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AERONAUTICAL ENGINEERING

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A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 17

APRIL 1972

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 17

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 March 1972 in

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



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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C.

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 409 reports, journal articles, and other documents originally announced in March 1972 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., A72-10969, 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

This publication is available on subscription from the National Technical Information Service (NTIS). The annual subscription rate for the monthly supplements, excluding the annual cumulative index, is \$18.00. All questions relating to subscriptions should be referred to the NTIS.

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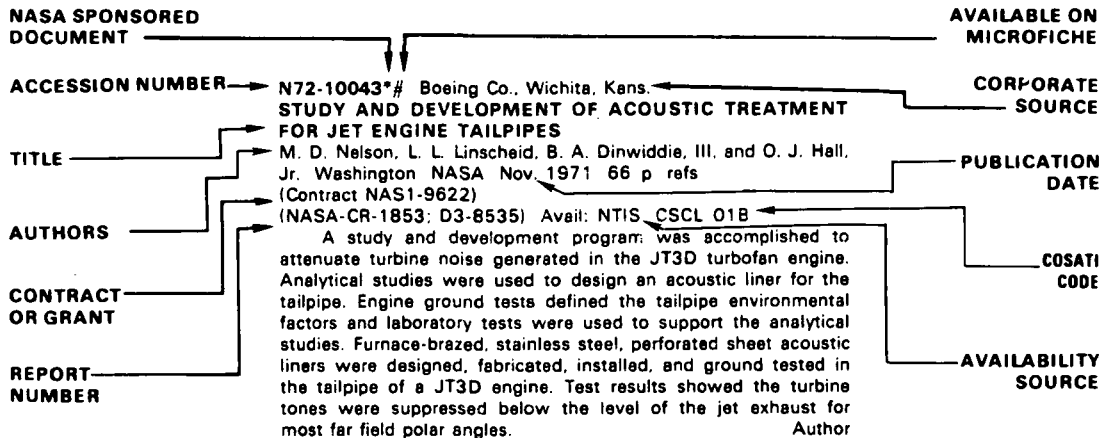
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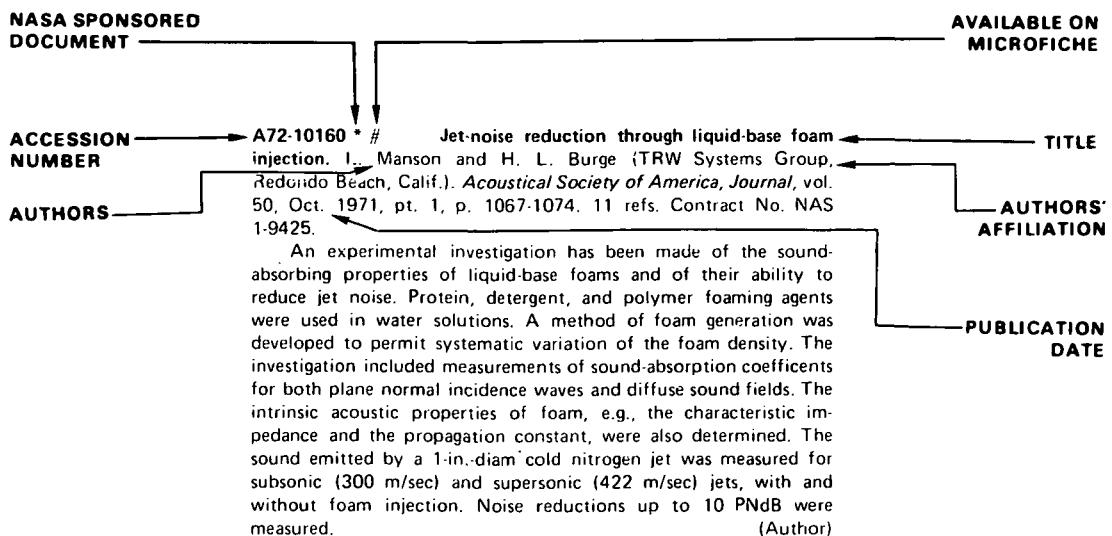
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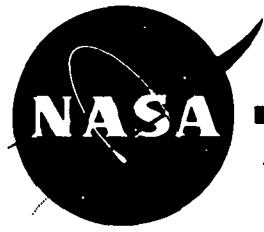
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AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 17)

APRIL 1972

IAA ENTRIES

A72-15772 # Implications of telephone size computers. B. B. Jackson (Bunker-Ramo Corp., Oak Brook, Ill.). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 20, 21.

A computer having the size of a desk telephone was designed for military tasks. The computer has the same ability as much larger machines. It uses only four basic circuits, existing MOS chips, as functional building blocks for register, universal logic, carry, and control. In several ways this new computer advances the state of the art. One survey predicts that in the next five years some 6000 computers of one kind or another will outfit aircraft area-navigation systems. G.R.

A72-15774 * # The new civil aviation within our grasp. E. M. Cortright (NASA, Langley Research Center, Hampton, Va.). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 30-34.

Noise and congestion present the two main technological constraints on air-transportation growth. Although some of the noise reduction will come with improved flight-path control and steep approaches, the main requirement remains quiet propulsion systems. Higher engine temperatures will compensate for efficiency losses due to noise suppression. Composite structures can reduce structural weight by 20%. New developments in rotorcraft transports are discussed together with advanced subsonic transports of the 1980s and the possibilities for further evolution of the SSTs, leading to a hypersonic aircraft. G.R.

A72-15775 # Canada's head start in STOL. C. C. Halton (Ministry of Transport, Ottawa, Canada). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 38-45.

It is pointed out that the availability of STOL will increase the contribution made by air transportation to the development of the north of Canada. Other uses of STOL are connected with the possibility of using airports with short runways in and close to urban areas. The Canadian manufacturing industry has, therefore, with federal assistance, developed a substantial capability in the design, development, and production of STOL aircraft. The characteristics for the STOL applications include short, steep, quiet takeoffs and landings, and full certification to civil air-transport standards. G.R.

A72-15776 * # Creating new cities through the large air-cushion vehicle. J. L. Anderson and P. M. Finnegan (NASA, Lewis

Research Center, Nuclear Systems Section, Cleveland, Ohio). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 46-54. 21 refs.

The air-cushion vehicle (ACV) can travel over concrete roads, grass, sand, mud, swamp, snow, ice, and water. This mobility makes possible a totally new geographical freedom in choosing transportation routes, locating ports, and laying out a city. By the 1980s fleets of large ACV freighters could begin carrying ocean-going cargo. The mobility of an ACV fleet would allow placing hoverports away from areas now crowded. New cities could rise along shallow or reef-bound seacoasts and rivers, just as cities once rose around deep-water seaports. G.R.

A72-15777 * # What can nuclear energy do for society. F. E. Rom (NASA, Lewis Research Center, Advanced Nuclear Propulsion Concepts Branch, Cleveland, Ohio). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 56-61. 12 refs.

It is pointed out that the earth's crust holds 30,000 times as much energy in the form of fissionable atoms as fossil fuel. Moreover, nuclear fuel costs less per unit of energy than fossil fuel. Capital equipment used to release nuclear energy, on the other hand, is expensive. For commercial electric-power production and marine propulsion, advantages of nuclear power have outweighed disadvantages. As to nuclear submarines, applications other than military may prove feasible. The industry has proposed cargo submarines to haul oil from the Alaskan North Slope beneath the Arctic ice. Other possible applications for nuclear power are in air-cushion vehicles, aircraft, and rockets. G.R.

A72-15780 * Civil Aviation Research and Development /CARD/ Policy Study. C. A. Syvertson (NASA, Washington, D.C.). In: NEREM 71; Northeast Electronics Research and Engineering Meeting, Boston, Mass., November 2-5, 1971, Record. Part 1. Newton, Mass., Institute of Electrical and Electronics Engineers, Inc., 1971, p. 58-60.

The results of the study lead to a number of conclusions regarding priority areas for R and D. It was found that aircraft noise abatement deserves highest priority because of widespread concern for the environment and because the success of the noise-abatement program will affect the solutions to other problems. Congestion is next on the list of priority problems. Its solution will involve an organized effort directed at the combination of air traffic control, runway capacity, ground control of aircraft, terminal processing, access and egress, parking, and airport location, acquisition, and development. A new short-haul system could help relieve congestion at existing airports. Constant improvements in technology for long-haul vehicles and their propulsion systems are essential to continued U.S. leadership. G.R.

A72-15781 Future trends in ATC communications and navigation systems. D. H. Featherstone (Aeronautical Radio, Inc.,

Washington, D.C.). In: NEREM 71; Northeast Electronics Research and Engineering Meeting, Boston, Mass., November 2-5, 1971, Record. Part 1. Newton, Mass., Institute of Electrical and Electronics Engineers, Inc., 1971, p. 61-64.

Statistics show that total aircraft activity in the U.S. is expected to almost double by 1980 and to more than double again by 1995. The expansion of the ATC service presently in hand would not be sufficient to enable these future demands to be met. It is suggested that from now until the turn of the century, the en route and terminal area navigation capability required for ATC will be provided by the use of improved versions of existing systems. The additional communications load will be handled by an air-ground-air data link.

G.R.

A72-15856 # Problems of measurement on a model of the thrust of standard nozzles on the afterbody of a supersonic aircraft (Problèmes de mesure sur maquette de la poussée d'un arrière-corps d'avion supersonique tuyères de référence). B. Masure (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (NATO, AGARD, Meeting on Inlets and Exhausts for Aerospace Engines, Sandefjord, Norway, Sept. 13-17, 1971.) ONERA, TP no. 978, 1971. 17 p. 13 refs. In French.

Description of the technique of measurement of the thrust of an afterbody in a wind tunnel with the help of an upstream cylindrical support. This measurement serves, in particular, to correct the overall measurements carried out on a complete model with a simplified hollow nacelle. The accuracy is checked by various calibrations including tests on a standard convergent-divergent nozzle. The checking and analyzing of the various complex configurations including a primary convergent nozzle are based on knowledge of mass flow rates and thrusts of corresponding sonic nozzles. Data for a rather broad variety of shapes result from accurate tests performed within the atmosphere, without external flow. The results are compared with currently available theoretical data.

F.R.L.

A72-15896 # Proposed gas turbine procurement standard - Gaseous and liquid fuels. H. T. Holzwarth (Brown Boveri Corp., North Brunswick, N.J.), G. S. Howard (Westinghouse Electric Corp., Small Steam and Gas Turbine Div., Philadelphia, Pa.), and T. E. Stott, Jr. (Stal-Laval, Inc., Elmford, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-3.* 7 p. Members, \$1.00; nonmembers, \$3.00.

Allowable specifications are discussed for gaseous and liquid fuels suitable for burning in gas turbines. The discussion is intended to help arrive at an improved gas turbine procurement standard. Special attention is given to the problem of fuel contaminants.

M.V.E.

A72-15899 # Modern jet engine development facility. R. L. Olive (AiResearch Manufacturing Co., Torrance, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-6.* 11 p. Members, \$1.00; nonmembers, \$3.00.

This paper discusses the newest jet engine development facilities in operation. The facility has been designed and constructed specifically for developing jet engines. The development demands of a modern, advanced technology jet engine require increased efficiency and reduced cycle time, which can be achieved with the utilization of the new technology in this and other similar engine development facilities.

(Author)

A72-15900 # Teledyne CAE small gas turbine test complex. D. J. Fressie (Teledyne CAE, Toledo, Ohio). *American Society of*

Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-7. 14 p. Members, \$1.00; nonmembers, \$3.00.

This paper reviews the test complex of U.S. Air Force Plant No. 27, Toledo, Ohio, operated by Teledyne CAE for the purpose of developing gas turbine engines. The facility features the machinery, equipment, and space to establish the proper environment for both engine component development and simulated flight test. Test operations encompass engine and component testing at sea level, altitude, and under conditions of high and low temperature. In order to meet these test objectives, the facility supports nine sea-level cells, two altitude chambers, an environmental chamber, three compressor drives, two cold flow turbine stands, a combustor rig, a high temperature cascade rig, two airflow stands, and an instrumentation calibration wind tunnel.

(Author)

A72-15901 # Capabilities for turbine engine testing at the Arnold Engineering Development Center. P. M. Hood (ARO, Inc., Engine Test Facility, Arnold Air Force Station, Tenn.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-8.* 13 p. 11 refs. Members, \$1.00; nonmembers, \$3.00.

The author presents the capabilities of the Arnold Engineering Development Center for testing turbine engines, describing typical test cells and test equipment used for simulation of flight conditions and duplication of portions of the flight environment. The paper also presents test techniques used for accurate measurement of airflow, fuel flow, and thrust and describes recently developed test techniques for the assessment of turbine engine stability margin. The use of real-time data processing combined with the turbine engine mathematical model in turbine engine testing is discussed.

(Author)

A72-15902 # Nitrogen oxide control with water injection in gas turbines. R. D. Klapatch (Turbo Power and Marine Systems, Inc., Farmington, Conn.) and T. R. Koblisch (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-9.* 8 p. 6 refs. Members, \$1.00; nonmembers, \$3.00.

Full-scale tests on an FT4 industrial turbine engine using natural gas as a fuel have demonstrated that a large reduction in NO(x) emission can be achieved by injecting water directly into the combustion chamber. Supporting tests in a single segment combustion chamber of the same design indicated that essentially similar reductions in NO(x) emission can be achieved when operating on liquid fuels. These tests indicated that the injection of water directly into the combustion chamber appears to minimize any deterioration in normal performance or durability.

(Author)

A72-15903 # Prediction of the effect of engine geometry on aircraft smoke visibility. A. K. Chesters (Delft, Technische Hogeschool, Delft, Netherlands). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-10.* 7 p. 8 refs. Members, \$1.00; nonmembers, \$3.00.

The visibility of aircraft exhaust smoke derives principally from light absorption and, hence, varies with smoke concentration and exhaust diameter. Because of complex exit aerodynamics and jet entrainment, however, effective exhaust diameters differ from actual. Entrainment rapidly transforms the exit profiles of smoke concentration to self-preserving Gaussian ones and causes slow decay of visibility. The initial visibility of the self-preserving jet is shown to depend on the mass emission rate of smoke times the square of ambient gas density and gross jet thrust. This expression also

describes, within about 10%, the actual exit visibility for current engine types. Quantitative criteria are also derived for the engine spacing, at which coalescence of parallel jets influences visibility, and for the magnitude of effect. (Author)

A72-15904 # Jet engine test facilities - Laboratories for tomorrow's engines. G. P. Adamson (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/GT-12.* 14 p. Members, \$1.00; nonmembers, \$3.00.

The paper describes jet engine test facilities at the Pratt & Whitney Aircraft Division of United Aircraft Corporation with particular reference to the overall capabilities of the experimental engine test laboratory and the particular capabilities of facilities used for testing of experimental and production models of the JT9D engine. (Author)

A72-15926 # The fluid mechanics of multiple-venturi systems and their applications to flow-rate metering. E. D. Klomp and G. Sovran (GM Research Laboratories, Warren, Mich.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/FE-27.* 7 p. 12 refs. Members, \$1.00; nonmembers, \$3.00.

The concept of a multiple-venturi system is applied to the design of a flow-rate meter. This meter type has the capability of offering a high signal-to-loss ratio over a broad flow range. Its internal fluid mechanics are discussed with a view toward design optimization. Experimental results are reported and analyzed for a three-element meter. (Author)

A72-15928 # Digital simulation of airplane hydraulic systems. W. Zielke (München, Technische Hochschule, Munich, West Germany). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/FE-21.* 12 p. 6 refs. Members, \$1.00; nonmembers, \$3.00.

Numerical techniques to simulate the dynamics of airplane hydraulic systems on a digital computer are described, and a general user-oriented computer package HYTRAN is presented. Time histories of pressures, flows, piston positions, etc. for hydraulic systems specified by the user can thereby be calculated. All significant nonlinearities are preserved in the analysis, and a distributed parameter presentation of transmission line dynamics is applied, utilizing the method of characteristics. Particular emphasis is placed on surges in the line system, but the dynamics of pressure compensated pumps, servo actuators, accumulators are included by solving their dynamic equations simultaneously with the line equations. (Author)

A72-15937 # An experimental study of compressible flow through convergent-conical nozzles, including a comparison with theoretical results. R. L. Thornock (Boeing Co., Seattle, Wash.) and E. F. Brown (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/FE-3.* 5 p. 8 refs. Members, \$1.00; nonmembers, 3.00.

Despite the widespread use of convergent-conical nozzles as propulsion nozzles in turbojet aircraft, little attention has been given to the effect of nozzle shape on their propulsive performance. This

paper presents the results of an experimental investigation in which the effect of nozzle angle on the internal characteristics of the flow field and on the propulsive performance of convergent conical nozzles was investigated. In addition, a theoretical solution is described which was developed as a part of this investigation. Fifteen, twenty-five, and forty-degree nozzles were tested at pressure ratios from 1.4 to 7.0. Measurements were made of the nozzle discharge coefficient, thrust coefficient, local flow angle, and wall static pressure. The properties of the internal flow field were seen to be affected by the nozzle angle and at pressure ratios less than the choked pressure ratio by the pressure ratio as well. The results of the theoretical analysis substantiate this behavior and are in reasonable agreement with the experimental data. (Author)

A72-15950 # Diffusion and fallout of particulates emitted by aircraft engines. S. L. Soo (Illinois, University, Urbana, Ill.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Av-2.* 12 p. 21 refs. Members, \$1.00; nonmembers, \$3.00.

Measurements have shown that aircraft contribute an increasing fraction of total community emission of pollutants. For given engines and fuels, the effect of pollutants around an airport can be reduced through operating procedures that consider the nature of diffusion and fallout of pollutants, including particulates during the idle, taxi, take-off, land, approach, and cruise modes of flight. The author shows that data and relations for the path of the plume in these flight modes can be determined from those for stacks, including effect of crosswind, buoyancy, and density gradient in the atmosphere. The paper correlates diffusion and fallout as a moving source problem, and discusses the effect of wing-tip vortices, plume visibility and monitoring, simulation and modeling. (Author)

A72-15956 # Flight director design for STOL aircraft. W. R. Seitz and R. E. Goodson (Purdue University, Lafayette, Ind.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Aut-9.* 7-p. 16 refs. Members, \$1.00; nonmembers, \$3.00.

All weather capabilities for aircraft depend heavily on precision guidance during the landing-approach maneuver, particularly in turbulent, low visibility conditions. Whether or not this type of maneuver can be accomplished by a pilot in zero-zero conditions by reference to instruments alone, with the consistent accuracy required, is a subject of some debate. A recent FAA study, described here, has concluded that present-day flight director systems do not allow pilots to demonstrate accuracy comparable to automatic systems. For the FAA study, intended to explore ways of giving the pilot information necessary to perform as well as an autopilot, a fixed-base flight simulator was built to observe pilot/director/aircraft performance in an approach down to touchdown, including a flare and decrab maneuver. Optimal control theory and the theory of manual control were used to find the feedback gains required to drive the display symbols. (Author)

A72-16002 # Unsteady viscous flow around an oscillating elliptic aerofoil. A. Okajima, T. Asanuma, and H. Takata. *Tokyo, University, Institute of Space and Aeronautical Science, Bulletin*, vol. 7, July 1971, p. 605-654. 13 refs. In Japanese, with abstract in English.

Navier-Stokes equations for the unsteady viscous flow about a stationary or oscillating elliptic airfoil are numerically solved, in order to investigate the role played by the viscosity effects of such a flow in the development of flutter and rotating stall in turbomachinery. Pressure and viscous-shear stress distributions, flow

configurations, and aerodynamic forces are obtained for Reynolds numbers ranging from 40 to 80 and angles of attack from 0 to 20 deg. M.V.E.

A72-16014 Aircraft engine overhauling - Planning and execution (La revisione di un motore aeronautico - Impostazione ed esecuzione). V. D'Alessandro. *Rivista Aeronautica*, vol. 47, Nov. 1971, p. 1885-1908. In Italian.

Discussion of the operations to which a turbojet aircraft engine must be subjected after it is removed from the aircraft and sent to the factory for overhauling or repair. The materials and arrangements required to get the work underway are reviewed, and the phases characterizing the overhauling of an engine are described. These phases include dismantling, washing and galvanic treatments, dimensional and integrity checks, salvaging and modifications, reassembly, acceptance testing, and quality control. A.B.K.

A72-16025 Measurement of intense noises in the presence of heat flow (Mesure des bruits intenses en présence de flux thermique). B. Baërd and J. Maulard (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*Revue d'Acoustique*, no. 15, 1971, p. 179-184.) *ONERA, TP* no. 1010, 1971. (p. 179-184) 8 p. In French.

Discussion of the 20 H 93-type detector, developed by ONERA, which is closed on its upper part by a porous bronze ('poral') cover, which protects the diaphragm from heat while ensuring correct acoustic transmission. A compromise between effective heat protection and adequate acoustic response was effected. The apparatus is suitable for measurements in the vicinities of jet engines, nozzle exits, turbine exhausts, volcanic craters, and all heat flows which may require noise measurement to be accomplished within a very short period. F.R.L.

A72-16026 # Aircraft noise in the 1980's. J. E. Ffowcs Williams (Imperial College of Science and Technology, London, England). (*National Society for Clean Air, Conference, Folkestone, Kent, England, Nov. 1971.*) *Tech Air*, vol. 28, Jan. 1972, p. 2-6.

Units and methods for measuring aircraft noise are reviewed. It is shown that the noisiest aircraft are the current jet transports; during their operational life, a maximum noise reduction of the order of 5 PNdB is achievable at a cost of around one billion dollars. Plots are presented showing how noisy the various current aircraft in airline service are at the three monitoring points for flyover, approach, and sideline. The noise can be, however, more effectively eliminated in the new generation jets; aircraft produced in five years' time will be fully 20 dB quieter than the current ones. Principal features of engine design for low noise are described, with particular attention to the Rolls Royce RB 211 engine development. O.H.

A72-16109 # Refinement of the nonplanar aspects of the subsonic doublet-lattice lifting surface method. W. P. Rodden, J. P. Giesing, and T. P. Kalmar (Douglas Aircraft Co., Long Beach, Calif.). *Journal of Aircraft*, vol. 9, Jan. 1972, p. 69-73. 13 refs. Research supported by the McDonnell Douglas Independent Research and Development Program; Contract No. F33615-70-C-1167.

The initial formulation of the doublet-lattice method has proven theoretically accurate for calculating the interference effects on arbitrary classes of oscillating nonplanar configurations with one known exception: nearly coplanar wing/horizontal-tail combinations. For this class of problems the integration of the kernel across the element loses accuracy. The reason for this loss of accuracy is

explained, and a refined method for performing the required integration is presented. Numerical studies using wing-tail configurations are presented to illustrate how well the refined method works. Also a T-tail calculation is repeated to show that calculations using other configurations are unaffected by the refinement. (Author)

A72-16110 * # Statistical analysis of several terminal area traffic collision hazard factors. J. R. Ruetenik (Kaman Sciences Corp., Burlington, Mass.). *Journal of Aircraft*, vol. 9, Jan. 1972, p. 79-83. 10 refs. Contract No. NAS12-698.

An 11 hr sample of air traffic, comprising 584 tracks recorded at Atlanta during peak periods of August 1967, is analyzed to examine the statistical characteristics of range-guard intrusions and airspace conflicts in a terminal area. The number of intrusions (of an imaginary 3-naut mile, 500-ft range guard surrounding each aircraft) and number of conflicts (of the projected airspace for two aircraft) for a track exhibit Poisson variations with track duration. The hourly rate of intrusions follows the gas model square-law variation with traffic density, but the hourly conflict rate, contrary to the gas model, decreases with greater traffic density. (Author)

A72-16112 # A simplified model for aircraft steering dynamics. C. Grubin (Hughes Aircraft Co., Culver City, Calif.). *Journal of Aircraft*, vol. 9, Jan. 1972, p. 93-96.

Both translational and rotational equations are developed. The former are obtained only from geometrical considerations and transfer functions for the lift magnitude and the lift bank-angle. The translational equations are particularly efficient for steering problems since there are only two variables which determine the direction of the interceptor aircraft velocity. Rotational dynamics are omitted and replaced by three conditions including zero sideslip, a transfer function relating achieved acceleration to commanded acceleration, and a transfer function relating achieved lift bank-angle to commanded bank-angle. G.R.

A72-16114 Advanced through-flow analysis applied to a low-speed axial flow compressor. M. D. C. Doyle (Fourah Bay College, Freetown, Sierra Leone). *International Journal of Mechanical Sciences*, vol. 13, Oct. 1971, p. 833-842. 12 refs.

This paper describes some calculations using the digital computer programme written by Marsh for the through-flow fluid mechanics of a turbomachine. The machine chosen as the subject for the calculation was a slow-speed single stage axial flow compressor in the Mechanical Engineering Department at Liverpool University. The deviations and losses for the blades were obtained from cascade correlations and the area blockages and secondary flow angle changes were derived from a simple annulus wall boundary layer calculation performed on an analogue computer. (Author)

A72-16122 On the flows of constant vortex shearing around an airfoil activated by any motion in the presence of a rectilinear wall (Sur les écoulements de cisaillement à tourbillon constant autour d'un profil animé d'un mouvement quelconque, en présence d'une paroi rectiligne). J. Obala (Besançon, Université, Besançon, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques*, vol. 273, no. 23, Dec. 8, 1971, p. 1168-1170. 6 refs. In French.

Continuation of a previous study (Obala, 1971) of the case of a fluid which is unlimited in all directions. The problem is treated by

two methods which are compared for a particular case. A rigorous expression for the complex potential of perturbation is obtained, using a calculation technique resembling that developed by Capodanno (1966).
F.R.L.

A72-16178 # The propulsion problem for a trainer-combat aircraft - A turbojet or a turbofan engine (Zagadnienie napędu samolotu treningowo-bojowego - Silnik jedno- czy dwuprzepływowy). W. Kordziński. *Technika Lotnicza i Astronautyczna*, vol. 26, Dec. 1971, p. 13-16, 24-27, 34. In Polish.

Flight performance characteristics, weight and size specifications, maintenance requirements, and development costs are compared for turbojet and turbofan engines from the viewpoint of installation in aircraft intended for both training operations and combat missions. A performance comparison shows that turbofan engines with a 2:1 bypass ratio are not suitable for such dual-mission aircraft. Turbofan engines with lower bypass ratios can provide significant advantages only if they are light and small with a simple structural design.
T.M.

A72-16179 # Problem of filtering dusty inlet air in aircraft turbine engines (Zagadnienie oczyszczania zapyłonego powietrza wlotowego w lotniczych silnikach turbinowych). R. Wiatrek. *Technika Lotnicza i Astronautyczna*, vol. 26, Dec. 1971, p. 28-30, 34. 8 refs. In Polish.

The consequences of turbine engine operation in a dusty atmosphere are discussed in terms of dust characteristics and mechanisms by which the particles affect engine components. Currently employed inlet filters are examined with respect to filtering efficiency, hydromechanical resistance, dimensions, size, endurance, and required maintenance operations.
T.M.

A72-16180 # Research on the perception of information about the spatial orientation of an aircraft (Badania nad spostrzeganiem informacji o położeniu przestrzennym samolotu). M. Żebrowski. *Technika Lotnicza i Astronautyczna*, vol. 26, Dec. 1971, p. 35-37, 39. In Polish.

Tests conducted with pilots examined (1) the accuracy in estimating flight path inclination in the absence of a visible horizon, (2) the accuracy in estimating the time remaining to touchdown under poor visibility, and (3) the structure of the ground image required for maximum accuracy in estimating flight path inclination and time remaining to touchdown. The tests involved electronically generated flight data, laboratory studies, simulation experiments, and statistical calculations. Results and conclusions are discussed extensively.
T.M.

A72-16187 Adaptation of the German commercial airports to traffic development (Die Anpassung der deutschen Verkehrsflughäfen an die Verkehrsentwicklung). U. Wolfram (Arbeitsgemeinschaft Deutscher Verkehrsflughäfen, Stuttgart, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1321-1327. In German.

The air traffic in the Federal Republic of Germany in 1980 is expected to reach 80-100 million passengers and approximately two million tons of freight. To meet the resulting requirements, extensive adaptation measures for the twelve existing German civil airports are necessary. These measures, which consist primarily in the enlargement of the current flight path capacity and of checking facilities, are examined in detail; several projects are reviewed. Construction of new airports is also considered. Some difficult problems associated with the financing of these projects are discussed.
O.H.

A72-16214 # Nonlinear problem of nonsteady flow of an incompressible fluid past a slender profile (Nelineinaiia zadacha o nestatsionarnom obtekanii tonkogo profilia neszhimaemoi zhidkost'iu). D. N. Gorelov and R. L. Kuliaev. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1971, p. 38-48. 12 refs. In Russian.

A method of calculating the nonstationary potential flow of a viscous incompressible fluid past a slender wing is proposed. The method is based on linearizing the problem about each moment of time and simulating the profile by a system of discrete vortices distributed over the mean profile. The condition that the fluid must not pass through the profile is satisfied at a number of properly selected points. As an example, the method is applied to the flow past a vibrating plate.
V.P.

A72-16215 # A nonplane small-aspect-ratio wing near an interface (Neploskoe krylo malogo udlineniia vblizi poverkhnosti razdela). V. I. Kholiavko. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Nov.-Dec. 1971, p. 49-55. In Russian.

The flow of a viscous incompressible fluid past longitudinally cambered small-aspect-ratio slender wing near a solid surface is examined. The possibility of longitudinally balancing the wing and decreasing drag for a given lift by applying cylindrical twist (curvature) to the wing is analyzed within the framework of slender body theory. It is shown that the wing under consideration is inferior to a plane wing near a solid surface, but is superior to the plane wing in the case of a hydrofoil moving below a free surface.
V.P.

A72-16348 Jet transport in turbulent air (Il velivolo da trasporto a reazione in aria agitata). F. Bosman (Roma, Università, Rome, Italy). *L'Aerotecnica - Missili e Spazio*, vol. 50, Aug. 1971, p. 199-208. 30 refs. In Italian.

Discussion of the status of knowledge concerning the dynamic response of transonic jets to atmospheric turbulence. The structural aspect as well as that of stability and control (upset) are described. It is pointed out that, while the former aspect can be considered adequately clarified both from the standpoint of the knowledge of the phenomenon and from that of its regulation, the same is not the case with the latter aspect. The stability facet is still under investigation, although many factors have been found to contribute to jet upset, and adequate flying procedures have been defined.
M.M.

A72-16350 Design of the optimal fixed point rotor by the pulse theory (Sul progetto del rotore ottimo a punto fisso con la teoria impulsiva). V. Giordano (Napoli, Università, Naples, Italy). *L'Aerotecnica - Missili e Spazio*, vol. 50, Aug. 1971, p. 217-224. 9 refs. In Italian.

The fundamental design parameter on which the tensile and torque coefficients and the factor of merit depend has been identified on the basis of the pulse theory. The optimization of the fixed point rotor, which requires a distribution of the velocity triangles along the blade other than that obtained by Betz, Theodorsen, Hirsch, et al., in the vortex theory field, has been established. An analogy between wing and rotor is pointed out. A nomograph for hovering rotor design is obtained, and contrivances for improving the static performance of the rotor during the early design stage are discussed.
M.M.

A72-16368 Soot oxidation rates in gas turbine engines. S. W. Radcliffe and J. P. Appleton (MIT, Cambridge, Mass.). *Combus-*

tion Science and Technology, vol. 4, Dec. 1971, p. 171-175. 16 refs.

A basis for extrapolating soot oxidation rate measurements obtained in laboratory flames to the more extreme operating conditions of gas turbine combustion chambers is proposed. The proposal is based on the observation that, within probable experimental uncertainty, the limited soot oxidation measurements correlate with the more extensive measurements of the surface oxidation rates of macroscopic sized samples of pyrographite. The soot oxidation rates thus determined for the conditions of a typical gas turbine combustion chamber are considerably lower than previous estimates which were based on simple extrapolations of the flame data. (Author)

A72-16399 Progress in heat and mass transfer. Volume 3 - Heat transfer reviews 1953-1969. Edited by E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.) and T. F. Irvine, Jr. (New York, State University, Stony Brook, N.Y.). Oxford and New York, Pergamon Press, 1971. 557 p. \$28.

This review covers the results of research in the field of heat transfer. The cooling problems encountered in aeronautics in the effort to increase the velocity of aircraft and missiles created interest in heat transfer under special conditions like supersonic velocities, rarefied gas flow, boundary layer flow, and very large temperature differences. Atomic power created interest in processes that result in specially large heat transfer coefficients. Research is continued on classical heat transfer processes such as heat transfer in separated flow regions, evaporation, and two-phase heat transfer. G.R.

A72-16400 # Electrical equipment and instrumentation of the An-24 aircraft (Elektropribornoe oborudovanie samoleta An-24) /2nd revised and enlarged edition/. S. D. Danich. Moscow, Izdatel'stvo Transport, 1971. 264 p. In Russian.

The design and principles of operation of the power supply sources on board the An-24 turboprop are discussed, along with the electrical control and safety systems, the onboard circuitry, and the loads. The flight, engine, and navigation instruments and their subsystems and elements are discussed. A special chapter is devoted to the AP-28L1 autopilot. Engine and aircraft-system checkout devices are examined. The textbook should be useful also to engineers, technicians, and civil aviation flight instructors. V.P.

A72-16417 Automated test equipment for phased-array modules. C. H. Dale (Texas Instruments, Inc., Dallas, Tex.) and A. R. Howland (Scientific Atlanta, Inc., Atlanta, Ga.). *IEEE Transactions on Microwave Theory and Techniques*, vol. MTT-20, Jan. 1972, p. 10-17.

A computer-controlled production test system for airborne phased-array microwave modules is described. In the transmit mode accurate measurements of module output power and phase as a function of input power and frequency are made automatically on a pulse basis, and with 4:1 frequency translation from module input to output. Module receiver gain, i.f. output phase, and noise figure are measured as a function of frequency and local oscillator input power in the receive mode. Other measurements under computer control include dc levels, gain compression, output pulse characteristics, spurious levels, and spectral purity. G.R.

A72-16430 # The adaptive optimal control system of landing of vehicles with aerodynamic performance. G. S. Pospelov and V. I. Toloknov. In: Symposium on Automatic Control in Space, 4th.

Dubrovnik, Yugoslavia, September 6-10, 1971, Proceedings. Belgrade, Izdavačko Preduzeće Tehnika, 1971, p. 2.17-2.22. 10 refs.

Consideration of the problem of automatic landing control for vehicles with subsonic flight capability at altitudes below 100 m in the terminal phase of landing. Synthesis pertaining to programmed motion control and to optimal adaptive control of motion disturbances is discussed. M.V.E.

A72-16472 # Path accuracy limitations of inertially based flight trajectory control systems in a turbulent environment. D. MacKinnon and P. Madden (MIT, Cambridge, Mass.). In: Symposium on Automatic Control in Space, 4th, Dubrovnik, Yugoslavia, September 6-10, 1971, Proceedings. Belgrade, Izdavačko Preduzeće Tehnika, 1971, p. 14.9-14.24. 10 refs.

This paper presents a class of parameter optimization algorithms which have been developed for optimizing stochastic, reduced state feedback, fixed configuration control systems. The algorithms are described and practical computational problems illuminated. Their application is illustrated by optimizing inertial measurement based vertical and lateral control systems for a jet transport aircraft. The mean square gust induced path deviation is minimized subject to a penalty on the mean square effector activity. The resulting solutions are presented as curves which display minimum rms position error and parameter values as a function of rms effector activity. The optimized solutions are compared to the performance achieved by a conventional trajectory control system using Instrument Landing System (ILS) measurements. (Author)

A72-16480 Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Conference sponsored by the Japan Society of Mechanical Engineers and the American Society of Mechanical Engineers. Tokyo, Japan Society of Mechanical Engineers, 1971. 306 p.

The investigations considered include a thermodynamic study of gas turbine power plants with an intercooler, an experiment on a supersonic axial-flow compressor, a study of the aerodynamic characteristics of rotating blades in a radial-flow turbine, and exhaust emission measurements involving small gas turbines. The two-dimensional cascade performance of circular-arc blades is discussed, together with the dynamic performance of stalled blade rows, effects of interference between moving blade rows on cascade flutter, gas-particle suspension properties in a cascade nozzle, combustion characteristics of a gas turbine combustor, corrosion characteristics of high-temperature alloys, and the influence of long-term heating on strength and microstructure of some gas turbine superalloys. G.R.

A72-16481 # An experiment on a supersonic axial-flow compressor. S. Otsuka, S. Yamaguchi, S. Futsukaichi (Nagoya University, Nagoya, Japan), T. Hashimoto, S. Yokoi, and H. Kishimoto. In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 25-32. 5 refs.

A shock-in-rotor type compressor was used in the experiment. At rotational speeds of 36,600 and 37,600 rpm the rotor showed supersonic performances with a total pressure ratio of 1.91 and an adiabatic efficiency of 0.67. Reasons for the low efficiency obtained are connected with the thickness of the boundary layer of the annular passage at the rotor inlet, insufficient diffusion in the hub region of the rotor exit, and the boundary layer separation caused by the interaction between shock and boundary layer on the blade. The

fact that the detached bow wave remained at the rotor inlet is also a responsible factor for the low efficiency. For the design of a more efficient supersonic compressor attention should be given to radial equilibrium relations in the rotor passage. The design of a stator blade with good performance characteristics at high subsonic speeds is also important. G.R.

A72-16482 # Some problems encountered in the design and development of a transonic compressor. T. Hiroki and H. Ishizawa (Ishikawajima-Harima Heavy Industries Co., Ltd., Aircraft Engine Div., Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 33-40. 16 refs.

A preliminary design study was made to determine the least number of stages possible for the compressor, the smallest hub/tip ratio, and the highest inlet axial velocity. The flow in the compressor was assumed to be axisymmetric. Momentum, energy, and continuity equations including entropy gradient, enthalpy gradient, and the radial component of the velocity were used for the flow pattern calculations. Multistage and single stage tests of the compressor were conducted. Aspects of the selection of the incidence angle are discussed, together with problems regarding deviation angle estimate, blade element pressure loss, stage matching, and flow stability. G.R.

A72-16483 # Several topics of axial-flow compressors research at the National Aerospace Laboratory (Japan). S. F. Ii and M. Matsuki (National Aerospace Laboratory, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 41-48. 10 refs.

High-speed flow measurements inside a single stage compressor with double circular-arc stator vanes are discussed, together with a prediction method for the performance of a five-stage compressor. Aerodynamic design and experimental results presented for five- and six-stage compressors provide some details regarding the effects of Reynolds number and blade airfoil shape on aerodynamic performance. G.R.

A72-16484 # A study of aerodynamic characteristics of rotating blades in a radial inflow turbine. N. Mizumachi, T. Endo (Tokyo, University, Tokyo, Japan), and M. Kitano (Toyota Central Research and Development Laboratories, Inc., Nagoya, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 49-56.

An experimental radial inflow turbine, equipped with straight nozzles and straight radial blades with exducers, was operated with cold air as working fluid which was delivered from two high pressure air sources. The design of the blade structure ensured that the cross-sectional area of the flow passage between the blades varied gradually from the inlet to the outlet. Tests involving structures with 10, 12, 14, 17, and 20 blades were carried out. It was found that the shape of the exducer has a serious effect on turbine performance. Reasons are discussed for differences observed between the flow direction from rotating blades and that of stationary cascades. G.R.

A72-16485 # Two-dimensional cascade performance of circular-arc blades. T. Ikui, M. Inoue (Kyushu University, Fukuoka,

Japan), and K. Kaneko. In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 57-64. 8 refs.

Cascade tests for various cambers were performed to obtain reliable two-dimensional circular-arc cascade data. The porous wall cascade tunnel testing technique was used in the investigations. The test results were compared with values obtained on the basis of classical potential theories. The coefficient of angle deviation introduced by Weinig was corrected, taking into consideration viscous effects. The camber ratio for a given design velocity diagram at a selected pitch-chord ratio was determined, together with the blade setting angle for the given inlet angle, pitch-chord ratio, and camber ratio. G.R.

A72-16486 # Application of two-dimensional cascade performance to the rotating blade row with spanwise stream. M. Inoue (Kyushu University, Fukuoka, Japan) and N. Mori (Ministry of International Trade and Industry, Public Utility Bureau, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 65-72. 14 refs.

An approach is proposed for correcting cascade performance data for the effect of the inclination of average stream surface. It is pointed out that this effect cannot be ignored for some operational conditions even in the case of common axial-flow compressors. In modern high-speed axial-flow compressors the annulus walls are usually inclined to the rotating axis. The inclination of annulus walls may introduce a meridional streamline inclination of substantial magnitude. The two-dimensional cascade data can also be used in the case of a mixed flow impeller with comparably small cone angle. G.R.

A72-16487 # Dynamic performance of stalled blade rows. S. Nagano, Y. Machida, and H. Takata (Tokyo, University, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 73-80.

The dynamic performance of stalled blade rows is investigated experimentally. The dynamic response of the total pressure loss across the blade row is expressed in terms of the inertia effect of the fluid in the blade channel and the time delay. The time delay is mainly due to the behavior of the boundary layers on the blade surface. An equation is presented for expressing the boundary layer time delay. The dynamic response of the outlet flow angle is also expressed by an equation. The time constant in the last equation varies considerably with the degree of blade stall. G.R.

A72-16488 # Effects of interference between moving blade rows on cascade flutter. H. Tanaka, Y. Hanamura (Tokyo, University, Tokyo, Japan), and H. Kobayashi. In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 81-88. 13 refs.

The investigation conducted of the relative motion between rotor and stator cascades is based on the relations of finite pitch aerofoil theory. The case in which the cascade of flexible blades is placed downstream from the cascade with rigid blades is investigated. It is found that the critical flutter velocity decreases as the cascade of flexible blades approaches the cascade of rigid blades. Similar results are obtained in the case in which the cascade of flexible blades is placed upstream from the cascade of rigid blades. G.R.

A72-16489 # A two-dimensional cascade test of an air-cooled turbine nozzle. T. Yoshida, K. Takahara, and H. Nouse (National Aerospace Laboratory, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 89-96.

A description is given of the aerodynamic characteristics and the heat transfer properties of air cooled turbine nozzles in which cooling air flows along the chordwise direction. A two-dimensional cascade test had been conducted with the aid of a low velocity wind tunnel. Corrections are applied to the data to obtain results regarding the cooling effectiveness of real turboengines. Numerical calculations conducted by the finite difference method are presented. An analog simulation test, in which the temperature distributions were simulated by an approach using electric resistance paper, is also discussed. G.R.

A72-16490 # Gas-particle suspension properties in a cascade nozzle. W. Tabakoff and M. F. Hussein (Cincinnati, University, Cincinnati, Ohio). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 97-104. 10 refs. Grant No. DAHC04-69-C-0016.

The analysis discussed gives information concerning the gas particle flow properties at any point in the cascade nozzle including the blade boundary. These results provide an indication of the tendencies and the behavior of particulate gas flow in the cascade nozzles. Experimental findings for the particulate gas flow pressure show good agreement with the theory at the different streamlines through the cascade nozzle. G.R.

A72-16491 # Study on a high intensity combustion chamber for gas turbines. K. Suzuki and A. Ishii (National Aerospace Laboratory, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 128-134. 7 refs.

A combustor for a lightweight lifting jet engine was designed which is shorter and has higher intensity combustion than the conventional type. Problems encountered were deterioration of combustion efficiency, increase of the exit temperature pattern factor, pressure loss, and lengthening of the flame in comparison to combustion liner length. The primary, secondary, and dilution zones were considered, and fundamental data concerning each zone was applied. The combustor studied was a straight-through annular type with swirl fuel atomizers, air swirlers, and combustion liners. F.R.L.

A72-16492 # A study of a fuel vaporizer for a gas turbine engine. T. Tamaru, K. Suzuki (National Aerospace Laboratory, Tokyo, Japan), and Y. Oppata (Toeiutaku-Sahbis-Kosha, Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 135-142.

Investigation of the characteristics of vaporizing tubes on the basis of simplified models. Vaporization of fuel is most effective near the temperature of the maximum boiling point. This state is, however, unstable. Increase of the air velocity affects the atomization of liquid fuel and increases the quantity of droplets suspended in the gas. In the case of a curved tube most of the droplets impinge on the curved part of the tube and cool it severely. A certain amount of air, calculated by the concept of 'air loading,' should be introduced into the primary zone in the combustor, adding it to the air through the tubes. F.R.L.

A72-16493 # Investigation of the air stream from air-entry holes of the aeronautical gas turbine combustor. T. Aiba (National Aerospace Laboratory, Tokyo, Japan) and M. Inoue (Mitsubishi Heavy Industries, Ltd., Nagasaki, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 143-150. 7 refs.

Results of experiments concerning the behavior of jets flowing from one, two, or three air entry holes. Measurements were carried out on the temperature distribution of the gas mixture caused by the cold air injected perpendicularly into the hot gas flows. The maximum penetration of the jets, the jet flow path, the mixing of the jets, and the discharge coefficients of the holes were investigated. Some empirical expressions were obtained for the case of the single entry air hole. The jets issuing from two or three holes showed behavior similar to that of a single air entry hole after a certain downstream distance from the holes. Their behavior was compared to the results from a single hole. The jet from a single air entry hole was also numerically analyzed, taking into account aerodynamic and thermodynamic characteristics and entrainment. F.R.L.

A72-16499 # Post war development of aircraft gas turbines in Japan. T. Iijima (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 258-263.

Post-war development of the aircraft gas turbine in Japan has not necessarily been large in scale nor excellent in its performance level. Only one family of engines, the J3, has succeeded in getting into production, and together with other experimental and developmental work on aircraft engines and components, it has helped to maintain and promote the aircraft engine and related industries. M.M.

A72-16500 # Development of and improvement to gas turbine compressor GCM1B. K. Miwa (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan). In: Tokyo Joint International Gas Turbine Conference and Products Show, Tokyo, Japan, October 4-7, 1971, Proceedings. Tokyo, Japan Society of Mechanical Engineers, 1971, p. 287-292.

Description of modifications of the bleed air type gas turbine GCM1B which was developed 15 years ago and is still in production. A reliability improvement program which was implemented in the operational phase is presented as an approach to solving problems which may be common to small gas turbines in general. M.M.

A72-16530 # Aircraft radio equipment (Radiooborudovanie letatel'nykh apparatov). O. V. Vlasov and I. V. Smokin. Moscow, Voenizdat, 1971. 360 p. 32 refs. In Russian.

The general principles of designing aircraft radio equipment are outlined, with particular reference to the physical processes involved and to the calculation of the quantitative characteristics of the equipment. Methods of transmitting and receiving information are examined, along with methods of measuring the coordinates and velocity of moving objects. The radio equipment of siting and navigation systems, flying-target interception systems, aircraft protection systems, reconnaissance systems, and landing systems is described. The book is intended for military and civil aviation flying personnel. It is useful also as a textbook. V.P.

A72-16534 * # Reduction of wave drag by antisymmetric arrangement of wings and bodies. R. T. Jones (NASA, Ames Research Center, Moffett Field, Calif.). *AIAA Journal*, vol. 10, Feb.

1972, p. 171-176. 13 refs.

The wave interference effects for bodies or wings in a mirror-symmetric arrangement, and in an antisymmetric arrangement are discussed. It is shown that while in the case of a mirror-symmetric arrangement large adverse interference effects can be observed, antisymmetric arrangements provide comparatively much smaller wave drags. The single continuous wing panels also adapt themselves more readily to varying angles of obliquity, and hence, to varying flight speeds. A detailed review is presented of the previous work on the aerodynamic properties and flight stability of oblique elliptic wing combinations. A possible mode of application of these combinations to transport aircraft operating at moderate supersonic speeds is suggested. O.H.

A72-16542 # Vortex-elliptic wing interaction. W. P. Jones (Texas A & M University, College Station, Tex.). *AIAA Journal*, vol. 10, Feb. 1972, p. 225-227. Grant No. DAHC04-69-C-0015. Project THEMIS.

The problem of wing-vortex interaction is treated analytically, and exact solutions are obtained for different vortex positions relative to the wing. When the vortex is below midspan, solutions for a whole range of aspect ratios can be found once the solution for the lowest aspect ratio has been obtained. The solutions presented ignore the structure and velocity distribution of the vortex core, as well as lifting surface effects. M.V.E.

A72-16553 Advances in Zener diode vehicular and aircraft transient suppressors. B. Reich and J. Erickson (U.S. Army, Electronics Technology and Devices Laboratory, Fort Monmouth, N.J.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Sept. 1971, p. 792-797.

The prime purpose of this paper is to describe the advances in Zener diode transient suppressors for ground vehicle and aircraft application. The evolution of the transient suppressor development for the U. S. Army is presented with emphasis on space, weight, and cost considerations. Improvements including an electronic thermal switch and a 'battle override' switch are also described. A futuristic transient suppressor of modular design developed for use as an integral part of the equipment being protected is functionally described. (Author)

A72-16556 Unified control systems. B. E. Keiser (Auditing Services of Virginia, Vienna, Va.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Sept. 1971, p. 809-829. 13 refs.

A survey of the subject of unified control systems for the guidance of unmanned vehicles, such as pilotless aircraft and satellites, is presented. Unified refers to the fact that the tracking, telemetry, and command functions are all performed using a single channel and, at least ideally, a single set of equipment. The principles are outlined, followed by descriptions of several novel applications to the control of multiple vehicles. Examples based upon existing systems also are provided. (Author)

A72-16559 Computed performance of glide slope arrays on sites with limited ground plane. R. W. Redlich (Ohio University, Athens, Ohio). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Sept. 1971, p. 854-862. 5 refs. Research supported by the Department of Civil Aviation of Australia and FAA.

The computed performance of four different types of glide slope transmitting arrays sited over idealized ground planes consisting of one-dimensional perfectly conducting strips of various lengths in free space is presented. The idealized ground plane approximates the practical case of a site consisting of an expanse of relatively flat ground plane ending in a precipitous dropoff or in rough diffusely reflecting terrain. The computed results show several phenomena which have repeatedly been observed. (Author)

A72-16571 * Analysis and design of antennas for air traffic collision avoidance systems. C. A. Balanis (West Virginia University, Morgantown, W. Va.) and C. R. Cockrell (NASA, Langley Research Center, Flight Instrumentation Div., Hampton, Va.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Sept. 1971, p. 960-967. 9 refs.

The analysis and design procedure of an antenna for a CW Doppler radar system being developed for pilot warning of midair collision hazards is presented. The antenna consists of two vertical arrays of half-wavelength dipoles mounted near a circular conducting cylinder. Each vertical array is composed of three vertical dipoles. Each array provides relatively uniform illumination (2.3 dB) in the forward 180-deg angular segment of the horizontal plane and approximately plus or minus 10 to 15 deg coverage in the vertical plane. The antenna could be used in a two-mode operation, either in a standard monopulse radar system (sum and difference patterns) or in a system where amplitude and phase are the measurable quantities. (Author)

A72-16574 A Bayesian analysis of avionics subsystem built-in test. E. C. Harmon (General Dynamics Corp., Fort Worth, Tex.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Sept. 1971, p. 982-987.

A major development in test philosophy of aircraft being built today and those being designed for the immediate future is the incorporation of on-board, computer-controlled 'built-in' testing (BIT) into the airplane as part of the avionics subsystem. A requirement being imposed by today's specifications is a probability of 0.95 or better that the BIT function will detect a failure. It is shown that a single specification of BIT capability is insufficient to completely define the requirements for BIT. The proof of this conclusion is offered in the form of an analysis of the conditional probabilities involved in the occurrence and reporting of subsystem failures. (Author)

A72-16597 * Aerospace vehicle noise-induced structural vibrations. H. H. Hubbard (NASA, Langley Research Center, Hampton, Va.). *Sound and Vibration*, vol. 5, Dec. 1971, p. 14-17. 7 refs.

The nature of aerospace noise-induced vibration problems is summarized, with emphasis placed on reviewing and categorizing types and sources of noise which are significant in such problems. Physical characteristics of representative noise loads associated with propellers, turbojet engine exhausts, and sonic boom waves are presented. Examples of noise-induced structural vibrations are discussed. (Author)

A72-16652 Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. Symposium sponsored by the Society of Flight Test Engineers.

California, Md., Society of Flight Test Engineers, 1971. 323 p. \$10.00.

The papers deal with an automatic approach and hover coupler for a helicopter, the flight testing of an automatic carrier landing system, the status of the 'Omega' system and its applications to airborne navigation, the use of photogrammetrics in flight-testing a navigation system, and simplified criteria for optimization and evaluation of control augmented aircraft aiming performance. Also treated are flight test evaluation of terrain-following concepts for helicopters, wind tunnel investigations of a closed-loop fluidic bidirectional jet flap control system for airfoil lift modulation, a variable stability program, a versatile flight control system for a V/STOL flight test program, test and field MTBF of a flight control system, test and evaluation of an automatic drone flight control system, flight test evaluations of a back-up flight control system, and open-loop control systems for external compression engine air inlets.

F.R.L.

A72-16653 Automatic approach and hover coupler for HH-53 helicopter. R. A. Andes (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 21 p.

The Automatic Approach and Hover Coupler provides the HH-53 rescue helicopter with the capability to automatically transition from forward flight, anywhere within the HH-53 flight envelope, to a hover over flat or rolling terrain, independent of gross weight and center of gravity. The approach coupler design is based on an approach trajectory characterized by a constant longitudinal deceleration of .8 knots/second and a constant rate of descent of 300 feet/minute until a ground speed of 40 knots is reached. At this point, the rate of descent is reduced to 100 feet/minute. The hover coupler provides altitude retention within plus or minus 3 feet and zero knot ground speed within plus or minus 1.5 knots of the Doppler radar measured velocity. A hover trim control is also provided to permit a limited repositioning of the aircraft by the pilot/copilot/crewman during the rescue operation. (Author)

A72-16654 Flight testing of the automatic carrier landing system. R. A. Russell (U.S. Naval Air Test Center, Patuxent River, Md.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 26 p.

Description of the U.S. Navy Automatic Carrier Landing System (ACLS), which was developed to provide for the safe and reliable final approach and landing of carrier based aircraft with minimum interference from conditions of severe weather and sea state. Test, evaluation and development of the ACLS began in 1963. Current shore-based and shipboard test techniques are discussed, and a block diagram description of the system is given. The shore-based test techniques are loop stability analysis of the aircraft in the control loop from in-flight measurements. Existing problem areas and the current status of fleet utilization are outlined. A brief analogous application of the in-flight loop stability test techniques to evaluation of an automatic bombing control system is included. F.R.L.

A72-16656 The use of photogrammetrics in flight testing the A-7D/E navigation system. R. R. Reed, Jr. (Vought Aeronautics Co., Dallas, Tex.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers.

California, Md., Society of Flight Test Engineers, 1971. 19 p.

Discussion of why and how photogrammetrics was used as a primary tool to evaluate the navigation system in the model A-7D and Model A-7E. The primary components of the Navigation/Weapon Delivery System (NWDS) are the digital computer, head-up display, Doppler radar, inertial measurement set, air data computer, projected map, forward looking radar, and radar altimeter. A technique devised by Church (1945), called Space Resectioning, met the requirements for evaluation. It requires that three ground control points be photographed within one frame of film. Then by projecting the film back on the controls, the position and attitude can be determined. The technique was found to yield data necessary to accomplish the flight test program at a cost substantially lower than that for other techniques. F.R.L.

A72-16657 A simplified criterion for optimization and evaluation of combat aircraft lateral aiming performance. D. G. Bailey (Honeywell, Inc., Government and Aeronautical Products Div., St. Paul, Minn.) and M. Mobarg (Saab-Scania AB, Göteborg, Sweden). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 37 p.

Suggestion of a criterion for optimization and evaluation of combat aircraft lateral aiming performance. The criterion applies to lateral bullet stream response to pilot roll commands, and is intended to provide a reference for objective evaluation of the ability of a particular system to hit a target with bullets from a body-mounted gun. It was found that at positive load factors, bullet stream lateral rate response to small bank angles should be fast and stable, with no rate reverses. Optimization of the lateral rate response can produce violations of existing handling quality requirements, i.e., sideslip transients during roll maneuvers. F.R.L.

A72-16658 Flight test evaluation of terrain following concepts for Army helicopters. C. D. Griffith (U.S. Army, Avionics Laboratory, Fort Monmouth, N.J.) and E. Allmer (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 24 p.

Outline of the objectives of a flight test program which is designed to evaluate various terrain following and/or terrain avoidance (TF/TA) concepts for rotary wing aircraft. The purpose is to provide a solid data base from which the correct TF/TA capability can be chosen in terms of operational capability, performance, and cost. Major attention is given to the Terrain Following Coupler, which is only one element of the overall complement of hardware. The development of a sound system concept, of which the coupler is an integral part, is found to be vital to the success of such a program. F.R.L.

A72-16659 Wind tunnel investigations of a closed-loop fluidic bi-directional jet-flap control system for airfoil lift control. R. E. Rose and G. A. Smith (Honeywell Systems and Research Center, St. Paul, Minn.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 31 p. 5 refs.

A bi-directional jet-flap called the Variable-Deflection-Thruster (VDT) has been investigated as part of a fluidic airfoil lift control

system. A wind tunnel test program was conducted to establish the feasibility of airfoil lift control using the fluidic VDT control system. The possible application to helicopter rotor blades was of primary interest. The lift control was achieved by automatic variation of the VDT jet angle for various angles of attack and free-stream velocities. The airfoil lift was sensed from the pressure differential at the airfoil mid-chord, and this pressure signal was amplified with fluidic circuitry to control the deflection angle of the VDT jet-flap.

(Author)

A72-16660 **NF-8D variable stability program.** R. A. Burton (U.S. Naval Air Test Center, Flight Test Div., Patuxent River, Md.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 26 p.

Description of the procedures used in the ground/inflight calibrations of the Variable Stability System (VSS) installed in NF-8D BuNo 147041, with comments on the relative merits of ground vs inflight calibration procedures. The procedures represent a technique which can successfully be used to identify the various elements of an automatic flight control system. Both the inflight and ground calibration techniques have their own relative merits and should be used in conjunction with each other to give test results the highest level of confidence possible. F.R.L.

A72-16661 **HOVVAC - Navy's versatile flight control system for V/STOL flight test programs.** J. C. Dendy (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 18 p. 6 refs.

Description of the HOVVAC (Hovering Vehicle Versatile Automatic Control), a digital hybrid flight control system. HOVVAC is a developmental flight system, adaptable to different configurations of helicopters and other V/STOL aircraft. A general purpose airborne digital computer performs the navigation/guidance (flight path control) computations; attitude stabilization and command augmentation are provided through a high-gain model-following analog design. The system is designed so that software changes, rather than hardware changes, make it adaptable to different aircraft and different missions. A part of the system is the Flight Test Calibration Unit which allows the flight test engineer to modify, in flight, the characteristics of the analog attitude control system and the digital flight path computer. F.R.L.

A72-16662 **Test and field MTBF of an aircraft flight control system.** J. Leidig and L. L. Montague (Honeywell, Inc., Minneapolis, Minn.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 19 p.

Discussion of the MTBF behavior of four major devices in a representative avionics system as measured under both MIL-STD-781 testing and field operation, with inclusion of the related data that were analyzed in greater depth to obtain general unbiased factors for adjusting MTBF predictions between field and AGREE test environments. These same factors can be subsequently used for future MTBF predictions under both field and AGREE test environments on similar systems with consistent baselines. F.R.L.

A72-16663 **Test and evaluation of a versatile drone automatic flight control system for the BQM-34A.** R. J. Gerrity (Lear Siegler, Inc., Astronics Div., Santa Monica, Calif.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 19 p.

Description of the flight test philosophy and results obtained during the flight test phase of the Versatile Drone Autopilot development program. The program was divided into three main tasks: the flight testing of the BQM-34A subsonic target drone, the XBQM-34E supersonic target drone, and the QT-33 droned jet aircraft trainer. The system was designed to fly various droned aircraft through both basic and advanced modes with relatively minor changes to the flight control box. At present, the autopilot has flown the three aircraft through their basic modes, and has flown the BQM-34A through one of its advanced modes. F.R.L.

A72-16664 **Flight test evaluation of A-7D/E emergency /back-up/ flight control system.** K. G. McEntire and E. H. Underwood, Jr. (Vought Aeronautics Co., Dallas, Tex.). In: Symposium on Test and Evaluation of Automatic Control Systems, Saint Mary's College of Maryland, Saint Mary's City, Md., August 31-September 2, 1971, Technical Papers. California, Md., Society of Flight Test Engineers, 1971. 28 p.

Description of the system design and function of the three hydraulic power control (PC) systems in the A-7 attack aircraft. Some of the unique features of the system are the fact that each of the three PC systems is really an emergency control system in itself and provides the capability of maneuvering and landing the aircraft; the design and routing of each hydraulic system is configured so that at least one PC system would remain operative in the event of combat damage to any localized part of the aircraft; and that the automatic flight control system is used to provide a portion of primary flight control in one emergency configuration of the back-up control system. The mechanics which are used to simulate PC failure for the flight test program are explained. Flight safety was a major consideration. The flight test results which evaluated each of the three PC systems are evaluated individually. F.R.L.

A72-16669 **Modification of Karl Fischer method for determination of water in light petroleum products including aviation fuels.** R. C. Misra (Indian Institute of Technology, Bombay, India). *Defence Science Journal*, vol. 21, Apr. 1971, p. 141, 142.

Classical Karl Fischer method has been modified so as to make it suitable for determining free and dissolved water present in aviation fuels in excess of 10 ppm which is considered as limiting concentration value for safe fueling of aircrafts particularly in the arduous climatic conditions as encountered in military operations. The modified method employed a special ethylene glycol solvent mixture and another water-saturated fuel sample as blank. (Author)

A72-16693 **Design airports for a maximum capacity.** M. Daly (Daly and Associates, Inc., Pleasant Hill, Calif.). *Airport Forum*, Dec. 1971, p. 7.

Proposal of a 'spiralport' to ensure maximum utilization of airport capacities. The spiralport is laid out so that there will be three full time, full use runways for landings, and three for takeoffs. The runways are set to converge in order that the points of intersection of the final approach courses will be more widely spaced. F.R.L.

A72-16694 **The A-300 B at the airport.** G. Schroll (Airbus Industrie S.A., Paris, France; Deutsche Airbus GmbH, Munich, West

Germany). *Airport Forum*, Dec. 1971, p. 9-16. In English and German.

Discussion of the use of considerably larger aircraft than have hitherto been available on short and medium haul routes, one type of which aircraft is the A-300 B. The layout and design make it possible to carry up to 260 economy passengers on stage lengths of 1600 n mi. The underwing location of the main power plants was chosen in preference to rear mounted engines because of the overriding importance of CG considerations and superstall problems. The auxiliary power unit is installed in the rear fuselage tail cone. The turning radius of the A-300 B is less than that of current aircraft of this size, and it is designed to be compatible with all existing airports.

F.R.L.

A72-16695 **Water-based airports.** R. Allen (Aviation Literary Services, Northampton, England). *Airport Forum*, Dec. 1971, p. 18-26. In English and German.

Examination of some of the numerous projects for offshore or island airports which are either in the planning stage or under active constructional consideration. A typical example of the natural island airport is Haneda, Tokyo, which is becoming obsolete. The best known example of an airport built at least in part over the sea is the Hong Kong Kai Tak airport. The Saltholm project, under consideration by Swedish and Danish authorities, is discussed, as well as projects for Lake Michigan and Lake Erie airports, an airport at Sandy Hook, N.J., and London's third airport at Foulness. The possibilities of floating airports are reviewed.

F.R.L.

A72-16696 **Newark prepares for the future.** J. Veerling (Port of New York Authority, New York, N.Y.). *Airport Forum*, Dec. 1971, p. 42-52. In English and German.

Discussion of the Newark Airport Redevelopment Program, the planning and construction of which is aimed at annual traffic levels of 12,000,000 passengers and 300,000 aircraft movements by 1975. In addition to this quantitative scale, the master plan also responds to certain peripheral influences. These include the intensity of public and private development around the airport, which precludes extension of existing land boundaries; assurance to the airport's neighbors that the Port Authority will not build runways which would direct traffic over neighboring urban areas; and a common 4-22 orientation of instrument runways at Newark with those of LaGuardia and Kennedy International. Attention is given to land preparation, public aircraft facilities, the central terminal area, terminal building design, support facilities, and program organization and scheduling.

F.R.L.

A72-16697 **Planning an air transport region.** G. Mücke and W. Apfel (Flughafen Frankfurt am Main AG, Frankfurt am Main, West Germany). *Airport Forum*, Dec. 1971, p. 57-60, 62, 63, 65, 66. In English and German.

Discussion of coordinated air transport planning, covering air transport in the German Federal Republic as one of its aspects, but forming an integrated component of the overall European air system. Such an air transport system includes the ground facilities and their conflict zones, the airspace and its control, flying equipment and its transport capacity, air service timetables and their intervals, safety, efficiency, demand areas, and the specific respects in which the air transport system differs from other transport systems.

F.R.L.

A72-16698 **The financing of airports.** K. von Laun. *Airport Forum*, Dec. 1971, p. 71-74, 76-82, 84. In English and German. Consideration of some of the major problems arising in the field

of airport financing which differ in special features from the financing of other business ventures. The creation of a new major airport requires an amount of money in the order of DM 1500 million. It is considered that airports can pass through different stages of development as far as their revenue-earning ability is concerned. Airports which provide, or are obliged to provide, facilities whose capacity is initially too great will live through low-revenue periods. However, it will usually follow that, as traffic increases and the facilities are more fully utilized, and as the interest burden is reduced, the revenue picture will improve.

F.R.L.

A72-16706 **Transformation of derivatives in flight mechanics (Umrechnung flugmechanischer Derivative).** G. Rosenau (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Dec. 1971, p. 512-517. In German.

Methods and formulas are described for the transformation of derivatives, using matrix representations. Such transformations are often necessary in problems of flight dynamics when a system of coordinates or a set of independent variables is to be used that is different from the one for which the derivatives have been originally determined.

M.V.E.

A72-16707 **Further development of Baranoff's analytical form of the kernel of the generalized Possio's integral equation.** J. Haas (Lockheed-Georgia Co., Marietta, Ga.). *Zeitschrift für Flugwissenschaften*, vol. 19, Dec. 1971, p. 518-521.

The completely analytical form of the kernel function, appearing in the generalized Possio integral equation for the case of the thin wing oscillating harmonically in subsonic flow, is further developed. The relationship to other presented forms is brought out. Certain parametric relationships which could be used in the case of nonplanar wings are given.

(Author)

A72-16708 **The rocket motor of the Mirage III E - Combat tool or gadget (Le moteur fusée du Mirage III E - Outil de combat ou gadget).** Gueguen. *Forces Aériennes Françaises*, vol. 26, Nov. 1971, p. 353-365. In French.

Description of the SEP 844 rocket motor, which uses a liquid propellant: nitric acid and kerosene. Because the mixture is not hypergolic, an igniter composed of triethylamine and xylydine (TX.2) is used. The duties of the flying groups using the motor are outlined. It was found that use of the rocket motor as a performance booster greatly enhanced the effectiveness of interception, as was demonstrated in recent NATO defense exercises.

F.R.L.

A72-16733 **Vertical takeoff and landing aircraft (Vertikal startende und landende Flugzeuge).** S. Harmsen (Berlin, Technische Universität, Berlin, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1401-1404. 32 refs. In German.

Discussion of the advantages of VTOL aircraft and of certain problems involved in their use. Means of enhancing flight safety and reducing engine noise in the case of VTOL aircraft are noted, the results of flight tests of the Hawker Siddeley Harrier are cited, and a number of VTOL projects conceived by West German, British, and American firms are described. The aerodynamics of VTOL operation are discussed, including the aerodynamic properties of a giant model with four lift fans arranged pairwise in wing pods.

A.B.K.

A72-16734 **Rotary wing aircraft (Drehflügel-Flugzeuge).** G. Reichert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn;

Darmstadt, Technische Hochschule, Darmstadt, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1404-1407. 46 refs. In German.

Description of the special features and performances of a number of currently used helicopters. The Huey Cobra, Cheyenne, and Blackhawk fighter helicopters are cited, as well as the giant Soviet helicopter, the Mil Mi-12, and the relation between recent helicopter developments and military requirements is noted. The incompleteness of existing knowledge concerning the phenomena occurring on a helicopter is cited as a factor limiting the improvement of performance. A.B.K.

A72-16735 Engine systems (Triebwerksanlagen). O. Lutz (Braunschweig, Technische Universität, Braunschweig, West Germany) and W. Alvermann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für luftsaugende Antriebe, Braunschweig, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1407-1413. 57 refs. In German.

Review of the present state of development of various types of aircraft and spacecraft engines, particularly with regard to noise reduction and reduction of exhaust gas emission. A number of proposed new French and British turbojet designs are described, including a bypass engine with a gear-driven fan with adjustable blades, which is especially suitable for V/STOLs, and two- and three-spool engines for V/STOLs with wing blowing and suction. Other proposed improvements concern miniature gas turbines, propeller turbines, reciprocating engines, ramjet engines, and propulsion systems for recoverable spacecraft. A.B.K.

A72-16736 Flight control (Flugregelung). W. Reuter, G. Schweizer, and H. Seelmann (Dornier AG, Friedrichshafen, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1414-1417. 74 refs. In German.

Review of advances made in the last decade in the development of flight control systems, and suggestion of future trends in this field. The role of the onboard computer in integrating the functions of all subsystems is noted, including some possible improvements achievable through the use of a decentralized computer arrangement. The possibility of further improvement in instrumentation, in stabilization and flight control systems (particularly for helicopters), and landing systems is discussed, and some features of inertial navigation and flight simulation are noted. A.B.K.

A72-16738 Flight safety (Flugsicherung). O. Heer (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1420-1426. 72 refs. In German.

Description of various flight safety measures to be undertaken by the Federal Republic of Germany on its own and in conjunction with other European countries. A plan covering the period from 1970 to 1975 is described, involving the construction of regional control stations in West Germany for use by the Federal Republic and the Benelux countries. Other measures taken to improve traffic control are cited, such as measures to relieve overloading of available radio frequencies and measures to relieve airlines, ground services, and ground networks of unnecessary work. Improvements in various types of navigation systems are described, as well as a plan to achieve multiple radar coverage of West Germany through the construction of a sufficiently dense network of radar systems. The possibilities of achieving automation of certain aspects of air traffic control are evaluated. A.B.K.

A72-16739 Aircraft fuels and aircraft lubricants (Flugkraftstoffe und Flugschmierstoffe). G. Spengler (München,

Technische Universität; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe; Landesgewerbeanstalt Bayern, Prüfamts für Brenn-, Kraft- und Schmierstoffe, Munich, West Germany), R. Erlmeier (Technische Akademie der Luftwaffe, Munich, West Germany), and E. Jantzen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe, Munich, West Germany). *VDI-Z*, vol. 113, Dec. 1971, p. 1427-1429. 83 refs. In German.

Review of trends noted in the development of fuels and lubricants for use in subsonic and supersonic jet aircraft. The use of highly thermostable hydrocarbon fuels is recommended for Mach numbers in the region of 4.5. The use of fuels such as RJ-5 is recommended for ramjet and combination propulsion systems at Mach numbers from 3 to 6. The use of a sterically inhibited ester containing oxidation inhibitors, metal deactivators, and high-pressure additives as a lubricant for the Concorde SST engines is noted, as well as the use of calcium fluoride as a lubricant for the ball bearings of the aerodynamic control surfaces. A.B.K.

A72-16779 # M-versions - Increase in productivity with regard to Soviet airliners (M-Versionen - Produktivitätssteigerung bei sowjetischen Verkehrsflugzeugen). K. H. Eyermann. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 11, 1971, p. 502-506. In German.

It is pointed out that a gain of 72 million workdays was obtained in 1970 as a result of the Soviet air traffic. It is planned to increase this number to 120 million workdays in 1975. It is intended to replace airliner types which were taken into service at the end of the 1950s or the beginning of the 1960s on the principal routes by new aircraft types. An example of this trend is the introduction of the Tu-154 into regular service in autumn 1971. Various new Soviet aircraft types are discussed including the 'aerobus.' G.R.

A72-16780 # The state of development of all weather landing aids for VTOL aircraft (Entwicklungsstand von Allwetterlandehilfen für VTOL-Luftfahrzeuge). P. Korell (Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 7, no. 11, 1971, p. 507-516. 30 refs. In German.

At present no standard landing aids are known which ensure the approach and the landing of VTOL aircraft and helicopters of the civil sector under all kinds of weather conditions. Three approaches for landings in bad weather are discussed. Methods for the improvement of visibility on the ground have the advantage that the aircraft does not have to carry special equipment for bad weather landings. Disadvantages of these methods are connected with high expenses involved in eliminating the mist by physical or chemical means. Doppler and inertial navigation methods were, therefore, developed during the last few years. A number of instrument landing systems are discussed including systems utilizing interferometric approaches or gamma-radiation from isotopes. G.R.

A72-16798 # A simple model for the theoretical study of slat-airfoil combinations. R. H. Liebeck and D. N. Smyth (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-221.* 8 p. 6 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F44620-70-C-0108.

The aerodynamics of slat-airfoil combinations has been studied using a single point vortex to represent the leading-edge slat. The main airfoil is chosen from an infinite set of airfoils whose mapping functions to the unit circle are analytically defined. (The classical Joukowski airfoils are members of this set.) This model allows the

entire flow field about the slat vortex plus main airfoil system to be described analytically and therefore an 'on-line' computer graphics program was prepared for its solution and evaluation. The vortex strength and position with respect to the main airfoil is prescribed and the program calculates and displays the velocity distribution on the airfoil with and without the vortex present. This program has been applied to the study and development of some basic slat design guidelines. (Author)

A72-16823 * # Use of leaning vanes for fan noise reduction. G. V. R. Rao (Rao and Associates, Sherman Oaks, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-126*. 4 p. 7 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS2-5730.

The obliquity of blade-vane interactions in an axial fan and its influence on noise generation are examined. Analysis indicates that leaning vanes decrease the amplitudes of the fluctuating pressures at the rotor-stator plane and modify the radial distribution. These changes lead to considerable cancellation in the near field and consequent reduction in radiated acoustic power. Acoustic measurements on a small scale fan with radial and leaning vanes compare favorably with analytical predictions. (Author)

A72-16824 * # The theoretical and experimental investigations on multiple pure tone noise. R. A. Kantola and M. Kurosaka (GE Research and Development Center, Schenectady, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-127*. 11 p. 7 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NASw-1922.

An investigation on multiple pure tone (MPT) noise is described. The model fan is operated, in Freon 12, in a closed loop acoustical facility. It has been found experimentally that the rotor relative Mach number and incidence angle are parameters important to the evolution of the MPT sound and the inlet duct length has a significant influence on the MPT sound emission. The experimental results are compared with a previous analysis. From the known blade nonuniformities of the model fan, the MPT distributions are computed. The analysis correctly predicts the frequency of the dominant multiple pure tone and sound pressures of the blade passing frequency noise and the dominant MPT that are in the same range as the experimental values. (Author)

A72-16827 # Quantitative effects in the use of simulators for training fighter pilots. R. K. Frick (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-161*. 13 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

Analysis of historical combat data indicates that the fraction of fighter pilots killed decreases as the number of decisive air-to-air combats increases. This could be a result of two groups of pilots being present; a superior group represented by those who learn from experience and an inferior group represented by those with no learning. A proposed plan for training, based on this hypothesis, is presented. Using a mathematical model, based on renewal theory, the paper shows how a training program using simulators can have significant payoff in terms of improved force effectiveness and reduced pilot losses. (Author)

A72-16828 # Aircraft engine anti-icing test and evaluation technology. H. H. Kissling (ARO, Inc., Arnold Engineering Develop-

ment Center, Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-162*. 15 p. 22 refs. Members, \$1.50; nonmembers, \$2.00.

Providing adequate flight safety and engine efficiency as aircraft became more sophisticated necessitated steadily improved test techniques in evaluating aircraft engine anti-icing systems. The state-of-the-art reached its most advanced point in an Arnold Engineering Development Center altitude environmental test cell. This paper describes ground facility and airborne efforts to test and evaluate anti-icing systems. Advantages and disadvantages of the four means of evaluation and of instrumentation and equipment are identified. The evidence supports a new approach to the qualification of aircraft engine anti-icing systems which will benefit engine manufacturers. (Author)

A72-16834 # Thermoelastic effect on vibration and flutter of built-up delta-wings with arbitrarily oriented structural components. T. C. Soong (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-174*. 16 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

An energy method is derived for vibration and flutter of built-up delta-wings with thermoelastic effect included. The necessary equations for beam-type members and layered anisotropic plates are tabulated so that structures using such members as components can be easily analyzed for static and dynamic problems with arbitrary thermal gradient and stiffness orientations. A large, built-up delta-wing of NACA with assumed temperature distribution was used for analytical studies. Preliminary results showed that with constant ambient temperature, flutter speed is increased when spars, stiffeners and major stiffness direction of plates are made to be parallel to, or swept back more than, the leading edge of the wing. Flutter characteristics are compared for delta-wings of solid skin, stiffened skin, honeycomb sandwich, and corrugated sandwich skin of equal weight with component orientations and stiffness directions of skin varied. For an assumed temperature distribution which is constant along boundaries of the wing and lower in the interior, thermal effect on vibration and flutter for fixed geometry seemed to be less significant when stiffeners were at swept-back positions than at tip-forward positions. (Author)

A72-16843 * # Relaxation techniques for three-dimensional transonic flow about wings. F. R. Bailey and J. L. Steger (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-189*. 15 p. 17 refs. Members, \$1.50; nonmembers, \$2.00.

A relaxation procedure has been developed to treat the three-dimensional, transonic small perturbation equations about finite lifting wings. A combination of two schemes is employed. For flow forward of the wing trailing edge the equations are written in terms of a velocity potential in order to minimize computer algebra and storage. For the remaining flow field the equations are written in terms of the velocity components in order to simplify the enforcement of the Kutta condition. Difference equations and relaxation procedures are described for both schemes. The computational method automatically captures the imbedded shock wave in the three-dimensional flow field. Computed results are given and compared to experiment and other inviscid methods. (Author)

A72-16849 * # Sonic boom generation propagation and minimization. A. Ferri (New York University, Bronx, N.Y.) and I. R. Schwartz (NASA, Ames Research Center, Moffett Field, Calif.).

American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-194. 13 p. 78 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGL-33-016-119.

Consideration of the possibility of reducing sonic boom noise to a level acceptable in populated areas. A detailed study is made of the possibility of predicting sonic boom generation, taking into account the effect of atmospheric conditions, air turbulence, and the effect of the shape and condition of the ground where people are located. The relation between the shape of the sonic boom signature on the ground and the aircraft shape is shown to be an important factor governing the use of supersonic aircraft over populated areas. A.B.K.

A72-16861 * # **Mathematical model for two-dimensional multi-component airfoils in viscous flow.** W. A. Stevens, S. H. Goradia, J. A. Braden (Lockheed-Georgia Co., Marietta, Ga.), and H. L. Morgan (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-2.* 11 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

A computerized analytical model of a multi-component airfoil in viscous, subsonic flow has been developed. The model, representing attached flow, defines viscous pressure distributions, lift, moments, and local boundary-layer properties on each element of an arbitrarily arranged slotted airfoil. The final viscous solution is obtained by an iterative technique for successively combining an inviscid solution with boundary-layer displacement thicknesses. Ordinary boundary-layers include laminar, transition, and turbulent types. A significant feature of the program is an analytical model representing the merging of the upper surface boundary layer with the slot efflux. Typical correlations with experiment are provided and program applications are discussed. (Author)

A72-16863 # **A calculation method for the turbulent transonic viscous-inviscid interaction on airfoils.** F. K. Enseki (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-5.* 14 p. 18 refs. Members, \$1.50; nonmembers, \$2.00.

An approximate method is presented for calculating the turbulent-boundary layer development for an airfoil at high transonic speeds. Upstream of the airfoil shock wave, the wall pressure distribution is assumed known and the boundary layer is calculated by an existing integral method. In the supersonic portion of the shock pressure rise, a direct coupling between the boundary-layer and wall-pressure developments is assumed. An analytical model for the coupling process is postulated and the appropriate equations defined. Downstream of the sonic point, the Mach number distribution at the edge of the boundary layer is assumed to be linear, and the boundary layer is calculated by an integral entrainment method. Required auxiliary functions are determined by correlating the method with the transonic shock/boundary-layer interaction data of Seddon. (Author)

A72-16864 # **A contribution to a survey on insert vane cooling.** E. C. Bassinot (SNECMA, Melun-Villaroche, France). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-7.* 15 p. 19 refs. Members, \$1.50; nonmembers, \$2.00.

Use of an internal insert for air blowing to satisfactorily solve the problem of cooling high pressure turbine guide vanes in aircraft turbine engines. The leading edge is cooled by impingement; some

test results are discussed. The trailing edge is protected by a cooling air film bled on the suction side. This cooling process overcomes the forced convection process through cooling holes without being counterbalanced by any aerodynamic performance degradation. An analysis of thermal stresses is carried out for a typical configuration. F.R.L.

A72-15875 * # **Test of 50-kw heat-pipe radiator.** G. M. Kikin and M. L. Peelgren (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D. C., Nov. 28-Dec. 2, 1971, Paper 71-WA/HT-16.* 9 p. Members, \$1.00; nonmembers, \$3.00.

A heat pipe radiator consisting of 100 sodium-filled, 1.91-cm OD, stainless steel heat pipes has been tested at temperatures up to 760 C. This radiator was initially designed to have a heat pipe temperature of 740 C with a central coolant channel temperature of 771 C. The as-fabricated radiator heat pipe temperatures varied from 605 C to 700 C when the central coolant channel average temperature was 740 C. The heat pipes operated at 25 C to 110 C lower-than-expected temperatures, resulting in a 43 kW heat rejection capability vs the 50 kW design goal and the 65 kW ultimate capability of the radiator. The 43 kW heat rejection yields a mass/heat rejection ratio of 0.182 kg/kWt which is good for this early state-of-the-art heat pipe radiator. An end-of-mission life specific weight of 0.154 kg/kW is apparently achievable with improvements in radiator fabrication and brazing techniques. (Author)

A72-16877 # **The external heat transfer distribution on film cooled turbine vanes.** R. D. Lander, R. W. Fish, and M. Suo (United Aircraft Corp., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-9.* 11 p. 10 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-68-C-1644.

Experiments are described which determined the heat transfer to the suction surface of two film cooled first stage turbine vanes containing different midspan pressure distributions. The film ejection geometry for both vanes was a two-row discrete hole scheme. Evaluation of the heat transfer to the film cooled vanes was made in a turbulent environment downstream of an aircraft turbojet engine combustor at moderately high primary gas stream temperatures and pressures. Three cases were considered: (1) a vane with no film cooling holes, (2) a vane with two rows of film cooling holes but no blowing, and (3) a vane with cooling holes at varying blowing rates. Results of these tests provided quantitative data on the adiabatic film effectiveness, in addition to the external heat transfer coefficients based on the difference between the film cooled adiabatic wall temperature and the wall temperature. It is shown that the presence of film cooling holes can increase the heat transfer even without blowing. Also, higher heat transfer coefficients were measured with blowing than without blowing when based on the measured adiabatic film temperature. (Author)

A72-16885 # **Atmospheric turbulence.** J. C. Houbolt (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-219.* 24 p. 35 refs. Members, \$1.50; nonmembers, \$2.00.

Atmospheric turbulence and its influence on the flight and design of aircraft is reviewed. Coverage includes accidents and costs incurred as a result of turbulence, the mechanisms of turbulence generation, prediction methods, the nature and interpretation of turbulence measurements that are made, aircraft response and design

procedures due to turbulence encounter, and loads alleviation devices. Basic research notions associated with the interpretation of turbulence data, some of which are controversial, and areas of weakness, are also discussed. (Author)

A72-16888 * # **Multielement suppressor nozzles for thrust augmentation systems.** R. L. Lawrence, J. V. O'Keefe, and R. B. Tate (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-131.* 18 p. 18 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS2-6344. NASA Task I.

The noise reduction and nozzle performance characteristics of large-scale, high-aspect-ratio multielement nozzle arrays operated at low velocities were determined by test. The nozzles are selected for application to high-aspect-ratio augmentor suppressors to be used for augmentor wing airplanes. Significant improvements in noise characteristics for multielement nozzles over those of round or high-aspect-ratio slot nozzles are obtained. Elliptical noise patterns typical of slot nozzles are presented for high-aspect-ratio multielement nozzle arrays. Additional advantages are available in OASPL noise reduction from the element size and spacing. Augmentor-suppressor systems can be designed for maximum beam pattern directivity and frequency spectrum shaping advantages. Measurements of the nozzle wakes show a correlation with noise level data and frequency spectrum peaks. The noise and jet wake results are compared with existing prediction procedures based on empirical jet flow equations, Lighthill relationships, Strouhal number, and empirical shock-induced screech noise effects. (Author)

A72-16899 * # **A method for analyzing dynamic stall.** P. Crimi and B. L. Reeves (Avco Corp., Avco Systems Div., Wilmington, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-37.* 13 p. 20 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS1-10213.

A method has been developed for analyzing dynamic stall which employs a model for each of the basic flow elements involved in the unsteady stall of a two-dimensional airfoil in incompressible flow. The interaction of these elements is analyzed using a digital computer. Calculations of the loading on an airfoil during transient and sinusoidal pitching motions are in good qualitative agreement with measured loads. Dynamic overshoot, or lift in excess of the maximum static value, and unstable moment variation are in clear evidence in the computed results. Quantitative differences can be attributed in part to the use of a linearized representation of the potential flow and a quasi-steady model of the viscous mixing region. Computations were also performed of the loading and pitch response which result from unsteady stall induced by a series of discrete vortices convected past an elastically restrained airfoil. The results were used to confirm that large torsional response of helicopter blades during a maneuver which had been detected in flight tests can be attributed to dynamic stall induced by previously formed tip vortices. (Author)

A72-16900 # **A preliminary analytical and experimental investigation of helicopter rotor boundary layers.** D. A. Blaser and H. R. Velkoff (Ohio State University, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-38.* 11 p. 11 refs. Members, \$1.50; nonmembers, \$2.00. Army-sponsored research.

A program was undertaken to obtain boundary layer data on a rotating airfoil and to compare these data with a theoretical boundary layer analysis. Laminar flow boundary layer calculations are made for steadily rotating airfoils at zero lift using momentum-

integral techniques. Initially, the flat plate zero pressure gradient case was considered. The similarity solution for this simple case serves as a check for the numerical techniques used to obtain approximate solutions to the momentum-integral equations. Following a successful solution to this case, the method was extended to include non-zero pressure gradients and airfoils of finite thickness with blunt leading edges. Shear stress and velocity profile distributions are presented for flat plate and NACA 0012 airfoil sections. Experimental measurements are obtained on a hover test stand using dual sensor hot wire probes. Boundary layer velocity profiles along the chordwise and spanwise coordinates are presented for an NACA 0012 airfoil at zero lift. A comparison of the analytical model and the hot wire data is made; however, only limited agreement is observed. (Author)

A72-16901 # **Subsonic and transonic potential flow over helicopter rotor blades.** F. X. Caradonna (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) and M. P. Isom (New York University, Bronx, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-39.* 16 p. Members, \$1.50; nonmembers, \$2.00.

Compressible potential flows over non-lifting, hovering helicopter blades are described by suitable linear and non-linear equations of motion for subsonic and transonic cases, respectively. Analytical and numerical results are presented for the linearized subsonic three-dimensional flow in the tip region. When the tip Mach number is transonic, the flow field is calculated using a computational method that is a formal extension to three dimensions of recently developed non-linear two-dimensional relaxation schemes. Calculations are presented for rectangular blades with 6% thick biconvex sections. Calculations show the relative importance of tip Mach number and aspect ratio on the growth and extent of shock waves in the tip region. (Author)

A72-16902 * # **The farfield structure of aircraft wake turbulence.** W. H. Mason and J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-40.* 15 p. 31 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGL-47-004-067.

Detailed mean flow measurements were obtained at stations up to thirty chordlengths downstream in an airfoil trailing vortex using a yawhead pressure probe in the Virginia Tech Six-Foot Subsonic Tunnel. Mass injection at the wingtip was shown to hasten the vortex decay. A theoretical method has been developed to show the effect of wing circulation distribution on the structure of the outer portion of the vortex and excellent agreement with the experimental data is demonstrated. Experimental results indicate a much slower decay and higher tangential velocities than previously expected. (Author)

A72-16903 # **Analytical studies of aircraft trailing vortices.** G. D. Kuhn and J. N. Nielsen (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-42.* 26 p. 13 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F44620-70-C-0052.

The effects of turbulent mixing and buoyancy on the motion and persistency of a trailing vortex wake behind an aircraft are considered. A model for the characteristics of a turbulent vortex, based on an analogy to a turbulent boundary layer, is presented. A theory of trailing-vortex characteristics behind an aircraft is presented based on considerations of the angular and linear momentum of the vortex and the total pressure variation along the axis. The turbulent shear of the axial flow was shown to be the

dominant mechanism for the growth of the core radius, the decay of the peak tangential velocity, and the decay of the axial velocity defect. A model of a buoyant vortex wake is presented in which the entrainment of ambient air is accounted for by diffuse mixing between the ambient air and the turbulent air in the vortex wake. Calculations showed that the entrainment of air due to such mixing can have significant influence on the vortex motions. (Author)

A72-16905 * # Automated aircraft scheduling methods in the near terminal area. L. Tobias (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-120.* 7 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

A general scheduling algorithm for aircraft from terminal area entry to touchdown is developed. The method has the following novel features: (1) many speed classes of aircraft are considered and speed variations within classes and along portions of the flight path are permitted; (2) multiple paths are considered which may merge or diverge - the analysis is not restricted to a single runway nor to departures only; (3) landings are scheduled along conflict free flight paths in minimum time. The algorithm is currently being incorporated in a fast-time simulation of a STOL air traffic system. (Author)

A72-16907 * # Calculation of sonic boom signatures by bi-characteristic methods. S. S. Davis (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-195.* 8 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.

An improved method is described for correcting the zeroth order (free stream) characteristics to obtain a uniformly valid first order solution to the exact equations of motion for a compressible fluid. The method is based on constructing first order bi-characteristic lines from the system of ordinary differential equations belonging to the exact equation for the characteristic surface. Calculated sonic boom signatures are compared with experiments conducted at Langley Research Center on a cone-cylinder at Mach numbers 2.96, 3.83, and 4.63. Theory and experiment agree well over the entire Mach number range. (Author)

A72-16917 # Subsonic unsteady aerodynamics for general configurations. J. P. Giesing, T. P. Kalman (Douglas Aircraft Co., Long Beach, Calif.), and W. P. Rodden. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-26.* 14 p. 38 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-70-C-1167. USAF Task 137003.

A technique for predicting steady and oscillatory aerodynamic loads on general configurations has been developed which is based on the Doublet-Lattice Method and the method of images. Chord and spanwise loading on lifting surfaces and longitudinal body load distributions are determined. Configurations may be composed of an assemblage of bodies (with elliptic cross sections and a variation of width or radius) and lifting surfaces (with arbitrary planform and dihedral, with or without control surfaces). Loadings predicted by this method are required for flutter, gust, frequency response, and static aeroelastic analyses and may be used to determine static and dynamic stability derivatives. (Author)

A72-16920 * # Aeroacoustic characteristics of jet flap type exhausts. H. D. Gruschka (Tennessee, University, Tullahoma, Tenn.)

and G. O. Schrecker. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-130.* 11 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-43-001-075.

This work which is intended to shed more light on the acoustic and fluid dynamic characteristics of jet flap type exhaust flows, reports and discusses some typical experimental results obtained with cold model air jets in a reverberation chamber. Acoustic data on the total sound power output and the overall noise spectrum of various jet flap configurations are given and compared with data from conventional circular jets. In addition various flow data for the same jets resulting from hot wire measurements are reported and general conclusions are obtained regarding the expected noise, source distribution. The results indicate the dependence of the acoustic and flow characteristics on the major nozzle parameters. For the jet flaps the total radiated sound power is found to follow a 3 to 6 power of the exhaust velocity while for the circular jets the 8 power law is confirmed. The noise produced in the secondary mixing region downstream of the flap trailing edge tends to exceed the noise issuing from the primary mixing region. (Author)

A72-16921 # Lifting fan noise studies with superimposed cross flows. G. Krishnappa (National Research Council, Engine Laboratory, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-128.* 12 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

Experimental studies on noise radiation from a single-stage lifting fan operating at subsonic tip speeds are described. The effects on noise radiation of inlet flow distortion due to superimposed cross flow are presented. Under zero cross flow conditions, narrow band analysis of the results shows the presence of discrete shaft order tones in addition to high level tones at blade passing frequencies at a subsonic tip speed of 628 ft/sec. Under cross flow conditions, there is an increase of up to 10 dB in the level of broadband noise. The shaft order tones become less conspicuous because of this rise in broadband noise. The radiation patterns of blade passing tones show strong dependence on the cross flow. An unexpected reduction in peak blade passing tone levels at some conditions of cross flow suggests the two interaction mechanisms, flow distortion with rotor and rotor with stator, are interdependent. (Author)

A72-16922 # An analysis of Navy approach power compensator problems. S. J. Craig, R. F. Ringland, and I. L. Ashkenas (Systems Technology, Inc., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-124.* 10 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. N62269-70-C-0172.

Conventional open- and closed-loop servo analysis methods are employed using current pilot model concepts to analyze problem areas associated with Naval aircraft Approach Power Compensator Systems (APCS). Pilot comments and observed performance in the carrier approach task for both manual and automatic (ACLS) operations are correlated with these analyses to identify root difficulties. The APCS' role as a flight path response augmentor as well as a regulator of airspeed is an important consideration. The problems are shown to stem directly from a small number of parameters descriptive of the dynamic response properties of the APCS-equipped aircraft. (Author)

A72-16925 # Theoretical and experimental investigation of sail rotors. S. B. Spangler and J. N. Nielsen (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of*

Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-66. 12 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

Theoretical and experimental investigation of a sail rotor with a view toward examining those aspects that would critically affect the feasibility of its use in a self-contained hovering platform. A theory was developed for rotor performance based on the use of ideal theoretical, two-dimensional, flexible airfoil section properties. The theory provided a rational method for designing rotor blades, defining the test conditions and measured quantities, and correlating test results. Tests were conducted on two rotors in hover and forward flight. Qualitatively, the tests demonstrated extremely stable behavior of the rotor with both hub and tip drive in hover and in forward flight at advance ratios up to 0.3, provided that the tip weight center of mass was kept forward of the 30% chord to eliminate a torsional instability mode. The blade fabric luffing criterion was verified through tests in the wind tunnel. Quantitatively, the rotors exhibited considerably lower performance than was predicted by the theory, which indicates performance comparable to a conventional rotor. The differences are ascribed to the small scale of the tests and to the use of ideal theoretical section properties in predicting performance. (Author)

A72-16931 # A subsonic oscillating-surface theory for wings with partial-span controls. V. J. E. Stark (Saab-Scania AB, Linköping, Sweden). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-61.* 12 p. 27 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the Swedish Board for Technical Development.

Wings with oscillating control surfaces are here treated by means of a source distribution the density of which has a jump agreeing with the jump in the normal velocity at the control surface edges. Subtraction of the corresponding potential suitably modified from the jump in the advanced velocity potential, which is formed by addition of the x-coordinate to the time argument, leaves a difference which is approximated by a linear combination. The calculation of the corresponding normal velocity is performed by subtracting a so called tangent function from part of the integrand and by using polar integration variables. The problem of elastic controls is touched upon, but the applications are limited to rigid ones on swept wings. The computer program has proved rapid.

(Author)

A72-16932 # An experimental and analytical study of nonlinear motion experienced on a slender-wing research aircraft. A. J. Ross (Royal Aircraft Establishment, Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-62.* 10 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

The Handley Page 115 is a small slender-wing research aircraft, built to explore the handling characteristics of an aircraft with such a planform at low speeds. The flight tests confirmed the expectation that the Dutch roll oscillation is undamped at high angles of attack, but also showed that the motion did not diverge completely. Instead, a limit cycle developed, with steady amplitude in bank angle of about 30 deg. This paper describes a combined experimental and theoretical investigation of the nature of this nonlinear behavior. The work brought together evidence from full-scale flight tests, from static and dynamic measurements in wind-tunnels, and from tests in the RAE Flight Dynamics Simulator. The motion was also analyzed theoretically using a new approximate method for obtaining solutions for nonlinear differential equations. The analysis gives the conditions sufficient for the existence of a sustained oscillation, and its amplitude and frequency in terms of the aerodynamic and inertia properties of the aircraft. (Author)

A72-16933 # Hingeless rotor response with nonuniform inflow and elastic blade bending - Theory and experiment. R. A. Ormiston and D. A. Peters (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-65.* 14 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

A linear theory for the steady state response characteristics of a hingeless rotor helicopter blade in forward flight is presented. A harmonic balance technique is used to solve for an arbitrary number of azimuthal harmonics for each of the desired elastic blade bending modes. The important effects of nonuniform inflow are included using a simple but general formulation which also permits solution of the inverse problem: determination of the inflow from experimental data. Results of the theory are compared with recent experimental data to illustrate the particular importance of nonuniform inflow and higher elastic blade bending modes. (Author)

A72-16935 # A theoretical method for the analysis and design of multi-element airfoils. J. G. Callaghan and T. D. Beatty (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-3.* 7 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Research sponsored by the McDonnell Douglas Independent Research and Development Program.

A theoretical method is presented for the computation of the two-dimensional high lift characteristics of multielement airfoils of arbitrary shape operating in a viscous incompressible fluid. This approach combines a geometry definition routine, a potential flow method based on a surface source distribution, and a finite-difference boundary layer method to accomplish the analysis. The geometry definition routine smooths and spaces the body coordinates for input to the potential flow program. The boundary layer characteristics are then calculated from the resulting potential flow pressure distribution and an equivalent inviscid body is formed by the addition of the boundary layer displacement thickness to the original body. These coordinates are then used to calculate a new pressure distribution for the equivalent body. This process is repeated until convergence is achieved. Correlations between theoretically calculated results and two-dimensional experimental measurements are presented. (Author)

A72-16940 # Rotor blade response to random loads - A direct time-domain approach. F. Y. M. Wan (MIT, Cambridge, Mass.) and C. Lakshmiathanam (U.S. Army, Theoretical and Applied Mechanics Laboratory, Watertown, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-169.* 6 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

The response of a helicopter rotor blade subject to random loads is treated within the framework of the theory of linear dynamical systems with time-varying coefficients, under quasi-stationary random driving functions. The statistically meaningful characteristics of the response, namely the (co)-variance and the correlation, are shown to be directly obtained from a pair of ordinary differential equations in the time domain. Extensive results for different models of a rigidly flapping blade in air turbulence have been obtained by this direct time-domain approach to demonstrate its simplicity and efficiency. (Author)

A72-16941 # Evaluation of pilot workload and handling qualities criteria for light airplanes during steep landing approach. H. Chevalier (Texas A & M University, College Station, Tex.) and J. A. Burke (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and*

Aeronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-125. 8 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

Flight tests of two typical general aviation airplanes were conducted to determine the increase in pilot's workload associated with steep landing approach angles and to relate these increases to handling quality parameters. Results show that the largest single contributor of the pilot's extra workloads is the motion of the controls necessary to maintain level wing attitude during the landing approach. Values of roll control and response parameters obtained are compared with existing handling qualities criteria to determine the adequacy of these criteria for general aviation airplanes. In general, both airplanes are within the acceptable range of current criteria; however, to reduce the pilot's workload, new criteria are needed to affect changes in airplane design. (Author)

A72-16942 * # **Prospects for low wing-loading STOL transports with ride smoothing.** R. B. Holloway, G. O. Thompson, and W. J. Rohling (Boeing Co., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-64.* 7 p. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS1-10410.

Airplanes with low wing-loadings provide STOL capability without reliance on auxiliary propulsion or augmented lift, but require a ride smoothing control system to provide acceptable passenger comfort. A parametric study produced a configuration having a .35 thrust-to-weight ratio and a 50 psf wing loading, and which satisfied specified mission requirements and airworthiness standards. A ride-smoothing control system (RCS) synthesis was then performed which consisted of ride quality criteria definition, RCS concept trades, and analysis of RCS performance benefits at significant flight conditions. Within the limitations of the study it is concluded that this is a viable approach to STOL airplane design. (Author)

A72-16944 # **Calculation of unsteady and three-dimensional boundary layer flows.** H. A. Dwyer (California, University, Davis, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-109.* 7 p. 5 refs. Members, \$1.50; nonmembers, \$2.00. Army-sponsored research.

A numerical solution technique has been developed and analyzed for the laminar, time-dependent and three-dimensional boundary layer equations. The method has been applied to a rotating flat plate in forward flight, which is of direct interest to helicopter rotors. The numerical method itself is a modification of the implicit schemes used in two- and three-dimensional boundary layer problems and the most significant difficulties were the initial value problem and reversed flow. The combined problem of both time-dependent influences and three-dimensionality on the flat plate exhibited a much different behavior than either of the effects alone. The most interesting behavior occurred near the retreating blade portion of the cycle where retreating blade stall has been a recurring problem. (Author)

A72-16945 # **Aircraft anti-collision system design and evaluation.** E. J. Koenke (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.) and W. M. Hollister (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-97.* 8 p. 7 refs. Members, \$1.50; nonmembers, \$2.00.

Development of two criteria - conflict ratio (a measure of system efficiency) and probability of missed critical alarm (a measure of system safety) - that provide a simple method for evaluation of existing anticollision systems and for formulation and examination

of new anticollision system concepts. These criteria depend only on system alarm thresholds, critical miss distances, and relative position prediction uncertainty. They are independent of both traffic density and traffic model. Also developed is a closed-form method for estimating system alarm rate. Numerical comparison of systems operating in a terminal area results in ranges of conflict ratio from 900 for a simple proximity warning indicator to 25 for a full state collision avoidance system. (Author)

A72-16946 # **A flight test investigation of direct side force control.** G. W. Hall (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-94.* 7 p. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-71-C-1240.

The concept of developing a controllable side force by deflecting the rudder and utilizing asymmetrical drag to cancel the resulting yawing moment was flight tested using the USAF/CAL variable stability T-33 aircraft. Primary objectives were to mechanize a direct side force control system and evaluate its usefulness. Three controllers were evaluated. Side force was used to command a wings-level, zero sideslip, steady yaw rate and evaluated in a simulated dive bombing mission. Direct side force control significantly improved the pilot's ability to acquire and maintain a target and therefore should be further investigated as a method of improving weapons delivery accuracy. (Author)

A72-16948 * # **Wind-tunnel studies of wing wake turbulence.** N. A. Chigier and V. R. Corsiglia (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-41.* 8 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

Description of velocity measurements made in the wake of wings in the Ames 7 x 10 ft wind tunnel. Distributions of velocity components were measured with a three-wire anemometer up to 12 chord lengths downstream of a CV-990 aircraft model and a rectangular wing. Results show that increasing the drag increases the vortex core radius, reduces the maximum tangential velocities, and increases the magnitude of axial velocity defects. For the rectangular wing, axial velocity changes from a defect (wake flow) for angles of attack less than 9 deg to an excess (jet flow) for angles of attack greater than 9 deg. Wind-tunnel measurements of the near flowfield are compared with flight measurements of the far flowfield. (Author)

A72-16953 * # **Calculation of aerodynamic characteristics of STOL aircraft with externally-blown jet-augmented flaps.** M. R. Mendenhall, M. F. E. Dillenius, and S. B. Spangler (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-63.* 10 p. 10 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS2-5247.

Analytical methods to predict the interference between lifting surfaces and high-bypass-ratio turbofan engines are described. A three-dimensional nonplanar vortex-lattice lifting surface method is used to predict the characteristics of a wing with leading-edge slat and multiple slotted trailing-edge flaps including effects of externally induced velocity fields. A flow model of the wake of a high-bypass-ratio turbofan is described which is capable of predicting the induced velocity field both inside and outside the jet wake. These methods are combined to predict the longitudinal characteristics of several STOL transport models utilizing externally-blown flaps and

comparisons with data are shown. The results indicate good agreement between experiment and theory for various configurations under a wide range of power conditions. (Author)

A72-16956 # Adaptive model following systems for flight control and simulation. I. D. Landau and B. Courtiol (Société Générale de Constructions Electriques et Mécanique Alsthom, Grenoble, France). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-95.* 10 p. 11 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

A method for the design of adaptive model following control systems has been developed using a hyperstability approach. Two types of adaptation are discussed: adaptation of the parameters of the control loop and signal synthesis adaptation for model following systems with a fixed structure. The adaptation mechanism is realized by a combination of linear filters with some positivity properties and of the multipliers which processes the model-plant error. The application of this method to the design of flight control and simulation systems is discussed. The feasibility and advantages of the procedure are illustrated by applying it to an aircraft longitudinal control problem. (Author)

A72-16957 * # Hailstone impact simulator. E. Alfaro-Bou (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-163.* 5 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

The hailstone impact simulator was constructed to provide experimental data in support of a program to develop the analytical methods for predicting hail damage to aircraft structures. This paper describes the simulator, its operation, the type of data obtained, and the resulting damage by individual hailstones to metallic flat sheets and spherical caps. Simulated hailstones of 1.3, 2.5, 3.8, and 5.1 cm in diameter were used at impact velocities of 60 to 600 m/s. (Author)

A72-16959 * # Performance estimates for a supersonic axisymmetric inlet system. N. E. Sorensen and D. B. Smeltzer (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-45.* 5 p. Members, \$1.50; nonmembers, \$2.00.

Results of recent tests of a large-scale axisymmetric mixed-compression inlet system designed for Mach number 2.65 indicate that the performance of the supersonic diffuser and required boundary-layer bleed system can be accurately estimated with relatively new analytic methods. Thus, many wind tunnel testing hours can be saved by avoiding much of the usual 'cut and try' wind tunnel development. (Author)

A72-16969 * # On the application of Rice's exceedance statistics to atmospheric turbulence. W. Y. Chen (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-136.* 6 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

Discrepancies produced by the application of Rice's exceedance statistics to atmospheric turbulence are examined. First- and second-order densities from several data sources have been measured for this purpose. Particular care was paid to each selection of turbulence that provides stationary mean and variance over the entire segment.

Results show that even for a stationary segment of turbulence, the process is still highly non-Gaussian, in spite of a Gaussian appearance for its first-order distribution. Data also indicate strongly non-Gaussian second-order distributions. It is therefore concluded that even stationary atmospheric turbulence with a normal first-order distribution cannot be considered a Gaussian process, and consequently the application of Rice's exceedance statistics should be approached with caution. O.H.

A72-16975 # A procedure for combined viscous-inviscid analysis of supersonic inlet flow fields. T. A. Reyhner and T. E. Hickcox (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-44.* 9 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

A procedure is described for analytically predicting the effects of a boundary layer on the flow field of a supersonic inlet and for dispensing with much of the testing the design of such inlets presently requires. The procedure consists in first calculating the inviscid flow without viscous effects. Then, the boundary layer growth in the inlet is calculated, along with the bleed, bleed scoops, and shock wave/boundary layer interactions. Finally, a second inviscid flow calculation is made which is matched to the boundary layer solution. Comparisons of predictions with experiments are presented. M.V.E.

A72-16978 * # A model following variable stability system for the NASA ARC X-14B. J. T. Gallagher, I. Saworotnow, R. Seemann (Northrop Corp., Hawthorne, Calif.), and T. D. Gossett (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-96.* 11 p. Members, \$1.50; nonmembers, \$2.00. NASA-Army-supported research.

A description of the basic design concept, hardware design, and flight evaluation of a Variable Stability System (VSS) installed on the NASA ARC X-14B is presented. The NASA ARC X-14B is a twin-engine, single-seated VTOL aircraft. The VSS is unique in that it employs a general purpose airborne digital computer as an integral part of the hybrid model following flight control system. The system design, analysis and testing phases are discussed in the paper from the application of optimal control techniques in the preliminary design of the system, through the flight demonstration of the VSS hardware. (Author)

A72-16981 # Effect of SST operational maneuvers on sonic boom. G. T. Haglund and E. J. Kane (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-196.* 12 p. 10 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. DOT-FA70WA-2315.

An extensive theoretical study was made of the effects of operational maneuvers on sonic boom. The results indicate that for large transport class airplanes it is possible to perform most normal operational maneuvers without producing pressure signatures that are appreciably stronger than those generated during steady flight. An exception is during initial acceleration to cruise which produces caustics and increased boom strength over a very small ground area. Sensitivity of sonic boom signatures to maneuvers is more pronounced at Mach numbers near but above threshold values. Specific results and a method for computing maneuver signatures from steady flight signatures are given. (Author)

A72-16992 **The Boeing 747 - The pilot's view.** B. S. Wygle (Boeing Co., Seattle, Wash.). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 821-825.

Discussion of the handling characteristics of the Boeing 747. The aircraft features high directional stability and classic stall characteristics. Rudder feel forces are varied with speed so as to approximate a constant sensitivity at all speeds. The aircraft can, in spite of the height of the cockpit above the ground, be landed accurately by permitting it to almost fly onto the runway. The inertial navigation system has an accuracy and reliability which has exceeded expectations. F.R.L.

A72-16993 **Boeing Model 347 - Flying qualities demonstrator.** W. E. Hooper (Boeing Co., Seattle, Wash.). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 826-838; Discussion, p. 838.

Discussion of the Model 347 helicopter program, which encompasses simulation, wind tunnel, whirl tower, and bench testing, culminating with flight test development and demonstration of a modified CH-47A airframe. The first phase of the program was aimed at establishing new standards for the flying qualities (handling, vibration, and noise) of transport helicopters in a conventional pure helicopter arrangement. The second phase was to allow assessment of the value of providing a high maneuver capability for a transport helicopter, as could be provided through the use of a fixed wing. One of the most significant features contributing to the Model 347 handling qualities is the Differential Airspeed Hold (DASH). F.R.L.

A72-16994 **The application of 'fast-time' simulation techniques to the study of ATC systems.** R. J. Burford (Software Sciences, Ltd., Farnborough, Hants., England). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 839-845.

Discussion of fast time simulation, which has proven to be a very powerful research and evaluation tool in dealing with the complex, sophisticated, and dynamic nature of ATC systems. The technique has the ability to cope with problems which are mathematically intractable and which resist solutions by other analytical methods, while at the same time avoiding the potentially high costs, dangers, and difficulties of experimenting with the real system. The technique can be applied right across the whole spectrum of ATC operation. F.R.L.

A72-16997 **The effect of carbon fibre composites on design.** R. C. Sanders (British Aircraft Corp., Ltd., Warton, Lancs., England). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 867-875.

Use of comparatively small amounts of unidirectional (U/D) composite reinforcing to save weight in aircraft structures. Lamina or U/D material properties are described in terms of their longitudinal strength, compression strength, tension and compression moduli, transverse properties, in-plane shear properties, Poisson ratio, coefficients of expansion, combined stresses, and off-axis loading. Attention is given to the use of stress envelopes in designing with carbon fiber composite material. F.R.L.

A72-16998 **A carbon fibre Vulcan airbrake flap.** J. Fray (Hawker Siddeley Aviation, Ltd., Woodford, England). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 875-879.

Description of a Vulcan airbrake flap which, by virtue of its relative simplicity, has become the lead item in the Hawker Siddeley carbon fiber development program. The airbrake is a simply supported panel with its support axis offset from the centerline toward the trailing edge. Supporting tests were carried out to

demonstrate the effect of various environmental conditions on carbon fiber structures in order to confirm the airworthiness clearance of the airbrake. These tests included thermal cycling, sustained loading, fluid immersion, corrosion, and lightning strike tests. F.R.L.

A72-16999 **The use of carbon fibre composites in helicopters.** H. F. Winny (Westland Helicopters, Ltd., Yeovil, Somerset, England). *Aeronautical Journal*, vol. 75, Dec. 1971, p. 880-885.

Demonstration that carbon fiber composites can show an appreciable saving in weight in many helicopter components. The mechanical properties of carbon fiber laminates are outlined. It was found that, although the cost is relatively high, carbon fiber laminates can be used to advantage for transmission shafts and intermediate transmission shafts for the Wasp/Scout helicopter, and for the tail boom of the Wasp helicopter. F.R.L.

A72-17057 # **An analytical method for pressure determination in the kinematic pairs of a spatial landing gear mechanism (Analiticheskii metod opredelenia davlenii v kinematicheskikh parakh prostranstvennogo mekhanizma shassi).** I. M. Mitriev. *Kazanskii Aviatsonnyi Institut, Trudy, Seriya Prikladnaia Mekhanika*, no. 127, 1970, p. 8-13. In Russian.

Theoretical analysis of the function of a three-dimensional four-unit landing gear design with four pairs of kinematic landing elements. Expressions are given to describe the reactions of a rotatory pair and a spherical pair of these elements to various combinations of momenta. A procedure is derived for determining the pressure developed in the elements. V.Z.

A72-17060 # **Determination of the optimal reversion coefficient for passenger aircraft engine thrust reversal (Opredelenie optimal'nogo koeffitsienta reverirovaniia reversov tiagi dlia dvigatelei passazhirskekh samoletov).** A. G. Gilerson. *Kazanskii Aviatsonnyi Institut, Trudy, Seriya Prikladnaia Mekhanika*, no. 127, 1970, p. 28-34. 5 refs. In Russian.

A theoretical procedure and a simpler empirical procedure are given for the optimization of aircraft thrust reversion coefficients identified as reversed-to-forward thrust ratios facilitating a high reversion effectiveness in short and long haul passenger aircraft and intercontinental liners. Required numbers of reversed thrust engines for given reversion coefficients can be obtained from plotted curves when the simpler empirical procedure is used. Reverse thrust engine design considerations are given on the basis of this study for aircraft designs of these classes. V.Z.

A72-17084 **Hydraulic fluids for extreme service.** R. L. Leslie (Sperry Rand Chemistry Laboratory, Troy, Mich.). *Machine Design*, vol. 44, Jan. 13, 1972, p. 114-117.

The temperature changes and extremes to which a mobile system is subjected can result in a change of viscosity of several orders of magnitude. This change must be considered when selecting hydraulic oils. A compromise viscosity is necessary. Dynamic lubrication is provided by interacting forces of moving surfaces and a liquid. Graphs are provided showing relative slippage as a function of viscosity and the kinematic viscosity as a function of temperature. The temporary loss of viscosity at high shear rates is discussed together with questions of fluid stability, wear resistance, and aspects of rust protection afforded by petroleum fluids. G.R.

A72-17100 # Altitude-velocity characteristics of a turboprop engine (Vysotno-skorostnyye kharakteristiki TVD). P. Kazandzhan. *Aviatsiia i Kosmonavtika*, Nov. 1971, p. 42-44. In Russian.

The dependence of the equivalent horsepower, propeller output, and specific fuel consumption of a turboprop engine on altitude and velocity is analyzed. Graphs showing these relations for single- and double-shaft turboprop engines are presented and discussed. The relationship between the principal performance characteristics and the ambient air temperature is examined. V.P.

A72-17192 Visualization of the flow in a supersonic axial compressor (La visualisation de l'écoulement dans un compresseur axial supersonique). J. Fabri (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *L'Aéronautique et l'Astronautique*, no. 32, 1971, p. 5-13. 7 refs. In French. Research supported by the Direction des Recherches et Moyens d'Essais.

Use of a rotating annular cascade of compressor blade profiles, moving at supersonic speed, as an approximate means for investigating the flow in an axial supersonic compressor. By using very short exposure time schlieren visualization, it is shown to be possible to define precisely the aerodynamic patterns governing the elementary processes taking place in these machines. F.R.L.

A72-17193 French civil aircraft at the 1971 Le Bourget Air Show (Les avions civils français au salon du Bourget de 1971). G. Bruner (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 32, 1971, p. 16-27. In French.

Descriptions of new French aircraft which were displayed at the Le Bourget Air Show. These were the Airbus A 300 B, the Concorde, the Caravelle 12, the Corvette, the Fregate, and the STOL-A-904 produced by Aérospatiale, and the Marcel Dassault Mercure, Falcon 20 F and Falcon 20T, and the Falcon 10. F.R.L.

A72-17194 Research and tests on laminar airfoils (Etude et essais de profils laminaires). B. de Lagarde and J. P. de Loof (Société Bertin et Cie., Paris, France). *L'Aéronautique et l'Astronautique*, no. 32, 1971, p. 29-39. 10 refs. In French.

Definition of conditions for the utilization of modern gliders, with development of ideal aerodynamic characteristics of the airfoils to be conceived. The study consists of the development of programs making it possible to calculate the pole of a given airfoil so as to determine the profile function of speed distribution, and then to study the distribution of favorable pressures leading to optimized airfoils. Wind tunnel tests on selected models make it possible to complete the family of airfoils to be proposed to constructors. F.R.L.

A72-17195 Units of measurement in aeronautical acoustics (Unités de mesure dans l'acoustique aéronautique). Y. Couillard (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 32, 1971, p. 53-61. In French.

Review of the nature of noise, the physical unit for its measurement, and the basic principles of spectral analysis, followed by definition of a number of currently used nuisance values. The practical rules making it possible to convert one unit into another are given, and the various new corrections proposed with a view to improving the nuisance measurement are outlined. F.R.L.

A72-17197 Thermal tests of the Concorde structure (Essais thermiques de la structure de Concorde). J. Plenier (Délégation Ministérielle pour l'Armement, Paris; Toulouse, Centre d'Essais Aéronautique, Toulouse, France). *L'Aéronautique et l'Astronautique*, no. 32, 1971, p. 70-76. In French.

Review of the complex tests to which the Concorde structure has been subjected, in view of the flight domain extension involved. The new tests give, in particular, a good idea of thermal constraint effects on aircraft strength and fatigue endurance. Besides a complete airframe for static loading, the structures successfully tested included several large sections which made possible a first approximation in fatigue problem analysis. The special facilities developed are described, with discussion of their use to simulate various flight conditions. F.R.L.

A72-17321 Radiation pyrometer for gas turbine blades. D. A. Rohy, T. E. Duffy, and W. A. Compton (International Harvester Co., San Diego, Calif.). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 10-14, 1972, Paper 720159*. 16 p. Members, \$1.00; nonmembers, \$1.50. Contract No. N00010-69-C-0683.

Advances in the development of radiation pyrometry for measuring the blade temperature in gas-turbine engines are reported. In this system, engine-mounted sensor heads collect thermal radiation from either a spot or a reasonably large area of the turbine blade. High-temperature fiber optics transmit the radiation to a remote detector housing where the photons are converted into an electrical signal by a silicon photovoltaic cell. A signal processor measures and displays on a real-time basis three temperature characteristics of the turbine blades with response better than 10 ms in most cases. Recent developments include smaller electronics, practical sensor heads, and 5000 h fiber optics. Importance of measuring the blade temperature, potential uses of the data, and actual engine tests are described. (Author)

A72-17322 Development of a high-temperature sensor for a gas turbine engine. R. F. Sullivan (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 10-14, 1972, Paper 720160*. 10 p. Members, \$1.00; nonmembers, \$1.50.

A reliable high-temperature thermocouple for sensing turbine inlet temperature of a gas turbine engine has been developed. This sensor employs noble-metal thermoelements but retains the high signal level associated with base-metal thermocouples. A unique system of secondary junctions, contained within the device itself, allows transition to relatively inexpensive standard thermocouple materials. The development of different sampling type protective probes, including an air-cooled design, accompanied the development of the thermoelements. Some of the unsuccessful as well as the successful steps in the development are discussed, and some thoughts on future temperature sensors are given. (Author)

A72-17325 New adhesive needs and concepts for the aircraft and aerospace industries. T. J. Reinhart, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 10-14, 1972, Paper 720118*. 11 p. 6 refs. Members, \$1.00; nonmembers, \$1.50.

Adhesive bonded components have been utilized successfully in both aerospace and ground vehicles and for many years. This paper examines several new applications for structural adhesives. Adhesives have proved to be cheaper, lighter, and better performing than their

riveted or spot-welded counterparts. Many other advantages of adhesive bonding are cited. Several varieties of adhesive bonding materials in extensive use - including the recent introduction of corrosion resistant primers for use at 250-350 F - are discussed. Among the field problems of adhesive-bonded components are: inferior manufacturing techniques or processing procedures, improper surface preparation of metal adherends, inadequate production inspection procedures, component underdesign, and extreme environmental exposure. Despite these problems, however, the use of adhesive bonding is expected to increase dramatically as adhesive technology develops further. (Author)

A72-17326 # **Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings.** Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 157 p. \$6.00.

The capabilities and limitations of the ATC system are appraised, and plans for the ATC system in the near-term future are outlined. Alternative control concepts and equipment that could augment planned facilities are examined, with particular reference to a fourth-generation (post 1980) ATC system. The role of Omega and of navigation satellites in future domestic short range navigation is assessed, and future changes in VORTAC are proposed. The impact of aviation on current national and international communications programs is studied.

V.P.

A72-17327 # **The FAA air traffic control automation program - Status paper.** S. S. Hunn (FAA, National Airspace System Program Office, Washington, D.C.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 21 p.

This paper provides a brief description of the automated En Route and Terminal Air Traffic Control (ATC) System and a status of field implementation. The report is in three sections, Section I covers the En Route Stage A program, Section II the Automated Radar Terminal System (ARTS III) program, and Section III NAS Automation Benefits. (Author)

A72-17328 # **Air traffic control improvements via automation.** L. F. Page (FAA, Washington, D.C.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 4 p.

Several development programs aimed at improving the ATC system by selective application of digital computers and data displays are reviewed. The primary aim is to improve ATC performance by increasing the capacity of the system, to improve safety of the system on the basis of improved knowledge of VFR traffic in mixed airspace, and to constrain the increase in operating costs by increasing controller productivity. V.P.

A72-17329 # **An airborne traffic display system.** H. G. Weiss (MIT, Lexington, Mass.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 18 p. 9 refs. Aviation Advisory Commission Contract No. CON AAC-71-02; Contracts No. F19628-70-C-0230; No. FA-71-WAI-234.

A class of airborne traffic situation displays which takes advantage of the FAA beacon and radar surveillance network as well as the ground computer processing facilities of the NAS and ARTS automation program is discussed. A version of the system for displaying traffic and other data in the cockpit is examined. Results of studies using a cockpit simulator are reviewed, and possible means of using such a display are examined. V.P.

A72-17330 # **Aircraft proximity control employing the National Secondary Surveillance Radar System (SSR) for CAS-PWI functions.** G. B. Litchford (Litchford Systems, Northport, N.Y.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 16 p. 8 refs.

The possibility of obtaining functions of PWI and/or CAS by adding a 'proximity control' function to the National Secondary Surveillance Radar System is demonstrated, proceeding from a review of early SSR problems and their solutions. The steps involved in implementing a pilot display for ATC proximity control are outlined. V.P.

A72-17331 # **The role of the airline pilot and the ATC systems of the future.** W. B. Cotton. In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 5 p.

Some aspects of pilot performance in an ATC system based on extensive automation, with the air traffic controller removed from the active control loop, are examined. Particular attention is given to the manner in which highly accurate and timely surveillance data and nearly instantaneous discrete communications may be used by the pilot. The extensive information provided to the pilot as a decision-maker in the fourth-generation system is reviewed. The role of the pilot in assuring separation by performing such functions as metering, sequencing, spacing, passing, station-keeping, conflict-resolution, and so forth is discussed. V.P.

A72-17332 # **The role of the pilot in the fourth generation air traffic control system.** V. J. Kayne. In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 5 p.

Future possibilities of unloading the ground control system and increasing the safety and effectiveness of air traffic by providing the pilot extensive information on the traffic situation are examined. The possibility of integrating the on-board situation display with the air navigation system, collision avoidance devices, and station-keeping equipment is noted. The situation display would be a source of information rather than a functional instrument for flying the aircraft. Other components of the avionics would be used in their normal function to control and navigate the aircraft. V.P.

A72-17333 # **Control concept alternatives of the fourth generation ATC system.** D. E. Findley (U.S. Department of Transportation, Washington, D.C.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 7 p.

The fourth-generation control concept discussed is understood to mean that part of a total system concept which addresses the airspace structure, the management concept for the airspace structure and its elements, and the rules and procedures for the use and operation in the airspace. Airspace structure includes the categories into which the overall airspace is to be divided, along with a specification of the geographic and jurisdictional boundaries of these airspace categories. Three different control concepts currently under consideration are examined. V.P.

A72-17334 # The role for Omega in domestic, short-range navigation. R. H. McFarland (Ohio University, Athens, Ohio). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 6 p. 6 refs.

It is shown that the Omega system (an eight-station network operating at 10.2 and 13.6 kHz) is well suited to provide navigation information to improve air navigation capability. Specifically, Omega can provide supplemental, area navigation type coverage, such that aircraft being forced because of weather to operate at low altitudes to maintain VFR will have a continuous navigation capability; it can provide supplemental coverage in mountainous areas where shadowing prevents line-of-sight vhf omnirange from serving, and also supplemental coverage for those areas where VORTACs are widely spaced. V.P.

A72-17335 # The satellite's role in domestic short-haul air navigation. R. Buntschuh (RCA, Astro-Electronics Div., Princeton, N.J.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 11 p.

The principles of position location systems using satellites as an air navigation aid are examined. The systems discussed are: single satellite angle based systems, multiple satellite ranging systems, and multiple satellite range difference systems. Among the advantages which accrue from the use of satellites as location sensors are: the precision available due to the geometry of the satellites is greater than the precision available with ground sensors; determination of user altitude is accomplished independently from other sensor requirements; economical bulk data processing resulting from the use of a single central data center which is also the ground control center for the satellites; and the economics of both the minimum and sophisticated avionics configurations. V.P.

A72-17336 # VORTAC system improvement. A. B. Winick (FAA, Washington, D.C.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 6 p.

A series of VOR/DME changes which would provide the level of performance needed through 1985 is proposed. These system improvements include: better signal quality for area navigation (removal of restricted areas); reduction of weather induced outages; elimination of existing hardware deficiencies (double side band Doppler; DME-6-mile false lock-on); 50 kHz and DME Y channel provisions; and new solid-state ground components. All of these can be accomplished in a completely compatible manner. System changes which require changes to ICAO and airborne design include: precision VOR; navigation data broadcast; increased DME traffic capacity (quasi-one-way ranging); and time synchronization signals for CAS. V.P.

A72-17337 # The ARINC plan for implementation of data-link for the airlines. N. D. Steele, Jr. (Aeronautical Radio, Inc., Annapolis, Md.). In: Radio Technical Commission for Aeronautics, Annual Assembly Meeting, Washington, D.C., November 17, 18, 1971, Proceedings. Washington, D.C., Radio Technical Commission for Aeronautics, 1971. 17 p.

A program initiated in 1966 by ARINC and major users of ARINC's air/ground communications service to provide more diversified and responsive services is reviewed. Hardware and software developed by December 1970 for datalink service between San Francisco and Hawaii are discussed. V.P.

A72-17345 Design and performance of four buried uhf antennas. R. G. Fitzgerald and L. L. Haidle (NOAA, Institute for Telecommunication Sciences, Boulder, Colo.). *IEEE Transactions on Antennas and Propagation*, vol. AP-20, Jan. 1972, p. 56-62. 12 refs.

As a result of a ten-month study by the Institute for Telecommunication Sciences, four uhf antennas were designed and fabricated, and their absolute power gains for elevation angles from 1 to 45 deg and azimuthal patterns at 5-deg elevation angle were measured with each antenna buried beneath 1 m of refractory concrete. Relative responses of the four antennas, placed in solid granite, to a signal transmitted from an aircraft at ranges up to 300 km were recorded. The performance of the best buried antenna was comparable to that of a quarter-wave monopole fed against a single-wavelength diameter ground plane resting on the ground surface near the buried antenna. (Author)

A72-17424 SAID - Supplementary Aviation Information Display. R. J. MacDonald and R. Catterall. *CATCA Journal*, vol. 3, Fall 1971, p. 15-17, 24.

The Supplementary Aviation Information Display (SAID) is a system that is expected to provide the air traffic controller with selective information at improved display characteristics. All information that is presently available to a controller will still be accessible on a subject basis. The equipment has a remote-sensing capability, requires less space than current systems and, in comparison to the latter, will produce significant cost savings. M.V.E.

A72-17560 Measurement of the pressure and the convective heat flow at the surface of the central body of an air inlet with a live point and axial symmetry (Mesure de la pression et du flux de chaleur convectée à la surface du corps central d'une entrée d'air à pointe vive et symétrie axiale). J. P. Guibergia and R. Marmey (Aix-Marseille, Université, Marseille, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques*, vol. 273, no. 25, Dec. 20, 1971, p. 1311-1314. 5 refs. In French.

Account of the results of pressure and density measurements of convective heat flow at the wall of barriers, using either a hypersonic wind tunnel of low enthalpy at an adjustable Mach number between 4 and 8, or a reflected shock wind tunnel at Mach 9 or 10. In the hypersonic wind tunnel the measurements of convective heat density flow were carried out using a previously described calorimetric method on heavy brass models; in the shock tunnel the thermometric method of a thin platinum film on plexiglas models was used. The pressure measurements were carried out in the hypersonic wind tunnel by use of variable reluctance detectors. It was noted that no detachment of the boundary layer took place on the models used. F.R.L.

A72-17582 Testing the 'Tomcat.' *Interavia*, vol. 27, Jan. 1972, p. 35-37.

Review of the Grumman F-14 ('Tomcat') test program. The first

aircraft was lost due to the fatigue failure of a small diameter titanium line in each of the two primary hydraulic systems. The second aircraft was instrumented to explore low speed performance, stalling, and eventually a spinning program. Performance of the two Pratt & Whitney TF30-P-412-afterburning turbofan engines has been practically perfect so far. Another part of the test program giving cause for satisfaction is that of in-flight refueling. The Automatic Telemetry System (ATS) is described. Time spent on various maneuvers is made by an Integrated Test Block (ITB), which basically contains a series of standard test maneuvers to meet the requirements for each test flight. F.R.L.

A72-17583 A new weapon against the submarine. *Interavia*, vol. 27, Jan. 1972, p. 59-62.

Description of the Lockheed S-3A land based ASW and maritime reconnaissance aircraft. The basic layout is conventional, with a high wing carrying underslung podded engines. The S-3A is designed to operate at loads between + 3.5 g and -1.0 g, and will accept a gust loading to +4.3 g at flight design gross weight. An operational feature of the aircraft stemming from its rugged structural design is its ability to make a 30-deg dive from 35,000 ft to sea level in less than 2 min with speed brakes extended. The primary flight controls are fully powered and are integrated with the automatic flight control system. The operational equipment and the system organization are described. F.R.L.

A72-17586 # Predicting the demand for STOL - A limited study based on available data. L. D. Reid (Toronto, University, Toronto, Canada) and D. K. Yue. *Canadian Aeronautics and Space Journal*, vol. 17, Dec. 1971, p. 399-405. 11 refs.

Discussion of certain steps involved in predicting the potential passenger market for STOL transport in Southern Ontario, with the aim of selecting as simple a traffic demand model as seems suitable for such a prediction. The steps reviewed include: (1) estimation of present traffic pattern between two population centers; (2) estimation of future traffic patterns between the two population centers; (3) prediction of STOL's share of the passenger market; and (4) influence of service frequency and fare on STOL's share of the market. M.V.E.

A72-17611 High-temperature oxidation and corrosion of superalloys in the gas turbine - A review. R. I. Jaffee and J. Stringer. *High Temperatures - High Pressures*, vol. 3, no. 2, 1971, p. 121-135. 32 refs.

Further industrial trends in the improvement of high-temperature oxidation and corrosion resistance of gas turbine superalloys are considered with particular attention to dispersion hardening, fiber strengthening, rare earth alloying, new precipitation mechanisms, and intermetallic compounds. Resistance to the thermal stress environment, metallurgical bonding to the substrate, thinness and uniformity, a self-healing capability, the ductility to withstand substrate deformation without cracking, harmlessness to the mechanical properties of the substrate, and diffusional stability are listed as the requirements which must be met by superalloy gas turbine coatings. Some R & D programs recommended for improved coating systems of future engines are specified. Also discussed are the mechanisms of the oxidation of gas turbine materials and of hot corrosion of superalloys, and methods of hot corrosion evaluation. V.Z.

A72-17629 * # Analysis of transonic airfoils. P. R. Garabedian and D. G. Korn. *Communications on Pure and Applied Mathematics*,

vol. 24, Nov. 1971, p. 841-851. 12 refs. Grant No. NGR-33-016-167.

A finite difference scheme for the analysis of transonic airfoils at off-design conditions is described. It is the ultimate goal of the investigations to avoid expensive wind tunnel tests by combining the mathematical techniques in a procedure for designing supercritical airfoils so that they will be effective over a wider range of angles of attack and Mach numbers. A mathematical method is considered for computing two-dimensional transonic flows past a prescribed profile. The method can provide accurate results for a comparison with a known shockless regime. The approach gives also data of engineering reliability concerning the location and the strength of shocks at off-design conditions. G.R.

A72-17713 # Low turbulence wind tunnel of Nagoya Univ. Y. Furuya, H. Osaka, and T. Kushida (Nagoya University, Nagoya, Japan). *Nagoya University, Faculty of Engineering, Memoirs*, vol. 23, May 1971, p. 102-111. Research supported by the Ministry of Education.

A special type of low-turbulence wind tunnel for systematic studies of turbulent boundary layers is described. The tunnel has a closed circuit design, is about 17.5 m long, its contraction ratio is 1/12.5, and it has a sufficiently long test section and equipment for adjusting the pressure gradient. The tunnel performance has been tested. Resulting findings on turbulence intensity, velocity distribution in the working section, turbulent boundary layers on the flat plate, and the total skin friction coefficient are presented. O.H.

A72-17717 Two linear rate-field displays. L. Swartzendruber, F. Ince, R. C. Williges, and S. N. Roscoe (Illinois, University, Savoy, Ill.). *Human Factors*, vol. 13, Dec. 1971, p. 569-575. 12 refs. Contract No. F33615-70-C-1165.

An airspeed display and a lateral displacement (runway) display, arranged vertically and horizontally, respectively, were concurrently tracked by relatively inexperienced pilots using a joy stick. On each display the primary indicator was a small band which moved lengthwise. A moiré-pattern rate field (RF) moved alongside and with the primary. Each of four experimental conditions included both primary indicators and (a) no rate fields, (b) the airspeed rate field only, (c) the runway rate field only, or (d) both rate fields. Response measures for each display included (a) latency of initial response, (b) control reversals, and (c) root-mean-square (RMS) tracking error. Rate fields decreased RMS error for the runway display. Latency was briefer, but more reversals occurred on the airspeed display than on the runway display. Rate fields apparently serve an attention gathering function, but this cannot be fully investigated until optimum direction-of-motion relations are determined. (Author)

A72-17727 # Extremal field properties in an optimal control problem (O svoistvakh polia ekstremalei v odnoi zadache optimal'nogo upravleniia). V. F. Illarionov and V. T. Pashitsev (Tsentr'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). *Akademiia Nauk SSSR, Doklady*, vol. 200, Oct. 21, 1971, p. 1291-1293. In Russian.

The parameters of optimal aircraft flight over an assigned distance with a minimum fuel consumption are discussed. Pontriagin's maximum principle is applied to obtain the optimal control requirements for determining the properties of a family of extremals in the plane of the specific mechanical energy and altitude (h) of flight. The properties are realizable in the open region of a set of permissible values of the engine thrust and h. V.Z.

A72-17811 Behavior in fatigue of aeronautical structures (Tenue en fatigue des structures aéronautiques). W. Barrois (Société

Nationale Industrielle Aérospatiale, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Revue Française de Mécanique*, no. 38, 1971, p. 41-65. 36 refs. In French.

Review of the qualitative features of the fatigue behavior of parts which have been notched for assembly purposes or damaged by undetected cracks, followed by discussion of practical aspects of the service life prediction problem. Basic reasons for the impossibility of exact prediction are considered. The problem can only be solved by using the fail-safe concept in the design and by improving the quality of structures by better design and maintenance procedures. F.R.L.

A72-17846 # Simulation of an increased Reynolds number by roughness on aircraft models in transonic flow (Simulation d'un accroissement du nombre de Reynolds à l'aide de rugosités sur une maquette d'avion en transsonique). X. Vaucheret (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale*, Nov.-Dec. 1971, p. 335-346. 7 refs. In French.

A high Reynolds number is necessary for obtaining in a wind tunnel the aerodynamic characteristics of a transport aircraft in the transonic range. Simulating an increased Reynolds number with roughness set on an aircraft model is an inexpensive way to make use of existing wind tunnels. Sticking glass balls or chordwise threads near the leading edge at a rather broad pitch, provides the most efficient roughness. The influence of this roughness on the shock-boundary layer interaction pattern increases the lift gradient and carries the neutral point rearwards. The parietal visualization technique using fluid paints, of which a few examples are shown in color, is a practical means for investigating flow separation. This method helps to understand the working of roughness. (Author)

A72-17850 # Numerical study of the influence of the wing tip shape on the rolling up of the vortex sheet (Etude numérique de l'influence de la forme de l'extrémité d'une aile sur l'enroulement de la nappe tourbillonnaire). C. Rehbach (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale*, Nov.-Dec. 1971, p. 367, 368. In French.

Results of calculation of the rolling up of a vortex sheet using Belotserkovskii's method (1970). The wing (reduced to its frame) and the sheet are replaced by a vortex surface. To the continuous distribution of vortices on this surface, a discretized distribution of vortices of horseshoe shape of finite intensity, and placed solely on the wing, is substituted. The sheet thus presents itself as a series of filament vortices arising, at moderate angles of attack, from the trailing edge and the wing tip. Starting from a given initial position these filaments evolve, in the course of an iterative calculation, in such a way as to take their equilibrium positions parallel to the mean velocity on the sheet. The results are presented graphically. F.R.L.

A72-17856 Preliminary experimental investigation of the simple-source theory of jet noise. T. D. Scharton (Bolt Beranek and Newman, Inc., Canoga Park, Calif.) and W. C. Meecham (California University, Los Angeles, Calif.). *Acoustical Society of America, Journal*, vol. 51, Jan. 1972, pt. 2, p. 383-386. 6 refs.

Starting with the simple-source theory of jet noise, an approximate relation between the radiated sound-power spectrum and the jet-pressure spectrum is derived. This relation is compared with 1/3-oct band sound-power levels and jet-pressure levels measured during ground runup of a small turbojet engine. The agreement between theoretical and measured values is encouraging. G.R.

A72-17858 A significant single quantity that typifies a sonic bang. C. H. E. Warren (Royal Aircraft Establishment, Farn-

borough, Hants., England). *Acoustical Society of America, Journal*, vol. 51, Jan. 1972, pt. 2, p. 418-420.

Introduction of the concept of the characteristic overpressure, defined as $4I/T$, where I is the maximum impulse - i.e., the maximum value of the running integral of the overpressure with respect to time, and T is the signature interval - i.e., the time interval between the onset of the first shock and the onset of the last shock in the signature. The characteristic overpressure is considered to be a significant quantity, particularly in regard to the effect of sonic bangs on structures. This is illustrated by the collapse that is achieved when the results of Crocker and Hudson (1969) are presented in a manner employing the characteristic overpressure. Finally, the characteristic overpressure is shown to lead to a particularly simple engineering formula for the dynamic magnification factor as a function of the product of the natural frequency of a structure and the signature interval. (Author)

A72-17912 # Influence of screen proximity on the lift generated by vertical continuous jets (Vliianie blizosti ekrana na pod'emnuu silu, sozdavaemuu vertikal'nymi sploshnymi struiami). F. S. Vladimirov. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, Sept.-Oct. 1971, p. 123-131. 16 refs. In Russian.

The influence of ground proximity on the lift generated by vertical continuous jets is investigated in connection with the development of V/STOL and air-cushion vehicles. The two-dimensional problem for the flow of a gas jet (issuing from a channel with parallel walls) around a dihedral obstacle is solved by the Chaplygin-Falkovich method. The calculations demonstrate the effects of screen proximity and fluid compressibility on the flow characteristics at transonic velocities. T.M.

A72-17922 * # Guidance technique for automated air traffic control. H. Q. Lee and J. D. McLean (NASA, Ames Research Center, Systems Analysis Branch, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-121*. 8 p. Members, \$1.50; nonmembers, \$2.00.

A guidance technique has been developed for flying an aircraft automatically along curved trajectories. The technique consists of a set of algorithms for automatically synthesizing flight profiles, i.e., the horizontal trajectory, the altitude and speed profiles, and a time sequence of commands. The flyability of the synthesized profile under wind disturbances and initial conditions error is verified by closing the loop around the synthesized trajectory and flying it in a computer-simulated jet aircraft. A control law having longitudinal, lateral, and heading deviation from the synthesized profile in the feedback loops is used for the simulated flight. The performance of the system is excellent, errors that are initially zero never exceed 230 ft, and large initial errors are reduced rapidly. The system also behaves quite well under wind disturbance. (Author)

A72-17944 * Inertial navigation systems analysis. K. R. Britting (MIT, Cambridge, Mass.). Research supported by the U.S. Department of Transportation and NASA. New York, Wiley-Interscience, 1971. 262 p. 71 refs. \$14.95.

This volume offers the avionic systems engineer a fundamental exposition of the mechanization and error analysis of inertial navigation systems. While the material is applicable to spacecraft and undersea navigation, emphasis is placed upon terrestrial applications on or slightly above the earth's surface. As a result, practical considerations are geared toward those aircraft navigation systems of particular current interest. Extensive use is made of perturbation techniques to develop linearized system equations, whose solutions closely approximate those obtained by nonlinear differential equa-

tions. A unified error analysis technique is developed that is applicable to virtually all system configurations. The technique provides a greatly simplified method for comparing the performance of competing system configurations. G.R.

A72-17972 Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. Conference sponsored by the Association for Computing Machinery, the American Institute of Industrial Engineers, the Institute of Electrical and Electronics Engineers, S.H.A.R.E., Scientific Computers, Inc., and the Institute of Management Sciences. New York, Association for Computing Machinery, 1971. 332 p. \$10.00.

Topics discussed include the use of simulation to describe traveler characteristics in transportation modal split analysis; a simulation model for the prediction of weapon system support elements and costs; the development of an exploratory model to determine the feasibility of simulating air traffic in the U.S.; an aircraft operations and maintenance simulation model; the use of the graphical evaluation and review technique in modeling and evaluating policies and processes in test and checkout; the use of this graphical technique in modeling assembly line operations, project management networks, conveyor systems, and inventory systems; a time-sharing simulation model to aid in the design of airport passenger facilities; and a newly developed interactive simulation system.

A.B.K.

A72-17973 # A simulation approach to transportation modal split analysis. W. K. Clarkson and J. R. Buyan (Aerospace Corp., El Segundo, Calif.). In: Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. New York, Association for Computing Machinery, 1971, p. 24-31. 7 refs.

This paper describes a unique simulation approach to transportation modal split analysis, which was developed and applied at The Aerospace Corporation. Modal split analysis attempts to determine the utilization of a number of alternative travel modes between specified origins and destinations. These studies have traditionally been done using regression methods. The method and associated computer program developed by the authors computes the modal split by generating simulated travelers - each having a set of pertinent attributes randomly selected from appropriate distributions. The method assigns them to travel modes on the basis of a cost function that includes time, service frequency, and traveler preferences in addition to out-of-pocket cost. A number of advantages over the traditional regression approach are offered by the method, and are discussed in the paper. Results of applying the simulation program to studies of the Portland-Seattle corridor and feeder modes for the Palmdale, California airport are presented. (Author)

A72-17974 # Detailed simulation of military aircraft operations and logistics. J. H. Keeney (Boeing Co., Military Airplane Systems Div., Seattle, Wash.). In: Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. New York, Association for Computing Machinery, 1971, p. 32-38.

The model described is programmed in GPSS/360 (General Purpose Simulation System). The model is called GOALS (General Operations and Logistics Simulation). GOALS is an operational model, which has been verified against actual Air Force operations. The model is designed to evaluate and measure the impacts of various operational plans, logistics concepts, and resource levels as they apply to operating and supporting a specified number of military aircraft over a desired time span. The results obtained show that the

model is a validated simulation tool which can be used to measure the impact on aircraft operations of various availabilities of logistics resources. G.R.

A72-17975 # Applying simulation techniques to an air traffic control study. R. C. Baxter, J. Reitman, and D. Ingerman (United Aircraft Corp., Norden Div., Norwalk, Conn.). In: Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. New York, Association for Computing Machinery, 1971, p. 39-44.

An exploratory model was developed to determine if a meaningful simulation of the air traffic in the U.S. may now be practical. The approach followed involved the study of a number of successive approximations, each covering a greater portion of the problem. A simulation of the flow of air traffic in the U.S. for the purpose of evaluating alternative ATC concepts was implemented using the GPSS/360-NORDEN programming language. Four computer runs were made, and sample data were collected. It is felt that this model provides a strong base for straightforward extensions so that it can be used as an evaluation tool in a number of air traffic problem areas. G.R.

A72-17976 # Maintenance Activities and Resources Simulation (MARS) model. J. J. Dougherty and R. G. Hazlett (Boeing Co., Vertol Div., Philadelphia, Pa.). In: Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. New York, Association for Computing Machinery, 1971, p. 106-110.

MARS is a Vertol Developed Aircraft Operations and Maintenance Simulation Model written in GPSS for application on the IBM-360-65 computer. The MARS model was developed to provide visibility of an aircraft's ability to comply with an imposed flight schedule and maintenance philosophy. Scheduled flight operations and available maintenance resources are interfaced to determine their effect upon aircraft availability and maintenance resource usage rates. Various relationships, such as the Availability/Utilization Function, may be investigated and optimized in compliance with the constraints imposed by the resources available, and mission profile designated. Primary applications of MARS are in the fields of Engineering and Logistics Support Planning Analyses. (Author)

A72-17979 # Simulation in airport facilities design - Lounge planning model. R. F. Seeman (American Airlines, Inc., New York, N.Y.). In: Conference on Applications of Simulation, 4th, New York, N.Y., December 9-11, 1970, Proceedings. New York, Association for Computing Machinery, 1971, p. 219-224.

The Lounge Planning Model is a tool to assist in the design of airport terminal facilities. Input consists of forecasted schedules and load factors, together with parameters of the terminal configuration under study. The model assigns aircraft to gates and simulates a day's activity, recording population flows through departure lounge areas. Since the model is a time-sharing application, various terminal designs and input assumptions can be tested and improved in a rapid-response environment. Output consists of a series of graphs which show lounge area populations and flows as a function of time of day. These in turn enable the facilities planners to test their sizing assumptions and determine how well a given design functions in scheduled operation. G.R.

A72-18111 # Three dimensional problems with moving boundaries in transient supersonic aerodynamics of a thin airfoil. E.

A. Krasil'shchikova (Akademiiia Nauk SSSR, Institut Problem Mekhaniki, Moscow, USSR). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 9th, Kazimierz, Poland, September 1-7, 1969, Transactions. Part 1. Warsaw, Państwowe Wydawnictwo Naukowe, 1971, p. 137-144.

Investigation of a three-dimensional velocity field which is excited by the foil vibrations propagating with a finite velocity along the elastic airfoil surface. The problem is shown to reduce to finding a function in a semispace equal to or greater than 0 which satisfies a certain wave equation with certain boundary conditions. F.R.L.

A72-18122 # On flow patterns ahead of obstacles at supersonic speed. A. I. Zubkov, Iu. A. Panov, and D. M. Voitenko (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 9th, Kazimierz, Poland, September 1-7, 1969, Transactions. Part 1. Warsaw, Państwowe Wydawnictwo Naukowe, 1971, p. 299-307.

Flow patterns near yawed obstacles of circular or rectangular cross section about the sharp leading edge of a flat plate base are investigated. The various flow characteristics pointed out by the results obtained include the presence of regions with particularly high pressure values and pressure gradients in front of the obstacle in the reversed separated flow zone. M.V.E.

A72-18128 # Final thickness delta wing in a hypersonic flow. A. L. Gonor and N. A. Ostapenko (Akademiiia Nauk SSSR, Institut Mekhaniki, Moscow, USSR). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 9th, Kazimierz, Poland, September 1-7, 1969, Transactions. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1971, p. 83-95.

The equation system of the conical flow is presented, including two Euler equations and equations related to the conditions of energy conservation, entropy, and the particle mass. A new variable is introduced, and a new system of equations is obtained by the transformation of variables. The solution of the boundary value problem is discussed together with the calculation of the diamond-shaped wing flow line. The values of the geometric characteristics of the optimum wing design are shown in a graph. G.R.

A72-18129 # Some results of the supersonic flow by V-shaped wings. A. L. Gonor, A. I. Shvets, and M. N. Kasakov (Akademiiia Nauk SSSR, Institut Mekhaniki, Moscow, USSR). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 9th, Kazimierz, Poland, September 1-7, 1969, Transactions. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1971, p. 97-106. 5 refs.

It was found that the V-shaped wing as an element of the two-petal star may be an effective design factor for obtaining superior aerodynamic characteristics. The flow past a model with V-shaped wings was studied for angles of attack in the range from 0 to 15 deg, a Mach number of four, and a wide range of wing configurations. A device for studying the flow between the wings was used. It was found that, depending on the wing configuration, there are several types of flow with different shock wave patterns. The relations obtained between the design parameters and the aerodynamic characteristics are shown in a number of graphs. G.R.

A72-18131 # Flow model of a viscous fluid through a movable and immovable cascade of blades. S. Kuczewski (Łódź,

Politechnika, Łódź, Poland). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 9th, Kazimierz, Poland, September 1-7, 1969, Transactions. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1971, p. 115-124.

The velocity field of a fluid flowing through a cascade of blades can be determined approximately by considering the vortices situated on the aerofoil central line. It is found that the curvatures of streamlines in front of a stationary cascade differ radically from the curvatures in front of a rotating blade. The streamlines in front of an impeller can be regarded as approximately straight. G.R.

A72-18154 # Air-system interrogator. M. Miranda (Hawker Siddeley Dynamics Engineering, Ltd., Hatfield, Herts., England). *Tech Air*, vol. 28, Feb. 1972, p. 2, 3.

Description of the air-system interrogator and airborne first line test apparatus fitted to the Hawker Siddeley Trident 3B. The purpose of the interrogator is to check out diagnostically an electrical system either known to have some fault or malfunction in one of the units/components comprising that system, or as a normal preflight check for correct operation, and to single out the unserviceable unit so that it may be replaced. The unit is manually operated by the ground crew who do not require any operating manuals, and is conveniently located in a forward equipment bay. F.R.L.

A72-18170 Some questions concerning airfield law occasioned by the decision of the Schleswig-Holstein Appeals Court of August 31, 1971 (Einige Fragen des Flugplatzrechts aus Anlass des Beschlusses des Schleswig-Holsteinischen Oberlandesgerichts vom 31. August 1971). H. Wessels. *Zeitschrift für Luftrecht und Weltraumrechtsfragen*, vol. 21, Jan. 1, 1972, p. 21-30. 30 refs. In German.

Criticism of a decision handed down in a suit brought by property owners in the vicinity of an airfield against the airfield operator for unnecessary noise caused by a flight school based on the airfield. Considering the problem from the standpoint of pilots' rights, it is concluded that the defendant could not impose any prohibition or limitations on the flight school, as long as the rights of pilots not associated with the school were not injured by the operations of the school. The inapplicability of the relevant law to prohibit or limit the offending activities of the school in this case is stressed by citing the fact that an airfield cannot be regarded as a piece of property governed only by private law, but must serve general traffic needs. A.B.K.

A72-18183 # Doppler scanning guidance system. C. W. Earp, F. G. Overbury, and P. Sothcott (Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England). *Electrical Communication*, vol. 46, no. 4, 1971, p. 253-270. 12 refs.

Description of a new experimental Doppler system which provides elevation guidance over a wide range of glide slopes, and azimuth guidance over a wide sector. The basic Doppler element is a linear directive antenna array which can define conical surfaces in space, in terms of frequency, with very great accuracy. It can be used as a building block to construct high precision ground based navigation and guidance systems, a specific use being its application as a replacement for conventional ILS. It can provide sufficiently accurate guidance in azimuth and elevation on one rf channel well within the stated limits of bandwidth and information rates. Collocation with existing landing systems should be possible. F.R.L.

A72-18245 # Flight simulator as a design tool. D. J. Acklam (British Aircraft Corp., Ltd., London, England). *Aircraft Engineer-*

ing, vol. 44, Jan. 1972, p. 4-8.

Demonstration of how flight simulators contribute to the design of a new aircraft from early project studies, through the detailed design stage to first flight and beyond, and well into the development program. Inevitably as the design of aircraft evolves, not always in predictable directions, situations arise where unconventional or marginal handling qualities are likely to occur and no hard and fast criteria exist. Performance and handling qualities often have opposing requirements - e.g., good handling qualities often demand large tail surfaces. Therefore, design becomes a compromise and the simulator enables the designer to make a decision avoiding the pitfalls of excess weight, drag, or complication on the one hand, and unacceptable handling qualities on the other hand. F.R.L.

A72-18246 # Dynamic manned vehicle simulator. *Aircraft Engineering*, vol. 44, Jan. 1972, p. 8, 9.

Discussion of a dynamic manned vehicle simulator (DMVS) which is capable of providing not only full-scale simulation of visual and aural effects, but also a high fidelity simulation of the changes in acceleration experienced by the occupants of the vehicle. The extra realism thus produced adds very considerably to the value of the results obtained. The DMVS facility possesses three separate cockpits: a typical single-seat fighter, a typical helicopter, and a typical two-pilot 2/4-engine airliner, with emphasis on STOL and VTOL characteristics. F.R.L.

A72-18247 # Time frequency system - Collision avoidance. *Aircraft Engineering*, vol. 44, Jan. 1972, p. 11, 12.

Description of the Eros II airborne Collision Avoidance System (CAS), which is actuated when the computer calculates the aircraft is within 25 sec or one-half mile of another aircraft, whichever event occurs first. CAS presently accommodates a total of 2000 aircraft at a time within a 100 mi radius. During a 3-sec interval each member, aircraft or ground station, transmits a radio message at a different time while all others listen. Each of the 2000 members is assigned a message slot which determines when it transmits. Precise clocks in the aircraft keep the system synchronized. Thus, each aircraft reports its precise range, altitude, and range rate every 3 sec to all other aircraft within a radius of 100 mi. Ground stations keep all aircraft on precise time. F.R.L.

A72-18248 # Rotorcraft for alleviation of the aircraft noise nuisance. J. W. Leverton (Westland Helicopters, Ltd., Yeovil, Somerset, England). *Aircraft Engineering*, vol. 44, Jan. 1972, p. 14-17. 11 refs.

Consideration of the airport noise nuisance, which can be considerably reduced by the introduction of a completely independent second air transport system based on the VTOL concept. It is shown that the noise generated by a convertible rotorcraft during takeoff and flyout blends in well with the structure of a city and is therefore well suited for use at large urban sites. For city center operations it appears that compound or winged helicopters are necessary, since low takeoff noise as well as low flyover noise is required. F.R.L.

A72-18249 # The theory of governing for aircraft turbo alternators. D. O. Burns. *Aircraft Engineering*, vol. 44, Jan. 1972, p. 20-22.

Study of frequency error detection in the theory of governing, followed by discussion of the mechanical-hydraulic governor. An advantage of the frequency error detector is the ease with which the

sensitivity may be increased by drift-free ac amplification before the phase-conscious detector. The mechanical-hydraulic governor has the advantage of being more robust than the electro-hydraulic governor, but the latter is more amenable to preliminary numerical assessment, and can be very easily modified subsequently to obtain optimum performance. F.R.L.

A72-18250 # Modular automatic test equipment for commercial airlines. R. Gustafson (Honeywell, Inc., Minneapolis, Minn.). *Aircraft Engineering*, vol. 44, Jan. 1972, p. 24-27.

Discussion of the Automatic Testing Equipment (ATE) solution to the testing problem, which applies ATE to those portions of the maintenance job where the computer, with its speed, its ability to handle tremendous amounts of data, and its consistency, are important. The ATE is cost effective in routine and repetitive testing - e.g., performance testing of avionics devices. A modular automatic test station is described, modularity being defined as a partitioning of the elements of the station into a logical grouping of software and hardware features. Modularity allows a number of stations to be built with common elements, individual special features being additions of new functional groups. A properly selected computer is the heart of the system. F.R.L.

A72-18283 ATC for the seventies. I. K. P. Gray (FAA, National Airspace System Program Office, Washington, D.C.). *Shell Aviation News*, no. 402, 1971, p. 8-12.

Outline of a program of air traffic control system modernization to provide automation at each of the Air Route Traffic Control Centers (ARTCC) and the busiest terminals. The rapid growth of air transportation in the USA has severely taxed the resources and capabilities of the current manual air traffic control system. The modernized facilities will be interconnected with data transmission links, and all the elements will function as a nationwide real-time automated system. Attention is given to the en route automation program, the radar data acquisition and transfer subsystem, and the central computer complex subsystem. F.R.L.

A72-18284 Developing an AIDS simulator for the DC-9. R. L. Van der Velde (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *Shell Aviation News*, no. 402, 1971, p. 13-17.

Development of an Aircraft Integrated Data System (AIDS) simulator to overcome interface problems before installing AIDS in a DC-9. AIDS is an onboard electronic system that records aircraft and flight parameters. The interface problems arise because AIDS installations are retrofits, hence none of the aircraft systems or sensors for connection to the AIDS equipment have been designed for that particular purpose. The Systems Simulator was designed merely to simulate each signal source, and no more. It was employed to check the multitude of possible functions of a modern AIDS equipment, to verify the integrity of AIDS input circuits; to demonstrate the absence of aircraft systems interaction and performance degradation, and to facilitate adjustment, calibration, system checking, maintenance, and trouble shooting. F.R.L.

A72-18285 In search of natural STOL. D. Stinton (Air Registration Board, London, England). *Shell Aviation News*, no. 402, 1971, p. 18-22.

Attempt to determine if a STOL aircraft can be developed using means other than mechanical devices such as multiple slotted flaps, swing wings, and sucking, blowing, and lifting engines. Natural methods considered are tail-first (canard) or tandem wing configurations. A disadvantage of the tandem layout is the presence of a second set of wing tips with their drag-inducing trailing vortex

systems superposed on and mixed with the trailing vortex system of the other wing. Calculations suggest that tandem wing arrangements like those discussed could, by natural means, shorten required field lengths by as much as 20% in some instances. It is considered that properly directed research could greatly benefit the development of low cost aerial work aircraft. F.R.L.

A72-18286 Can the joint use of inertia and radio methods reduce the cost of navigation systems (L'utilisation conjointe de l'inertie et des moyens radio peut-elle diminuer le cout des systèmes de navigation). J. Walrave (Société de Fabrication d'Instruments de Mesure, Massy, Essonne, France). *Navigation (Paris)*, vol. 20, Jan. 1972, p. 17-22. In French.

Consideration of the possibilities of uniting inertial and radio navigation systems, the first serving as a filter and the second as a memory. The accuracy of the best inertial systems is not comparable with that obtainable by such radio methods as VOR and DME. Radio methods, however, do not have enough stations to provide complete coverage of all regions overflown. A French system is described which consists of an inertial sensor system and a navigation computer. It is possible to carry out inertial flights of up to four hours, and the VOR-DME data make very precise navigation possible. F.R.L.

A72-18288 Application of space navigation experience to ergonomic problems of aerial and marine navigation (Application de l'expérience de la navigation spatiale à des problèmes ergonomiques de navigation aérienne et maritime). P. G. Felleman (MIT, Cambridge, Mass.). *Deutsche Gesellschaft für Ortung und Navigation, Réunion, Essen, West Germany, Oct. 27, 1971.* *Navigation (Paris)*, vol. 20, Jan. 1972, p. 61-76. 7 refs. In French.

Examination of the tasks of the Apollo astronauts which related to navigation, with emphasis on the practical aspects of automation. The command module and lunar module systems are briefly described, and the interface between the crew and the systems is discussed. Attention is given to the cislunar, rendezvous, and lunar landing phases of the mission. The mission demonstrated the possibility of navigating in space using several different modes: pure inertial, inertial aided by radar, and inertial aided by optics. The role of the navigator can be facilitated in the accomplishment of his particular tasks thanks to various degrees of automation. It is considered that automated procedures of navigation should be adapted to aircraft and ships in view of their increasing speed and complexity, and in order to lower operating costs. F.R.L.

A72-18322 # Stresses in a fuselage model due to concentrated radial loads. J. Graham (Belfast, Queen's University, Belfast, Northern Ireland) and J. Larkin (Short Brothers and Harland, Ltd., Belfast, Northern Ireland). *Strain*, vol. 8, Jan. 1972, p. 7-13. 5 refs.

Experimental values of shear and direct stresses on cross-sections of a fuselage model, due to concentrated radial loads applied to a frame, are compared with values predicted by a matrix force analysis. The results include the effect of cut-outs in the surface of the shell. Comparisons are also made of the direct stress on the inner flange of the directly-loaded frame and of the frames bounding the cut-outs. Results indicate that the degree of accuracy of the theoretical stresses is adequate for the purpose of design. (Author)

A72-18387 Constrained optimization problems using multiplier methods. S. S. Tripathi and K. S. Narendra (Yale University, New Haven, Conn.). *Journal of Optimization Theory and*

Applications, vol. 9, Jan. 1972, p. 59-70. 11 refs.

A modified multiplier method for optimization problems with equality constraints is suggested and its application to constrained optimal control problems described. For optimal control problems with free terminal time, a gradient descent technique for updating control functions as well as the terminal time is developed. The modified multiplier method with the simplified conjugate gradient method is used to compute the solution of a time-optimal control problem for a V/STOL aircraft. (Author)

A72-18396 The microwave instrument landing system. R. J. Shank (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Farmingdale, N.Y.). *Microwave Journal*, vol. 15, Jan. 1972, p. 6, 13.

Brief review of ILS history and of the present state of microwave ILS. Presently considered ILS varieties include: (1) scanning beam - continuously scanned, (2) scanning beam - step scanned, and (3) Doppler scanned. Each of these approaches has unique advantages and disadvantages, and it is the task of FAA to marshal the nation's technical resources to help select the optimal system. M.V.E.

A72-18397 An application of step-scan to the RTCA landing system. F. B. Brady (Singer Co., Kearfott Div., Washington, D.C.) and G. Henf (Singer Co., Kearfott Div., Pleasantville, N.Y.). *Microwave Journal*, vol. 15, Jan. 1972, p. 14, 17-20, 48.

A landing system technique is described in which a series of microwave fixed linear arrays produces a pattern of narrow overlapping beams to provide signal coverage over a desired area. The beams are individually coded and are switched sequentially to produce a stepped-scan effect at the airborne receiver. The receiver decodes the beams and a tracking system extracts guidance information similar to that of a conventional scanning-beam system. Advantages are claimed in simplicity and system economy, particularly in its application to the needs of the secondary airport. The proposed technique uses the RTCA SC-117 signal format. (Author)

A72-18398 The microwave Doppler scanning landing guidance system. C. W. Earp (Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England). *Microwave Journal*, vol. 15, Jan. 1972, p. 23, 24, 26-29.

After a brief statement of the principle of the Doppler Scanning System, followed by a short historical review which includes the earliest use of the principle, the reasons for the new consideration of Doppler for modern landing guidance are given. The very close relationship between the Doppler system and conventional scanning-beam systems is demonstrated, and some of the special techniques which are essential to Doppler are described. Suggestions are made with regard to possible parameters of a complete system, showing how it may be possible to take advantage of new developments to provide a simplification of the signal format produced by the Special Committee SC-117 of RTCA. (Author)

A72-18399 Microwave landing system using continuously scanning beams. J. E. Woodward (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Farmingdale, N.Y.). *Microwave Journal*, vol. 15, Jan. 1972, p. 30, 32, 33, 48.

Description of the microwave landing system (MLS) based on continuously scanning beams, and review of the experience gained in its development and use. This experience is shown to give assurance that continuous scanning systems can meet every desired objective. It is felt that coverage, channelization, and all other extended requirements

ments or additional functions can be met in a practical manner by these systems. M.V.E.

A72-18435 **The use of cost data during aircraft design.** P. H. Cosier (British Aircraft Corp., Ltd., Bournemouth, Hants., England). In: International Symposium on Information Systems for Designers, University of Southampton, Southampton, England, July 6, 7, 1971, Proceedings. Southampton, University of Southampton, 1971, p. 12-1 to 12-13.

Data resulting from the application of value engineering studies to aircraft in production are discussed and analyzed. Several examples are presented which show that considerable cost savings and other benefits are gained at the detail design stage if there are meaningful cost targets. Rules for cutting costs during design are proposed which lead not only to lower costs but also to a better product which is more profitable for the manufacturer, the user, and the nation. O.H.

A72-18450 # **Vanes for sensing incidence angles of the air from an aircraft.** D. H. Lenschow (National Center for Atmospheric Research, Boulder, Colo.). *Journal of Applied Meteorology*, vol. 10, Dec. 1971, p. 1339-1343. 6 refs.

Description, analysis, and comparison of two types of vanes that were used to measure the angle of the airstream with respect to an aircraft. One type is a rotating vane that is free to align itself with the airstream, and the angle is sensed by an angle transducer. The other type is constrained from rotating, and the angle is obtained by measuring the force exerted on the vane by the airstream and dividing by the pitot-static pressure. The free vane measures the angle directly and is not sensitive to acceleration, while the constrained vane has a faster response time and has no bearing friction. At an aircraft speed of 70 m/sec, both vanes are able to resolve changes in angle of less than 0.02 deg, which corresponds to a gust velocity of about 2 cm/sec, and respond to within 5% of a step-function change in angle in a distance of less than 5 m. An in-flight comparison between the two vanes indicates that they both measure the same angle with a correlation coefficient of 0.97. (Author)

A72-18487 **Pilots handbook for critical and exploratory flight testing.** Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972. 196 p. Members, \$20; nonmembers, \$30.

The papers deal with practices and procedures to be followed in flight tests of airloads and structural integrity, flutter boundary, spin, and other qualities. Topics considered include rotary wing first flight and envelope expansion, lifting bodies, engines, jet engine airstart for single-engine fighter/attack aircraft, structural suitability for aircraft carriers, catapult launch and minimum end airspeed, firing and separation, thunderstorm penetration, and civil transport aircraft icing. F.R.L.

A72-18488 **First flight.** R. K. Smyth (Grumman Aerospace Corp., Bethpage, N.Y.). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 1-16.

Exposition of the procedures to be followed by a test pilot on the first flight of a new aircraft design, during which he will be called upon to exercise all of his accumulated test experience, judgment, and wisdom. The preparation phase involves design consultation, simulation, maintaining or regaining pilot proficiency on the aircraft

type, observation of final assembly and checkout, and conducting engine and taxi runs. First flight constraints, which involve weather, configuration, instrumentation, and abort criteria should be documented well in advance of the first flight date. The first flight profile should be conservative and should be performed in stages. F.R.L.

A72-18489 **Structural demonstration flight testing /U.S. Navy/.** E. Von der Heyden (Grumman Aerospace Corp., Bethpage, N.Y.). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 17-24.

Discussion of that portion of the early phases of an aircraft's career in which its strength, integrity, and ability to operate throughout its operational envelope is demonstrated. The designer, with the proposed aircraft's mission requirements in mind, analytically provides the basis for a suitable speed/acceleration envelope. Structural requirements are defined by the various portions of the mission envelope. Time constraints generally dictate that the second or third flight aircraft be chosen for structural testing. Before structural buildup flights are planned, important questions must be asked and answered on a maneuver-by-maneuver basis. A maneuver checklist is presented. F.R.L.

A72-18490 **Airloads and structural integrity flight testing /U.S. Air Force/.** W. H. Harse (General Dynamics Corp., Fort Worth, Tex.). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 25-29.

Discussion of structural integrity demonstrations, which have evolved and expanded to keep pace with more complex and sophisticated aircraft. Ground and flight tests of the instrumented aircraft, together with fatigue and static article testing, are required to determine aircraft service life and verify the designed structural limits when the aircraft is operated within the intended envelope and mission requirements. The flight program includes gathering dynamic response data to confirm load levels, and temperature data to verify thermodynamic and stress criteria of all primary structural members. The flight phase will also verify loads and demonstrate integrity of those airframe components that are difficult to predict or measure such as access doors, fairings, wing and tail leading edges, spoilers, etc. F.R.L.

A72-18491 **Flutter boundary testing.** D. W. McCracken (North American Rockwell Corp., Columbus, Ohio). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 30-35.

Consideration of flutter boundary testing, which is one of the more hazardous types of flight testing. The nature of a flutter encounter is often a sudden structural failure, and the test pilot and crew are faced with the necessity of egress in a highly unfavorable environment. The family of poorly damped, neutrally damped, or divergent rapid surface oscillations ranges from the classical 'buzz' phenomena of a tab or control surface to 'explosive' or 'catastrophic' flutter which can diverge into the loss of a major structure in less than a second at very high speeds. In preparation for the flight test program, attitude, interest, and understanding are of paramount importance. Details of execution of a flutter flight program are described. F.R.L.

A72-18492 Initial spin tests. C. A. Sewell and R. D. Whipple (Grumman Aerospace Corp., Bethpage, N.Y.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 36-56. 12 refs.

Consideration of initial spin testing, which requires a comprehensive and logical buildup program. This is due to frequently unpredictable and disorienting poststall aircraft characteristics, sometimes unanticipated spin modes, and the requirement for a rapid pilot analysis of the situation and initiation of immediate corrective action. Spins are caused by a combination of two primary factors: stalled angle of attack and sideslip, which produce the phenomenon of autorotation, the theory of which is described in detail. Preparatory studies are carried out in a spin tunnel and with radio controlled models. Emergency spin recovery devices, special equipment, and instrumentation are described. Recommended test techniques are outlined, and spin data are presented. F.R.L.

A72-18493 Rotary wing first flight and envelope expansion. R. S. Decker (United Aircraft Corp., Sikorsky Aircraft Div., Bridgeport, Conn.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 57-64.

Discussion of first flight and envelope expansion, which commences shortly after design inception, and continues through to the actual flight test program. As a team member for a first flight, the test pilot must become totally knowledgeable of the helicopter's mechanical, aerodynamic, and electronic functions. In preparation for the first flight the requirements of the customer's test specification must be learned thoroughly. Recorded data from the computer analysis, simulator, and tunnel testing must be equated to the test procedures and test points required for flight demonstration. Pre-ground run checks, the first ground run, the first hover and first forward flight, and envelope expansion at design gross weight are discussed. F.R.L.

A72-18495 Engine testing. F. A. Bastidas and G. M. Gordon (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 72-103.

General guidelines for the testing of turbojet and turbofan engines, with and without afterburners, as applied primarily to fighter/attack aircraft. The test vehicle may be a flying test bed or the operational aircraft. The engine test pilot initiates his contribution to the engine development program with the initial flights of the prototype engine, confirming contractual specifications such as airstart/relight envelope, engine and afterburner performance, and engine transient operation for stall investigation. Some of the basic engine operating and performance theory are described so that the test pilot may better understand the phenomena he is likely to observe, and to provide him with some of the techniques for the conduct of engine testing. F.R.L.

A72-18496 Jet engine airstart flight testing for single engine fighter/attack aircraft. H. W. Blot and D. G. Ebbert (U.S. Naval Air Test Center, Service Test Div., Patuxent River, Md.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc.,

1972, p. 104-110.

Outline of the procedures for jet engine airstart flight testing, which is considered to be one of the more interesting aspects of propulsion systems flight testing. The airstart envelope is dependent upon the ability of the windmilling engine and engine control systems to provide the proper combustion chamber fuel-air conditions to allow ignition and to sustain engine acceleration to idle RPM without engine compressor stall, hangup, or overtemperature. Aircraft preparation, preliminary flight tests and pilot training, and airstart flight tests are described. Test data should include flight conditions, engine windmill RPM, fuel flows, exhaust gas temperature, and engine off, engine ignition, and acceleration times. F.R.L.

A72-18497 Carrier suitability structural testing. D. R. Wilson (LTV Aerospace Corp., Dallas, Tex.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 111-136.

Discussion of the carrier suitability demonstration, which is a structural demonstration of the entire aircraft, with prime interest in the landing gear and its supporting structure under conditions either simulating shipboard conditions or recreating design conditions. Landing gear loads, as recorded by strain gages, contribute to safety by permitting comparison of actual loads with the known strengths of the gear components, by showing trends which permit buildup toward demonstration conditions, and by showing the customer that the loads for which the aircraft was designed are those which actually result when the aircraft is subjected to design landing conditions. Touchdown sink rate is the major requirement in half the demonstration arrestments. F.R.L.

A72-18498 Catapult launch and minimum end airspeed tests. W. C. Bowes and L. V. Stento (U.S. Naval Air Test Center, Patuxent River, Md.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 137-152.

Investigation of the launch envelope for a typical aircraft in order to understand the various factors necessary for determining the medium catapult end airspeed for an aircraft. Minimum catapult end airspeed is defined as that end airspeed achieved at the bow of the carrier below which the aircraft cannot maintain itself in the air. For reasons of safety, it is the intent of catapult minimum airspeeds testing to reach an airspeed no closer than 1 to 4 kt above the aircraft's absolute minimum. In conducting these tests, the test pilot must determine the optimum pilot launch technique. Theoretical aspects, test equipment, crew preparation, pilot techniques, and caution areas are discussed. A general check list is presented. F.R.L.

A72-18499 Firing and separation tests. M. W. Dixon, R. B. Davis, and R. A. Wilson (U.S. Naval Air Test Center, Patuxent River, Md.). In: Pilots handbook for critical and exploratory flight testing.

Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 153-163.

Discussion of the problem of establishing a safe weapons release envelope, the solution of which ultimately lies with exploratory flight testing. Accurate prediction of the trajectories of stores separating from aircraft is extremely difficult due to the complex (turbulent) airflow in the vicinity of the external stores and bomb racks, and the multitude of variables involved. Flight test methods used to determine aircraft weapon compatibility by firing weapons and conducting store separation tests depend upon the desired

envelope, whether the test item is a new aircraft, new store, or both; and whether it is a fixed or rotary wing aircraft. Various other areas may also present store separation difficulties. F.R.L.

A72-18500 **Thunderstorm penetration.** D. Z. Skalla (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 164-172.

Study of thunderstorm penetrations, which are carried out to evaluate aircraft, engine and system operating characteristics in severe weather and turbulence, and to collect meteorological research data. Of primary concern to the test pilot is the effect of atmospheric water and ice on both engine operation and airframe integrity. Exceeding the safe water ingestion limit can produce compressor stall, engine flameout, and compressor damage due to blade rub. The effects of ice and hail, lightning, and turbulence are discussed. Unique equipment and instrumentation, and recommended techniques are described. A general check list is presented. F.R.L.

A72-18501 **Icing tests /Civil transport aircraft/.** R. L. McPherson (Boeing Co., Seattle, Wash.). In: Pilots handbook for critical and exploratory flight testing. Lancaster, Calif., Society of Experimental Test Pilots; New York, American Institute of Aeronautics and Astronautics, Inc., 1972, p. 173-176.

Discussion of the procedures carried out to meet Federal Air Regulations Part 25, which requires demonstrations of safe aircraft flight operations in continuous maximum and intermittent maximum icing conditions. These demonstration tests normally consist of flights in dry air, flights in natural icing conditions, and flights to evaluate performance, as well as stability and control with simulated ice shapes attached to the unheated portions of both the wing and empennage leading edges. Related ground tests to evaluate slush spray patterns are also conducted prior to certification of civil transport aircraft. F.R.L.

A72-18582 **Rotocraft - A crashproof STOL aircraft (Der Rotoplan: Ein absturzsicheres STOL-Flugzeug).** R. Bucher. Lucerne, Verlag Verkehrshaus der Schweiz (Sonderveröffentlichung, No. 1), 1971. 133 p. 18 refs. In German. \$5.95.

The development of the Rotoplan system, which is an aircraft with short takeoff and landing qualities, capable of flight at extremely slow and normal flying speeds, completely crashproof, and designed primarily as a rescue aircraft, is dealt with. The underlying idea is the combination of two design principles - i.e., the orthodox rigid wing and a special rotary wing, called shallow vane rotor. Air tunnel experiments are described and evaluated along with flight tests. O.H.

A72-18647 **Effect of method of producing blanks on the mechanical properties of heat-resistant alloys.** A. F. Belov, N. D. Bobovnikov, and O. Kh. Fatkullin (VILS, Moscow, USSR). (*Problemy Prochnosti*, vol. 3, June 1971, p. 105-109.) *Strength of Materials*, vol. 3, no. 6, 1971, p. 733-737. Translation.

Improvements in the technological processes of preparing nickel- and tungsten-base jet-engine alloys achieved during the past few years are examined. Particular attention is given to such factors as isothermic closed-die forging of blades and disks, investment casting, combined closed-die forging and rolling of blades, new melting

processes, and the use of powder metallurgy, diffusion welding, and so forth. The advantages which accrue from electric arc vacuum melting and improvements in electrode technology are noted. A comparison of aircraft-engine heat-resistant alloy specifications over the last 15 years is given in tabular form. V.P.

A72-18658 **The UIT-1200/50 device for determining the heat resistance of sealing materials.** 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 Predpriatii po Izgotovleniiu Izmeritel'nykh Priborov, Leningrad, USSR). (*Problemy Prochnosti*, vol. 3, Mar. 1971, p. 92-96.) *Strength of Materials*, vol. 3, no. 3, Nov. 1971, p. 335-339. 6 refs. Translation.

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.

A72-18689 **A method of investigating the vibration of flat turbine blading in high-temperature gas streams.** A. A. Kaminer and N. Ia. Nastenka (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR). (*Problemy Prochnosti*, vol. 3, May 1971, p. 111-113.) *Strength of Materials*, vol. 3, no. 5, Dec. 1971, p. 610-612. Translation.

A facility is described which makes it possible to study blade vibrations in subsonic and sonic high-temperature air streams, with allowance for the flow parameters, the aerodynamic characteristics of the profile, and the geometrical parameters of the blades. The flow parameters measured (and controlled) during the tests include: the total pressure in front of and behind the cascade; the static pressure in front of and behind the cascade; the pressure distribution over the blade profile both during plane-parallel vibrations and in the stationary state; and the flow and blade temperatures. V.P.

STAR ENTRIES

N72-13977*# Rochester Applied Science Associates, Inc., N.Y.
DEVELOPMENT AND APPLICATION OF A METHOD FOR PREDICTING ROTOR FREE WAKE POSITIONS AND RESULTING ROTOR BLADE AIR LOADS. VOLUME 2: PROGRAM LISTINGS

S. Gene Sadler Washington NASA Dec. 1971 149 p
 (Contract NAS1-8448)

(NASA-CR-1912; Rept-69-11-Vol-2) Avail: NTIS CSCL 01A

Computer program listings are presented for two separate programs: the wake geometry 1 blade loads and response. These listings correspond to the calculations discussed previously.

Author

N72-13978*# National Aeronautics and Space Administration,
 Langley Research Center, Langley Station, Va.
WIND TUNNEL STUDY OF SLOT SPOILERS FOR DIRECT LIFT CONTROL

Dominick Andrisani, II, Garl L. Gentry, Jr., and Joseph W. Stickle
 Washington Jan. 1972 42 p refs

(NASA-TN-D-6627; L-8014) Avail: NTIS CSCL 01A

An investigation was conducted in a 300-mph 7- by 10-foot tunnel to obtain data for a slot spoiler direct lift control system. Slot spoilers are believed to have advantages over flap-type direct lift control (DLC) systems because of the small amount of power required for actuation. These tests, run at a Reynolds number of 1,400,000 showed that up to 78 percent of the lift due to flap deflection could be spoiled by opening several spanwise slots within the flaps. For a given lift change the drag change was significantly less than that which would be obtained by a variable flap DLC system. A nozzle-shaped slot was the most effective of the slot shapes tested.

Author

N72-13980# Centre National de la Recherche Scientifique,
 Meudon (France).

DELTA WINGS, WITH OR WITHOUT TRAILING EDGE FLAP, IN A RAREFIED HYPERSONIC GAS FLOW

Jean Allegre Apr. 1971 63 p refs In FRENCH; ENGLISH summary

(Rept-71-2) Avail: NTIS

The aerodynamic characteristics of delta wings located in a rarefied hypersonic gas flow at various angles of attack are presented. Trailing edge flap effects are recorded and associated separations are investigated. The flow is characterized by a Mach number of 8 and a free stream Reynolds number of 2200 per cm, simulating roughly a flight altitude of 60 km. Results are included for drag and lift coefficients at incidences up to 50, wall pressure data along the wing center-line, and external flow probing. Visualizations obtained by means of glow discharge and oil film deposit allow definitions of incident shock such as separation and flap shocks locations. The tri-dimensional separation spreading is indicated for various wing incidences and flap configurations. Data are compared, when possible, with previous experimental results and available theoretical approaches in weak and strong interaction regimes.

Author

N72-13982# United Aircraft Corp., East Hartford, Conn.
AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF HELICOPTER ROTOR HOVER PERFORMANCE AND WAKE GEOMETRY CHARACTERISTICS Final Report,
 Jul. - Oct. 1969

Anton J. Landgrebe Jun. 1971 232 p refs

(Contract DAAJ02-69-C-0056; DA Proj. 1F1-62203-A-139)

(AD-728835; UARL-K910828-31; USAAMRDL-TR-71-24)

Avail: NTIS CSCL 01/3

An analytical and experimental investigation was conducted to acquire systematic model rotor performance and wake geometry data and to evaluate the accuracy of various analytical methods in predicting the effects on performance of changes in helicopter rotor design and operating parameters. Both classical hover performance analyses and analytical methods recently developed at the United Aircraft Research Laboratories were evaluated. Of primary concern in the study was the assessment of assumptions in the analyses regarding the geometry of the rotor wake. Of particular interest was the prediction by the analysis of an instability of the tip vortex helix at moderate distances from the rotor which appeared to be substantiated by available experimental results.

Author (GRA)

N72-13983# Defense Documentation Center, Alexandria, Va.
HUMAN FACTORS IN DESIGN AND CONTROL OF AIRCRAFT A DDC bibliography, Jul. 1955 - Jul. 1970

Aug. 1971 236 p refs

(AD-729840; DDC-TAS-71-43) Avail: NTIS CSCL 01/3

The annotated bibliography contains references to reports which provide human engineering configurations dealing with location and arrangement of controls and displays in aircraft. It also includes pertinent information on the psychological and biomedical aspects of human performance in aviation training as well as in actual flight. A Corporate Author-Monitoring Agency and Subject Index are included.

Author (GRA)

N72-13984*# Massachusetts Inst. of Tech., Cambridge. Dept.
 of Aeronautics and Astronautics.

RIDE COMFORT CONTROL IN LARGE FLEXIBLE AIRCRAFT
 M.S. Thesis

Michael Edward Warren May 1971 123 p refs

(Grant NGR-22-009-548)

(NASA-CR-116775; TE-48) Avail: NTIS CSCL 01B

The problem of ameliorating the discomfort of passengers on a large air transport subject to flight disturbances is examined. The longitudinal dynamics of the aircraft, including effects of body flexing, are developed in terms of linear, constant coefficient differential equations in state variables. A cost functional, penalizing the rigid body displacements and flexure accelerations over the surface of the aircraft is formulated as a quadratic form. The resulting control problem, to minimize the cost subject to the state equation constraints, is of a class whose solutions are well known. The feedback gains for the optimal controller are calculated digitally, and the resulting autopilot is simulated on an analog computer and its performance evaluated.

Author

N72-13985*# National Aeronautics and Space Administration,
 Ames Research Center, Moffett Field, Calif.

PRELIMINARY RESULTS ON TWO-SEGMENT NOISE ABATEMENT STUDIES

Dallas G. Denery, Kent Bourquin, and Fred J. Drinkwater, III
 22 Sep. 1971 27 p refs

(NASA-TM-X-62098) Avail: NTIS CSCL 01B

The two-segment noise abatement approach procedure has been evaluated in an operational cockpit environment using

operational equipment. The upper segment glide slope was determined by a three dimensional area navigation system and the lower segment glide slope was provided by the ILS glide slope beam. The flight director steering computer was modified to provide the pilot with continuous command information during the entire approach. A thirty-day flight test program was conducted at Stockton Metropolitan Airport, Stockton, California. Twenty-eight pilots representing the airlines, professional pilot associations, NASA, and the FAA participated in the flight evaluation. One hundred ninety two-segment approaches consisting of a six-degree upper glide slope and a 400 ft ILS intercept altitude were flown. Noise data and aircraft position data were measured on the ground during the approach studies. Although the data presented in this report are preliminary, the two-segment approach appears to be an operationally feasible way of reducing airport community noise. Author

N72-13986*# National Aeronautics and Space Administration, Washington, D.C.

EXPERIMENTAL STUDY ON THE GROUND EFFECT OF A MODEL HELICOPTER ROTOR IN HOVERING

Jiro Koo and Toichi Oka Dec. 1971 23 p refs Transl. into ENGLISH of Natl. Aerospace Lab., Tokyo, report NAL-TR-113 (NASA-TT-F-13938; NAL-TR-113) Avail: NTIS CSCL 01B

Aerodynamic characteristics of a model helicopter rotor hovering in the ground effect have been experimentally investigated. Measurements of the thrust, torque and induced velocity of the hovering rotor in the ground effect/and flow visualizations around the hovering rotor in the ground effect by the use of tuft. The qualitative results obtained are as follows: (1) when a hovering rotor in higher pitch angle gets near to the ground, there is a saturation in the thrust increase from the ground effect according to the blade stall, and (2) it appears from flow observations that the periodical fluctuation of interference flow between down-wash and up-wash may introduce the unsteady phenomena of a hovering helicopter in the ground effect. Author

N72-13987*# Scientific Translation Service, Santa Barbara, Calif.

METHOD OF MEASUREMENT AND ANALYSIS OF NOISE OF AN AIRCRAFT IN FLIGHT

S. Auzolle and J. Hay Washington NASA Dec. 1971 39 p Transl. into ENGLISH of "Methodes de Mesure et d'Analyse du Bruit des Auiens en Vol" Paris, Soc. Natl. d'Etude et de Construc. de Moteurs d'Aviation, 1971 27 p Presented at the 10th Intern. Aeron. Congr. of AFITA, Paris, 1-3 Jun. 1971 (Contract NASw-2035) (NASA-TT-F-14058) Avail: NTIS CSCL 20A

An aircraft-noise-measuring installation developed by several French organizations for full scale measurements of aircraft noise in flight is described. The system uses an extensive measurement chain network equipped with microphones, cinetheodolites, and magnetic tape recorders. A computer analysis of annoyance level, directivity, and statistical properties of the noise is presented. Author

N72-13988# Department of Transportation, Washington, D.C. Office of Supersonic Transport Development.

AN ANALYSIS OF THE UNITED STATES AEROSPACE AND AIR TRANSPORT INDUSTRIES

17 Mar. 1971 76 p refs

Avail: NTIS

It is stipulated that aerospace and air transport industries are essential to the U.S. economy because they provide the

bulwark of the national defense, are the largest single employer, and the backbone of the passenger common carriage system. It is in the public interest for the United States to sponsor research and programs which will keep the U.S. in the forefront of high technology fields and maintain its leadership position on the world market. Aerospace production decrease can result in increased unemployment and reliance on foreign imports. G.G.

N72-13989# Civil Aeromedical Inst., Oklahoma City, Okla.

SURVIVAL IN EMERGENCY ESCAPE FROM PASSENGER AIRCRAFT

Clyde C. Snow, John J. Carroll, and Mackie A. Allgood Oct. 1970 58 p refs

(FAA-AM-70-16) Avail: NTIS

The human factors data from three aircraft accidents involving emergency evacuations are reviewed. Of the 261 passengers aboard, 105 died in attempts to escape during 1- to 3-minutes prior to the build-up of a lethal thermotoxic environment within the cabin. In all three accidents, decelerative forces were mild and cabin destruction and impact injuries minimal. The three most prominent factors influencing survival were found to be: (1) distance between the occupant's seat and the exit he attempts to use, (2) sex, with adult males having a strong advantage, and (3) among adult males, age, with younger males the more frequent survivors. Age and sex are also significant factors in determining the frequency and severity of injuries among survivors. Comparison of the accident evacuations with test evacuations indicate that, in the latter, the biobehavioral factors disadvantageous to elderly males and adult females are not present. Author

N72-13990# National Transportation Safety Board, Washington, D.C.

DELTA AIR LINES, INC. DOUGLAS DC-9-32, N3329L, LOUISVILLE, KENTUCKY, 8 SEPTEMBER 1970

17 Nov. 1971 17 p ref

(NTSB-AAR-71-15; File-1-0016) Avail: NTIS

Delta Air Lines Flight 439, a Douglas DC-9, N3329L, touched down 156 feet short of Runway 29 at Standiford Field, Louisville, Kentucky, September 8, 1970, at 2114, e.d.t., while making a visual landing approach. In the area of the initial impact, the ground sloped upward toward the runway threshold at a 5 percent gradient. After initial impact, the aircraft slid 73 feet on the ground, became airborne, and again touched down, this time on the runway, and the aircraft slid an additional 4457 feet before it came to rest. The aircraft was damaged substantially, and the fuselage had fractured and buckled in the area between fuselage stations 737 and 794. The National Transportation Safety Board determines that the probable cause of this accident was the pilot's misjudgement of altitude due to the absence of sufficient lights in the approach area, misleading information produced by deceptive sloping terrain, and that the pilot did not position the aircraft on the ILS glide slope while he was establishing the final approach profile. Author

N72-13991*# General American Transportation Corp., Niles, Ill. **THE DEVELOPMENT OF A SONIC BOOM SIMULATOR WITH DETONABLE GASES**

R. T. Strugielski, L. E. Fugelso, L. B. Holmes, and W. J. Byrne Nov. 1971 177 p refs

(Contract NAS1-9252)

(NASA-CR-1844) Avail: NTIS CSCL 01A

A sonic boom pressure profile was simulated in the far-field by detonation of a methane-oxygen mixture contained in a slender, shaped Mylar envelope. Ideal N-waves were synthesized

with peak overpressures from two to five psf and durations of 30 to 75 milliseconds. The detonation of the gas mixture was initiated by a single Primacord strand running the length of balloon. The N-wave producing balloon was synthesized as a composite structure, utilizing experimental pressure profiles obtained from the detonations of slender, axisymmetric balloons with elementary, non-cylindrical shapes. Author

N72-13992# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
APPLICATION OF SELF ADAPTIVE CONTROL TECHNIQUES IN THE DESIGN OF A NORMAL ACCELERATION CONTROL SYSTEM FOR A HIGH-PERFORMANCE SUPERSONIC AIRCRAFT M.S. Thesis
 Richard Robert Paul Jun. 1971 152 p refs
 (AD-730162; GGC/EE/71-17) Avail: NTIS CSDL 01/3

The thesis presents a design approach for a self-adaptive normal acceleration control system which is required for a hypothetical aerospace vehicle that operates throughout a wide range of Mach numbers and dynamic pressures. The control problem includes the realistic complications of undesirable structural modes, a nonlinear servoactuator, and the statistical nature of the aircraft stability derivatives and bending mode parameters. A systematic design procedure is developed which employs a servoactuator control loop with a variable gain, in addition to the conventional pitch-rate and normal acceleration control loops, both of which use constant loop gains. The control system is simulated on an analog computer and tested at each flight condition, where variation of the servoactuator loop gain is accomplished manually. At each individual flight condition, this gain is adjusted to the value that would have ordinarily been dictated by an Off-Line Adaptive Computer (OLAC)4 which uses elevator position and pitch-rate measurements from the aircraft to identify and compute changes in elevator effectiveness. Collective examination of the analog results reveals that the aircraft responses to command inputs and wind gust disturbances meet the design specifications for the majority of the flight envelope. Author (GRA)

N72-13993*# National Aeronautics and Space Administration, Washington, D.C.
INFLUENCE OF LIFT AND CRUISE ENGINE DESIGN ON THE TRANSITION CHARACTERISTICS AND GROUND ACOUSTIC FIELD OF VTOL TRANSPORT AIRCRAFT
 H. Pakendorf and G. Bottger Jan. 1972 39 p refs Transl. into ENGLISH of "Einfluss der Hub- und Reisetriebwerkauslegung auf die Transition und das Bodenschallfeld Vertikalstartender Transportflugzeuge", German report DGLR-70-040 Presented at Symp. on VTOL Engines, Munich, 22-23 Oct. 1970
 (NASA-TT-F-14059; DGLR-70-040) Avail: NTIS CSDL 01B

A transition technique for maximum horizontal acceleration is used to evaluate the influence of engine design and thrust vector control on the transition characteristics. It is shown that the vertical balance of forces in transition, and hence the transition characteristics, are influenced directly by the input-output impulse ratio and by the thrust vector control characteristics of the lift and cruising engines, and indirectly by optimal adaptation of the cruising engines to the cruising flight requirements and by the number of lift and cruising engines installed. A parametric analysis of mixed and direct lift configurations shows that thrust vector control over an angle of at least 30 deg for the lift engines is essential for ensuring safe transition. Author

N72-13994# Sandia Labs., Albuquerque, N.Mex.
SUPERSONIC AND TRANSONIC DEPLOYMENT OF

RIBBON PARACHUTES AT LOW ALTITUDES

Randall C. Maydew and Donald W. Johnson [1971] 17 p refs
 Presented at the Royal Aeron. Soc. Symp., London, 15 Sep. 1971

(SC-DC-714022; Conf-710904-1) Avail: NTIS

Results are presented for twenty-five flight tests of a 22.2-ft (6.8-m) diameter ribbon parachute (reefed for 0.5 sec) with a nominal 2000-lb (907 kg) store. The design, fabrication, and packing of the parachute system are discussed. Low altitude drop tests were made with F-4 and A-4 aircraft at Mach numbers from 0.57 to 1.22, and rocket-boosted tests were made at Mach numbers from 1.62 to 1.70, the latter corresponding to a maximum dynamic pressure of 2720 psf (130 kN/sq m sq). The maximum measured snatch load, reefed stage opening shock, and second stage opening shock were approximately 65 klb (289 kN), 165 klb (734 kN) and 150 klb (667 kN), respectively. The measured load data and sequence of parachute function times are relatively consistent and repeatable. There is no discernible effect of Mach number on the steady state drag area of the reefed parachute at Mach numbers from 0.7 to 1.50. Author

N72-13995# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Aeroelastik.

FLUTTER ANALYSIS OF AIRCRAFT TAKING INTO ACCOUNT THE EFFECTS OF SERVOMECHANISMS

H. Foersching 1971 124 p refs In GERMAN; ENGLISH summary
 (DLR-FB-71-37; AVA-FB-7107) Avail: NTIS; DFVLR, Porz: 32.70 DM

The theory and method of flutter analysis of servocontrolled aircraft are presented, taking into account the influences of the servocontrol systems and possible couplings between structural and rigid body vibrations of the airframe and the dynamical behavior of control system elements located within the structure. Based upon the modified two-dimensional flutter system, the basic dynamic relations of hydraulic servocontrol systems and the flight mechanical stability augmentation systems are discussed. The modified aeroservoelastic flutter equations of the entire airplane are derived, and the possibilities of an analytical and analog-digital solution of these equations are considered. Finally, the procedures of the experimental determination of the characteristic servomechanical parameters necessary for aeroservoelastic flutter investigations are discussed.

Author (ESRO)

N72-13996# Boeing Co., Philadelphia, Pa. Vertol Div.
DESIGN STUDIES AND MODEL TESTS OF THE STOWED TILT ROTOR CONCEPT. VOLUME 2: COMPONENT DESIGN STUDIES

Bernard L. Fry Wright-Patterson AFB, Ohio AFFDL Jul. 1971 135 p refs
 (Contract F33615-69-C-1577)
 (AD-729428; D213-10000-2-Vol-2; AFFDL-TR-71-62-Vol-2)
 Avail: NTIS CSDL 01/3

This volume presents the results of the detailed component design studies carried out during the latter portion of the Phase I study. General preliminary design criteria is developed from proposed and existing military specifications. A number of potentially critical design conditions are specified for the purpose of preliminary component design and evaluation. Design efforts are concentrated on the determination of component concepts and their evaluation with respect to critical loading conditions, critical design areas such as space envelopes and mechanical complexity, and the determination of problem areas peculiar to the stowed-tilt-rotor vehicle concept. Components investigated in this study are the wing, nacelle, nacelle tilt mechanism, rotor blade, rotor hub, blade-fold mechanism and power-transmission system. Author (GRA)

N72-13997# Boeing Co., Philadelphia, Pa. Vertol Div.
DESIGN STUDIES AND MODEL TESTS OF THE STOWED TILT ROTOR CONCEPT. VOLUME 3: APPENDIXES
 Bernard L. Fry Wright-Patterson AFB, Ohio AFFDL Jul. 1971 144 p
 (Contract F33615-69-C-1577)
 (AD-729429; D213-10000-3-Vol-3; AFFDL-TR-71-62-Vol-3)
 Avail: NTIS CSCL 01/3

This Appendix contains a description of the drag prediction methodology used in this study, minimum parasite drag breakdowns for all the point design aircraft, and detailed performance data for the Design Point 1, 2, and 3 aircraft.

Author (GRA)

N72-13998# Boeing Co., Philadelphia, Pa. Vertol Div.
DESIGN STUDIES AND MODEL TESTS OF THE STOWED TILT ROTOR CONCEPT. VOLUME 1: PARAMETRIC DESIGN STUDIES
 Bernard L. Fry Jul. 1971 324 p refs
 (Contract F33615-69-C-1577)
 (AD-729427; D213-10000-1-Vol-1; AFFDL-TR-71-62-Vol-1)
 Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01/3

The stowed-tilt-rotor stoppable rotor concept offers great potential for three missions requiring 2 combinations of relatively low downwash characteristics, good hover efficiency, and relatively high cruise speed and efficiency. These missions are high-speed long-range rescue, capsule recovery, and VTOL medium transport. The present study will provide information on design criteria including the size and configuration of aircraft required to fulfill each of the three missions. The current study indicates that there is reasonable compatibility between the rescue and capsule recovery aircraft because their speed capabilities and required useful loads are similar. However, a much larger aircraft is required to accommodate all three missions. (A reduction in cargo box size for the transport mission can however provide a single compromise airframe size.) Consequently, a baseline configuration has been selected with a common lift/propulsion system combined with different fuselages for rescue aircraft and medium transport aircraft. The compromise made in the transport fuselage box size still provides a capacity in excess of most current medium transports, both helicopter and fixed-wing.

Author (GRA)

N72-13999# Army Foreign Science and Technology Center, Charlottesville, Va.
SPECIFICS OF AERODYNAMICS OF THE LIFTING ROTOR OF A HELICOPTER
 A. M. Mkhitarian 4 Aug. 1971 16 p Transl. into ENGLISH from the publ. "Aerodinamika" Moscow, 1970
 (AD-729587; FSTC-HT-23-1348-71; T702301-2301) Avail: NTIS CSCL 01/3

Depending on the aerodynamic plan of a helicopter, there are many designs for lifting rotors, providing for performance of its varied functions. Particular attention is given to inclined air-stream incidence to the rotor.

GRA

N72-14000# Minnesota Univ., Minneapolis.
STABILITY AND DRAG OF PARACHUTES WITH VARYING EFFECTIVE POROSITY Final Report, Jun. 1958 - Jun. 1961
 Helmut G. Heinrich and Eugene L. Haak Wright-Patterson AFB, Ohio AFFDL Feb. 1971 78 p refs Supersedes AD-288572, ASD-TDR-62-100
 (Contract AF 33(616)-8310; AF Proj. 6065)
 (AD-729858; AD-288572; ASD-TDR-62-100; AFFDL-TR-71-58;

Task-606503) Avail: NTIS CSCL 01/3

The tangent force, normal force, and moment coefficients versus the angle of attack of ten different types of parachutes were determined by means of wind tunnel measurements. Models formed from sheet metal as well as made out of non-porous and porous cloth were used. The nominal porosity of the cloth varied from 10 to 275 cu ft/sq ft min under a differential pressure of 1/2 inch of water. This corresponds to a range of effective porosity from 0.003 to 0.096. The aerodynamic coefficients were related to the effective and nominal porosity characteristics expressed as derivatives with respect to the porosity term. It was found that the static stability of all types of parachutes could be significantly improved through higher porosity, although this reduces slightly the air resistance for the parachute.

Author (GRA)

N72-14001# United Aircraft Corp., Stratford, Conn.
ADVANCED ANTITORQUE CONCEPTS STUDY Final Technical Report, Jun. 1970 - Jan. 1971
 Arthur W. Grumm and Groves E. Herrick Jul. 1971 166 p refs
 (Contract DAAJ02-70-C-0049)
 (AD-729860; SER-50697; USAAMRDL-TR-71-23; Task-1F162204AA4405) Avail: NTIS CSCL 01/3

The report summarizes a study of possible alternatives to the tail rotor on single-rotor shaft-driven helicopters. The objective was to select concepts that show improvements over the tail rotor in high-speed dynamics, vulnerability, reliability and maintainability, safety, and at a lower priority level, acoustic detectability, and erosion and foreign object damage. These characteristics were to be obtained without incurring unacceptable penalties in aircraft weight, performance, or cost. The stability and control criteria of MIL-H-8501A were imposed throughout.

Author (GRA)

N72-14002# North American Rockwell Corp., Columbus, Ohio.
AN INVESTIGATION OF LANDING GEAR - SOFT SOIL INTERACTION UTILIZING THE OV-10A AIRCRAFT Final Technical Report, Nov. 1968 - Jan. 1970
 Charles E. Cook and Joseph D. Gargiulo Jan. 1971 383 p refs
 (Contract N00019-69-C-0063)
 (AD-729685; NR-70H-570) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01/2

The results of an investigation of the interaction between landing gear and soft soil are presented. The OV-10A aircraft was used to perform sixteen landings and takeoffs on soft unprepared terrain at Blackstone Army Air Base, Virginia. Two fifty channel oscillographs were used to measure time histories of the airplane response. Measurements were also taken of the terrain contour and static and dynamic strengths of the soil. Equations of motion are presented for a mathematical model of the OV-10A landing and taking off from yieldable uneven terrain. The model simulates the soil-tire interactions, landing gear-airplane interactions, and the airplane dynamic response. A system of 20 nonlinear, coupled second order differential equations results.

Author (GRA)

N72-14003# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VARIABLE SWEEP
 S. Yu. Skripnichenko 20 Jul. 1971 54 p refs Transl. into ENGLISH from the Monograph Izmennyayemaya Strelovidnost, Moscow, 1969 p 73-120
 (AD-730043; FTD-MT-24-23-71) Avail: NTIS CSCL 01/3

Contents: About the problems of producing aircraft with the changeable sweepback wing; Military aircraft of western

countries with changeable sweepback wing; About the prospects of the use of the changeable sweepback wing on the military aircraft. GRA

N72-14004# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
DEVELOPMENT OF ADVANCED TECHNIQUES FOR THE IDENTIFICATION OF V/STOL AIRCRAFT STABILITY AND CONTROL PARAMETERS Final Report, May 1969 - Dec. 1970

Robert T. N. Chen, Bernard J. Eulrich, and J. Victor Lebacoz
 Aug. 1971 353 p refs
 (Contract N00019-69-C-0534)
 (AD-730121; CAL-BM-2820-F-1) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01/3

Contemporary analyses of transition flight of V/STOL aircraft are based on aerodynamic data measured in a wind tunnel or on analytical prediction using methods developed for conventional aircraft. The validity and accuracy of these techniques for V/STOL aircraft has not yet been established, and it is essential that they be correlated with flight test data through parameter identification. In spite of the complicated nature of V/STOL dynamics in transition, some method of identifying these characteristics is required. This report documents the development of identification techniques to meet this requirement. The report first presents the selection of a mathematical model to represent a V/STOL aircraft (the X-22A). This is followed by a discussion of available identification techniques. Based upon a thorough knowledge of the requirements of this program and the limitations of the available techniques, advanced techniques suitable for identification of V/STOL aircraft stability and control parameters are developed. Author (GRA)

N72-14005# Air Force Flight Test Center, Edwards AFB, Calif.
METHODS OF AUDITORY DISPLAY FOR AIRCRAFT COLLISION AVOIDANCE SYSTEMS Final Report

Richard G. Hector Aug. 1971 77 p refs
 (AD-729765; AFFTC-TD-71-3) Avail: NTIS CSCL 01/2

When two aircraft are physically oriented so that continuation on their individual flight paths will result in collision, the final decision of the pilot to take avoiding action is most often based on visual detection of the other aircraft. Considerable laboratory experimentation has been conducted and reported on various aspects of visual detection, although little has been reported on methods to aid the pilot in visual searching. A head-up aid is desirable, rather than an in-the-cockpit display. For this reason, an auditory display was investigated. The display requires auditory localization in both the horizontal and vertical dimensions. Experimentation was conducted to determine physical factors of localization in the vertical plane. The results of the research and experimentation indicated that the external portion of the ear, the pinna, imposes a pattern of organization on the high frequencies of the sound whose source is located vertically. Specifically, this pattern is a shift in the dominant frequencies and attenuated frequencies with change in elevation. This knowledge allowed the proposal of a full two-dimension stereophonic auditory display for the pilot to localize the intruding aircraft. Author (GRA)

N72-14006# Dynamic Science, Phoenix, Ariz.
STUDY TO DETERMINE THE APPLICATION OF AIRCRAFT IGNITION SOURCE CONTROL SYSTEMS TO FUTURE ARMY AIRCRAFT Final Report

John K. Drummond Fort Eustis, Va. AAMRDL Jun. 1971 57 p refs
 (Contract DAAJ02-69-C-0030; DA Proj. 1F1-62203-A-529)
 (AD-729870; AVSER-4200-17-10; USAAMRDC-TR-71-35)
 Avail: NTIS CSCL 13/12

The report presents the results of a program that was conducted to provide design information applicable to future Army aircraft relative to crash sensors, ignition-source suppression systems, and circuitry for the automatic activation of the suppression systems. The program involved a comprehensive literature search, the development of requirements for the initiating subsystem of the overall ignition source control system, and the consideration and comparison of several illustrative activating circuits. The development of a workable ignition-source suppression system was found to be feasible. Several systems have already been developed to cool hot surfaces, to inert atmospheres, and to de-energize electrical systems. The areas of the ignition-source control problem which require development are: the selection and the degree of redundancy of crash sensors, the locations of the sensors on the aircraft, and the complexity of the activating and control circuitry. Author (GRA)

N72-14007# Systems Technology, Inc., Hawthorne, Calif.
ANALYSIS OF LIMITED AUTHORITY MANUAL CONTROL SYSTEM Final Report, Sep. 1969 - Jun. 1970

Lee Gregor Hofmann, Kishor V. Shah, and Dunstan Graham Wright-Patterson AFB, Ohio AFFDL Jul. 1971 253 p refs
 (Contract F33615-70-C-1075; AF Proj. 8219)
 (AD-729869; STI-TR-194-1; AFFDL-TR-71-6) Avail: NTIS CSCL 01/3

Systematic procedures for predicting pilot-vehicle-flight control system performance and proneness to pilot induced oscillations and instabilities are here developed and applied to examples. The systems analyzed have very limited maximum control surface rates and deflections. Performance analysis is by means of applying random input describing function theory to predict the root mean square level of key system variables as a function of the control surface rate and deflection limit levels. Acceptable limit levels are only two to three times the root mean square value of the variable at the point in the system where each limiter nonlinearity occurs. Results of analyzing three minimum back-up manual flight control system modifications for the F-4 C are compared with data from piloted fixed-base simulator experiments for the same system configurations. Author (GRA)

N72-14008# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
AN IN-FLIGHT INVESTIGATION OF LATERAL-DIRECTIONAL DYNAMICS AND ROLL-CONTROL POWER REQUIREMENTS FOR THE LANDING APPROACH Final Report

C. Warren Hall and Edward M. Boothe Oct. 1970 180 p refs
 (Contract F33615-69-C-1664; Contract DOTFA69WA-163; AF Proj. 8219)
 (AD-725461; CAL-BM-2821-F-5-A; FAA-RD-71-26; Task-821905) Avail: NTIS CSCL 01/2

Lateral-directional handling qualities and roll control power requirements for the executive jet class of airplanes in the landing approach flight phase were investigated in the USAF/CAL variable stability T-33 airplane. Particular emphasis was placed on the effects of crosswinds and turbulence. Simulated IFR ILS approaches and VFR offset and crosswind approaches were made. Specifically, two Dutch roll frequencies, three Dutch roll damping ratios, three roll-to-sideslip ratios, and three roll mode time constants were investigated. It was found that for the range of parameters investigated, lateral-directional dynamics do not establish a limiting crosswind value; however, they do determine the ease or difficulty with which a crosswind approach can be accomplished. Roll control power requirements were determined from actual control usage data obtained throughout the evaluation program and were found to be a function of the lateral-directional dynamics. Minimum acceptable levels of roll control power were determined by reevaluating a number of configurations with limited roll control power. It was found that available roll control power can establish a limiting crosswind component. Author (GRA)

N72-14009# Federal Aviation Administration, Washington, D.C.
CONGRESSIONAL AIR TRANSPORTATION CONGESTION STUDY, PART 1

1971 184 p refs
 (AD-725326) Avail: NTIS CSCL 01/2

House of Representatives Report No. 91-1115 directed the Department of Transportation, in close collaboration with the Civil Aeronautics Board, to study the problem of aircraft traffic during prime travel hours and the extent to which this concentration results from unrealistic scheduling of flights by the airlines. The resultant effects on safety and controller staffing were to be investigated. This report presents the findings, conclusions, and recommendations of the two agencies concerning the problem. Author

N72-14010# Mechanics Research, Inc., Los Angeles, Calif.
STABILITY AND CONTROL OF HELICOPTERS IN STEEP APPROACHES. VOLUME 1: SUMMARY REPORT Final Report

Julian Wolkovitch and John A. Hoffman May 1971 186 p refs 4 Vol.
 (Contract DAAJ02-69-C-0004; DA Proj. 1F1-62204-a-142)
 (AD-729847; MRI-2284-1-Vol-1; USAAVLABS-TR-70-74A)
 Avail: NTIS CSCL 01/3

Aerodynamics and control characteristics of helicopters in level flight and steep descents at low speeds are analyzed. Single-rotor, tandem-rotor, and compound helicopters are considered and are specifically represented by the S-58, AH-56A, and YHC-1A, for each of which derivatives and transfer functions are presented. New analytic methods are used to describe the flow about descending rotors. Using these methods, predictions are made of the boundaries of the vortex-ring state and of tip loss factors. Good agreement with experiment is obtained. A new modular stability derivative program, MOSTAB, is described and is used to calculate derivatives for the S-58 and AH-56A, including lateral-longitudinal cross-coupling derivatives. It is shown that, for these helicopters, control of flight path by collective pitch becomes difficult for low-speed steep descents even with stability augmentation, due to a nonminimum phase transfer function and the associated wrong-way step response characteristic. The effect is identified as an important factor in the observed degradation of flying qualities in steep approaches. Author (GRA)

N72-14011# Mechanics Research, Inc., Los Angeles, Calif.
STABILITY AND CONTROL OF HELICOPTERS IN STEEP APPROACHES. VOLUME 2: THE MOSTAB PROGRAM Final Report

Julian Wolkovitch and John A. Hoffman May 1971 203 p refs 4 Vol.
 (Contract DAAJ02-69-C-0004; DA-Proj. 1F1-62204-A-142)
 (AD-729848; MRI-2284-1-Vol-2; USAAVLABS-TR-70-74B)
 Avail: NTIS CSCL 01/3

The general approach used in the MOSTAB modular stability derivative program is described. Details are presented of the aerodynamic representations of modular aircraft elements such as bodies and lifting surfaces, and the rotor dynamic equations are explained. A listing of the MOSTAB program (MOSTAB B version) is given. Author (GRA)

N72-14012# European Research Office, London (England).
VISIT TO SIAI-MARCHETTI, SESTO-CALLENDE/VERGIATE (VARESE), ITALY

Richard L. Scharpf 13 Aug. 1971 7 p
 (AD-729377; Fro-9-1971) Avail: NTIS CSCL 01/3

The report describes the SV-20 helicopter being developed

by SIAI-Marchetti, Italy. A visit was made to become familiar with the concept and with the development status.

Author (GRA)

N72-14013# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.

CREW COMPARTMENT VIBRATION ENVIRONMENT IN THE B-58 AIRCRAFT DURING LOW ALTITUDE, HIGH SPEED FLIGHT Final Report, Jul. 1966 - Dec. 1970

Jerry D. Speakman and Justus F. Rose, Jr. Jul. 1971 201 p refs

(AF Proj. 7231)
 (AD-730288; AMRL-TR-71-20) Avail: NTIS CSCL 01/3

Measurements were made of the crew compartment vibration environment experienced in the B-58 aircraft during low-altitude, high-speed flight. Data were obtained of the longitudinal, lateral and vertical linear accelerations and the roll axis angular velocities and accelerations present during five flights made in July 1966. The terrain contour following flights at 500 to 900 feet above the flat to semi-mountainous regions of Louisiana and Arkansas were conducted at 450 knots true airspeed. Data analyses included probability density and distribution and the auto-power spectral density functions in addition to tests for stationarity, randomness and normality. The individual degree-of-freedom results are presented in graphical and tabular form and allow evaluation of operational flight environments and exposure conditions in terms of existing tentative vibration exposure criteria for various crew functions. They will also form the urgently required basis for simulating these environments for further biomedical laboratory research on human tolerance and performance. Author (GRA)

N72-14014# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

AN INVESTIGATION OF CROSS-COUPLING THE ELEVATORS AND THROTTLE SYSTEMS FOR THE KC-135 AIRCRAFT IN THE LANDING CONFIGURATION M.S. Thesis

Ronald Edward Goodfellow Jun. 1971 127 p refs
 (AD-730153; GGC/EE/71-8) Avail: NTIS CSCL 01/3

The purpose of this study was to investigate the possibility of using cross-coupling methods as additional controls during automatic landing approaches. This investigation was for aircraft that have the engine thrust line below the center of gravity of the aircraft. The KC-135 aircraft dynamics were used in this study. Three methods of cross-coupling were investigated. These methods were the cross coupling of a thrust signal into the elevator system; the cross-coupling of the glide slope beam error signal into the engine system; and a combination of these two methods. This study showed that the pitch handling characteristics of the aircraft in the landing configuration were improved with all three of the methods investigated. Author (GRA)

N72-14015# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

DESIGNING A CONTROL AUGMENTATION SYSTEM FOR THE H-53 HELICOPTER M.S. Thesis

Robert W. Radloff 1971 124 p refs
 (AD-730160; GGC/EE/71-20) Avail: NTIS CSCL 01/3

The thesis presents the procedures used in designing a control augmentation system (CAS) for the H-53 helicopter. The conventional root locus design techniques, along with an analog computer simulation, were used to design the system. Two control loops were formed; the height rate control loop (collective pitch control) and the pitch control loop (cyclic pitch control).

When both loops are closed the helicopter does not respond correctly to pitch commands. The problem of improper height response during pitch commands was solved by cross coupling some of the pitch command to the height control loop. The results show that a simple CAS is feasible and desirable to improve the controllability of present day helicopters.

Author GRA

N72-14016# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

A STUDY OF THE PRACTICALITY OF ACTIVE VIBRATION ISOLATION APPLIED TO AIRCRAFT DURING THE TAXI CONDITION M.S. Thesis

Charles Dominic Corsetti Jun. 1971 164 p refs
(AD-730141; GGC/EE/71-6) Avail: NTIS CSCL 01/3

The feasibility of using an active control in the landing gear system of an aircraft to reduce wing fatigue damage resulting from ground induced vibration during taxiing is considered. The characteristics of three vehicle models are discussed: a single landing gear system, a tricycle landing gear system and a system of five landing gears. Mathematical expressions for the runway inputs to each vehicle model are obtained in the form of random inputs represented by Gauss-Markov processes. The model for a linear hydraulic actuator which is used as the active control element in the landing gear system is presented. The results indicate that the combined optimal active control parameters that are necessary and desirable in the optimal system, together with the physical demands placed on the actuator, are determined.

Author (GRA)

N72-14017# Wyle Labs., Inc., Hampton, Va.

HELICOPTER AURAL DETECTABILITY Final Report

John B. Ollerhead Jul. 1971 198 p refs
(Contract DAAJ02-69-C-0083; DA Proj. 1F1-62204-A-142)
(AD-730788; WR-71-3; USAAMRD-L-TR-71-33;
Task-1F162204-A-14235) Avail: NTIS CSCL 17/1

The principal objective of the study is to develop the methodology for the prediction of helicopter aural detection thresholds from measured or estimated parameters of significance. The subjective aspects of helicopter noise are discussed. A review is presented of the effects of atmospheric and terrain features upon the observed sound, and of the limitations in the measurement and analysis of helicopter noise. An experimental program is described, in which a group of subjects listened to a large number of synthetic and recorded helicopter sounds inside a specially designed acoustic chamber. Through these experiments, a model for calculating aural detection thresholds is developed, tested, and found to be accurate to within plus or minus 4dB. Appendices to the report include detailed instructions for applying several versions of the developed method and also provide simplified procedures for estimating propagation losses.

Author (GRA)

N72-14018# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

AN EXPERIMENTAL STUDY OF HELICOPTER ROTOR IMPULSIVE NOISE Final Report

William E. Bauch, Charles L. Munch, and Ronald G. Schlegel Jun. 1971 245 p refs
(Contract DAAJ02-69-C-0035; DA Proj. 1F1-62204-A-142)
(AD-730359; USAAVLABS-TR-70-7223;
Task-1F162204-A-14235) Avail: NTIS CSCL 20/1

Results of a study of helicopter rotor impulsive noise (RIN) are presented. Rotor noise, together with rotor blade dynamic and pressure data, was measured during hover and cruise of a CH-53A helicopter for use in a correlation study of calculated

and measured noise. In addition, the rotor rotational noise analysis described in U. S. Army Aviation Materiel Laboratories (USAAVLABS) Technical Report 70-1B was modified to reduce computation time and to include blade flapping and coning motions. The inclusion of these motions, however, is shown to have little effect on the predicted noise. Correlation of calculated and measured noise harmonic amplitudes is generally within 5 dB through the third harmonic at distances less than 1000 feet in front of the helicopter. Waveform correlation of calculated and measured time histories of acoustic pressure is good. RIN is identified as being primarily a rotational noise phenomenon, ordered at the blade passage frequency and its harmonics, rather than amplitude modulated broadband noise. Hover RIN is shown to be due to vortex interference (blade/wake interaction RIN), while cruise RIN is shown to be due to the combination of acoustic effects of a high subsonic tip Mach number on wave propagation and blade drag, and is referred to as advancing blade RIN.

Author (GRA)

N72-14019# Mechanics Research, Inc., Los Angeles, Calif.
STABILITY AND CONTROL OF HELICOPTERS IN STEEP APPROACHES. VOLUME 3: DERIVATIVES AND TRANSFER FUNCTIONS FOR THE YHC-1A TANDEM-ROTOR HELICOPTER AND THE S-58 SINGLE-ROTOR HELICOPTER Final Report

Julian Wolkovitch and John A. Hoffman May 1971 303 p refs
(Contract DAAJ02-69-C-0004; DA Proj. 1F1-62204-A-142)
(AD-730362; MRI-2284-1-Vol-3; USAAVLABS-TR-70-74C)
Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01/3

Derivatives and transfer functions are presented for the Boeing-Vertol YHC-1A tandem-rotor helicopter and for the Sikorsky S-58 single-rotor helicopter. The flight conditions considered for the YHC-1A include forward speeds from 0 to 80 knots and descent rates from 0 to 25 fps. For the S-58 forward speeds of 0 to 100 knots and descent rates of 0 to 22.5 fps are considered.

Author (GRA)

N72-14020# Lockheed-Georgia Co., Dawsonville.
STABILITY AND CONTROL OF HELICOPTERS IN STEEP APPROACHES. VOLUME 4: DERIVATIVES AND TRANSFER FUNCTIONS FOR THE AH-56A COMPOUND HELICOPTER AND DATA ON LOW ALTITUDE TURBULENCE REPRESENTATION Final Report

Julian Wolkovitch and John A. Hoffman May 1971 206 p refs
(Contract DAAJ02-69-C-0004; DA Proj. 1F1-62204-A-142)
(AD-730363; MRI-2284-1-Vol-4;
USAAVLABS-TR-70-740-Vol-4) Avail: NTIS CSCL 01/3

Derivatives and transfer functions are presented for the Lockheed AH-56A helicopter. The flight conditions considered include airspeeds of from 0 to 100 knots and descent rates from 0 to 28.8 fps. A critical review is given of data on low altitude turbulence.

Author (GRA)

N72-14021# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

AN EXPERIMENTAL INVESTIGATION OF COMPOUND HELICOPTER AERODYNAMICS IN LEVEL AND DESCENDING FORWARD FLIGHT AND IN GROUND PROXIMITY Final Data Report

William F. Putman and Joseph J. Traybar Jul. 1971 318 p refs
(Contract DAAJ02-67-C-0025; DA Proj. 1F1-62204-A-142)
(AD-730364; AMS-971; USAAMRD-L-TR-71-19) Avail: NTIS
HC \$6.00/MF \$0.95 CSCL 01/1

A series of experiments was performed on the Princeton Dynamic Model Track on a compound helicopter model with an 8-foot-diameter hingeless rotor. Rotor, wing and fuselage forces and moments were measured as functions of advance ratio, rotor angle of attack, and collective pitch at various combinations of wing size and position, including wing off and wing and fuselage off. Test conditions included forward level flight, partial-power steep descent, and slow longitudinal and lateral flight in ground proximity. The results of these experiments are presented as functions of advance ratio in nondimensional coefficient form based on rotor tip speed and an appropriate characteristic area, such as rotor area or wing area. Author (GRA)

N72-14188# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
AVIONICS, COMMUNICATIONS EQUIPMENT Final Report
 10 Jun. 1971 31 p
 (AMCR Proj. 310-6)
 (AD-729846; MTP-6-3-025) Avail: NTIS CSCL 01/3

The procedure defines methods of evaluating the performance of aircraft communications equipment. Author (GRA)

N72-14189# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
RADAR REFLECTIVITY Final Report
 1 Sep. 1971 10 p
 (AMCR Proj. 310-6)
 (AD-729851; MTP-7-3-524) Avail: NTIS CSCL 17/9

The document provides procedures for evaluating the radar reflectivity of aircraft. Author (GRA)

N72-14192# RAND Corp., Santa Monica, Calif.
ON THE ACCURACY ANALYSIS OF AIRBORNE TECHNIQUES FOR PASSIVELY LOCATING ELECTROMAGNETIC EMITTERS
 L. H. Wegner Jun. 1971 84 p refs
 (Contract F44620-67-C-0045)
 (AD-729767; R-722-PR) Avail: NTIS CSCL 17/4

Discussion of methods of locating electromagnetic emitters from airborne electronic reconnaissance systems, using passive measurements on the electromagnetic waves of the emitter taken from several locations. Measurements for finding the emitter may be either the direction of arrival at 2 or more locations along the aircraft's flight path for single-aircraft DF (direction-finding) systems, or the relative time of arrival of emitter pulses at the different aircraft locations for 3-aircraft TOA (time-of-arrival) systems. Emitter location accuracy is a function of the accuracy of these indirect measurements of the emitter location and the estimation procedure used to combine the accuracies of various measurements of location and bearing. A general expression is derived for a lower bound to the covariance matrix of the unbiased estimates of emitter location coordinates (and consequently the location CEP), using the Cramer-Rao inequality. Examples illustrate the application of the Cramer-Rao lower bound to the emitter CEP for both DF and TOA systems. Author (GRA)

N72-14223# Hamilton Standard, Windsor Locks, Conn.
USER'S MANUAL FOR PROPELLER NOISE DETECTABILITY PROGRAM Final Report, 1 May 1970 - 1 May 1971
 Frank W. Barry Wright-Patterson AFB, Ohio AFAPL Jun. 1971

183 p refs
 (Contract F33615-70-C-1583; AF Proj. 3066; AF Proj. 3066)
 (AD-729435; HSER-5835; AFAPL-TR-71-38) Avail: NTIS CSCL 09/2

The report is the user's manual for a propeller noise detectability program written in Fortran 4 language. This program consists of ten subroutines which are to be used with the proprietary Hamilton Standard propeller performance program made available to the AFAPL previously. The noise program calculates the propeller harmonic rotational noise and the broad-band noise and compares these predicted noise levels with a selected aural detectability criterion to determine the minimum undetectable altitude. Several calculation and input data options are provided in order to enhance the value of the program to a user and are discussed in this manual. The input data and the computer output for four sample cases are presented and discussed. A listing of the source cards and a flow chart of the ten subroutines are provided. Author (GRA)

N72-14224# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
TOWARD A DIFFERENTIAL GAME SOLUTION TO A PRACTICAL TWO-AIRCRAFT PURSUIT-EVASION PROBLEM IN THREE-DIMENSIONAL SPACE M.S. Thesis
 S. Miles D. Williamson-Noble Jun. 1971 127 p refs
 (AD-729777; GA/MC/71-5) Avail: NTIS CSCL 15/7

A practical two aircraft pursuit-evasion problem in three-dimensional space is posed as a zero sum, perfect information differential game. The purpose of the thesis is to solve this differential game and to obtain optimal or near optimal closed-loop control laws for the two players. Three models of the aircraft dynamics are used. The first model is primarily a realistic one, and as the state equations are non-linear and highly coupled, it is not possible to obtain optimal closed-loop solutions. The second model is a simplified version of the first. Using this model, the solution is carried further - the costate variables are eliminated from the controls - but closed-loop solutions still cannot be found. The third model used has different controls from the other two, but is roughly similar in nature. Optimal closed-loop controls are obtained for this model. The results obtained from these models show that the three-dimensional problem cannot be considered as a simple extension of the two-dimensional game. The necessary inclusion of the bank angle or a similar control introduces an extra order of complexity into the problem. Author (GRA)

N72-14243# Ohio State Univ., Columbus. Electro Science Lab.
ADAPTIVE ANTENNA ARRAYS FOR AIRCRAFT COMMUNICATION SYSTEM Internal Technical Report, 15 Aug. 1970 - 15 Feb. 1971
 R. T. Jr. Compton Jul. 1971 44 p refs
 (Contract N00014-67-A-0232-0009)
 (AD-729106; ESL-3098-1) Avail: NTIS CSCL 09/5

The report describes the progress under ONR Contract N00014-67-A-0232-0009 for the first six-month period, 15 August 1970 to 15 February 1971. The primary purpose of the work is to investigate the use of adaptive array techniques for obtaining scannable patterns from arrays as curved surfaces. During this six-month period, the electronic and RF circuitry for a 4-element array was completed, and a mockup of an aircraft fuselage with four multiturn loop antennas was constructed. Author (GRA)

N72-14247# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
STATIC ELECTRICITY DISSIPATOR Final Report

1 Aug. 1971 18 p refs

(AMCR Proj. 310-6)

(AD-729534; MTP-7-3-120) Avail: NTIS CSCL 09/1

Procedures are given for evaluating the performance of static electricity dissipators used on fixed and rotary wing aircraft. Author (GRA)

N72-14272# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

INFRARED SUPPRESSION DEVICES Final Report on Materiel Test Procedure

1 Sep. 1971 19 p refs

(AMCR Proj. 310-6)

(AD-729603; MTP-7-3-523) Avail: NTIS CSCL 14/2

The report describes test methods and techniques for evaluating infrared suppression devices and determining their effectiveness for suppressing or masking aircraft infrared emissions. GRA

N72-14273# National Aviation Facilities Experimental Center, Atlantic City, N.J.

INTERMEDIATE ACTIVITY LEVEL TOWER CAB EVALUATION, PHASE 2 Final Report, Jul. - Sep. 1971

J. Roy Bradley, Jr. Dec. 1971 47 p

(FAA Proj. 144-170-06X)

(FAA-NA-72-2; FAA-RD-71-104) Avail: NTIS

Air traffic controllers acceptance of an intermediate activity level, airport traffic control tower, proposed for construction on a national basis, was investigated. Full-scale mockups of the tower cab and associated junction room were constructed and equipped with operational equipments. A 2 week evaluation was conducted with participation by air traffic control specialists. Results indicate that the proposed tower would be highly acceptable from an operational, as well as an environmental standpoint. Concern was expressed over the large size of tower cab corner posts and window mullions and over unknown factors relative to the adequate performance of the heating, ventilating, and air conditioning system. Numerous suggestions for both local and national application were determined and documented. Author

N72-14274*# McDonnell Aircraft Corp., St. Louis, Mo.

AN INVENTORY OF AERONAUTICAL GROUND RESEARCH FACILITIES. VOLUME 4: ENGINEERING FLIGHT SIMULATION FACILITIES

C. J. Pirrello, R. D. Hardin, L. P. Capelluro, and W. D. Harrison Washington NASA Nov. 1971 160 p 4 Vol.

(Contract NAS2-5458)

(NASA-CR-1877) Avail: NTIS CSCL 14B

The general purpose capabilities of government and industry in the area of real time engineering flight simulation are discussed. The information covers computer equipment, visual systems, crew stations, and motion systems, along with brief statements of facility capabilities. Facility construction and typical operational costs are included where available. The facilities provide for economical and safe solutions to vehicle design, performance, control, and flying qualities problems of manned and unmanned flight systems. Author

N72-14279# ARO, Inc., Arnold Air Force Station, Tenn.

ICING TEST CAPABILITY OF THE ENGINE TEST FACILITY PROPULSION DEVELOPMENT TEST CELL J-1 Final Report, 13 Nov. 1969 - 31 Oct. 1970

E. S. Gall and F. X. Floyd AEDC Aug. 1971 60 p refs

(Contract F40600-72-C-0003; ARO Proj. RJ2040; ARO Proj. RJ0053)

(AD-729205; AEDC-TR-71-94; ARO-ETF-TR-71-52) Avail: NTIS CSCL 21/5

The propulsion development test cell (J-1) has been modified to test turbine engines, with airflows up to 1200 lb/sec, in altitude icing conditions. Uniform ice distributions were obtained in the plane of the simulated icing cloud from 0.3 to 4.0 gm/stere, where a stere is defined as one cubic meter. Water droplet size was varied from 19 to 28 microns (mean volumetric diameter) with the present spray nozzles, and this range can be extended by changing spray nozzles. The holography system used to determine water droplet size is a state-of-the-art advancement in obtaining these data. The droplet data were obtained in a sample, 2 in. in diameter and 3 ft long, without disturbing the airstream. The hologram containing these data is reconstructed. The droplet size and number were determined electronically so that icing data were available within hours after the test period. Author (GRA)

N72-14286# Army Engineer Waterways Experiment Station, Vicksburg, Miss.

COMPARISON OF PERFORMANCE OF EXPERIMENTAL MEMBRANES, NONSKID COMPOUNDS, ADHESIVES, AND EARTH ANCHORS WITH REGARD TO C-130 AIRCRAFT OPERATIONAL REQUIREMENTS Final Report, Oct. 1966 - Aug. 1969

Timothy W. Voller Aug. 1971 184 p refs

(DA Proj. 1T0-62103-A-046)

(AD-729803; AEWES-TR-S-71-11) Avail: NTIS CSCL 01/5

Laboratory and field tests were conducted at the U. S. Army Engineer Waterways Experiment Station (WES) to evaluate experimental membranes and materials that showed promise of improving the performance of membranes used to surface assault-type airfields for operations of C-130 aircraft. Eleven membranes were evaluated during this investigation. The adhesives submitted were one-part adhesives composed of a synthetic rubber resin dispersed in a solvent. The minimum requirements for evaluating the adhesives were the minimum values obtained from tests conducted with the G580-25 adhesive, which has been accepted previously for use with the T17 membrane. Twelve commercial nonskid compounds were submitted to the WES for evaluation. These nonskid compounds were evaluated using simulated C-130 operations. Four anchor types, i.e., the guy, disk-type, two-legged, and arrowhead anchors, were evaluated to determine which would be the most suitable for use with membrane-surfaced assault airfields. The durability and holding strength of each anchor were evaluated. Author (GRA)

N72-14288# Naval Air Engineering Center, Philadelphia, Pa. Engineering Dept. (SI).

CVA-67 SPRING CONSTANTS FOR THE SHOCK ANALYSIS OF CATAPULT INSTALLATIONS Final Report

Thomas A. Mazzella and Julian Holowchak 4 Jan. 1971 200 p refs

(Air Proj. 17-X-4912.1403)

(AD-729249; NAEC-ENG-7649; Code-80020;

Job-84F02-21-58471) Avail: NTIS CSCL 13/9

The Spring Constants of the ship's portion of the foundation springs for the launching engine section of the catapult installations aboard the CVA-67 are determined or summarized.

Author (GRA)

N72-14289# Princeton Univ., N.J. Dept. of Civil and Geological Engineering.

A FIRST APPROXIMATION SATELLITE TERMINAL SYSTEM EVALUATION MODEL Final Report

Jack E. Snell Mar. 1971 173 p refs
(Contract DOT-FA70WA-2385)
(AD-724958; FAA-AV-71-1) Avail: NTIS CSCL 01/5

To evaluate a variety of off-airport Satellite Air Terminal concepts, an iterative evaluation model is developed that is focused primarily on time and cost impedances. An analysis is made of the entire process by which a passenger gains access to an aircraft and from this analysis, component sub-models are developed to define system demand flow rates, level of service supplied, and system costs. These sub-models are then synthesized into the desired evaluation model and a methodology to be used in establishing off-airport Satellite Terminal system planning guidelines is developed. The approach utilizes generalized or gross characteristics for the airport access process and avoids specific details of regional characteristics, airport design and transport technology. A hypothetical example is tested and sensitivity analyses are made for a number of cost and time parameters. Author (GRA)

N72-14292 THICKNESS EFFECTS IN NONSTATIONARY CASCADE FLOW Ph.D. Thesis

John William Nemesh 1970 181 p
Avail: Univ. Microfilms Order No. 71-1176

A method for calculating nonstationary lift and moment coefficients for an unstalled vibrating cascade of blades with finite thickness and camber is developed. A FORTRAN program is given for the calculation. Quasi-static experiments were performed to give a check for the steady thickness and camber part of the theory. The data are extrapolated back to vanishingly small torsional amplitudes. In addition, it is shown that, for a quasi-static type of motion, flutter is possible due to the existence of a phase angle between adjacent blades.

Dissert. Abstr.

N72-14301*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.**FACTORS WHICH INFLUENCE THE ANALYSIS AND DESIGN OF EJECTOR NOZZLES**

Bernhard H. Anderson 1972 10 p refs Presented at 10th Aerospace Sci. Meeting, San Diego, Calif., 17-19 Jan. 1972
(NASA-TM-X-67976; E-6698) Avail: NTIS CSCL 20D

A theoretical analysis of the viscous interaction between the primary and secondary streams of ejector nozzles was developed. The analysis accounts for real sonic line effects and the streamwise variation in stream mixing and boundary layer within the ejector. The aspects of the analysis are explained and illustrated by applying the theory to a variety of ejector configurations including cylindrical shroud, contoured flap and plug nozzles. Extensive comparisons are made between theory and data to show the importance of various analytical assumptions and such design variables as diameter ratio, spacing ratio, total temperature ratio, and primary nozzle geometry. Author

N72-14302*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.**PEAK AXIAL-VELOCITY DECAY WITH SINGLE- AND MULTI-ELEMENT NOZZLES**

U. H. VonGlahn, D. E. Groesbeck, and R. G. Huff 1972 18 p refs Presented at 10th Aerospace Sci. Meeting, San Diego, Calif., 17-19 Jan. 1972
(NASA-TM-X-67979; E-6703) Avail: NTIS CSCL 20D

Jet peak-velocity decay data were obtained for a variety of circular and noncircular single-element and multi-element nozzles

for application to externally-blown-flap (EBF) STOL aircraft. These data permit a rational approach, in terms of element type and element spacing, to nozzles designed to promote mixing of the jet exhaust with the surrounding air. Rapid mixing and the resulting lower axial jet velocity decreases the noise caused by the interaction of jet impingement on the flap assembly of EBF STOL aircraft. Empirical relationships are presented that permit the prediction of peak axial-velocity decay curves for a wide spectrum of mixer-type nozzles. The data are useful also in the design of ejector-type noise suppressors and for the suppression of VTOL downwash velocities caused by vertically oriented exhaust nozzles. Author

N72-14308# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.**A COMPUTER PROGRAM FOR THE CALCULATION OF BOUNDARY LAYER DEVELOPMENT**

P. Bradshaw Nov. 1971 18 p refs Addendum to NPL-71-24
(IC-AERO-71-24; NPL-71-24) Avail: NTIS

Extensions to the computer program used in two-dimensional turbulent boundary layer calculations based on a hyperbolic system and using a numerical method are described. The basic method and the extensions are given for compressible adiabatic flow, constant heat transfer, three-dimensional flow (for an infinite swept wing), and two-dimensional ducted flow. Further versions of the basic program are described. ESRO

N72-14310# Ballistic Research Labs., Aberdeen Proving Ground, Md. Exterior Ballistics Lab.**AN EXPERIMENTAL INVESTIGATION OF THE SUPER-SONIC TURBULENT BOUNDARY LAYER IN A MODERATE ADVERSE PRESSURE GRADIENT. PART 2: ANALYSIS OF THE EXPERIMENTAL DATA**

W. B. Sturek Jun. 1971 61 p refs
(RDT/E Proj. 1T0-61102-A-33-D)
(AD-729325; BRL-1543-Pt-2) Avail: NTIS CSCL 20/4

Turbulent boundary layer equations applicable to compressible flow over a surface with longitudinal curvature are evaluated by numerical integration using the tabulated profile data. Curvature corrections to the equation for conservation of streamwise momentum are shown to be small but of the same order of magnitude as the wall shear stress. The data are shown to correlate in law of the wall and velocity defect dimensionless coordinates using an integral compressibility transformation. Values of skin friction coefficient calculated using the experimental data are compared to other experimental data and to values predicted using the Spalding-Chi method. Author (GRA)

N72-14321# Pratt and Whitney Aircraft, East Hartford, Conn. OPTICAL TECHNIQUES FOR FLOW VISUALIZATION AND FLOW FIELD MEASUREMENTS IN AIRCRAFT TURBOMACHINERY Final Report on item 2, 14 Dec. 1970 - 14 Jul. 1971

Walter G. Alwang, Lawrence A. Cavanaugh, Ronald J. Burr, and Allan Hauer Aug. 1971 91 p refs
(Contract N00019-69-C-0322; Proj. R010-04-02)
(AD-730063; PWA-4276) Avail: NTIS CSCL 20/4

In the program two new optical methods of flow measurement were evaluated for eventual use in aircraft turbine engines. The methods studied were: holographic interferometry for visualization of flow and laser Doppler velocimetry (LDV) for pointwise measurement of velocity. Prototype instruments of each type were built and tested in measurements on a supersonic cascade. It was found that double-pulse diffuse-background holographic interferometry can disclose the

position of moving density gradients such as blade shocks. The LDV system, a dual beam, dual scatter system capable of both forward and back scatter operation, was found to be effective in measuring mean velocity and turbulence intensity. Capabilities and limitations of both instruments were assessed and requirements for internal measurements in turbomachinery determined. In general, it was concluded that the equipment developed is ready for application in turbine engines.

Author (GRA)

N72-14325# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

A PRELIMINARY HOT-WIRE INVESTIGATION OF CONE-WAKE TRANSITION AT M EQUALS 16 Final Report, 15 Jul. 1970 - 15 Jun. 1971

Seymour M. Bogdonoff and Francis R. Hama Jun. 1971 22 p refs

(Contract F04701-70-C-0302)

(AD-729881; SAMSO-TR-71-167) Avail: NTIS CSCL 20/4

Hot-wire surveys were conducted across the wake behind a magnetically-suspended, 10 deg. half-angle cone of 1 in. base diameter in the Mach 16 helium wind tunnel, both at the unit Reynolds numbers 120,000 and 270,000. At the higher Reynolds number, transition was observed at approximately 8 diameters downstream. The turbulent fluctuations were limited in the region near the outer edge of the wake, spreading out at an extremely slow rate.

Author (GRA)

N72-14343 Texas Univ., Austin.

DETECTION AND ANALYSIS OF CLEAR AIR TURBULENCE USING RADAR AND OTHER SENSORS Ph.D. Thesis

Allan Barr Plunkett 1970 115 p

Avail: Univ. Microfilms Order No. 71-174

It is generally known that a region of clear air turbulence will many times have associated with it a sufficient amplitude of disturbed refractive index to allow detection by radar. The study objectives were to determine: (1) The characteristics of the radar return associated with a region of disturbed refractive index, and (2) The relationship between the magnitudes of the mechanical turbulence and the disturbed refractive index. These objectives were accomplished by using airplane carried refractometers, temperature sensors, and accelerometers to examine locally the regions in question at the same time as the radar was operating. The results show that a knowledge of the wind shear plus the buoyancy force is sufficient to determine the existence of a region of mechanical turbulence. The magnitude of the mechanical turbulence can be determined fairly well from the magnitude of the disturbed refractive index if the gradient of the average refractive index with the height is known and is sufficiently large.

Dissert. Abstr.

N72-14379# National Aeronautical Establishment, Ottawa (Ontario).

STRATOSPHERIC TURBULENCE AND TEMPERATURE GRADIENTS MEASURED BY AN RB-57F: COLDSKAN FLIGHTS 57 TO 92

J. J. MacPherson and E. G. Morrissey Oct. 1971 81 p refs

(NRC-12318; LR-551) Avail: NTIS

Throughout most of the period from January 1969 to June 1971, high altitude weather reconnaissance aircraft carried special instrumentation to measure and record stratospheric turbulence and horizontal temperature gradients encountered on routine flights at altitudes from 40,000 to 65,000 feet. The purpose was to collect data at altitudes to be flown by supersonic transports. Eighty-eight missions were flown covering over 136,000 nautical miles. A summary of the results of all the flights is included. Data are presented on the correlation between measured stratospheric turbulence and horizontal

temperature gradients, on the altitude and geographical distributions of the turbulence and temperature change encounters, and on the positions of the recorded incidents relative to the jet stream. Detailed accounts are given of a selection of 15 events from flights 57 through 92 that showed significant temperature gradients or light to moderate turbulence. These presentations include time histories of the recorded variables, flight tracks showing event positions, and meteorological analyses. Author

N72-14382# Institut d'Aeronomie Spatiale de Belgique, Brussels. **NITROUS OXIDE IN THE STRATOSPHERE [L'OXYDE AZOTEUX DANS LA STRATOSPHERE]**

M. Nicolet and E. Vergison 1971 19 p refs In FRENCH; ENGLISH summary

(A-N-90-1971) Avail: NTIS

The formation of nitric oxide in the lower stratosphere is due to the reaction of nitrous oxide with the excited oxygen D singlet atom. The total production of NO molecules is related to the eddy diffusion coefficient in the stratosphere which is required to sustain N₂O subject to photodissociation. With eddy diffusion coefficients between 1000 and 10,000 sq cm/sec, the natural production of nitric oxide molecules is of the same order of magnitude as occurs with artificial injection in the lower stratosphere by 500 supersonic jets. Author

N72-14461# Aeronautical Research Labs., Melbourne (Australia). **A LINEAR DIFFERENTIAL PRESSURE TRANSDUCER INCORPORATING HIGH STABILITY VARIABLE FREQUENCY OSCILLATORS AND A CAPACITANCE SENSOR**

N. J. Sullivan Apr. 1971 51 p refs

(ARL/ME-132) Avail: NTIS

A differential pressure transducer incorporating a capacitance sensing element and highly stable oscillators to provide a variable frequency output is described. Both the sensing element and the oscillator are examined from first principles with the primary considerations being accuracy, linearity and stability. The requirements for application of the transducer as an airspeed indicator with the output to be recorded on a magnetic tape recorder are considered. Experimental results for the complete transducer are presented and compared with the design specifications. Author

N72-14462# Aeronautical Research Labs., Melbourne (Australia). **AN IMPROVED DESIGN OF STRAIN GAUGE STING BALANCE FOR SMALL WIND TUNNEL MODELS**

N. Pollock Jul. 1971 24 p refs

(ARL/A-Note-331) Avail: NTIS

A six-component strain gage sting balance for a wind tunnel model was designed and tested. The balance, which has a normal force capacity of 250 lb., incorporates a number of novel design features which result in reasonably high output and small interactions being obtained along with small size, high stiffness and ease of manufacture. Author

N72-14473# Naval Research Lab., Washington, D.C.

AIRBORNE RADIAC Progress Report, 1 Jul. - 31 Dec. 1970

Charles W. Peters and M. Odell Rhue Jul. 1971 9 p refs

(NRL Proj. H01-32)

(AD-729254; NRL-MR-2303) Avail: NTIS CSCL 18/4

The report discusses the design and development of a

Flyable Breadboard and an NRL-Breadboard of the Airborne Radiac. The NRL-Breadboard has been completed. The Flyable Breadboard is completed except for delivery of the data convertor and final tests. Computer calculations of the detector response have been completed by the U. S. Army Nuclear Effects Laboratory and are being analyzed to determine the best analytical response function for the detector. Author (GRA)

N72-14498*# General Electric Co., Evendale, Ohio. Aircraft Engine Group.

DEVELOPMENT OF THE ACTIVATED DIFFUSION BRAZING PROCESS FOR FABRICATION OF FINNED SHELL TO STRUT TURBINE BLADES

L. G. Wilbers, T. F. Berry, R. E. Kutchera, and R. E. Edmonson
Nov. 1971 151 p refs
(Contract NAS3-12433)
(NASA-CR-72844) Avail: NTIS CSCL 13H

The activated diffusion brazing process was developed for attaching TDNiCr and U700 finned airfoil shells to matching Rene 80 struts without obstructing the finned cooling passageways. Creep forming the finned shells to struts in combination with precise preplacement of brazing alloy resulted in consistently sound joints, free of cooling passageway clogging. Extensive tensile and stress rupture testing of several joint orientations at several temperatures provided a critical assessment of joint integrity of both material combinations. Trial blades of each material combination were fabricated followed by destructive metallographic examination which verified high joint integrity.

Author

N72-14504# Hamilton Standard, Windsor Locks, Conn.

LIGHTWEIGHT GEARBOX DEVELOPMENT FOR PROPELLER GEARBOX SYSTEMS APPLICATIONS. PHASE 1: DEVELOPMENTS OF ION-SPUTTERED COATINGS FOR TITANIUM ALLOY GEARS Technical Report, Feb. 1970 - 31 Mar. 1971

E. J. Delgrosso, E. A. Fahy, E. L. Paradis, and D. J. Quinn
Wright-Patterson AFB, Ohio AFAPL Aug. 1971 66 p refs
(Contract F33615-70-C-1391; AF Proj. 3066)
(AD-729839; HSER-5832-Ph-1; AFAPL-TR-71-41-Ph-1) Avail:
NTIS CSCL 13/9

A process known as ion-sputtering was utilized to deposit several coating compounds on titanium gear tooth surfaces. Roller tests and small scale gear tests were utilized in the coating evaluation. The evaluation did indicate some potential for WC - 14% Co coating on a titanium substrate. However, surface imperfections are considered to have reduced the test duration significantly from that expected.

Author (GRA)

N72-14506# Naval Air Systems Command, Washington, D.C. Professional Development Center.

THE PREPARATION OF A SPECIFICATION FOR HYDRAULIC FLUID FILTERS FOR AIRCRAFT GROUND SUPPORT EQUIPMENT

W. C. Boswell, Jr. 9 Jul. 1971 39 p refs
(AD-730027; SP-71-01) Avail: NTIS CSCL 13/7

The use of a hydraulic fluid to transmit power in aircraft presents many problems. One of the major areas of concern is fluid contamination. The contamination may take the form of inorganic material, metal particles, other minute particles, and water. This contamination requires that aviation ground support equipment be designed to eliminate as much as possible. The report deals with the preparation of a specification for ground support equipment hydraulic filters. Much of the theory concerning filtration is empirical in nature. This paper attempts to justify some of the empirical tests with theoretical work presented in the literature. Further, some of the requirements of the specification are included where appropriate. Author (GRA)

N72-14584# Naval Air Development Center, Johnsville, Pa. Aero Materials Dept.

PROTECTIVE FINISHING SYSTEMS FOR MAGNESIUM AIRCRAFT COMPONENTS Phase Report

Stanley R. Brown 7 Jul. 1971 97 p refs
(AD-729651; NADC-MA-7102) Avail: NTIS CSCL 11/3

Evaluations of magnesium finishing systems were made to select surface treatments and topcoats for rework and repair of naval aircraft parts. Corrosion resistance of finishes for the power section was determined on QE 22A-T6 magnesium alloy cyclically exposed to 5% NaCl salt spray and 400F. Magnesium airframe part finishes were evaluated after immersion testing in a NaCl solution. MIL-M-45202B, Type II Dow 17 anodize exhibited high corrosion resistance with several topcoat systems. A lesser degree of protection has been selected around which the interface requirements have been described. Author (GRA)

N72-14585*# Boeing Co., Seattle, Wash.

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF AIRCRAFT METAL STRUCTURES REINFORCED WITH FILAMENTARY COMPOSITES. PHASE 1: CONCEPT DEVELOPMENT AND FEASIBILITY

S. Oken and R. R. June Washington NASA Dec. 1971 129 p refs

(Contract NAS1-8858)
(NASA-CR-1859) Avail: NTIS CSCL 11D

The analytical and experimental investigations are described in the first phase of a program to establish the feasibility of reinforcing metal aircraft structures with advanced filamentary composites. The interactions resulting from combining the two types of materials into single assemblies as well as their ability to function structurally were studied. The combinations studied were boron-epoxy reinforced aluminum, boron-epoxy reinforced titanium, and boron-polyimide reinforced titanium. The concepts used unidirectional composites as reinforcement in the primary loading direction and metal for carrying the transverse loads as well as its portion of the primary load. The program established that several realistic concepts could be fabricated, that these concepts could perform to a level that would result in significant weight savings, and that there are means for predicting their capability within a reasonable degree of accuracy. This program also encountered problems related to the application of polyimide systems that resulted in their relatively poor and variable performance.

Author

N72-14607# Oklahoma Univ., Norman.

DRAW CHARACTERISTICS FOR A COMPLIANT SURFACE AIRFOIL Ph.D. Thesis

Humphrey H. Chu 1971 114 p refs
(Contract DA-31-124-ARO(D)-349; DA Proj.
2-O-061102-B-33-G)

(AD-729921; AROD-5596-10-E) Avail: NTIS CSCL 11/3

As part of a program to investigate the feasibility of reducing aerodynamic skin-friction drag by the use of compliant coatings, a detailed wind-tunnel study was made to determine the drag characteristics of a compliant coating on an airfoil. The compliant surface was constructed with different thicknesses (0.001 to 0.025 inch) of polyvinyl-chloride (PVC) membrane backed by a 3/16 to 6/16 inch damping layer of polyurethane foam (40 PPI). The foam was bonded to specially designed airfoils to form NACA 0009 airfoils. Hard surface NACA 0009 airfoils were also constructed. A reduction of skin friction drag was recorded in order to be sure the drag reduction did not come from the shifting of the transition line, both experimental (china-clay) and theoretical (von-Karman-Pohlhausen) methods were used to determine the transition point. Author (GRA)

N72-14674# Ohio Univ., Athens. Dept. of Electrical Engineering. **ALL-WEATHER, LOW-LEVEL NAVIGATION Semiannual Report, Oct. 1970 - Apr. 1971**

Aug. 1971 57 p refs

(Contract DAAB07-68-C-0084; Proj. Themis)

(AD-729358; ECOM-0084-3; SAR-3) Avail: NTIS CSCL 17/7

During this reporting period a second Rubidium clock stabilized low-frequency transmitting station was mechanized with a phase-locked loop synthesizer to permit a flyable demonstration of a precision all-weather, low-level navigation system using passive, direct-ranging techniques. Phase measurements of the respective transmitter carriers are optimally obtained by means of two maximum likelihood receivers with an onboard clock. A General Automation SPC-12 digital computer provides coordinate conversion to an x-y position format, a route storage capability, and execution of a flight director algorithm. Extension and additions to the theoretical maximum likelihood receiver work provides a comprehensive comparison of this technique with the conversational phase-locked loop for phase estimation purposes. A special display-conventional terminal was designed and fabricated to provide a flexible and useful means of communicating with the SPC-12 computer both in the laboratory and during airborne exercises. Novel time and memory conserving computer software is also discussed.

Author (GRA)

N72-14677# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

AIRBORNE STATION KEEPING DEVICES Final Report

1 Aug. 1971 19 p refs

(AMER Proj. 310-6)

(AD-729532; MTP-6-3-208) Avail: NTIS CSCL 01/4

Procedures are defined for evaluating the ability of airborne station keeping devices to meet Army requirements.

Author (GRA)

N72-14678# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

RADIO NAVIGATIONAL EQUIPMENT, AM/FM Final Report

1 Aug. 1971 21 p refs

(AMCR Proj. 310-6)

(AD-729533; MTP-6-3-209) Avail: NTIS CSCL 17/7

Procedures are given for service testing radio navigational equipment, AM/FM.

Author (GRA)

N72-14679# National Bureau of Standards, Washington, D.C. **APPROACHES TO EVALUATING THE EFFECTS OF VFR TOWERS ON FLOW AND SAFETY AT AIRPORTS**

L. S. Joel, W. A. Steele, J. J. Filliben, and G. B. Hare Apr. 1971 185 p refs

(Contract DOT-FA70WAI-188; NBS Proj. 4314427)

(AD-729443; NBS-10562) Avail: NTIS CSCL 01/2

The Federal Aviation Administration is reviewing its criteria (now based on annual traffic levels) for airports to be eligible for the installation of VFR towers. In support of that review, a study was commissioned to seek mathematical methods and models for measuring the effects of a VFR tower on flow and safety at airports with different traffic volumes. The report discusses a variety of methodologies, viewpoints, and concepts. The first version of a mathematical model, intended to portray a tower's ability to expedite flow by abridging the full operation sequence, was formulated and exercised in illustrative calculations. Available aggregated data are not adequate for identifying functional relations between collision rates and activity levels at tower and non-tower airports; however a novel statistical approach has established the association between tower-presence and lower

collision rates on a firmer basis than before. More knowledge is needed concerning pilots' information needs, relative to potential hazards, which go unmet in the absence of a VFR tower; as an initial contribution along this line, a computerized model was developed to air in studying the pilot's time-varying field of vision as limited by cockpit geometry and other structural obstructions.

Author (GRA)

N72-14700*# Scientific Translation Service, Santa Barbara, Calif.

STUDIES OF COHERENT AND INCOHERENT STRUCTURES OF NOISE OF AERODYNAMIC ORIGIN

J. DeBelleva, P. Harel, J. Lambourion, and M. Perull Washington

NASA Dec. 1971 8 p refs Transl. into ENGLISH of "Etude

des Structures Coherentes et Incoherentes de Bruit d'Origine

Aerodynamique", ONERA report ONERA-TP-983 Presented at

7th Intern. Congr. on Acoustics, Budapest, 1971

(Contract NASw-2035)

(NASA-TT-F-14091; ONERA-TP-983) Avail: NTIS CSCL 20A

With the aid of theoretical models currently in use, the coherent and incoherent structures of noise spectra of compressors are presented. The near pressure field of a compressor and the infrared emission of a hot jet are analyzed using spatial and temporal correlations in order to derive the structures of the sources.

Author

N72-14709# Hamilton Standard, Windsor Locks, Conn.

NOISE DETECTABILITY PREDICTION METHOD FOR LOW

TIP SPEED PROPELLERS Final Report, 1 May 1970 -

1 May 1971

F. W. Barry and Bernard Magliozzi Wright-patterson AFB, Ohio

AFAPL Jun. 1971 192 p refs

(Contract F33615-70-C-1583; AF Proj. 3066)

(AD-729432; HSER-5834; AFAPL-TR-71-37) Avail: NTIS CSCL 20/1

Experience in the field of quiet aircraft for reconnaissance/surveillance applications indicated a need for a reliable quiet propeller design procedure. The report describes the development of a computer program intended to fulfill this need. The propeller noise detectability computer program predicts propeller harmonic rotational noise using non-steady blade loads and broad-band noise using a new integration method and compares these predictions with an appropriate aural detectability criterion to estimate the minimum undetectable flight altitude. Supporting tasks include development of aural detectability criteria, a theoretical study of the effect of airfoil section shape on vortex noise, static noise tests of several propeller configurations, correlation of unsteady blade loads corresponding to measured harmonic noise levels, design and testing of a new quiet propeller, and a propeller noise detectability trend study.

Author (GRA)

N72-14784# Dynamic Science, Phoenix, Ariz. AvSER Facility. **SAFETY EVALUATION OF EMULSIFIED FUELS Final Report**

L. Maurice Shaw Fort Eustis, Va. AAMRDL Jun. 1971 193 p refs

(Contract DAAJ02-69-C-0030; DA Proj. 1F1-62203-A-529)

(AD-729330; AvSER-9130-71-3; USAAMRDL-TR-71-29) Avail: NTIS CSCL 21/4

A comprehensive test program was conducted to establish emulsified fuel screening test procedures, to obtain safety evaluation criteria, and to evaluate the safety performance of emulsified and gelled aviation fuels in a simulated full-scale crash environment. A series of screening tests was formulated and conducted to obtain fuel characteristics as a function of hot-surface ignition, wind shear, and impact dynamics associated

with fuel breakup, atomization/dispersion, and ignition. The data obtained from these screening tests were used to establish emulsified fuel safety evaluation criteria. A simulated full-scale experiment was designed to simulate the full-scale helicopter crash environment adequately and, in addition, to be reproducibly controllable at minimal cost. The screening tests revealed that, for the emulsified fuels tested, safety was directly dependent upon the fuel yield stress and its internal phase base fuel. The data obtained from the simulated full-scale tests provided definition of a nonhazardous limiting value for the ignition susceptibility parameter. Further, tests were performed on gelled fuels to offer a comparison between the safety of emulsified and gelled fuels. Three of the emulsified fuels tested were found to result in a nonhazardous postcrash fire: EF8R-104H emulsion, EF8R-104 emulsion, and Jet-A EXP-4 emulsion. The gelled fuels did not perform as well as the emulsified fuels; however, one gel, Jet-A gel no. 1, indicated a sizeable advantage over liquid fuels. In summary, the results of this program confirmed that aircraft fuel emulsions can be formulated which are nonhazardous within the helicopter survivable crash limit envelope.

Author (GRA)

N72-14785# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

AVIATION TURBINE FUEL Final Report

1 Aug. 1971 144 p refs

(AMCR Proj. 310-6)

(AD-729544; MTP-10-3-061) Avail: NTIS CSCL 21/4

Procedures are given for service testing aviation turbine fuel.

Author (GRA)

N72-14791*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

FLIGHT INVESTIGATION OF AN UNDERWING NACELLE INSTALLATION OF THREE VARIABLE-FLAP EJECTOR NOZZLES

Verlon L. Head Washington Jan. 1972 47 p refs

(NASA-TM-X-2478; E-6564) Avail: NTIS CSCL 21E

A modified F-106B aircraft with underwing engine nacelles was flight tested to investigate airframe installation effects on ejector nozzles. Nozzle thrust coefficients, boattail drag coefficients, and boundary layer characteristics were obtained for the three nozzles. All the nozzles were geometrically similar and had 15 deg conical boattails with juncture radii of curvature equal to 0.5 maximum nozzle diameter. The effects of boattail location relative to the wing trailing edge and the ejector to primary nozzle exit diameter ratio were investigated. Shortening the length by 0.48 nozzle diameter lowered the transonic boattail drag rise Mach number from 0.97 to 0.95. Decreasing the nozzle exit diameter, which reduced the ejector to primary nozzle exit diameter ratio from 1.30 to 1.18, increased the gross thrust coefficient 4.8 percent.

Author

N72-14792*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

A TURBOJET SIMULATOR FOR MACH NUMBERS UP TO 2.0

Fred W. Steffen, Edward A. Satmary, Michael R. Vanco, and Stanley M. Nosek 1972 30 p refs Proposed for presentation at 16th Ann. Intern. Gas Turbine Conf. and Products Show, San Francisco, Calif., 23-30 Mar. 1972

(NASA-TM-X-67973; E-6690) Avail: NTIS CSCL 21E

A turbojet simulator was designed and fabricated for use in wind tunnel models. The simulator contains a six-stage, axial-flow compressor powered by a three-stage, axial-flow turbine. High pressure heated air was used to drive the turbine. At design conditions, compressor axial flow, turbine exit flow, and a third

supplementary flow all entered the exhaust nozzle at equal values of pressure and temperature. Overall aerodynamic design, compressor operating conditions, automatic controls, turbine aerodynamic design, instrumentation, and calibration procedure is presented. Performance of the device when used to simulate a J-85 turbojet engine at transonic speeds is reported. The installed nozzle performance obtained with the simulator is also discussed and compared with flight data.

Author

N72-14793*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

DESIGN STUDIES OF LIFT FAN ENGINES SUITABLE FOR USE IN CIVILIAN VTOL AIRCRAFT

Richard J. Roelke and Steve Zigan (GE, Cincinnati, Ohio) 1972 13 p refs Proposed for presentation at Gas Turbine and Fluid Eng. Meeting, San Francisco, Calif., 26-30 Mar. 1972

(NASA-TM-X-67977; E-6699) Avail: NTIS CSCL 21E

Low pressure ratio fan engines are receiving increasing attention as a means to provide low speed lift for civilian VTOL transports. Two general types of fan lift engines that are being studied are integral fans and remote power fans. Preliminary engine design studies of both types of lift fan systems have been made. The paper summarizes a portion of the results of the engine design studies, including the crucial engine requirements, and some of the characteristics of the emerging engine designs of each type.

Author

N72-14794*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

VARIABLE GEOMETRY AFT-FAN FOR TAKEOFF QUIETING OR THRUST AUGMENTATION OF A TURBOJET ENGINE

Richard J. Weber and David G. Evans Dec. 1971 22 p refs

(NASA-TM-X-67983 E-6714) Avail: NTIS CSCL 21E

A concept is presented that combines the low-noise and high-thrust characteristics of a turbofan at takeoff, together with its high efficiency at subsonic flight speeds, with the high efficiency of a turbojet at supersonic cruise. It consists of a free turbine with tip fan mounted behind the turbine of a conventional turbojet engine. Fan air is supplied from blow-in doors or is ducted from the main engine inlet. At high flight speeds where fan augmentation is not desirable, the fan inlet is closed and the free turbine is stopped by adjustment of its variable-camber stators. Estimates of noise, cycle performance, and example configurations are presented for a typical supersonic transport application.

Author

N72-14802# Garrett Corp., Torrance, Calif. AiResearch Mfg. Div.

INTEGRATED ENGINE INSTRUMENT SYSTEM: SELECTED STUDIES ON LOW-CYCLE FATIGUE Final Report

Robert R. VanNimvegen, Saurindranath Majumdar, and Joseph Kukul Sep. 1970 182 p refs

(Contract N00014-69-C-0343; NR Proj. 213-073)

(AD-728045; Rept-70-6785) Avail: NTIS CSCL 21/5

The objective of the analytical program was to define the engine operating parameters that affect the low-cycle fatigue and creep damage of critical components of naval aircraft engines during fleet operations. The following major program tasks were performed leading to the selection of a suitable model for predicting cumulative engine damage: A typical naval attack mission profile was selected for engine-aircraft operation. Control studies were made to determine engine response to transient operation at various ambient conditions. Transient and steady-state temperature distributions were determined for the critical engine components. Combined thermal and centrifugal stress, or pressure-induced stresses and plastic strains, were

determined. Using existing material properties, low-cycle fatigue life was determined for the critical components. An analytical model was defined that simulated component thermal and stress response to selected engine parameters to be used in computing damage. Engine parameters were defined that can be monitored for calculating component low-cycle fatigue damage.

Author (GRA)

N72-14923# Army Materials and Mechanics Research Center, Watertown, Mass.

ANALYSIS OF CRACKS IN WIDE ORTHOTROPIC PLATE WITH LONGITUDINAL STIFFENERS

Chatta Lakshmikantham Aug. 1971 19 p refs

(DA Proj. 1T0-62105-A-349)

(AD-729801; AMMRC-TR-71-29; AMCMS-Code-502E.11.299; DA-OC4693) Avail: NTIS CSCL 20/11

Recently, the Howland-Isida approach to cracks in isotropic strips was extended by Lakshmikantham to the case of an orthotropic strip with edge stiffeners. The present report uses his techniques in solving the problem of a tensioned wide plate with parallel stringers and stress free cracks in alternate panels. The results of this problem together with the previous study are expected to cover many cases of aircraft structural importance; especially where fiber-reinforced composites are used.

Author (GRA)

N72-14931# Army Engineer Waterways Experiment Station, Vicksburg, Miss.

ARMY AIRCRAFT PROTECTIVE STRUCTURES DESIGNS. REPORT 3: RESPONSE OF SELECTED MATERIALS TO HIGH-SPEED FRAGMENT IMPACT

Jerry W. Brown and Willis G. Dykes Aug. 1971 32 p refs

(DA-Proj. 4A6-6270-A-859)

(AD-730673; AEWES-TR-N-69-8-3) Avail: NTIS CSCL 19/4

In order to design effective fragment protection schemes that will allow optimum use of time, personnel, and materials, it is necessary to understand the behavior of various materials under fragment impact. Therefore, a study has been conducted using textiles, wood, and earth materials to gain an understanding of the basic physical laws governing their response to fragment impact. Mathematical analyses of the physical characteristics of the various materials as well as experiments in which fragment simulating projectiles were used have yielded insight into the basic mechanics of fragment defeat. Materials were tested by impacting them with projectiles weighing between 17 and 300 grains at velocities ranging from 500 to 5,000 ft/sec. Data from these tests are presented to illustrate the relations between mass, velocity, and penetration depths of the projectiles into ballistic nylon, wood, sand, and clay.

Author (GRA)

N72-14976# Commission of the European Communities, Brussels (Belgium).

THE AERONAUTICAL AND SPACE INDUSTRIES OF THE COMMUNITY COMPARED WITH THOSE OF THE UNITED KINGDOM AND THE UNITED STATES. VOLUME 4: THE AERONAUTICAL MARKET

1971 227 p refs 5 Vol.

(Rept-7042-Vol-4) Avail: NTIS

The markets for civil aircraft and military aircraft and missiles are discussed. With respect to civil aviation, the types and numbers of aircraft, the airline companies, and air traffic are described, and the structure size of the light aircraft market are given. The number and types of civil aircraft in service in 1980 and the demand in the period 1968 to 1979 are estimated. The military aircraft and missile forces, expenditures, and trends in the European Economic Community, the United Kingdom, and the United States are also discussed, and assumptions concerning the development of the demand for military aircraft and missiles

in the seventies are emphasized. The international trade in aircraft, airframes, and aircraft engines is described, and details are given on the imports and exports of the Community, the United Kingdom, and the United States. N.E.N.

N72-14985*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EFFECT OF GROOVED CASING TREATMENT ON THE FLOW RANGE CAPABILITY OF A SINGLE-STAGE AXIAL-FLOW COMPRESSOR

Everett E. Bailey Washington Jan. 1972 15 p refs

(NASA-TM-X-2459; E-6560) Avail: NTIS CSCL 20D

Comparisons of the results of testing a single-stage axial-flow compressor with a solid-wall casing and with grooved casings are presented. The depth, location, and number of circumferential grooves in the casing over the casing over the rotor tip were varied. The near-stall weight flow was lower than that with the solid-wall casing for all but one grooved configuration indicating an improvement in the stall margin. The greatest reduction in the near-stall weight flow was noted for the configuration with five grooves located over the blade midchord region.

Author

N72-14986*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EFFECT OF TRAILING EDGE GEOMETRY AND THICKNESS ON THE PERFORMANCE OF CERTAIN TURBINE STATOR BLADING

Herman W. Prust, Jr. and Ronald M. Helon Washington Jan. 1972 22 p refs

(NASA-TN-D-6637; E-6613) Avail: NTIS CSCL 20D

The experimental and analytical investigation included solid blades with five different trailing-edge thicknesses and four different trailing-edge geometries. One of the geometries was round, one was square, one was tapered from the suction surface, and the other tapered from the pressure surface. One of the trailing-edge thicknesses was sharp edged; the other four thicknesses were equivalent to about 5, 11, 16, and 20 percent of the blade throat width. The experimental results show increased efficiency loss for increased trailing-edge thickness for all trailing-edge geometries. The blade with round trailing edge, equal to about 11 percent of the blade throat width, had 60 percent more loss than the sharp-edged blade. For the same trailing-edge thickness, square trailing edges caused more loss than round trailing edges, and the tapered trailing edges caused about the same loss as the round trailing edges.

Author

N72-14989*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF 1380 FOOT PER SECOND TIP-SPEED AXIAL-FLOW COMPRESSOR ROTOR BLADE TIP SOLIDITY OF 1.5

Calvin L. Ball, David C. Janetzke, and Lonnie Reid Washington Jan. 1972 100 p refs

(NASA-TM-X-2379; E-5723) Avail: NTIS CSCL 20D

This presents the aerodynamic design parameters along with the overall and blade element performance of an axial-flow compressor rotor designed to study the effects of blade solidity on efficiency and stall margin. At design speed the peak efficiency was 0.892 and occurred at an equivalent weight flow of 65.0 lb/sec. The total pressure ratio was 1.83 and the total temperature ratio was 1.215. Design efficiency, weight flow, pressure ratio, and temperature ratio were 0.824, 65.3, 1.65, and 1.187, respectively. Stall margin for design speed was 10 percent based on the weight flow and pressure ratio values at peak efficiency and just prior to stall.

Author

N72-14990*# Rochester Applied Science Associates, Inc., N.Y. DEVELOPMENT AND APPLICATION OF A METHOD FOR PREDICTING ROTOR FREE WAKE POSITIONS AND RESULTING ROTOR BLADE AIR LOADS. VOLUME 1: MODEL AND RESULTS

S. Gene Sadler Washington NASA Dec. 1971 123 p refs (Contract NAS1-8448) (NASA-CR-1911; Rept-69-11-Vol-1) Avail: NTIS CSCL 01B

Rotor wake geometries are predicted by a process similar to the startup of a rotor in a free stream. An array of discrete trailing and shed vortices is generated with vortex strengths corresponding to stepwise radial and azimuthal blade circulations. The array of shed and trailing vortices is limited to an arbitrary number of azimuthal steps behind each blade. The remainder of the wake model of each blade is an arbitrary number of trailing vortices. Vortex element end points were allowed to be transported by the resultant velocity of the free stream and vortex-induced velocities. Wake geometry, wake flow, and wake-induced velocity influence coefficients are generated by this program for use in the blade loads portion of the calculations. Blade loads computations include the effects of nonuniform inflow due to a free wake, nonlinear airfoil characteristics, and response of flexible blades to the applied loads. Computed wake flows and blade loads are compared with experimentally measured data. Predicted blade loads, response and shears and moments are obtained for a model rotor system having two independent rotors. The effects of advance ratio, vertical separation of rotors, different blade radius ratios, and different azimuthal spacing of the blades of one rotor with respect to the other are investigated. Author

N72-14992*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE DETERMINATION OF THE GEOMETRIES OF MULTIPLE-ELEMENT AIRFOILS OPTIMIZED FOR MAXIMUM LIFT COEFFICIENT Ph.D. Thesis - Illinois Univ., Urbana

Allen Wen-shin Chen 1971 96 p refs (NASA-TM-X-67591) Avail: NTIS CSCL 01A

Optimum airfoils in the sense of maximum lift coefficient are obtained by a newly developed method. The maximum lift coefficient is achieved by requiring that the turbulent skin friction be zero in the pressure rise region on the upper surface. Under this constraint, the pressure distribution is optimized. The optimum pressure distribution consists of a uniform stagnation pressure on the lower surface, a uniform minimum pressure on the upper surface immediately downstream of the front stagnation point followed by a Stratford zero skin friction pressure rise. When multiple-element airfoils are under consideration, this optimum pressure distribution appears on every element. The parameters used to specify the pressure distribution on each element are the Reynolds number and the normalized trailing edge velocity. The newly developed method of design computes the velocity distribution on a given airfoil and modifies the airfoil contour in a systematic manner until the desired velocity distribution is achieved. There are no limitations on how many elements the airfoil to be designed can have. Author

N72-14993# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

THE NONLINEAR WING THEORY BY K. GERSTEN [UEBER DIE NICHTLINEARE TRAGFLAECHEENTHEORIE VON K. GERSTEN]

D. Nikolitsch Bonn Bundeswehramt 1971 85 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung

(BMVg-FBWT-71-20) Avail: NTIS; Bundeswehramt: 25 DM

The Gersten nonlinear wing theory is extended to include

compressibility effects in the subsonic range due to the Prandtl-Glauert factor. It was found that the Gersten numerical solution has limited use, and therefore had to be modified. Results applied to the aerodynamic center determination are compared with the linear wing theory of E. Truckenbrodt. The convergence behavior on the nonlinear theory deviates from that of the linear theory and represents a problem with respect to the usability of the entire theory. Coefficients of the nonlinear wing theory are indicated as a function of wing geometry and Mach number. Author (ESRO)

N72-14994# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

APPLICATION OF K. GERSTEN'S NONLINEAR WING THEORY TO TRANSONIC FLOW [UEBER DIE ANWENDUNG DER NICHTLINEAREN TRAGFLAECHEENTHEORIE VON K. GERSTEN AUF DEN FALL DER SCHALLANSTROMUNG]

D. Nikolitsch Bonn Bundeswehramt 1971 50 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung

(BMVg-FBWT-71-21) Avail: NTIS; Bundeswehramt: 25 DM

From lifting surface theory at subsonic range, integral equations are derived that are valid for Mach number 1. These equations also describe the case of vanishing aspect ratio. The forms of these equations allow exact solutions of load distributions and lift coefficients to be stated for wings with leading edges formed by parabolic, elliptic, or circular arcs. This theory imposes the restriction of straight trailing edge. Author (ESRO)

N72-14996# Royal Aircraft Establishment, Farnborough (England).

THE INFLUENCE OF NEAR-WAKE ASSUMPTION ON THE LIFTING CHARACTERISTICS OF A ROTOR BLADE

J. G. Woodley Mar. 1971 77 p refs (RAE-TR-71046; BR-25410) Avail: NTIS

The interrelation between a simplified wake model and the loading on a rotor blade is made. For this model the wake is treated as an infinite vortex sheet of simplified shape in quasi-steady flow and an iterative scheme is used to solve the downwash equation on the blade derived from lifting surface theory. Using this model as a basis, a comparison is made of the influence of some near-wake assumptions on the lifting characteristics of a rotor blade. In particular, the treatment of sweep effects and the vortex lattice approximation for vorticity are studied. Based on the latter comparisons, a scheme is proposed whereby the near-wake model studied could be used to improve the wake representation for a complete rotor performance computer program. Author (ESRO)

N72-14997*# Battelle Memorial Inst., Columbus, Ohio. A PROPOSED CRITERION FOR AIRCRAFT FLIGHT IN TURBULENCE

Richard F. Porter and Alfred C. Robinson [1971] 63 p refs (Contract NASw-2063)

(NASA-CR-124834) Avail: NTIS CSCL 01B

A proposed criterion for aircraft flight in turbulent conditions is presented. Subjects discussed are: (1) the problem of flight safety in turbulence, (2) new criterion for turbulence flight where existing ones seem adequate, and (3) computational problems associated with new criterion. Primary emphasis is placed on catastrophic occurrences in subsonic cruise with the aircraft under automatic control. A Monte Carlo simulation is used in the formulation and evaluation of probabilities of survival of an encounter with turbulence. Author

N72-14998*# North American Aviation, Inc., Los Angeles, Calif.

XB-70 AERODYNAMIC, GEOMETRIC, MASS, AND SYMMETRIC STRUCTURAL MODE DATA

John H. Wykes and Alva S. Mori Mar. 1970 93 p refs
(Contract NAS4-1580)

(NASA-CR-116773; NA-70-158) Avail: NTIS CSCL 01B

XB-70-1 mass, structural, and aerodynamic data were updated to reflect as closely as possible the characteristics of the airplane at three specific flight conditions which were actually flown. A nominal Mach number of 0.90 at an altitude of 25,000 feet (two cases), a nominal Mach number of 1.6 at an altitude of 40,000 feet (one case) were used. In-flight response characteristics at a number of points on the vehicle were obtained by exciting a pair of shaker vanes on the nose of the airplane. Data were recorded with the basic stability augmentation system (SAS) operating both alone and together with the identical location of accelerometer and force (ILAF) structural mode control system. Detailed total vehicle weight, mass characteristics, structural frequencies, generalized masses, all aerodynamic data used in the present analyses, and a description of the actual mode shapes are tabulated and presented. Author

N72-14999*# Systems Technology, Inc., Hawthorne, Calif.
MOTION EFFECTS ON AN IFR HOVERING TASK: ANALYTICAL PREDICTIONS AND EXPERIMENTAL RESULTS

R. F. Ringland, R. L. Stapleford, and R. E. Magdaleno Washington NASA Nov. 1971 203 p refs
(Contract NAS2-5261)

(NASA-CR-1933) Avail: NTIS CSCL 01B

An analytical pilot model incorporating the effects of motion cues and display scanning and sampling is tested by comparing predictions against experimental results on a moving base simulator. The simulated task is that of precision hovering of a VTOL having varying amounts of rate damping, and using separated instrument displays. Motion cue effects are investigated by running the experiment under fixed and moving base conditions, the latter in two modes; full motion, and angular motion only. Display scanning behavior is measured on some of the runs. The results of the program show that performance is best with angular motion only, most probably because a g-vector tilt cue is available to the pilot in this motion condition. This provides an attitude indication even when not visually fixating the attitude display. Vestibular threshold effects are also present in the results because of the display scaling used to permit hovering position control within the motion simulator limits; no washouts are used in the simulator drive signals. The IFR nature of the task results in large decrements in pilot opinion and performance relative to VFR conditions because of the scanning workload. Measurements of scanning behavior are sensitive to motion conditions and show more attention to attitude control under fixed base conditions. Author

N72-15000*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF CLOSE-COUPLED WING-CANARD CONFIGURATIONS AT MACH NUMBERS FROM 1.60 TO 2.86

Samuel M. Dollyhigh Washington Dec. 1971 116 p refs
(NASA-TN-D-6597; L-7962) Avail: NTIS CSCL 01B

An experimental investigation was made in the Mach number range from 1.60 to 2.86 to determine the static longitudinal aerodynamic characteristics of close-coupled wing-canard configurations. Three canards, ranging in exposed planform area from 17.5 to 30.0 percent of the wing reference area, were employed in this investigation. The canards were either located in the plane of the wing or in a position 18.5 percent of the wing mean geometric chord above the wing plane. Most data obtained were for a model with a 60 deg

leading-edge-sweep wing; however, a small amount of data were obtained for a 44 deg leading-edge-sweep wing. The model utilized two balances to isolate interference effects between wing and canard. In general, it was determined that at angle of attack for all configurations investigated with the canard in the plane of the wing an unfavorable interference exists which causes the additional lift on the canard generated by a canard deflection to be lost on the wing due to an increased downwash at the wing from the canard. Further, this interference decreased somewhat with increasing Mach number. Raising the canard above the plane of the wing also greatly decreased the interference of the canard deflection on the wing lift. However, at Mach 2.86 the presence of the canard in the high position had a greater unfavorable interference effect at high angles of attack than the canard in the wing plane. This interference resulted in the in-plane canard having better trimmed performance at Mach 2.86 for the same center-of-gravity location. Author

N72-15001*# Mechanics Research, Inc., Los Angeles, Calif.
FUNDAMENTAL LIMITATIONS ON V/STOL TERMINAL GUIDANCE DUE TO AIRCRAFT CHARACTERISTICS

Julian Wolkovitch, Charles W. LaMont, and D. William Lochtie Washington NASA Dec. 1971 182 p refs
(Contract NAS1-9163)

(NASA-CR-1901) Avail: NTIS CSCL 01B

A review is given of limitations on approach flight paths of V/STOL aircraft, including limits on descent angle due to maximum drag/lift ratio. A method of calculating maximum drag/lift ratio of tilt-wing and deflected slipstream aircraft is presented. Derivatives and transfer functions for the CL-84 tilt-wing and X-22A tilt-duct aircraft are presented. For the unaugmented CL-84 in steep descents the transfer function relating descent angle to thrust contains a right-half plane zero. Using optimal control theory, it is shown that this zero causes a serious degradation in the accuracy with which steep flight paths can be followed in the presence of gusts. Author

N72-15002# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

STOL TECHNOLOGY BIBLIOGRAPHY UPDATE

J. H. DeLeeuw Dec. 1971 71 p refs

(UTIAS-176; CTC-RR-23) Avail: NTIS

In choosing the papers to be included in the bibliography, areas of immediate interest to Canada were covered. Most vehicle-oriented topics are concerned with the first generation of STOL transports (i.e. those with turboprop powerplants), although some papers on turbofan STOL transports are reviewed. The bibliography is fully annotated by the reviewers for quality and relevance of the contents of the papers. The outlines presented reflect the reviewers' impressions of the work and may differ considerably from the authors' abstracts. This bibliography is organized under five main headings: vehicle design and performance, operational aspects; navigation, guidance, and air traffic control; nonpassenger public acceptance, and STOLports. There are 130 entries in the update. Author

N72-15003*# Translation Consultants, Ltd., Arlington, Va.
THE VTOL JET FOR A FUTURE V/STOL TRANSPORT SYSTEM

B. Huinink and K. B. Brink Washington NASA Jan. 1972 23 p refs Transl. into ENGLISH from proc. of DKLR Symp., Hamburg, 29 Jan. 1970, p 7-32

(Contract NASw-2038)

(NASA-TT-F-14076) Avail: NTIS CSCL 01B

The prerequisites for realization and successful operation of commercial transportation systems using vertical takeoff aircraft

are discussed. The aerodynamic characteristics of the Dornier 31 aircraft are described. The application of the DO-31 aircraft to meet the requirements for successful VTOL operations on a commercial basis is examined. P.N.F.

N72-15004*# Allied Research Associates, Inc., Concord, Mass.
SOME ANALYSES OF THE VARIABILITY OF ATMOSPHERIC PARAMETERS AT LOW ALTITUDES SIGNIFICANT FOR AIRCRAFT PROPAGATION

David T. Chang Washington NASA Jan. 1972 72 p refs
 (Contract NAS1-9837)
 (NASA-CR-1945; Rept-9G77-F) Avail: NTIS CSCL 04B

The results are discussed in terms of the meteorological data acquisition procedures necessary to monitor changes in atmospheric parameters to support aircraft flyover noise measurements and aircraft noise certification programs. The data consisted primarily of sequential radiosonde ascents to approximately 5000 ft spaced some half-hour to an hour apart. The weather covered by the data sample was predominantly that of clear skies and calm-to-light surface winds associated with well established high-pressure systems. Under these restrictive weather conditions, the study shows that the largest variabilities in temperature and humidity occur during the early morning hours resulting from the effects of direct solar heating of the surface. These rapid changes apparently do not penetrate above approximately 1000 ft. In the late morning hours, the atmosphere appears to become stabilized so that net changes in temperatures and relative humidities at all levels are insignificant even in time periods exceeding three hours. By noon, however, turbulent fluctuations in surface wind and the wind speed itself increase to levels which would make the microphone recording of acoustic signals in the field difficult. Author

N72-15005# National Transportation Safety Board, Washington, D.C.

AIRCRAFT INCIDENT REPORT: NORTHWEST AIRLINES, INC., BOEING 747-151, N607US, HONOLULU, HAWAII, 13 MAY 1971

15 Dec. 1971 10 p
 (NTSB-AAR-71-16; File-4-0005) Avail: NTIS

An aircraft incident caused by the failure of a jet engine on a Boeing 747 commercial aircraft during climbout after takeoff from Honolulu, Hawaii is discussed. The probable cause of the incident was the in-flight separation of the second stage turbine disk of the number three engine. An emergency landing was made at Honolulu and no injuries were sustained. Author

N72-15006# National Aviation Facilities Experimental Center, Atlantic City, N.J. Test and Evaluation Div.

INVESTIGATION OF JET TRANSPORT AIRCRAFT VORTEX SYSTEMS DESCENDING INTO AND GENERATED IN GROUND EFFECT Data Report, 27 May - 6 Jun. 1970

Leo J. Garodz Nov. 1970 164 p refs

(Proj. 504-303-03X)

Avail: NTIS

Full scale flight tests of heavy jet transport aircraft were conducted to determine the characteristics, particularly persistency, of vortex systems generated near the ground and those generated out of but descending into ground effect. The data are applied to air traffic control criteria establishing the safe lateral and longitudinal separation of aircraft taking off and landing. Emphasis is placed on airline operations at terminals with dual and/or crossing runways. Author

N72-15007# National Aviation Facilities Experimental Center, Atlantic City, N.J. Test and Evaluation Div.

INVESTIGATION OF THE RELATIVELY LONG TIME-HISTORY VORTEX CHARACTERISTICS OF THE CONVAIR CV-880 AIRPLANE IN TERMINAL AREA TYPE FLIGHT OPERATIONS Data Report, Flight test period Jul. - Aug. 1970

Leo J. Garodz Nov. 1970 612 p refs

(Proj. 504-303-03X)

Avail: NTIS HC \$9.00/MF \$0.95

Tests to obtain relatively long time-history characteristics of the vortex systems of a four engine jet transport aircraft in terminal area-type operations are discussed. Data obtained from the investigation are applied to air traffic control separation criteria associated with simultaneous operations of heavy jets and other aircraft from parallel runways. The major parameters for consideration were aircraft vortex flow velocities and persistency and the effect of atmospheric characteristics and ground effect on the vortex systems. Author

N72-15008# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Abteilung Schwingungen.

DIGITAL PROGRAM FOR THE CALCULATION OF FORCES, MOMENTS, AND TIME HISTORIES FOR A HELICOPTER ROTOR WITH HINGED BLADES. PART 1: LIST OF THE EQUATIONS

O. Storm 1971 159 p refs In GERMAN; ENGLISH summary (DLR-FB-71-67; DK-533.661; DK-681.32.06) Avail: NTIS; DFVLR, Porz: 24.50 DM

The equations for the calculation of forces, moments, and time histories of motion of a helicopter in forward flight are arranged and prepared for digital computer programming. The degrees of freedom; longitudinal, lateral and normal velocities, the rolling, pitching and yawing rates, the flapping and lagging blade motions as well as variable rotor rotational velocity are considered. Author (ESRO)

N72-15009# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

INTERFERENCE OF A CRUCIFORM WING CONFIGURATION [ZUR INTERFERENZ DER KREUZFLUEGELANORDNUNG]

G. Gregoriou Bonn Bundeswehramt 1971 43 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung (BMVg-FBWT-71-18) Avail: NTIS; Bundeswehramt: 25 DM

Based on the lifting surface theory for the yawing wing and on the method for calculating the downwash, an attempt was made to calculate the interference of a cruciform wing in the subsonic range with the aid of an iterative process. Calculations were made for several wing shapes. The results of these calculations are presented as coefficients of forces and moments or as distributions of normal forces and pitching moments. In a few cases it was possible to compare the present method with other theories. Author (ESRO)

N72-15011# Messerschmitt-Boelkow-Blohm G.m.b.H., Otto-brunn (West Germany).

PRESSURE DISTRIBUTION MEASUREMENTS ON A SLENDER BODY AND TWO WING-SLENDER BODY COMBINATIONS FOR INVESTIGATION OF NONLINEAR NORMAL FORCE AND MOMENT CHARACTERISTICS [DRUCKVERTEILUNGSMESSUNGEN AN EINEM RUMPF UND ZWEI FLUEGEL-RUMPF-KOMBINATIONEN ZUR UNTERSUCHUNG NICHTLINEARER NORMALKRAFT- UND MOMENTENCHARAKTERISTIKEN]

K. Hartmann (DFVLR) and H. Barth Bonn Bundeswehramt 1971 52 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Verteidigung (BMVg-FBWT-71-24) Avail: NTIS; Bundeswehramt: 25 DM

A survey of pressure distribution measurements, on a slender body and two wing-body combinations, is made to determine nonlinear normal forces and moments at Mach numbers from 0.7 to 1.2 and angles of attack up to 30 degrees. The normal force distributions on the isolated body and the differences of the normal forces on the afterbody, between isolated body and wing-body combination, are evaluated by integration of the pressure distribution. Author (ESRO)

N72-15012# Notre Dame Univ., Ind. Dept. of Aerospace and Mechanical Engineering.

PARAFOIL FLIGHT PERFORMANCE Final Report, Apr. 1968 - Apr. 1971

John D. Nicolaidis and Michael A. Tragarz Wright-Patterson AFB Ohio AFFDL Jun. 1971 73 p refs (Contract F33615-68-C-1459; AF Proj. 6065) (AD-731143; AFFDL-TR-71-38) Avail: NTIS CSCL 01/3

The steady state flight performance of the Parafoil is computed by using aerodynamic coefficient data obtained from wind tunnel tests of both small scale models and full scale aspect ratio 2.0 units. The actual free flight performance of the Parafoil is obtained from both manned ascending flights and manned jumps from aircraft. Attention is also given to the flight stability and control of the Parafoil and to its unique landing flare. The agreement between the performance predictions based on the wind tunnel data and the results obtained from actual flight tests is presented. The performance of a more advanced aspect ratio 3.0 Parafoil design is considered. Author (GRA)

N72-15013# Naval Missile Center, Point Mugu, Calif.

UTILITY OF THE VERTICAL CONTACT ANALOG DISPLAY FOR CARRIER LANDINGS: A DIAGNOSTIC EVALUATION

K. D. Cross and F. R. Cavaliero 20 Sep. 1971 79 p refs (ONR Proj. Order 0-0077; ONR Proj. Order 0-0078; ONR Proj. Order 0-0079) (AD-730464; NMC-TP-71-52; JANAIR-701212;) Avail: NTIS CSCL 01/4

The report describes an experiment designed* to provide a diagnostic evaluation of the VCAD (vertical contact analog display) within a carrier-landing context. The design provided both an estimate of error associated with the performance of a carrier landing under full-scale simulation conditions with the VCAD and a means for partitioning this error into components due to: display resolution, temporal loading, and control complexity. Subjects were trained to an asymptotic level on each of five experimental conditions and their asymptotic performance (attitude and position errors) compared across conditions. The results showed that roll, pitch, and heading deviations could be detected to an accuracy of 0.5 degree on the VCAD and that attitude control, in general, was unaffected by Temporal Loading. GRA

N72-15014# School of Aerospace Medicine, Brooks AFB, Tex. **NOISE ASSOCIATED WITH T-41A AND T-41C TRAINER AIRCRAFT** Final Report, Nov. 1970 - May 1971

Donald C. Gasaway Aug. 1971 24 p refs

(AF Proj. 7755)

(AD-731128; SAM-TR-71-22) Avail: NTIS CSCL 20/1

Acoustic noise measurements were obtained within Cessna T-41A and T-41C trainer aircraft during various phases of ground and airborne operation. Factors contributing to speech interference

and auditory risk were identified, and recommendations are provided relative to improving voice communications and reducing auditory risks. Ambient noise within the T-41A and T-41C interferes significantly with speech, but this problem can be reduced when earplugs, such as the V-51R, are worn. The attenuation provided by the V51R earplugs should prevent temporary or permanent noise-induced hearing loss.

Author (GRA)

N72-15015# Wyle Labs., Inc., Hampton, Va.

PROPELLER NOISE AT LOW TIP SPEEDS Final Report, Nov. 1969 - Mar. 1971

David Brown and John B. Ollerhead Wright-Patterson AFB, Ohio AFAPL Sep. 1971 212 p refs

(Contract F33615-70-C-1135; AF Proj. 3066; Proj. 9356)

(AD-731156; WR-71-9; AFAPL-TR-71-55) Avail: NTIS CSCL 20/1

The study comprises an analytical and experimental investigation of the vortex noise generated by low-tip speed propellers. Initially, the treatment of the subject is focussed on an examination of the origins of broadband noise and the methods by which these can be analytically represented. Subsequent noise measurements on simple-design propellers indicate how the typical spectra in the Strouhal frequency range are significantly influenced by an extensive range of high order harmonics of the blade passage frequency, and a treatment of this harmonic content is included in this study report. The broadband and harmonic components of noise data, obtained from propellers with blade number and blade angle variations, have been analyzed in detail and noise prediction methods have been derived for each. It is postulated that the noise source mechanisms may be associated with unstable laminar flow separation (or transition) at the blade surfaces. The report also includes a set of graphical procedures by which both harmonic and random spectral details of the radiated noise can be calculated by tip Mach numbers in the range 0.2 to 0.6.

Author (GRA)

N72-15016# School of Aerospace Medicine, Brooks AFB, Tex. Clinical Sciences Div.

NOISE WITHIN THE F-4E DURING GROUND AND AIRBORNE OPERATIONS Final Report, Oct. 1969 - Dec. 1970

Donald C. Gasaway May 1971 19 p refs

(AF Proj. 7755)

(AD-731092; SAM-TR-71-14) Avail: NTIS CSCL 20/1

Noise levels encountered within the front and rear cockpits of the F-4E (McDonnell-Douglas) were obtained during ground and airborne operations. The acoustic features of the noise environment, as well as features of auditory risk and voiced communications, are discussed. Author (GRA)

N72-15017# Naval Ordnance Lab., White Oak, Md.

EFFECTS OF CANOPY GEOMETRY ON THE DRAG COEFFICIENT OF A CROSS PARACHUTE IN THE FULLY OPEN AND REEFED CONDITIONS FOR A W/L RATIO OF 0.264

William P. Ludtke 20 Aug. 1971 68 p ref

(AD-731023; NOLTR-71-111) Avail: NTIS CSCL 01/3

The report describes a series of wind-tunnel tests on the cross-type parachute. The effects of cloth permeability, number of suspension lines, and suspension line length were investigated. Forty-inch-diameter models with a canopy arm width-to-length ratio (W/L) of 0.264 were tested at various velocities from 50 fps to 300 fps in the fully inflated state. Results of these tests demonstrate that the parachute geometry

does have an effect on the drag capability of the cross parachute. Additional tests of reefed configurations for several reefing line lengths-to-canopy-diameter ratios from 0.45 to 1.6 at a constant velocity of 275 fps established the reefed characteristics of this parachute. Data are presented in tabular and graphical format. Photographs of representative canopy shapes are included for illustration. Author (GRA)

N72-15019# Honeywell, Inc., St. Paul, Minn. Research Dept. **CONCEPTUAL STUDY TO APPLY ADVANCED FLIGHT CONTROL TECHNOLOGY TO THE COIN OR TRIM AIRCRAFT** Final Report, 1 Jul. 1970 - 3 Feb. 1971
G. A. Smith, J. M. Hammer, and R. E. Rose Jun. 1971 156 p refs
(Contract N00019-70-C-0349)

(AD-730571; Rept-12225-FR(R)) Avail: NTIS CSCL 01/3
Investigations of the Variable Deflection Thruster (VDT) for a non-external-moving surfaces (NEMS) flight control system have been extended to determine the effects of finite aspect ratio and part-span blowing at subsonic speeds. Wind tunnel tests have revealed that full-span blowing is more effective than part-span blowing for obtaining lift or rolling moments. It was also shown that the lift effectiveness decreases when the ratio of blown area to wing area decreases or when a part-span blown area is moved toward the wing tip. The results of the wind tunnel study indicate that available theoretical analyses provide satisfactory predictions of jet-flap lift for full span blowing, but further theoretical work is needed, especially to determine the effects of part-span blowing. A study to examine the feasibility of using VDT blowing for primary flight control of COIN (counterinsurgency) or TRIM (trails, roads and interdiction missions) aircraft was undertaken. The estimates of the required thrust, mass flow and horsepower seemed reasonable, so duct losses were calculated, and the weight and fuel requirements were estimated. A VDT primary flight control system weighing 480 lb was hypothesized, and the maneuvering capability of an aircraft with this NEMS system was compared to the aircraft with conventional controls. It was found that the aircraft performance was generally improved with the NEMS control system. Author (GRA)

N72-15020# Wyle Labs., Inc., Rockville, Md. Payne Div. **AN OPTIMUM ACCELERATION TIME HISTORY FOR AN ESCAPE SYSTEM** Report for Jun. 1967 - Feb. 1968
Peter R. Payne and David A. Shaffer Wright-Patterson AFB, Ohio AMRL Aug. 1971 24 p refs
(Contract F33615-67-C-1807; Task-7231-01)
(AD-731194; Working-Paper-140-2; AMRL-TR-70-143) Avail: NTIS CSCL 01/3

Large accelerations must be imposed upon an escape system in order for this system to rapidly leave the cockpit and safely clear the aircraft empennage. An upper bound to this acceleration-time history is imposed by the physiological limitations of the escape system occupant. The report contributes to the search for an optimum acceleration-time history which will, for a given physiological stress level, minimize the escape time and maximize the escape velocity. The authors conclude that an impulsive velocity spike, followed by a zero rise time constant acceleration, will give a 70% reduction in escape time, relative to present systems. Although this velocity profile is not shown to be the mathematically optimum form of excitation, it is the best of those investigated. Author (GRA)

N72-15138# Naval Air Development Center, Johnsville, Pa. Aero Materials Dept.

A SURVEY OF AIRCRAFT MAINTENANCE CHEMICALS SUSPECTED OF CONTRIBUTING TO WATER POLLUTION

Jack Smith 23 Aug. 1971 15 p refs
(WF Proj. 51-543-202)
(AD-730473; NADC-MA-7153) Avail: NTIS CSCL 11/11

The composition of chemical materials commonly used in the maintenance of naval aircraft was studied in order to determine the presence of ingredient chemicals known or suspected to contribute to water pollution. This information may be used to reduce the pollutants by reformulation where and whenever effective non-polluting substitutions can be made or as a means of determining safe methods of disposal. Author (GRA)

N72-15140# Xonics, Inc., Van Nuys, Calif. **VORTEX OBSERVATIONS BY THE XONICS ACOUSTIC RADAR AT NAFEC** Final Report
Martin Balster, Arthur E. Nagy, and Andrew P. Proudian Dec. 1971 122 p
(Contract DOT-FA71WA-2672)
(TR-7; FAA-RD-71-103) Avail: NTIS

A series of flight tests was conducted in order to demonstrate feasibility of the concept of the acoustic vortex detector. The first tests consisted of simultaneous observations in close proximity by both the detector equipment and the instrumented tower of vortices shed by a low-flying aircraft. Except for the few cases where data was lost through equipment misalignment or malfunction or operator error, vortex returns were observed on virtually all of the runs. A total of 55 runs, which represents a substantial fraction of all of the data gathered, were selected for analysis. The vortex velocity measurements exhibit a clear correlation with aircraft configuration, and appear to confirm their use as a valid indicator or vortex intensity. Tests were run to demonstrate the tracking capability of the acoustic sensor. Two principal modes of operation were employed, and many variations of equipment parameters were tested within each of them. Successful tracks were obtained in both modes, and a number of samples are presented. Strong signals leading to good tracks were observed for a nominal aircraft height of 800 ft., but returns were unaccountably weak and sporadic for aircraft height of 1000 and 1200 ft. An analysis is given of the enhanced system performance that is probably required to achieve confident tracking at altitudes up to 1700 ft. Author

N72-15186# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Rechenanlagen. **DEVELOPMENT OF A TIME-SHARING SYSTEM FOR THE TELEPROCESSING OF WIND TUNNEL MEASUREMENTS WITH THE IBM 7040 COMPUTER AS CENTRAL PROCESSOR**
T. Herbert Nov. 1970 78 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-68; AVA-FB-7044; DK-681.14-523.8; DK-518.5)
Avail: NTIS; ZLDI Munich: 20,50 DM

The IBM 7040 operating system, IBSYS, was originally designed for batched job processing. Following an analysis of the structure of tests and processing of data for the transonic and 3m-subsonic wind tunnel, a time-sharing system was developed on the basis of IBSYS. The new system provides background processing of batched jobs and foreground real-time analysis of measurement data, which is controlled from terminals in a dialog mode. In this mode of operation the results for each test point are listed and plotted on the terminal immediately following the measurement. Additional provisions are made for a limited remote job entry and for the use of the on-line plotters by batch jobs. Author (ESRO)

N72-15216# Royal Aircraft Establishment, Farnborough (England).

A DUAL OUTPUT 1.6 GHz SOLID-STATE POWER SOURCE
B. Lake Jan. 1970 18 p refs
(RAE-TR-70002; UDC-621.374.4) Avail: NTIS

An experimental system feeding two antennas with 10 W at 1.6 GHz is described, with possible application to aircraft communication via a satellite. This was achieved by frequency multiplication and power amplification of an existing 400 MHz power source. Two frequency doubling stages were used in each arm of the system, after division with a coaxial hybrid tee junction. A UHF power transistor was used in the varactor mode to produce power gain in addition to frequency doubling, and this was followed by a step recovery varactor diode frequency doubler producing 10W at 1.6 GHz. ESRO

N72-15234# Naval Air Development Center, Johnsville, Pa.
PROCEEDINGS OF SYMPOSIUM ON ADVANCED AIRCRAFT ELECTRIC SYSTEMS (SOSTEL)
22 Apr. 1971 212 p refs Symp held at Warminster, Pa., 20-22 Apr. 1971
(AD-731077) Avail: NTIS CSCL 09/3

Contents: SOSTEL II data handling system; The logical approach to power management; Application of solid state power management; SOSTEL for A-7 electrical system; An automatic electrical distribution system; Application study results for multiplexed aircraft electric systems; Plated wire memories for military application; A cost effective solid state indication and control; Solid state power controllers; Solid state power controllers, circuit breakers, and relays for present day aircraft; Compatibility of solid state power controllers with aircraft electric systems; Remote power switch with overcurrent protection; A new miniature state-of-the-art proximity switch for position sensing; Transcendent semiconductor development; High voltage DC power systems for aircraft. GRA

N72-15244*# Education Research, Inc., Berkeley, Calif. 01e
ECONOMIC UTILIZATION OF GENERAL AVIATION AIRPORT RUNWAYS

Robert R. Piper Apr. 1971 235 p refs
(Contract NAS2-5737)
(NASA-CR-114406) Avail: NTIS

The urban general aviation airport economics is studied in detail. The demand for airport services is discussed, and the different types of users are identified. The direct cost characteristics of the airport are summarized; costs to the airport owner are largely fixed, and, except at certain large airports, weight is not a significant factor in airport costs. The efficient use of an existing airport facility is explored, with the focus on the social cost of runway congestion as traffic density at the airport builds up and queues form. The tradeoff between aircraft operating costs and airport costs is analyzed in terms of runway length. The transition from theory to practice is treated, and the policy of charging prices only on aircraft storage and fuel is felt likely to continue. Implications of the study from the standpoint of public policy include pricing that spreads traffic peaks to improve runway utilization, and pricing that discriminates against aircraft requiring long runways and causes owners to adopt V/STOL equipment. Author

N72-15252# Illinois Univ., Urbana. Aviation Research Lab.
A FLIGHT DYNAMICS EVALUATION OF A SINGER-LINK GAT-2 AS A QUASI-SIMULATOR WITH CONTROL MODIFICATIONS M.S. Thesis
Stewart A. Stoddart Jun. 1971 78 p refs
(Contract F44620-70-C-0105; AF Proj. 9778)

(AD-731135; ARL-71-13/AFOSR-71-4; AFOSR-71-2585TR)
Avail: NTIS CSCL 14/2

The flight dynamics of a Singer-Link General Aviation Trainer-2 (GAT-2) are analyzed theoretically and experimentally to determine the fidelity of the simulation of a light twin-engine airplane. The simulation is shown to be reasonable for experimental purposes. Four control modifications, sideslip compensation, lift compensation, position-position roll correspondence, and follow-up trim, are presented and documented.

Author (GRA)

N72-15254# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

AIRCRAFT GUIDED MISSILE SUBSYSTEMS Final Report
1 Sep. 1971 25 p
(AMCR Proj. 310-6)

(AD-731189; MTP-7-2-011) Avail: NTIS CSCL 14/2

The procedure provides guidance for conducting engineering tests of aircraft guided missile subsystems, with references for the testing of subsystem components. Author (GRA)

N72-15273*# Techtran Corp., Glen Burnie, Md.
EFFECT OF WING TIP SHAPE ON VORTEX SHEET ROLLING UP

R. Lengendre Washington NASA Jan. 1972 6 p Transl. into ENGLISH from Rech. Aerosp. (France), no. 4, Jul. - Aug. 1971 p 227-228

(Contract NASw-2037)

(NASA-TT-F-14111) Avail: NTIS CSCL 20D

Laws of separation over a whole wing are applied to the study of straight or moderately sweptback wings. The effect of vortex sheet rolling up can be avoided by tailoring the profile of the trailing edge to the edge of a wing or blade, with constant or zero leading edge sweepback, in such a way as to make a clear distinction between the leading and trailing edges. The associated break phenomena are investigated. Author

N72-15277# Technische Hogeschool, Delft (Netherlands).
AN EXPERIMENTAL INVESTIGATION OF THE EXPANSION FLOW FIELD OVER A DELTA WING AT SUPERSONIC SPEED

W. J. Bannink and G. Nebbeling Sep. 1971 57 p refs
(VTH-167) Avail: NTIS

An experimental investigation has been made of the inviscid flow field on the expansion side of a flat delta wing with a semi-apex angle of 45.3 deg and at an angle of incidence of 12 deg. The measurements were performed at a Mach number of 2.94 in a 15 cm x 15 cm blow down wind tunnel. A comparison of measurements performed in different planes normal to the root chord showed that the flow may be considered as conical. The obtained results suggest that the conical-sonic line and the inboard shock wave meet in a point well inside the central region of the flow field (in this region the influence of both halves of the delta wing is felt). The present measurements indicate that, away from the wing surface, the inboard shock wave bends towards the plane of symmetry of the wing. A flow model is discussed based on the present investigations. Author

N72-15292# Royal Aircraft Establishment, Farnborough (England).

SCALE EFFECTS IN FLOWS OVER SWEEPED WINGS

M. G. Hall, D. Kuechemann, and Maskell Mar. 1971 55 p refs
Presented at the AGARD meeting on Facilities and Tech. for

Aerodyn. Testing at Transonic Speeds and High Reynolds Numbers, Goettingen, West Ger., 26-28 Apr. 1971 Revised (RAE-TR-71043) Avail: NTIS

A review is given of current knowledge of the effects of variations in Reynolds number on the possible types of flow over a swept wing and the boundaries between them. Three main flow regimes are discussed: (1) the attached boundary layer which may be laminar or turbulent and where the position of transition is important, (2) the thin wake which extends downstream from the trailing edge of the wing; (3) and the regime of separated flow. Their interactions with the external flow and each other are included. The flow structures are three-dimensional. Reynolds number effects are best understood where simple extensions from two dimensions can be made. The most serious gaps in understanding are found where compressibility and strong interactions are important. If these gaps could be filled model testing would be much more reliable.

Author (ESRO)

N72-15434# National Aviation Facilities Experimental Center, Atlantic City, N.J.

INERTIAL LOCATOR TEST AND EVALUATION Final Report, Jun. 1969 - Sep. 1971

John E. Walls Feb. 1972 79 p refs (Proj. 212-301-03X)

(FAA-RD-72-3) Avail: NTIS

The design, development and evaluation of an Inertial Locator Equipment (ILE) are discussed. The ILE provides aircraft position information and on-board computer data processing for flight inspection of ground navigation facilities. An evaluation of the ILE performance was performed during flight tests. The ILE demonstrated a potential for performing inspection of instrument landing systems with inertial equipment.

Author

N72-15449# Solar, San Diego, Calif.

RADIATION PYROMETER FOR GAS TURBINE BLADES Final Report, 8 Feb. 1970 - 16 Jun. 1971

David A. Rohy and W. A. Compton 16 Jun. 1971 115 p refs (Contract N00019-69-C-0683)

(AD-730837; RDR-1698) Avail: NTIS CSCL 14/2

The report describes the results of a program that has advanced the concepts and practical feasibility of radiation pyrometry for measuring the first stage blade temperature in gas turbine engines. Thermal radiation is accepted from the blades by sensor heads employing one of two different optical systems. The two sensor heads were designed to collect thermal radiation from either a spot or a reasonably large area of the turbine blade. High temperature fiber optics have been used to transmit the radiation to a remote detector housing, where the photons are converted into an electrical signal by a silicon photovoltaic cell. The current produced by the cell is routed to a signal processor which amplifies the signal, extracts one of three desired signal characteristics and then produces an output signal directly proportional to the temperature. This system measures and displays on a real time basis the average temperature of blades on a wheel, the average of the highest temperatures on a wheel, or the temperature of the hottest blade on the wheel. Both analog and digital signal information is available. System response is better than 10 msec in most cases. End to end system accuracy when calibrated with an electrically heated strip target was better than plus or minus 10F across the range of 1400 and 2200F.

Author (GRA)

N72-15529# National Aerospace Lab., Amsterdam (Netherlands). **TITANIUM ALLOYS FOR AEROSPACE**

R. J. H. Wanhill May 1971 30 p refs Revised Sponsored by the Neth. Agency for Aerospace Programs (NLR-TR-71003-U-Rev) Avail: NTIS

The metallurgy and heat treatment of titanium alloys and their development, availability and applications in the aerospace industry are reviewed. Problems suitable for materials research are outlined. Classified tables of alloys are given in an appendix; the alloys are classified into four strength ranges. Within each range competitive alloys are compared for a variety of properties.

ESRO

N72-15530# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Inst. fuer Werkstoff-Forschung.

AN ANALYSIS OF CUMULATIVE DAMAGE BY MEANS OF BIHARMONIC LOADING

H. Nowack (Ph.D. Thesis - Aachen Univ.) 1971 118 p refs In GERMAN; ENGLISH summary (DLR-FB-71-23) Avail: NTIS; DFVLR Porz: 32 DM

The accumulation of fatigue damage caused by consecutive load cycles with varying amplitudes and mean stresses is investigated systematically by applying biharmonic loading to notched AlCuMg2 specimens. The stress-strain behaviour of the material at the notch root is experimentally determined at the beginning of fatigue life. For this purpose a special strain pick up was developed. The measured stress-strain curves are analysed and no significant correlation is found between the plastic strain range or the hysteresis energy at the notch root and the fatigue life. The crack propagation is a function of the deformations measured very close to the tip of the crack. An analytical expression for crack propagation is suggested. Several often used cumulative damage theories are also discussed.

Author (ESRO)

N72-15531# Rolls-Royce, Ltd., Leavesden (England). Small Engines Div.

EVALUATION OF ANTI-FRETTING COMPOUNDS FOR THE PREVENTION OF FRETTING FATIGUE OF ALUMINUM ALLOYS AT TEMPERATURES UP TO 150 C

W. J. Harris London Min. of Defence Jul. 1971 23 p (D-MAT-174) Avail: NTIS

Fretting fatigue researches were carried out to investigate the fretting problems of aluminum alloys, operating up to 150 C. A simple practical scheme, providing full protection, follows: (1) parent aluminum alloy given a protective chromate filming treatment, and (2) anti-fret scheme superposed, consisting of air-cured isocyanate-epoxy resin medium loaded with molybdenum disulfide 2. Attempts to incorporate corrosion inhibition with chromates in the anti-fret film led to unacceptable depreciation of fatigue strength. A molybdenum disulfide 2 loaded epoxy resin scheme cured at 150 C and solid shims of carbon fiber-resin mats also eliminate fretting effects but would be less attractive in practical use.

Author (ESRO)

N72-15560*# Israel Program for Scientific Translations, Ltd., Jerusalem.

NEW VARIATIONAL METHODS IN FLIGHT DYNAMICS

V. F. Krotov, V. Z. Bukreev, and V. I. Gurman 1971 216 p refs Transl. into ENGLISH of the publ. "Novye Metody Variatsionnogo Ischisleniya v Dinamike Poleta" Moscow, Mashinost., 1969 (NASA-TT-F-657; TT-70-50186; UDC-629.7.015:519.3) Avail: NTIS CSCL 12A

Variational methods for the optimization of motion of aircraft and other objects are considered. The elements of variational method theory are discussed first. A number of specific methods and the synthesis of optimal control are presented. The structure and analysis of degenerate and sliding controls are also treated. Solutions to a number of problems of powered flight dynamics are presented, including vertical rocket

ascent in a vacuum, rocket dynamics in a homogeneous field in a vacuum, and powered aircraft flight. A detailed construction is given of an approximate synthesis of optimal aircraft control on the ascent section. Author

N72-15591# Army Cold Regions Research and Engineering Lab., Hanover, N.H.

ICE FOG MODIFICATION BY USE OF HELICOPTERS

James R. Hicks and Motoi Kumai Sep. 1971 13 p refs
(DA Proj. 1T0-61102-B-52-A; DA Proj. 1T0-62111-A-126)
(AD-731215; CRREL-SR-162) Avail: NTIS CSCL 04/2

The objects of the report are to increase the knowledge of the physical and optical properties of ice fog and to develop techniques for its dispersal. Two series of flight tests to determine the effects of CH-47 helicopter downwash on ice fog were conducted near Ft. Wainwright, Alaska, in January 1971. During the first series, clearings were produced which were large enough for helicopter operations. This series of tests was conducted when the ice fog was in a dissipating state. The second series of tests was conducted in a denser ice fog during its developing stage. The same flight procedures were used, but clearings were not produced. Author (GRA)

N72-15598# Institute for Telecommunication Sciences, Boulder, Colo.

INTERFERENCE PREDICTIONS FOR VHF/UHF AIR NAVIGATION AIDS (SUPPLEMENT TO IER 26-ITSA 26 AND ERL 138-ITS 95)

G. D. Gierhart and M. E. Johnson Jan. 1971 64 p refs
(Contract DOT-FA-68-WAI-145)
(AD-718465; OT/ITSTM-19) Avail: NTIS CSCL 17/7

A supplement is presented to information previously developed on interference predictions for VHF/UHF air navigation aids. Included are: (1) radiation patterns needed to adapt curves previously developed for the instrument landing system (ILS) localizer and tactical air navigation (TACAN) to new equipment types, (2) comparisons of the propagation models used for predictions made from 1962 to the present, (3) propagation information in a different form, i.e. attenuation greater than free space for distance measuring equipment (DME), TACAN and VHF omnirange (VOR), (4) DME, TACAN and VOR service volume without interference curves for equipment configurations not previously considered, and (5) an errata list for earlier ESSA technical reports. Author

N72-15600# Air Force Cambridge Research Labs., Bedford, Mass. Microwave Physics Lab.

CORRECTIONS FOR TROPOSPHERIC RANGE ERROR

Edward E. Altshuler 27 Jul. 1971 46 p refs
(AF Proj. 8682-03-01)
(AD-731170; AFCRL-71-0419; AFCRL-ERP-369) Avail: NTIS CSCL 17/7

Satellite systems like the 621B have been proposed for air traffic control and navigation. Such systems are designed to provide aircraft position and velocity data based on time delay measurements of propagation between the aircraft and a network of satellites. Since the index of refraction of the troposphere is greater than unity, radiowaves propagate through the troposphere slower than through freespace and the time delay is therefore longer. Range error corrections calculated from various models of index of refraction generally require the use of numerical methods and a large capacity high speed computer, particularly for low elevation angles. This paper presents a simple empirical expression for range error for elevation angles above 5 degrees. The CRPL Reference Atmosphere 1958 was the

model used. A simple regression line that yields range error corrections within 1 percent of the values obtained by means of more sophisticated techniques was derived. GRA

N72-15601# Lincoln Lab., Mass. Inst. of Tech., Lexington.

AIR TRAFFIC CONTROL Quarterly Technical Summary Report, 1 May - 31 Jul. 1971

Herbert G. Weiss 15 Aug. 1971 15 p refs
(Contract F19628-70-C-0230; AF Proj. 649L)
(AD-730601; ESD-TR-71-248) Avail: NTIS CSCL 17/7

The report describes the activities in air traffic control which are funded by the Air Force. Where these activities have led to projects supported by other agencies or are intimately related to such work, this interrelationship has been noted. Progress on other ATC tasks during this quarter included the completion of a Technical Development Plan for a Discrete Address Beacon System for the FAA, two studies relating to Fourth Generation ATC System Concepts for the Transportation Systems Center of DOT, and the Evaluation of a Laser Beam Alerting System for Logan Airport sponsored by the Massachusetts Port Authority. Author (GRA)

N72-15625*# Stanford Research Inst., Menlo Park, Calif.

THE STRUCTURE OF JET TURBULENCE PRODUCING JET NOISE Annual Report

C. E. Wooldridge, D. C. Wooten, and A. J. Amaro Jun. 1971 72 p refs
(Contract NASw-1938; SRI Proj. SCU-8139)
(NASA-CR-126483) Avail: NTIS CSCL 20A

The structure of the turbulence in the mixing region for the first few diameters downstream from the outlet of a circular subsonic jet is characterized at three Mach numbers, 0.3, 0.5, and 0.7, with most of the measurements taken at $M = 0.3$. Profiles of turbulence intensity showed that downstream of the lip intensity is independent of axial distance, while in the core intensity varies by a factor of eight between the jet outlet and the end of the core. A digital data reduction program was used to calculate the auto- and cross-correlations of axial velocity fluctuations and the power spectral densities. Convection velocities were measured using broadband, hot wire signals and signals that were digitally filtered for band-passes about center frequencies of 0.8, 1.3, 1.6, and 3.2 kHz. The center frequency of 1.3 kHz corresponded to the peak energy in the core spectrum. The results support the hypothesis that the coherent pressure field is driven by the intermittent fluctuations at the core boundary, which in turn are related to the large (low frequency) eddies. Author

N72-15712*# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.

SOOT OXIDATION RATES IN GAS TURBINE ENGINES

Samuel W. Radcliffe and John P. Appleton Jun. 1971 18 p refs
(Grant NGL-22-009-378)

(NASA-CR-125404; FML-Publ-71-12) Avail: NTIS CSCL 21E

A basis is proposed for extrapolating soot oxidation rate measurements obtained in laboratory flames to the more extreme operating conditions of gas turbine combustion chambers. The proposal is based on the observation that, within probable experimental uncertainty, the limited soot oxidation measurements correlate with the more extensive measurements of the surface oxidation rates of macroscopic samples of pyrographite. The soot oxidation rates thus determined for the conditions of a typical gas turbine combustion chamber are considerably lower than estimates which were based on simple extrapolations of the flame data. Author

N72-15713*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
DIMENSIONAL ANALYSIS CONSIDERATIONS IN THE ENGINE ROTOR FRAGMENT CONTAINMENT/DEFLECTION PROBLEM

John W. Leech, Emmett A. Witmer, and Raffi P. Yeghiayan Dec. 1971 24 p refs
 (Grant NGR-22-009-339)
 (NASA-CR-120841; ASRL-TR-154-3) Avail: NTIS CSCL 21E

Dimensional analysis techniques are described and applied to the containment/deflection problem of bursting high-rpm rotating parts of turbojet engines. The use of dimensional analysis to select a feasible set of experiments and to determine the important parameters to be varied is presented. The determination of a containment coefficient based on the nondimensionalized parameters is developed for the reduction of experimental data and as an assist to designers of containment/deflection devices. Author

N72-15714*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SWIRL CAN PRIMARY COMBUSTION Patent Application. Robert E. Jones and Richard W. Niedzwiecki Filed 27 Oct. 1971 10 p
 (NASA-Case-LEW-11326-1; US-Patent-Appl-SN-192970) Avail: NTIS CSCL 21E

A swirl can, full-annulus combustor operable over a wide range of exit average temperatures is described for use in a high performance gas turbine engine for advanced aircraft. A large number of swirl can modules are mounted in an array in each combustor. NASA

N72-15716*# Curtiss-Wright Corp., Wood-Ridge, N.J.
INTEGRAL LIFT ENGINE PRELIMINARY DESIGN

W. Pratt, A. Leto, and R. Schaefer Nov. 1971 119 p refs
 (Contract NAS3-14327)
 (NASA-CR-120838; CW-WR-71-091F) Avail: NTIS CSCL 21E

A preliminary mechanical design of a complete lift fan engine system is reported. A description of the lift fan engine, layout drawings of the components and complete engine, and a discussion of the design analyses and results are presented. The design features and areas of analysis include fan and compressor rotor blades of composite construction, a combustor folded over the compressor, relatively high-temperature blades in the high-pressure turbine, the first stage of the low-pressure turbine used for bearing support and ducting of lubricant to the bearings, a complete lubrication system, critical speeds of the shafting, and vibration and flutter of the blading. Author

N72-15721# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AVIATION ENGINE VIBRATION THEORY AND CALCULATION

D. V. Khronin 25 Aug. 1971 533 p refs Transl. into ENGLISH of the book "Teoriya i Raschet Kolebanii v Dvigatelyakh Letatelnykh App." 1970 p 1-412
 (AF Proj. 3066; Task-604010)
 (AD-731351; FTD-HC-23-780-70) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 21/5

The book deals with basic data on the general theory of vibrations of linear and nonlinear systems, their application to calculation of vibrations of parts, units and systems of aircraft engines. Given are contemporary methods for calculation of vibrations, which are developing in connection with the use of high speed computers; the method of initial parameters, the method of dynamic rigidities, the methods of discrete models

and the integral method. The book represents a text book for students specializing in the strength of aircraft engines; it can be useful also to engineers of the aircraft industry. Author (GRA)

N72-15797# British Aircraft Corp., Weybridge (England). Acoustics Lab.

ACOUSTIC TESTING, AIRCRAFT STRUCTURES c32
 John A. Hay *In* Soc. of Environ. Engr. Environ. Eng. 1970 27 p refs
 Avail: NTIS HC \$6.00/MF \$0.95

Acoustic fatigue testing is outlined for aircraft structures, and the mechanism and causes of the phenomenon are discussed. Common forms of test facilities and methods of testing are reviewed. ESRO

N72-15812 Shock and Vibration Information Center (Defense), Washington, D.C.

THE SHOCK AND VIBRATION BULLETIN, NO. 40. PART 2: SHOCK

Dec. 1969 255 p Presented at 40th Symp. on Shock and Vibration, Fort Monroe and Hampton, Va., 21-23 Oct. 1969 7 Vol.

(AD-723341; Bull-40-Pt-2) Avail: Director, Navy Publ. and Printing Serv. Office, Naval District Of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

Data covering experimental results and design recommendations for structures and equipment subjected to shock and vibration are presented. Detailed descriptions are given for such effects on fluid systems, aircraft structures, gas turbines, helicopter structures, and protective buildings.

N72-15822 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

RESPONSES OF AIRCRAFT STRUCTURES SUBJECTED TO BLAST LOADING

Nelson M. Isada, Richard K. Koegler, and Donald O. Bliven *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 2 Dec. 1969 p 123-132 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

The responses of aircraft structural elements subjected to blast loading were studied. The nature and extent of damage of concern for representative aircraft structures were established to define the specific regions and load distributions to be investigated. After this was done, it was found feasible to use both a linear and a nonlinear (to consider the plastic effects) dynamic response analysis in predicting the transient blast loading required to cause failure in specified structural components. The prediction is carried out by means of structural isodamage curves that were constructed for this study and discussed in this paper. Author

N72-15824 Defence Research Establishment Suffield, Ralston (Alberta).

TESTING THE RESPONSE OF GAS TURBINES TO AIR BLAST c28

J. C. Muirhead, R. Naylor, and C. G. Coffey *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 2 Dec. 1969 p 147-156 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval

District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

The effect of blast on gas turbine engines is explored. Exploratory experiments used an Orenda 8 engine, which was subjected to blast waves from a valve-operated, compressed air driven shock tube. No significant effects were caused by inlet loadings, but blast waves impinging on the exhaust caused compressor stall and flame-out at low rpm. A general review of the program is given. Author

N72-15833 Shock and Vibration Information Center (Defense), Washington, D.C.

THE SHOCK AND VIBRATION BULLETIN NO. 40. PART 6: TRANSPORTATION

Dec. 1969 162 p refs Presented at the 40th Symp. on Shock and Vibration, Fort Monroe and Hampton, Va., 21-23 Oct. 1969 7 Vol.

(AD-723345; Bull-40-Pt-6) Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

Conference papers are presented on various shock and vibration studies, encompassing ejected missiles, aircraft noise, and aircraft landings. Rail transportation at high speeds is also evaluated for human comfort.

N72-15835 Honeywell, Inc., Hopkins, Minn. Ordnance Div. **WIND TUNNEL SIMULATION OF FLIGHT VIBRATION AND ACOUSTIC LEVELS ON AN EXTERNAL STORE**

K. A. Herzing and S. N. Schwantes *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 6 Dec. 1969 p 9-25 refs

(Contract F08635-69-C-0148)

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

A prototype munitions dispenser designed for external carriage on tactical aircraft was tested in a wind tunnel to verify the structural integrity of several modifications. As a result of the wind tunnel test, it appears feasible to utilize a wind tunnel to subject an external store to representative flight vibration and acoustic levels. The tunnel must be capable of providing flow conditions over the full design flight regime. The store described was also tested in two configurations subject to cavity resonance. Comparisons are made to flight data and a conventional random vibration test using an electrodynamic shaker. Author

N72-15836 Vought Aeronautics, Dallas, Tex.

A METHOD TO SIMULATE GUNFIRE INDUCED VIBRATION ENVIRONMENT

J. A. Hutchinson and R. N. Hancock *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 6 Dec. 1969 p 27-35 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

Samples of measured flight nongunfire and gunfire data obtained from the M61 rapid-fire gun in the A-7D airplane are presented. It defines a basic procedure for simulating the gunfire environment in the vibration laboratory through the use of a pulse train input function. To substantiate this method, the results of two laboratory tests are given. Conclusions are presented based upon the results of these laboratory tests concerning the repeatability of the test input spectrum and the

accuracy of the gunfire simulation. It is recommended that a test of this type be used to supplement the tests defined by current military specifications governing vibration qualification for equipment located in the vicinity of large caliber, rapid-fire gun systems. Author

N72-15837 Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.

THE SHOCK AND VIBRATION EXPERIENCED BY NAVAL AVIONICS DURING ARRESTED LANDING c02

Vaughn M. Foxwell, Jr. *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 6 Dec. 1969 p 37-59

Avail: NTIS Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

The problem was investigated and the environment defined through a flight test program. Subsequent to the environmental definition, a design fix was implemented consisting of additional mounts and snubbers to limit high excursion without degrading normal vibration isolation characteristics. The investigation revealed that MIL-E-5400 did not completely define the rigorous shock and vibration environment of carrier-based aircraft. Author

N72-15838 Tustin Inst. of Tech., Santa Barbara, Calif.

A SURVEY OF PRACTICAL PROBLEMS ENCOUNTERED IN REPRODUCING THE CAPTIVE FLIGHT ENVIRONMENT BY MEANS OF SHAKERS AND SHOCK TEST MACHINES c11

Wayne Tustin *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 6 Dec. 1969 p 61-66 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

Attention is paid to tests on partial and complete weapons and stores which are carried to their missions by aircraft. Test specifications, particularly the catalog variety, are questioned. Methods for attaching test items are discussed. Various techniques for selecting accelerometer locations and for utilizing multiple accelerometer signals are mentioned. Effects of tracking filters, of distorted motion, and of crosstalk on the outcome of tests are mentioned. Advantages of acoustic and wind tunnel environmental testing are mentioned. Author

N72-15839 General Dynamics/Pomona, Calif.

STANDARD ARM CAPTIVE CARRY LIFE EXPECTANCY PREDICTION AND VIBRATION QUALIFICATION TESTING

B. N. Downing *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 40, Pt. 6 Dec. 1969 p 67-83 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set

Imposing classical testing methods for qualification of the air-launched standard ARM missile for the captive carry vibration environment resulted in a major airframe fatigue failure and identification of the critical structural element. An overtest was clearly demonstrated by actual life expectancy studies. A tactical air carry mission model was synthesized from the most significant flight phases characteristic of the parent A-6B Intruder aircraft. Environmental measurements were made with a fully-instrumented missile for each phase and presented by peak bending moment distribution graphs. Laboratory tests were conducted to define the fatigue properties of the critical airframe element. Conventional

analyses of the fatigue and environmental data indicated, with *inherent conservatism, a captive carry life expectancy of 850 hours; a relatively generous duration for this type of weapon. Force excitation concepts were used in the design of a revised missile level qualification test which was successfully performed. Improvements offered by the test and validity of assumptions are discussed.* Author

N72-15841*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MEASURED VIBRATION RIDE ENVIRONMENTS OF AN STOL AIRCRAFT AND A HIGH SPEED TRAIN

John J. Catherines *In Shock and Vibration Inform. Center The Shock and Vibration Bull.*, No. 40, Pt. 6 Dec. 1969 p 91-97 refs

(NASA-TM-X-67586) Avail: NTIS; Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; \$15.00/set CSCL 20K

Ride environments of several models of transportation were measured and analyzed in an effort to establish the relationship of the vibration levels to human comfort. A small, inexpensive, FM recording system was developed to record the vibratory accelerations of the vehicles. Acceleration measurements are presented in the form of peak accelerations, power spectral density, and histograms. Results show that the ride environments are characterized by low-frequency responses. Preliminary results show good correlation between peak accelerations and subjective responses of passenger with the lateral accelerations causing more discomfort than the vertical accelerations. Author

N72-15879# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugzeugbau.

APPLICATION OF THE RAYLEIGH-RITZ METHOD WITH MESHWISE INTERPOLATION FOR CALCULATING THE BUCKLING LOADS OF SHALLOW SANDWICH SHELLS WITH PARALLEL EDGES

K. Rohwer 1971 46 p refs *In GERMAN; ENGLISH summary (DLR-FB-71-30)* Avail: NTIS; DFVLR Porz. 9,50 DM

The buckling loads of shallow orthotropic sandwich shells with parallel edges are investigated. The potential energy, established for rectangular coordinates is translated to skew parallel coordinates, so the boundary conditions may be described more easily. The buckling loads are determined as eigenvalues from a Ritz set up with mesh Hermite interpolation polynomials. Results of computed examples, such as the sandwich panels for sweptback wings, are presented. Author (ESRO)

N72-15892*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THERMAL DESIGN STUDY OF AN AIR-COOLED PLUG-NOZZLE SYSTEM FOR A SUPERSONIC CRUISE AIRCRAFT

John S. Clark and Arthur Lieberman Washington Jan. 1972 50 p refs

(NASA-TM-X-2475; E-6348) Avail: NTIS CSCL 20M

A heat-transfer design analysis has been made of an air-cooled plug-nozzle system for a supersonic-cruise aircraft engine. The proposed 10deg half-angle conical plug is sting supported from the turbine frame. Plug cooling is accomplished by convection and film cooling. The flight profile studied includes maximum afterburning from takeoff to Mach 2.7 and supersonic cruise at Mach 2.7 with a low afterburner setting. The calculations indicate that, for maximum afterburning, about 2 percent of the engine primary flow, removed after the second

stage of the nine-stage compressor, will adequately cool the plug and sting support. Ram air may be used for cooling during supersonic-cruise operations, however. Therefore, the cycle efficiency penalty paid for air cooling the plug and sting support should be low. Author

N72-15898*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NEW FIRE RETARDANT FOAMS AND INTUMESCENTS

c18

John A. Parker *In Univ. of S. Calif. Fireproofing and Safety Symp. Proc.* 27 May 1972 p 55-108 refs

Avail: NTIS CSCL 11D

The development of fire retardant foams and intumescent paints for protection of commercial aircraft passengers in the event of fire is discussed. Recommended materials and methods for evaluating the effectiveness of the materials are presented. Typical problems resulting from aircraft fires and the basic protective mechanisms to cope with these problems are examined. Author

N72-15909*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPARISON OF TEMPERATURE DATA FROM A FOUR-VANE STATIC CASCADE AND A RESEARCH GAS TURBINE ENGINE FOR A CHORDWISE-FINNED, IMPINGEMENT- AND FILM-COOLED VANE

Herbert J. Gladden, John N. B. Livingood, and Daniel J. Gauntner Washington Feb. 1972 33 p refs

(NASA-TM-X-2477; E-6597) Avail: NTIS CSCL 20M

Experimental heat-transfer data obtained for a chordwise-finned, impingement- and film-cooled turbine vane tested in a four-vane static cascade to a gas temperature and a gas pressure of 2250 F and 80 psia, respectively, are presented. Average and local vane temperatures are correlated and compared with correlations of temperature data obtained from tests of the same vane in a modified J-75 turbojet engine. The measured vane temperatures obtained from these tests in the two test stands are also compared with analytically determined temperatures. Author

N72-15925# Civil Aeronautics Board, Washington, D.C. Bureau of Economics.

CIVIL AERONAUTICS BOARD PLANNING STUDY. STOL - VTOL AIR TRANSPORTATION SYSTEMS

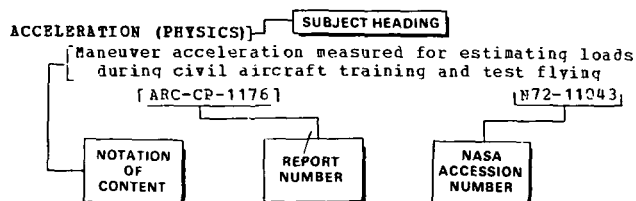
Carl Hintze, Jr. [1971] 37 p refs

Avail: NTIS

An analysis of the use of VTOL and STOL aircraft for short-haul transportation operations is presented. A description of the changing socio-economic aspects of the major metropolitan area of the nation and the anticipated effects on urban transportation requirements is included. The probable course of events in the evolution of short-haul operations is discussed. Author

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Typical Subject Index Listing



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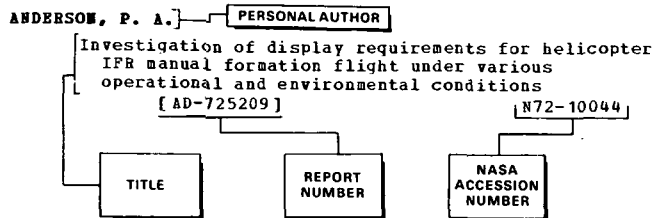
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