during the flight trials and also

as a result of the service experience are discussed. Changes made to the original design as a result of this experience, applicable to the approach and landing phase, are described in relation to the different levels of clearance. The second part of the paper covers the in-service recording and statistical proving of the automatic landing system.   Author

N71-23415# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
OPERATIONAL PROVING OF AUTOMATIC FLIGHT CONTROL SYSTEMS FOR V/STOL FIGHTER AIRCRAFT
G. Kissel and H. Schmidtlein (Vereinigte Flugtech. Werke G.m.b.H., Bremen, West Germany) In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience Incidents and Accidents Mar. 1971 26 p refs
Avail: NTIS HC $6.00/MF $0.95
    Four different types of automatic flight control systems for V/STOL fighter aircraft were flight tested within the past years. The VJ 101 C aircraft makes use of pure jet-thrust-modulation control in the thrust sustained flight regime for rolling and pitching and thrust vector control for yawing. The VAK 191 flying bedstead uses puff-pipe (bleed air) control with additional thrust augmentation for pitching. The main characteristics of the systems are: (1) stability augmentation system with high authority superimposed on the mechanical flight control system versus fly by wire system; (2) integrating control system versus proportional system; (3) pure VTOL versus V/STOL capability; (4) pure thrust modulation control versus puff-pipe control; and (5) puff-pipe control by means of fly by wire with mechanical back up. With all four systems acceptable handling qualities could be reached but it is shown that, especially in case of thrust modulation where the aircraft has nonlinear characteristics, for large control inputs a nonlinear control system gives higher stability.   Author

N71-23416# Deputy Chief of Naval Operations (Development), Washington, D.C.
DESIGN LESSONS LEARNED FROM THE OV-10A BRONCO
Hugo G. Sheridan In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 13 p
Avail: NTIS HC $6.00/MF $0.95
    The OV-10A Bronco is one of the aircraft designed specifically for low level counterinsurgency warfare. The original design requirements for the aircraft as well as the engineering changes found necessary during the flight test stage are reviewed. Use of the Bronco in combat operations in Southeast Asia is summarized including loss and damage rate. As a result of these combat operations, conclusions are drawn as to the validity of the original requirements for the OV-10A. Design requirements desirable for the next counterinsurgency aircraft in light of the experience in Southeast Asia are recommended.   Author

N71-23417# Hawker Siddeley Aviation, Ltd., Woodford (England).
LESSONS FROM OPERATION AND TRIALS OF TWIN TURBO PROP AIRCRAFT ON ROUGH AIRFIELDS
M. J. Taylor In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience Incidents and Accidents Mar. 1971 13 p refs
Avail: NTIS HC $6.00/MF $0.95
    Trials and operations of a civil twin turboprop airliner and of its military counterpart have taken place over a period of nearly ten years. During this time both measured data and operating experience have been accumulated from movements on unprepared airfields. In particular the investigation into two landing accidents involving the civil type has led to performance measurements on grass and hard surfaces. Information is given on the following: (1) undercarriage load measurements, (2) airframe contamination and superficial damage, and (3) aeroplane performance.   Author

N71-23418*# National Aeronautics and Space Administration, Washington, D.C.
AVOIDANCE OF AIRCRAFT TRAILING VORTEX HAZARDS
William A. McGowan In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 23 p refs
(NASA-TM-X-67125) Avail: NTIS CSCL 01C
    Trailing vortices have been the cause of aircraft accidents. Results of accident investigations, theoretical exercises, wind tunnel experiments, and flight tests are used to describe the formation and severity of trailing vortices and the spatial extent of their influence, including factors governing persistence. This information is then used to outline procedures for ready application by pilots, tower operators, and those concerned with the flow of traffic during tactical operations. The procedures provide the necessary appreciation of the physical attributes of trailing vortices, the potential hazards involved when encountering them, and how best to avoid the dangerous portions of the wake during flight operations. Schemes under investigation to monitor remotely both the trailing vortex location and intensity in the airport area and to prohibit formation of high intensity vortices, through aircraft design, are discussed.   Author

N71-23419# Mississippi State Univ., State College. Dept. of Aerophysics and Aerospace Engineering.
THE HANDLING QUALITIES REQUIRED FOR SAFE OPERATION OF SINGLE ENGINE BOUNDARY LAYER CONTROLLED AIRCRAFT IN THE STOL MODE
S. C. Roberts In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 16 p refs
Avail: NTIS HC $6.00/MF $0.95
    Operations of single engine, boundary layer control, STOL aircrafts since 1958 are reported. The vehicles have been the high lift, super cub L-21, the modified Cessna L-19, the XAZ-1, and the XV-11A with wing loadings ranging from 13 lb/sq ft to 28 lb/sq ft. All of these aircraft had a distributed suction boundary layer control system for lift augmentation and XAZ-1 and the XV-11A also had shrouded propellers for static thrust augmentation. The performance, stability and control, and handling qualities of these aircraft have been evaluated and considerable experience gained in the operational aspects of such STOL aircraft with regard to the handling qualities required for safe operation in the STOL mode.   Author

N71-23420# Breguet-Aviation, Velizy (France).
ESTABLISHING SAFETY MARGINS FOR THE TAKE OFF AND APPROACH OF THE BREGUET 941 [ESTABLISSEMENT DES MARGES DE SECURITE AU DECOLLAGE ET A L'ATTERRISSAGE POUR LE BREGUET 941]
J. Bastidon In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 9 p
Avail: NTIS HC $6.00/MF $0.95
    The safety margins to be considered are of the two following types: (1) speed margins (takeoff and approach speed); and (2) field length margins. These two margins are examined and discussed considering the BR 941. Determination of these margins is based on theoretical considerations, flight measurements and operational test results. Allowance is also made for discussions determining special conditions for civil airworthiness of this airplane.   Author

N71-23421# Naval Air Systems Command, Washington, D.C.
LOW ALTITUDE HIGH SPEED FLIGHT EXPERIENCE
Ralph C. A'Harrah In AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 13 p refs
Avail: NTIS HC $6.00/MF $0.95

An extensive flight test evaluation of the operational capabilities of contemporary military aircraft in performing low altitude missions is reported. The particular test phase being reviewed, namely the visual target acquisition test, involved 8 aircraft and 200 pilots making more than 400 low altitude sorties. Assigned penetration speeds ranged from 175 to 550 Knots. Two altitude corridors were assigned: minimum safe altitude to 400 feet and 500 to 900 feet above the terrain. Author

N71-23422# Ecole Nationale Superieure de l'Aeronautique, Toulouse (France).
INFLUENCE OF SIMPLE AERODYNAMIC MODIFICATIONS ON THE PERFORMANCE OF AN AIRCRAFT [INFLUENCE DE MODIFICATIONS AERODYNAMIQUES SIMPLES SUR LE COMPORTEMENT D'UN AVION]
J. E. Forestier *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience Incidents and Accidents Mar. 1971
12 p
Avail: NTIS HC $6.00/MF $0.95
Described are modifications made on prototype Vautour aircrafts during their development phase. Principle difficulties encountered were lateral control and beyond Mach 0.93 longitudinal control characteristics. Adjustments of the turbulence generator positions on the outer airfoils just before the wing tip, and modifications in the chamber of the wing leading edge provided the desired performance improvements. Transl. by G.G.

N71-23423# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands).
MAN/MACHINE COMBINATION IN THE LIGHT OF SAFETY REQUIREMENTS
F. W. L. Herckenrath, J. J. P. Moelker, and C. M. Ramsey *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 10 p refs

Avail: NTIS HC $6.00/MF $0.95
A description is given of a few limiting factors in man and their bearing upon aircraft design. Examples are given of limitations in attention, perception, learning, memory and intelligence, and decision making. Present design deficiencies are considered in the light of crew training and procedures. It is stressed that from the earliest conception of a design close cooperation between designers, safety organisations and prospective operators is of vital importance to assure safety in aerospace operations. Author

N71-23424# National Aeronautical Establishment, Ottawa (Ontario).
REVIEW OF SEVERAL FACTORS RELEVANT TO JET UPSETS
B. Caiger *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 11 p refs
Avail: NTIS HC $6.00/MF $0.95
Various contributory factors to jet upsets are reviewed covering instrument or control system failures and severe turbulence encounters. Related problems of pilot disorientation are discussed. The need for detailed analyses of upsets is emphasized. It is concluded that well designed autopilot systems may provide more effective control in severe turbulence encounters than the human pilot, but that suppression of primary structural modes and the use of head-up displays are still desirable to alleviate the pilot's difficulties. Author

N71-23425# Boeing Co., Seattle, Wash. Commercial Airplane Group.
APPROACH PATH CONTROL FOR REDUCED NOISE AND IMPROVED TRAFFIC CAPACITY

D. R. Clifford *In* AGARD Lessons with Emphasis and Flight Mech. from Operating Experience Incidents and Accidents Mar. 1971 22 p refs
Avail: NTIS HC $6.00/MF $0.95
Final approach control for transport aircraft consists primarily in aerodynamic performance during cruise. The specific objectives defined for the Boeing 727 and 737 in this respect, and the boundary layer control research with the 707 prototype, are outlined, together with results achieved. Steep angle, decelerating, and curving approaches have been considered singly and in combination. A simple speed control for decelerating approach on the normal glidepath angle is under development for the 747 and research activities include extending the capability of high quality area navigation equipment to control of flightpath, speed and configuration on final approach so as to minimize noise. Described are the operational characteristics of the airborne system for terminal path guidance on reduced noise trajectories, including the system configuration, functions of key elements, redundancy requirements, control law aspects, and cockpit displays. Author

N71-23426# National Aeronautics and Space Council, Washington, D.C.
A REVIEW OF V/STOL AIRCRAFT ACCIDENTS IN THE US
John H. Enders and William E. Thurman *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 14 p refs
Avail: NTIS HC $6.00/MF $0.95
V/STOL research and development aircraft accidents have occurred for the same major reasons and over the same operational phase spectrum as have accidents to conventional aircraft. Excluding hover and transition phases from the operational phases, a pattern of accident distribution of V/STOL aircraft is similar to that for conventional aircraft - about 55-60% during landing, about 20% in cruise, and about 20% during takeoff. The pattern of accidents suggests no clearly dominant remedial action to reduce these accidents across-the-board, but increased attention in each of the cause factor areas will effect an improvement. Nearly every accident investigation prompted changes in either design, methods of operation, management structure, pilot training methods, or maintenance procedures. Author

N71-23427# Ministry of Defence, London (England).
V/STOL IN THE ROYAL AIR FORCE: SOME LESSONS FROM THE FIRST 18 MONTHS
R. G. Lofting *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents, and Accidents Mar. 1971 4 p
Avail: NTIS HC $6.00/MF $0.95
Some 18 months of V/STOL operations with the Harrier ground attack and reconnaissance aircraft have been completed and the aircraft's flight safety record during this period is discussed. The record has been encouragingly good, taking into consideration the novel problems of V/STOL operation, and field covered by the complete Harrier flight safety record is not a large one. Selected are the following four topics from the Harrier flight safety record which lie reasonable close to flight mechanics: (1) stability and control; (2) exhaust gas reingestion; (3) ejection facilities; and (4) control system. Author

N71-23428# Messerschmitt-Boelkow G.m.b.H., Munich (West Germany).
V/STOL ACCIDENTS OR INCIDENTS
O. Richarz *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 10 p
Avail: NTIS HC $6.00/MF $0.95
Performance tests on two models of the VJ 101C VTOL high performance aircraft are reported and observed accidents connected with flight mechanical aspects are analyzed. Four out of

the five accidents reported had something to do with hot gases and recirculation. A great deal of the recirculation problems experienced were directly connected to the triangular arrangement of the aircraft's 6 engines.   G.G.

N71-23429# Sud-Aviation, Toulouse (France).
ALL WEATHER SUD/LEAR LANDING SYSTEM INSTALLED ON THE CARAVELLE [SYSTEME D'ATTERRISSAGE TOUS TEMPS SUD/LEAR INSTALLE SUR CARAVELLE]
G. Payeur *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 10 p
Avail: NTIS HC $6.00/MF $0.95
Experience with the all weather SUD/LEAR landing system confirms its reliability in phase 3a automatic approach and landing requirements. The system encorporates a flash warning signal on the panel in front of the flight captain that combines all essential warnings relating to aircraft flight control and integrates in particular the following warnings: (1) HZ-4 and MR-4 indicator flags; (2) beam error detector warnings; (3) autopilot warnings; and (4) altitude error warnings transmitted by the radio altimeter AF-and servo-mechanism unit. The fact that the warnings are combined in a single flash enables the flight captain to continue outside the aircraft and yet perceive within his immediate field of vision a possible malfunction flash signal; he can make a decision (down to 50 ft) to continue the approach or to initiate go-around.
Transl. by G.G.

N71-23430# Army Aviation Systems Command, St. Louis, Mo.
PROBLEMS ENCOUNTERED IN NAP OF THE EARTH FLYING AND THEIR EFFECT ON AIRCRAFT DESIGN MISSION PERFORMANCE
Lawrence R. Dewey, Jr. *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 5 p refs
Avail: NTIS HC $6.00/MF $0.95
Reviewed are some of the design problems that are accentuated by tactical helicopter maneuvering close to ground. Considered are aerodynamic coupling effects that cause the aircraft to roll during climb with sudden forward pitching for a gun run on target, and dynamic structural aircraft vibrations during low level high speed terrain avoidance maneuvers. Proposed safety measures include an automatic information and warning system for the pilot and safety margins that realistically encompass fatigue dynamics inherent in close to ground operations.   G.G.

N71-23431# Ministry of Technology, London (England).
WEATHER AS A FACTOR IN FATAL ACCIDENTS INVOLVING CIVIL TRANSPORT AIRCRAFT
J. Burnham *In* AGARD Lessons with Emphasis on Flight Mech. from Operating Experience, Incidents and Accidents Mar. 1971 21 p refs
Avail: NTIS HC $6.00/MF $0.95
An analysis is given of the importance of weather in fatal accidents involving civil transport category aircraft during the period 1946-69. Out of a total of 1,433 accidents involving 25,801 fatalities, weather is known to have been a factor in 318 accidents involving 6,778 fatalities, and may have been involved in others. The average of 13 accidents per year in which weather was involved comprise about 10 per year in poor visibility, 2 per year due to gusts and 1 per year due to icing and other weather hazards. The only type of weather accident which has increased in frequency in recent years is that of approach and landing in poor visibility.   Author

N71-23438# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
EVALUATION OF THE AQUA-GLO SERIES 2 FREE WATER DETECTOR Summary Report
Charles R. Martel Nov. 1970 74 p refs
(AD-718418; AFAPL-TR-70-63) Avail: NTIS CSCL 14/2
The Aqua-Glo Series II free water detector, for use in measuring the quantity of free (undissolved) water in hydrocarbon fuels, was evaluated. Two dynamic test loops and a batch-blending calibration apparatus were used to check the accuracy and repeatability of the Aqua-Glo Series II. The Aqua-Glos response to free water in fuel was found to be affected by the presence of fuel additives in the fuel and by the degree to which the water was dispersed in the fuel. Corrosion inhibitors such as Santolene C, AFA-1, and Lubrizol 541 were found to decrease the Aqua-Glos response to free water while the fuel system icing inhibitor was found to increase the Aqua-Glos response to free water. A poor dispersion of the free water in fuel, i.e., one that has a few large drops versus a good dispersion, where there are many small drops, resulted in decreased repeatability and a lowered Aqua-Glo response. In general, the Aqua-Glo Series II free water detector was found to be suitable for field use in its present configuration over the range of 2 to 40 milligrams per liter of water in the fuel.
Author (GRA)

N71-23475# Lockheed-Georgia Co., Marietta.
A THEORETICAL INVESTIGATION OF A CIRCULAR LIFTING JET IN A CROSS FLOWING MAINSTREAM Final Report, Jul. 1969 - Dec. 1970
James E. Hackett and H. Ronald Miller Wright-Patterson AFB, Ohio AFFDL Jan. 1971 59 p refs
(Contract F33615-69-C-1753)
(AD-718121; LGR-ER-10940; AFFDL-TR-70-170) Avail: NTIS CSCL 1/1
Finite-element potential-flow-modeling theoretical techniques are described which predict, from first principles, both the rolled-up geometry and the path of a round lifting jet convergent into a cross-flowing mainstream, as on VTOL or direct lift-assisted STOL aircraft. Starting with a straight-cylinder geometry, point vortex elements are perturbed using a pre dictor-corrector stepping method to give a first estimate of the bent-back shape, using assumed circulation values. A collocation scheme is next used to revise the circulation values, and after three or four iterations, a final exit-plane pressure distribution may be calculated. The fan-induced total pressure rise is simulated by injecting vortex rings at a chosen position in th duct which feeds the jet. Since the scope of the method is entirely non-viscous, separations toward the rear of real jets and the associated pressure changes are not simulated and base-pressure type of pressures cannot be expected. Nevertheless, for forward speed ratios of 0.1, 0.2, 0.3 and 0.4, the low-pressure contours at each side of the jet do show an increasing rearward shift, just as is found experimentally. Somewhat surprisingly, the simulated plumes were more stable at higher velocity ratios. At lower forward speeds, there was a tendency to flap, rather like a hose end when freed. It is anticipated that, if viscous effects were simulated, these motions might damp out.   Author (GRA)

N71-23480# Ballistic Research Labs., Aberdeen Proving Ground, Md.
WIND TUNNEL SUPPLY HEADERS
Anders S. Platou Dec. 1970 45 p refs
(AD-718227; BRL-MR-2085) Avail: NTIS CSCL 14/2
It has been found that good quality, low turbulence flow in a wind tunnel test section is dependent on the flow and turbulence conditions in the supply header. This report indicates how good quality, low turbulence flow can be obtained in a supply header and presents flow surveys taken in a supply header before and after modification.   Author (GRA)

N71-23487# RAND Corp., Santa Monica, Calif.
FUEL-OPTIMAL RETROTHRUSTED SOFT LANDING THROUGH AN ATMOSPHERE. PROJECT RAND

M. L. Juncosa Dec. 1970 33 p refs
(Contract F44620-67-C-0045)
(AD-718405; R-515-PR) Avail: NTIS CSCL 1/2

A simple analysis of the problem of achieving a soft landing for airdrop by fitting the payload with retrorockets, and a direct iterative numerical procedure for determining the switch-on point for minimal fuel consumption, in terms of either time or altitude. Through appropriate reversals of sign, the formulas may also be used for ascent trajectories of full-thrust, vertically boosted rockets where the assumption of a constant gravity field is acceptable. Since the unretrothrusted portion of the descent is identical with free fall, the dynamical equations are integrable in closed forms. For a constant atmosphere, closed form analytic solution is also obtained for the retrothrusted descent. For an exponentially varying atmosphere, however, one cannot escape a numerical integration of the dynamical equations. Author (GRA)

N71-23488# Naval Air Engineering Center, Philadelphia, Pa. Engineering Dept.
SHIPBOARD TEST PROCEDURE FRESNEL LENS OPTICAL LANDING SYSTEM MK 6 MOD 2
Wesley F. Davis 19 Jan. 1971 88 p
(AD-718335; NAEC-ENG-7656) Avail: NTIS CSCL 1/5

This procedure is a guide to be used by the Test Engineer, Field Service Representative or Test Officer for Shipboard testing the Fresnel Lens Optical Landing System MK 6 MOD 2 after initial installation or the completion of a major change, overhaul or extensive repairs. These tests are necessary to demonstrate the integrity of the installation as well as functional readiness for operation. Author (GRA)

N71-23497* National Aeronautics and Space Adminstration. Langley Research Center, Langley Station, Va.
LEADING EDGE CURVATURE BASED ON CONVECTIVE HEATING Patent
Dewey E. Wornom, inventor (to NASA) Issued 16 Jul. 1968 (Filed 1 Sep. 1965) 5 p Cl. 244-13
(NASA-Case-XLA-01486; US-Patent-3.392.936; US-Patent-Appl-SN-484485) Avail: US Patent Office CSCL 01A

A high speed flight vehicle having improved flight efficiently at both subsonic and high speeds is described. All leading edges of the vehicle are provided with leading edge curvature while the leading edge sweep is maintained, along with a corresponding decreasing leading edge radius, such that the relationship between sweep and radius that is normally associated with aerodynamic heating at high speeds is not altered.
Official Gazette of the U.S. Patent Office

N71-23498# Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
BEAGLE B125 BULLDOG G-AXEH (LYCOMING 10-360A1C). PART 1: PREVIEW HANDLING TRIALS
T. Heffernan, J. J. Lee, and R. Hargreaves 14 Oct. 1970 17 p
(AAEE-963-Pt-1) Avail: NTIS

A brief handling assessment has been made of the Beagle Bulldog at a representative training loading. The overall impression of the aircraft was most favorable, and it is well suited to the trainer role. No handling problems were encountered and the characteristics were even better than those of the Pup 150. The aircraft was easy to fly while providing scope to achieve precision. Ground handling was excellent, pedal forces being lighter than on the Pup. Stability and control were good about all axes. Stalling tests showed that the controls were effective throughout and recovery was prompt. The aircraft could be made to spin more easily than the Pup and the rate of rotation, though fast, was acceptable in view of the stable nature of the spin. Aerobatics were if anything better than on the Pup die to the clear view canopy, constant speed propeller, and larger rudder. Recommendations are made for improving the cockpit layout. Author (ESRO)

N71-23499* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DECONTAMINATION OF PETROLEUM PRODUCTS Patent
James R. Mosier, inventor (to NASA) Issued 16 Jul. 1968 (Filed 18 May 1965) 2 p Cl. 44-77 Sponsored by NASA
(NASA-Case-XNP-03835; US-Patent-3.393.059; US-Patent-Appl-SN-456874) Avail: US Patent Office CSCL 07C

A description is given of a means and method of effectively controlling bacteria growth in petroleum products, as well as trapping other impurities such as water and solid particles which normally settle to the bottom of stored petroleum products, by the use of a small effective amount of honey.
Official Gazette of the U.S. Patent Office

N71-23528# School of Aerospace Medicine, Brooks AFB, Tex.
SIX INDICES FOR PREDICTING SPEECH INTERFERENCE WITHIN AIRCRAFT Final Technical Report, 1 Oct. 1968 – 6 Jul. 1970
Donald C. Gasaway Dec. 1970 35 p refs
(AD-718098; SAM-TR-70-72) Avail: NTIS CSCL 17/2

Acoustic noise within aircraft during flight often causes some degree of interference with aural communication. Several methods have been used over the years to identify and predict degrees of speech interference. Six of these methods are discussed: four involve octave-band averaging; two use frequency weighting. The assessment is based on application of each of the six indices to noise levels measured within the cockpits of 191 fixed-wing and 58 rotary-wing aircraft, grouped into 11 categories by engine type. Equivalent speech interference levels obtained from the use of each of the six indices are provided for the acoustic spectra developed for the 11 classes of vehicles. The operational considerations which influence speech interference values are described. Noise attenuation provided by headset devices commonly used by Air Force aircrew members is shown for different groups of noise spectra. Criteria are given for evaluating protected and unprotected exposures to noise that compromise communications. Author (GRA)

N71-23538# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT
V. Lutskii et al 4 Dec. 1970 13 p ref Transl. into ENGLISH from Aviatsiya i Kosmonavtika (Moscow), no. 4, 1970 p 25–27
(AD-718474; FTD-HC-23-600-70) Avail: NTIS CSCL 1/3

A general discussion is presented of various factors which affect the stability and controllability of supersonic aircraft. GRA

N71-23547# Aluminum Lab. Ltd., Banbury (England).
DEVELOPMENT OF SIZE 22 TYPE D.50.S SILICON-MAGNESIUM-ALUMINIUM ALLOY AIRCRAFT CABLES AND TERMINATIONS
G. W. Hunton Aug. 1970 67 p
(Contract KJ-D-3908-CB55C)
(TRC-BR-19785) Avail: NTIS

The performance of size 22 aircraft cables with conductors of type D.50.S silicon-magnesium-aluminum alloy is assessed together with their associated terminations, and these are compared with their copper equivalents. Author (ESRO)

N71-23591# Naval Ship Research and Development Center, Washington, D.C.
UNSTEADY HYDRODYNAMIC LOADS ON A TWO DIMENSIONAL HYDROFOIL Final Report
John H. Pattison Nov. 1970 150 p refs
(AD-717953; NSRDC-3245) Avail: NTIS CSCL 13/10

Unsteady hydrodynamic lift, moment, and drag on a two-dimensional NACA 16-209 hydrofoil are determined experimentally as functions of depth of submergence, forward speed

mean angle of attack, and frequency of oscillation in pure heave and pure pitch motions. Various theoretical and experimental results are compared with the experimental steady and unsteady load coefficients on the hydrofoil model. The comparisons include both finite and zero forward speed effects. Added-mass coefficients are obtained from the zero forward speed case. Theoretical and experimental results do not agree because of limitations in both the theories and experiments. Author (GRA)

N71-23596# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin (West Germany). Inst. fuer Turbulenzforschung.
SOUND GENERATION BY A DISTURBED SIMPLE LAMINAR JET
Alfons Michalke Jan. 1971 38 p refs
(DLR-FB-71-02) Avail: NTIS; ZLDI Munich: 9,70 DM
The sound generation by a part of a circular jet is investigated theoretically. The investigation is limited to that part of the jet for which a linear theory is applicable. In this "linear flow region there exists a laminar jet flow approximately parallel with small spatially growing disturbances. The source term of the Lighthill equation and the sound far-field is calculated for this laminar fluctuating jet flow. For the special jet flow produced by a cylindrical vortex sheet the directivity of sound is discussed at various Strouhal numbers and Mach numbers. It is found that the directivity depends strongly on the Strouhal number and is quite different for axisymmetric and azimuthal source components. Author (ESRO)

N71-23597# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Hauptabteilung Wissenschaft und Technik.
NUMERICAL METHOD FOR EVALUATING AERODYNAMIC COEFFICIENTS OF THIN SUPERSONIC WINGS AT ANGLE-OF-ATTACK CONDITIONS [NUMERISCHES VERFAHREN ZUR BESTIMMUNG ANSTELLWINKELABHAENGIGER AERODYNAMISCHER BEIWERTE DUENNER UEBERSCHALLFLUEGEL]
Walter Helmut Diesinger Jan. 1971 68 p refs In GERMAN; ENGLISH summary
(DLR-FB-71-01) Avail: NTIS; ZLDI Munich: 17,50 DM
The numerical method makes use of the linearized potential flow theory and is limited to wings where Evvard's theorem can be applied. The method fits especially to preliminary design calculations where influence of warping and thickness of the wing are not needed. The aerodynamic coefficients are evaluated by numerical integration of the velocity potential for which the numerical accuracy can be determined by a simple additional procedure. Because of the comparatively small amount of calculations the method may be applied to reduce the running time of existing computer programs. For the application at desk calculation machines tables are listed and simple examples presented. Author (ESRO)

N71-23609# Collins Radio Co., Cedar Rapids, Iowa.
INTEGRATED HIGH-FREQUENCY ANTENNA SYSTEM, APPENDIX D Final Report, 13 Nov. 1969 - 9 Nov. 1970
Nov. 1970 361 p refs
(Contract N62269-70-C-0016)
(AD-718054; Rept 523-0763421-00111M-App-D) Avail: NTIS CSCL 9/5
The document describes tests to determine the spectral characteristics of an AN/ARC-132(V) Radio Set consisting of the units and modules specified in paragraph 5.2. The subject tests are a requirement of the Integrated High Frequency Antenna System (IHFAS) Phase III Contract (N62269-70-C-0016), and will be performed in accordance with MIl-STD-449C Author (GRA)

N71-23625# Air Force Systems Command, Wright-Patterson AFB, Ohio Materials Lab

AIR FORCE MATERIALS SYMPOSIUM 1970. TECHNICAL SPECIALIST SESSIONS. SUMMARY ABSTRACTS
22 May 1970 101 p Conf. held at Miami Beach, Fla., 18-22 May 1970
(AD-718432) Avail: NTIS CSCL 11/6
The document contains the 100-word abstracts of all the papers presented in the Technical Specialist Sessions of the Air Force Materials Symposium 70 held in Miami Beach, Florida on 18-22 May 1970. Author (GRA)

N71-23659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OVERALL PERFORMANCE IN ARGON OF A 16.4 CENTIMETER (6.44 INCH) SWEPT BACK BLADED CENTRIFUGAL COMPRESSOR
Carl Weigel, Calvin L. Ball, and Edward R. Tysl Washington Apr. 1971 21 p refs
(NASA-TM-X-2269; E-6100) Avail: NTIS CSCL 20D
Overall compressor performance is presented as a function equivalent weight flow. At the design equivalent weight flow of 0.69 kg/sec (1.52 lb/sec) and the design equivalent tip speed of 325 m/sec (1066 ft/sec), the compressor produced an overall total pressure ratio of 2.28 and an adiabatic efficiency of 0.80. The peak efficiency at design speed was 0.808 at an equivalent weight flow of 0.65 kg/sec (1.43 lbm/sec) Author

N71-23660# Martin Marietta Corp., Baltimore, Md. Research Inst. for Advanced Studies.
SPAN LOADING AND WAKE FORMATION
Peter F. Jordan Dec. 1970 27 p refs Presented at AF-OSR-Boeing Symp. on Aircraft Wake Turbulence, Seattle, 1 - 3 Sep. 1970
(Contract F44620-69-C-0096)
(AD-718024; RIAS-TR-70-12C; AFOSR-70-2873-TR) Avail: NTIS CSCL 1/1
Contrary to the classical assumption of an elliptic span loading, the actual span loading contains a logarithmic term. In consequence, there is an infinite upwash directly behind the wing just inside the wing tip. This explains why the aircraft wake rolls up faster than classical analyses predict. The downwash distribution behind the circular wing is calculated in some detail. Author (GRA)

N71-23673# Solar, San Diego, Calif.
TUNGSTEN REINFORCED OXIDATION RESISTANT COLUMBIUM ALLOYS Final Report, 1 Nov. 1969 - 1 Nov. 1970
M. J. Klein, A. G. Metcalfe, and R. B. Domes Nov. 1970 78 p refs
(Contract N00019-69-C-0137)
(AD-717969; RDR-1635-8; SOLAR-R-P-6-3113-7) Avail: NTIS CSCL 11/4
The approach used in this investigation was to combine weak but oxidation resistant matrices with high-strength filaments to produce a composite with oxidation resistance under loads at temperatures above 2000F. These operating temperature and strength goals are needed for gas turbine engines, but are beyond the range of nickel- and cobalt-base superalloys which have maximum temperature capabilities of about 1900F. Ideally, the composite material could be used uncoated but could also serve as a fail-safe material when coated. During the period covered by this report (the second year) characterization of the mechanical properties, oxidation resistance and filament-matrix compatibility of the model system was continued. Author (GRA)

N71-23702*# Scientific Translation Service, Santa Barbara, Calif.
THE EFFECTS OF FLOW CONTAINING DUST ON THE RESULTS OF HYPERSONIC WIND TUNNEL EXPERIMENTS [VLIYANIYE ZAPYLENNOSTI POTOKA NA REZUL'TATY

ISPYTANIYV GIPERZVUKONUKH AERODINAMICHESKIKH
TRUBAKH)
B. I. Bakum et al Washington NASA Apr. 1971 7 p refs Transl.
into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidkosti i
Gaza (Moscow), no. 4, Jul. – Aug. 1970 p 187 -- 189
(Contract NASw-2035)
(NASA-TT-F-13529) Avail: NTIS CSCL 20D
     The influence of flow containing dust upon aerodynamic
experiments in hypersonic wind tunnels is considered. It is found
that there is an increase in drag for thin profiles, and a drag
decrease for blunt profiles.   Author

N71-23720# Civil Aeronautics Board, Washington, D.C.
CAPTIVES OF INDUSTRY
Whitney Gillilland 1970 9 p refs Presented at Braniff Intern.
Airlines Management Club, Dallas, 16 Nov. 1970
Avail: Issuing Activity
     The role played by the CAB in determining passenger fares,
granting new routes, and encouraging competition among air
carriers and among aircraft manufactures is described. It is felt that
the air transportation system which has evolved is characterized
by operational efficiency, excellent quality and extent of services,
economy, and reasonable fare levels.   N.E.N.

N71-23726* National Aeronautics and Space Administration.
Marshall Space Flight Center, Huntsville, Ala.
ANEMOMETER WITH BRAKING MECHANISM Patent
Robert E. Turner and Dennis W. Camp, inventors (to NASA)
issued 9 Sep. 1969 (Filed 15 Aug. 1967) 4 p Cl. 73-189; Int.
Cl. G01w1/02
(NASA-Case-XMF-05224; US-Patent-3,465,584;
US-Patent-Appl-SN-660842) Avail: US Patent Office CSCL 14B
     An anemometer having a wind driven member mounted
on a shaft journaled for rotation in a cylindrical base, and a braking
mechanism positioned on the base for engagement with the shaft
to stop movement of the wind driven member is described. The
braking mechanism includes a housing, a brake lever and solenoid
mounted on the housing and a linkage connecting the solenoid and
brake lever where the brake lever can be pivoted to a position of
engagement with the shift journaled for rotation in the base.
                         Official Gazette of the U.S. Patent Office

N71-23738# Boeing Scientific Research Labs., Seattle, Wash.
FINITE DIFFERENCE CALCULATIONS OF THE BEHAVIOR
OF A DISCONTINUOUS SIGNAL NEAR A CAUSTIC
R. Seebass, E. M. Murman, and J. A. Krupp Jan. 1971 11 p
refs Presented at the Conf. on Sonic Boom Res., 3d, Washington,
D.C., 29 – 30 Oct. 1970
(AD-718835; D1-82-1040) Avail: NTIS CSCL 20/1
     It is important to predict sonic boom overpressure signatures
in the vicinity of a caustic. In particular, one needs to be able to
calculate the overpressure when the caustic surface intersects, or
when it is near the ground. While the analytical formulation of this
problem is a simple one, the solution by formal mathematical
techniques presents great difficulties. Consequently, there is great
impetus for developing numerical techniques that can provide such
predictions. Here the authors report on the extension to the
caustic problem of a technique developed by Murman and Cole for
transonic flows.   Author (GRA)

N71-23746# Environmental Science Services Administration,
Rockville, Md. BOMAP Office.
HIGH LEVEL CLOUD PHOTOGRAPHY INVENTORY: BOMEX
PERIOD 4, 11 28 JULY 1969
Vance A. Myers Mar. 1971 70 p Reprinted
(ESSA-TM-ERLTM-BOMAP-1) Avail: NTIS
     The high-level cloud photography missions flown by RB-57F

aircraft during the Barbados Oceanographic and Meteorological
Experiment (BOMEX) July 11 to 28, 1969 are documented with
specific information on the character and location of the photography.
The photographic products, the tabulation of cloud photography
data, the procedure used to reconstruct flight tracks and position
photographs are described with the availability of archived data.
                                                    Author

N71-23748# School of Aerospace Medicine, Brooks AFB, Tex.
NOISE ASSOCIATED WITH AIRBORNE OPERATION OF
C-141A AIRCRAFT Final Report, 1 Mar. 1969 - 28 Feb. 1970
Donald C. Gasaway Dec. 1970 34 p refs
(AD-718097; SAM-TR-70-74) Avail: NTIS CSCL 20/1
     Acoustic noise measurements obtained within several Lockheed
C-141A aircraft during various operational missions are reported;
factors of aeromedical significance are identified and described;
and methods with which undesirable effects can be controlled are
proposed.   Author (GRA)

N71-23764*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.
SHUTTLE AIRBREATHING PROPULSION
Warner L. Stewart, Arthur J. Glassman, and Stanley M. Nosek
[1971] 15 p Presented at the 7th Propulsion Joint Specialist
Conf., Salt Lake City, 14 - 18 Jun. 1971; sponsored by AIAA
(NASA-TM-X-67806) Avail: NTIS CSCL 21A
     Airbreathing gas turbine engines are considered to provide
cruise, landing, go-around, and ferry capability for space shuttle
vehicles. The study reported is based on the necessity to determine
which engines are most suitable and to examine them for
modifications and technology needed to meet new requirements
such as launch, space residence, and reentry. A review is made of the
requirements imposed on the engine, the effect of fuel selection,
and the studies currently being conducted to assess candidate
engine designs.   Author

N71-23778# Aeronautical Research Labs., Melbourne (Australia).
STATIC PRESSURE PROBES AT MACH 7.5
M. J. Williams Sep. 1970 15 p refs
(ARL/A-327) Avail: NTIS
     Two static pressure probe shapes with pressure holes at
varying distance from the nose have been tested at Mach number
7.5 in the Reynolds number range from 3200 to 9600, based on
probe diameter. Self-induced pressures produced by boundary layer
interaction with the external inviscid flow were strongly dependent
on hole position and could not be correlated by the flat plate
viscous interaction parameter. The influence of nose shape was
negligible at stations not too close to the shoulder, as was the effect
of probe temperature. As a result of these tests design and
calibration data for probes suitable for detailed exploration of the
core of the tunnel flow are now available.   Author

N71-23779*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.
MEASUREMENTS OF BOUNDARY LAYER TRANSITION,
SEPARATION AND STREAMLINE DIRECTION ON
ROTATING BLADES
William J. McCroskey Washington Apr. 1971 38 p refs
Prepared in cooperation with Army Air Mobility Res. and Develop.
Lab; Moffett Field, Calif.
(NASA-TN-D-6321; A-3863) Avail: NTIS CSCL 20D
     Laminar separation, transition to turbulence, and surface
streamline directions were measured on helicopter rotor blades in
a variety of rotating and nonrotating configurations. The results
indicate that the centrifugal effects of rotation do not significantly alter
the boundary layer development for most operating conditions.
Laminar separation bubbles were observed near the leading edge

N71-23796

of the upper surface of the blades at moderate and large angles of attack, and this phenomenon triggered a sudden transition to turbulent flow. Surface streamline patterns were found to be the same for both laminar and turbulent flows.　　　　　Author

N71-23796*# Techtran Corp., Glen Burnie, Md.
LAMINAR BOUNDARY LAYER ON A WING AND A BODY OF REVOLUTION IN THE PRESENCE OF BLOWING |LAMINARNYY POGRANICHNYY SLOI NA KRYLE I TELE VRASHCHENIYA PRI NALICHII VDUVANIYA|
L. F. Kozlov et al Washington NASA Apr. 1971 12 p refs Transl. into ENGLISH from Samoletostr. Tekh. Vozdush. Flota (USSR), no. 17, 1970 p 19 25
(Contract NASw-2037)
(NASA-TT-F-13627) Avail: NTIS CSCL 20D
　　　　A method is developed for calculating the characteristics of a two dimensional axisymmetric incompressible boundary layer on a blown wing, using a sixth-order polynomial for approximating the velocity distribution across the boundary layer. An arbitrary velocity distribution at the outer boundary of the layer is assumed. A solution to the problem is obtained with the aid of Karman's integral relation. The method can be readily extended to the calculation of blown laminar boundary layers on bodies of revolution.
　　　　　　　　　　　　　　　　　　　　　　　Author

N71-23805# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.
EFFECTS OF FUEL SLOSH AND VIBRATION ON THE FLAMMABILITY HAZARDS OF HYDROCARBON TURBINE FUELS WITHIN AIRCRAFT FUEL TANKS Technical Report, 1 Sep. 1969 - 30 Apr. 1970
Edwin E. Ott Nov. 1970 63 p refs
(AD-718091; AFAPL-TR-70-65) Avail: NTIS CSCL 21/2
　　　　The report deals with the effects of liquid fuel motion on the flammability of hydrocarbon turbine fuels in aircraft fuel tanks. Three military turbine fuels, JP-4, JP-5, and JP-8, were used in the testing. The fuels were placed in an explosion proof cylindrical test vessel (80-gallon capacity) and subjected to slosh and vibration. An electric arc was formed within the ullage which ignited any flammable fuel-air mixture present. The pressure rise from combustion was measured and correlated with initial conditions. The major effect of fuel slosh and vibration was to lower or abolish the lean flammabile temperature limit of the fuel. The rich flammable temperature limit was unchanged. An analysis was performed on these results and an explanation proposed based upon the hypothesis that all the fuel vapor in the ullage burns for combustion below the flash point.　　　　　　　　　　　　　　Author (GRA)

N71-23809* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONTROL DEVICE Patent
Nozomu Iwasaki and Wayne O. Hadland, inventors (to NASA) Issued 14 Oct. 1969 (Filed 28 Nov. 1967) 4 p Cl. 74-89.19; Int. Cl. F16j15/50
(NASA-Case-XAC-10019; US-Patent-3,472,086; US-Patent-Appl-SN-686209) Avail: US Patent Office CSCL 13I
　　　　A potentiometer mounted on a small housing or bracket with a driving wheel or disc secured to the shaft is described. A sector of the disc is provided with gear teeth and another sector is provided with a cam profile against which a cam follower acts. The cam follower is carried on a slide and is urged to engage with the cam profile by a biasing spring or the like which acts against a bearing member. The spring acts on the bearing member in a direction toward the cam profile so as to balance the force transmitted to the shaft by the cam follower itself. A large internal gear sector is pivotly mounted on the frame so that movement through a relatively small arc will produce rotation of the cam through its complete profile. The frame is adapted to be secured to some operating member of aircraft such as the steering wheel

or control yoke and an arm secured to the internal gear sector extends immediately adjacent to the steering wheel so that it is within easy reach of the pilot's thumb.
Official Gazette of the U.S. Patent Office

N71-23818# Air Force Systems Command, Wright Patterson AFB, Ohio. Foreign Technology Div.
STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT
V. Lutskii et al 3 Dec. 1970 10 p Transl. into ENGLISH from Aviatsiya i Kosmonautika (USSR), no. 10, 1969 p 21 - 23
(AD-718285; FTD-HC-23-596-70) Avail: NTIS CSCL 1/3
　　　　Controllability and stability are interrelated and determine one another. The characteristics of the stability and controllability of modern supersonic aircraft in longitudinal and lateral movement are analyzed.　　　　　　　　　　　　　　Author (GRA)

N71-23822*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NOZZLE PERFORMANCE MEASUREMENT ON UNDERWING NACELLES OF AN F 106 UTILIZING CALIBRATED ENGINES AND LOAD CELLS
Harold W. Groth [1971] 21 p refs Presented at 7th Propulsion Joint Specialist Conf., Salt Lake City, 14-18 Jun. 1971; sponsored by AIAA
(NASA-TM-X-67816) Avail: NTIS CSCL 01C
　　　　Installation effects on turbojet engine exhaust nozzles over a range of flight Mach number from 0.60 to 1.30 are discussed. Two J85-13 afterburning turbojet engines were mounted in underwing nacelles. Exhaust nozzle propulsion efficiency is being measured using load cells, calibrated engines, and flight calibrated nacelle tare forces. Reference nozzles of known performance were used to determine nacelle tare forces. Analysis of flight calibration data shows that the system is capable of determining nozzle efficiency to a one-sigma random error + or 1.5 percent.　　　　Author

N71-23860*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A WIND TUNNEL INVESTIGATION OF STATIC LONGITUDINAL AND LATERAL CHARACTERISTICS OF A FULL-SCALE MOCKUP OF A LIGHT TWIN ENGINE AIRPLANE
Marvin P. Fink, James P. Shivers, and Charles C. Smith, Jr. Washington Apr. 1971 269 p refs
(NASA-TN-D-6238; L-7607) Avail: NTIS CSCL 20D
　　　　The model was a full-scale mockup of a light, twin-engine, low-wing monoplane. Tests were made over an angle-of-attack range of - 4 deg to 24 deg and over a sideslip range of + or - 8 deg at thrust coefficients of 0, 0.19, and 0.28. Control effectiveness and hinge moments were determined for a full range of deflections on the aileron, elevator, and rudder. Downwash surveys were made in the region of the horizontal tail. Limited tests were made with simulated ice on the wing and horizontal tail.
　　　　　　　　　　　　　　　　　　　　　　　Author

N71-23861*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LARGE-SCALE WIND TUNNEL INVESTIGATION OF A DUCTED FAN: DEFLECTED-SLIPSTREAM MODEL WITH AN AUXILIARY WING
Michael D. Falarski and Kennety W. Mort Washington Apr. 1971 49 p refs Prepared in cooperation with Army Air Mobility R and D Lab.
(NASA-TN-D-6323; A-3670) Avail: NTIS CSCL 20D
　　　　The longitudinal aerodynamic characteristics of a semispan wing deflected-slipstream configuration with a double-slotted flap and an auxiliary wing were determined. The model was powered by two low-pressure-ratio ducted fans. A comparison of static test

400

results with results obtained from various propeller-driven configurations indicates that the turning effectiveness of fan-powered deflected-slipstream configurations can be correlated with propeller-powered configurations with the same flap-chord to slipstream-diameter ratio. The turning effectiveness of the auxiliary wing was essentially the same as would be produced by a conventional slotted flap system with the same flap-chord to slipstream-diameter ration. The auxiliary wing reduced the thrust required at low speeds as would be expected due to the increase in lifting surface area. **Author**

N71-23922*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
COMPARISON OF WIND TUNNEL AND FLIGHT-MEASURED BASE PRESSURES FROM THE SHARP-LEADING-EDGE UPPER VERTICAL FIN OF THE X-15 AIRPLANE FOR TURBULENT FLOW AT MACH NUMBERS FROM 1.5 TO 5.0
Sheryll A. Goecke Washington May 1971 38 p refs
(NASA-TN-D-6348; H-602) Avail: NTIS CSCL 20D

Pressures measured at six locations on the base of the sharp-leading-edge upper vertical fin of the X-15 airplane during the power-off portion of eight flights are compared with previous flight data obtained from a blunt-leading-edge fin, theory, and wind tunnel data. The flight and wind tunnel base pressure ratios for the Mach number range from 1.5 to 5.0 are presented as a linearized function of turbulent boundary-layer height and base width by using a Mach-number-dependent factor derived in the study. The resulting curve seems to provide another criterion for determining whether flow is laminar or turbulent. The difference between base pressure and free-stream pressure for any specific Mach number of the study is found to be a linear function of both free-stream pressure and dynamic pressure. Data from the sharp-leading-edge upper vertical fin agree with data from the blunt-leading-edge upper vertical fin. The flight data show the variation in pressure across the base to be negligible. **Author**

N71-23927*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INSTANTANEOUS AND DYNAMIC ANALYSIS OF SUPERSONIC INLET-ENGINE COMPATIBILITY
James E. Calogeras, Paul L. Burstadt, and Robert E. Coltrin [1971] 16 p refs Presented at the 7th Propulsion Joint Specialist Conf., Salt Lake City, 14 - 18 Jun. 1971; sponsored by AIAA
(NASA-TM-X-67821) Avail: NTIS CSCL 21A

An experimental wind-tunnel investigation was made to determine the effects of time-variant distortions produced in a supersonic inlet on a J85-GE-13 turbojet engine. Results are presented principally in terms of instantaneous distortion amplitudes and contours measured through compressor stall. They indicate that although a time-averaged distortion may be far from a stall-inducing value, corresponding instantaneous distortion amplitudes can approach or exceed this value. A film made by combining instantaneous distortion contours demonstrates that severe total pressure fluctuations at the compressor face can result in an instantaneous distortion of a type completely different from the time-averaged distortion. **Author**

N71-23931# Aeronautical Research Labs., Melbourne (Australia).
DEPARTMENT OF SUPPLY, AERONAUTICAL RESEARCH LABORATORIES ANNUAL REPORT, 1969 - 1970
Canberra, Australia Australian Govt. Publishing Serv. 1971 92 p refs Original Contains Color Illustrations
Avail: NTIS

Summaries for the research during this period are presented. Topics include: wind tunnel facilities, aerodynamics, structural analysis, atmospheric turbulence, and instrumentation. **F.O.S**

N71-23934 National Lending Library for Science and Technology, Boston Spa (England).
DESIGN OF A NONEXPANDING REFLECTOR BALLOON
E. Reininger 16 Feb. 1971 41 p refs Transl. into ENGLISH from Meteorol. Nationale (France), no. 255
(NLL-M-20326-(5828.4F)) Avail: Natl. Lending Library, Boston Spa, Engl.: 4 NLL photocopy coupons

Theoretical considerations are presented for a nonexpanding reflector balloon capable of measuring the fine structure of the high stratosphere after a fast ascent through the troposphere. Balloons which expand a great deal (of Neoprene), balloons which expand very little (of natural latex), and balloons of both types inside each other are discussed. Pressure, volume, weight, ascent rate, and burst altitude are considered for each case. It is shown that the dual arrangement with the enclosed balloon for the nonexpanding material gives the best results. To achieve a maximum increase in height and minimum weight, excess pressure is permitted to escape to the atmosphere through a tube with a valve adjusted for very low internal excess pressure. The inner balloon is composed of tetrahedral sections made of metallized polyethylene. **N.E.N.**

N71-23953*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SURFACE-FLOW VISUALIZATION INVESTIGATION OF A DELTA WING SHUTTLE CONFIGURATION AT A MACH NUMBER OF 7.4 AND SEVERAL REYNOLDS NUMBERS
H. Lee Seegmiller Jun. 1970 56 p refs
(NASA-TM-X-62036) Avail: NTIS CSCL 20D

Surface-flow visualization photographs are presented for a model of a delta wing shuttle concept. An oil flow technique was used to visualize the surface flow at a Mach number of 7.4 and several Reynolds numbers between 1,400,000 and 5,700,000. Angles of attack from 15 deg to 60 deg were tested at zero sideslip. A sideslip angle of 5 deg was also tested at an angle of attack of 15 deg. Details of the surface patterns are shown which illustrate the complexity of the hypersonic flow. **Author**

N71-23967*# Techtran Corp., Glen Burnie, Md.
ESRO HAS BEGUN THE INITIAL STUDIES FOR A EUROPEAN SYSTEM OF AIR TRAFFIC CONTROL VIA SATELLITE [L'ESRO A LANCE LES PREMIERES ETUDES D'UN SYSTEME EUROPEEN DE CONTROLE DU TRAFIC AERIEN PAR SATELLITE]
Jacques Morisset Washington NASA May 1971 5 p refs Transl. into ENGLISH from Air et Cosmos (France), no. 363, 10 Apr. 1971 p 15
(Contract NASw-2037)
(NASA-TT-F-13651) Avail: NTIS CSCL 22A

The progress of European development of a UHF air traffic control satellite under the direction of ESRO is examined in the light of American decisions regarding cooperation. **Author**

N71-23980*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COLD AIR INVESTIGATION OF A TURBINE WITH TRANSPIRATION COOLED STATOR BLADES 4: STAGE PERFORMANCE WITH WIRE-MESH SHELL STATOR BLADING
Frank P. Behning, Harold J. Schum, and Edward M Szanca Washington Apr. 1971 30 p refs
(NASA-TM-X-2176; E-6028) Avail: NTIS CSCL 21E

Turbine performance characteristics were obtained with a single-stage axial-flow turbine which had stator blades employing transpiration coolant ejection through a wire-mesh shell. The turbine was tested over a range of speed and pressure ratio and with nominal coolant fraction of 0.031. Additional tests were made at the design speed, in which the coolant flow was varied from 0 to

0.07 of the primary flow. The results were compared to similar results obtained from turbines using stator trailing-edge coolant ejection and discrete hole transpiration-cooled stator. A base turbine with no cooling provisions was used as a standard for comparisons.
Author

N71-24001*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SURFACE-FLOW VISUALIZATION PHOTOGRAPHS OF THE MSC ORBITER AND A 55 DEG SWEPT DELTA WING MODIFICATION FOR SEVERAL REYNOLDS NUMBERS AT MACH NO. 10.4
H. Lee Seegmiller Apr. 1970 110 p refs
(NASA-TM-X-62033) Avail: NTIS CSCL 20D
Surface flow visualization photographs are presented for the straight wing orbiter concept. Results are also shown for a 55 deg swept delta wing modification to the configuration and for the fuselage without wings. The surface flow streamlines were visualized with an oil flow technique at a Mach number of 10.4 and length Reynolds numbers of 0.5, 0.84, and 2.7×1 million. The angles of attack were 18 deg, 40 deg, 50 deg, 60 deg, and 70 deg.
Author

N71-24009*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOW SPEED JET NOISE FROM A 1.83 METER (6 FOOT) FAN FOR TURBOFAN ENGINES
Gene L. Minner and Charles E. Feiler [1971] 11 p refs Presented at the 4th Fluid and Plasma Dyn. Conf., Palo Alto, Calif., 21 23 Jun. 1971 Sponsored by AIAA
(NASA-TM-X-67825) Avail: NTIS CSCL 21E
The jet noise contribution to the far field sound from a 1.83 meter diameter fan has been determined for two simulated nacelle configurations. One nacelle had hard walls, while the other has acoustic liners on the wall and on inlet splitter rings. The jet velocities, typical of high bypass ratio fan engines, varied from 137 to 223 meters per second. The results of the study show that the acoustic liners effectively eliminate low frequency noise from internal sources. Data from the lined configurations were found to be in good agreement with the eighth power dependence on jet velocity. Data from the hard wall configurations, because of the influence of internally generated noise, show higher noise levels and a weaker velocity dependence.
Author

N71-24021*# Lockheed-Georgia Co., Marietta.
RESIDUAL TENSILE PROPERTIES OF MATERIAL FROM C-130 CENTER WING SECTION AFTER SERVICE   Final Report
L. R. Kaisand [1970] 15 p
(Contract NAS1-9485)
(NASA-CR-111828) Avail: NTIS CSCL 01B
No adverse correlation was found between the residual tensile properties of 7075-T6 material and the associated number of flight hours of the C-130 aircraft from which the specimens were extracted.
Author

N71-24053*# Scientific Translation Service, Santa Barbara, Calif.
PREVAPORIZATION OF LIQUID FUEL IN A SMALL RAMJET ENGINE   [DIE VORVERDAMPFUNG VON FLOSSIGKRAFTSTOFF IN EINEM KLEINEN STAUSTRAHLTRIEBWERK]
F. Gehring (Ph.D. Thesis Stuttgart Univ.) Washington NASA Apr. 1971 128 p refs Transl. into ENGLISH from Deut. Luft- und Raumfahrt, German report DLR-FB-69-67
(Contract NASw-2035)
(NASA-TT-F-13605) Avail: NTIS CSCL 21E
In order to improve the combustion efficiency the liquid fuel is heated up by the dissipated heat of the ramjet engine to such an extent that it evaporates immediately during expansion in

the injection system. The application and functional reliability of this fuel preevaporation system in small tip drive ramjet engines is demonstrated and proved by means of tests. The influence of the operational parameters, such as velocity of air flow, altitude, air-fuel ratio, fuel flow rate and pressure on the caloric state of the fuel before injection and after expansion was theoretically investigated.
Author

N71-24081*# Wayne State Univ., Detroit, Mich. Research Inst. for Engineering Sciences.
STUDY OF CONCEPTUAL AND OPERATIONAL FEASIBILITY OF LASER DOPPLER DETECTION SYSTEMS
Progress Report
J. Alex Thomson 30 Nov. 1970 103 p refs
(Contract NAS8-24810)
(NASA-CR-103105) Avail: NTIS CSCL 20E
Continuing research is reported in a program aimed at establishing the feasibility and design criteria of a laser doppler system for detecting and mapping turbulence levels and wind or velocity profiles in various applications. Current efforts include: (1) the design of an optical mechanical system for the laser van; (2) calculations to obtain detailed profiles for the system radial and axial response for various operating conditions and methods, and aperture apodization functions; (3) compilation of a set of specific experiments and experimental objectives for the laser van system; and (4) construction of a source that can be used as a standard scatterer. A summary of completed projects is included.   D.L.G.

N71-24298# National Aeronautical Establishment, Ottawa (Ontario).
FREE VIBRATIONS AND RANDOM RESPONSE OF AN INTEGRALLY STIFFENED PANEL
Mervyn D. Olson and Garry M. Lindberg Oct. 1970 121 p refs
(LR-544; NRC-11855) Avail: NTIS
The free vibrations and random response to jet noise of an integrally-stiffened five-bay panel were studied both theoretically and experimentally. A finite element approach was used to represent the panel and the predictions were verified by measurements on a model panel integrally machined from solid aluminum stock. The comparison between predicted and measured vibration modes and frequencies revealed good correlation of frequencies while the correlation of mode shapes was only fair, especially for higher modes. The predicted models and frequencies were used in a modal analysis of the panel's response to jet noise with a consistent finite element method being introduced to calculate the required cross-spectral modal force terms. Quantitative agreement between predicted and measured RMS stresses and displacements was realized, whereas only qualitative agreement was obtained for the associated spectra.
Author

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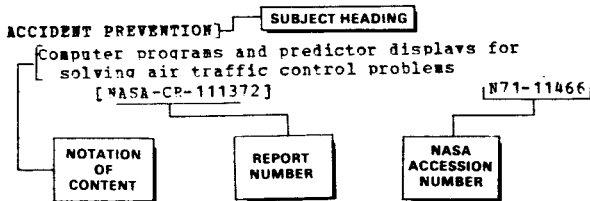
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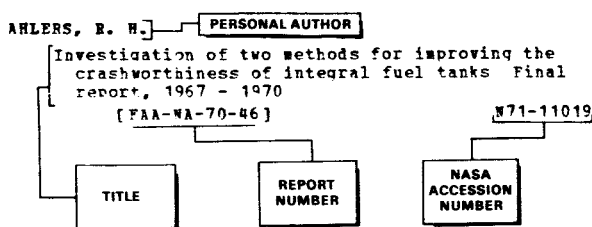[AD-717717]   N71-22300

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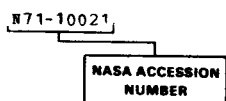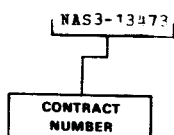
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1. Report No. NASA SP-7037 (07)	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 7)		5. Report Date July 1971
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		11. Contract or Grant No.
		13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address		14. Sponsoring Agency Code
15. Supplementary Notes		

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17. Key Words (Suggested by Author(s)) Aerodynamics Aeronautical Engineering Aeronautics Bibliographies		18. Distribution Statement Unclassified – Unlimited		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified		21. No. of Pages 144	22. Price* $3.00HC

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