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AERONAUTICAL ENGINEERING

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A SPECIAL BIBLIOGRAPHY
WITH INDEXES

Supplement 9

SEPTEMBER 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PREVIOUS BIBLIOGRAPHIES IN THIS SERIES

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 9

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 August 1971 in

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



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INTRODUCTION

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 376 reports, journal articles, and other documents originally announced in August 1971 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

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

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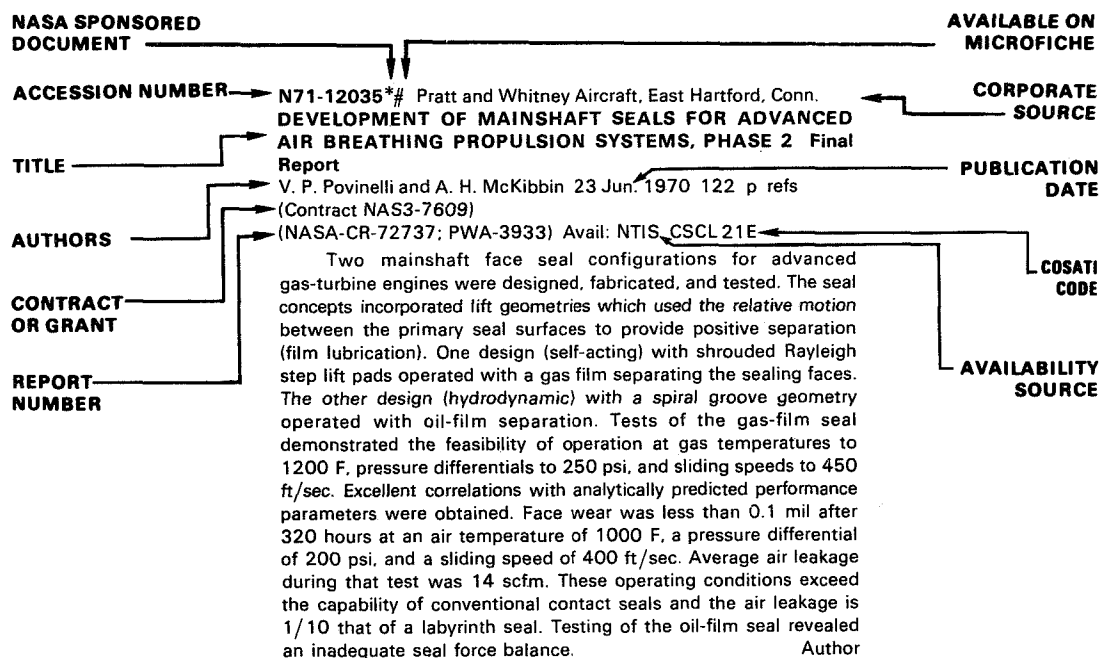
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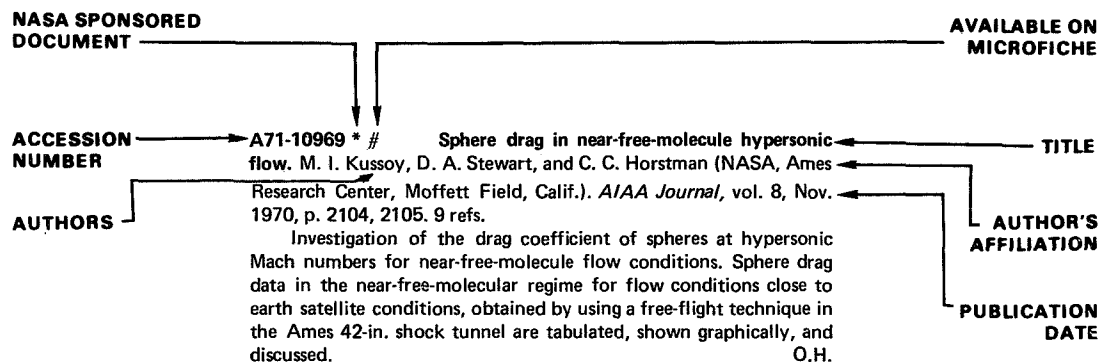
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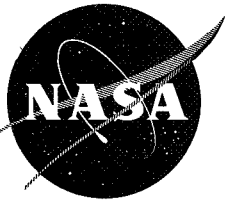
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AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 9) SEPTEMBER 1971

IAA ENTRIES

A71-31167 # Solution of planar subsonic problems involving thick profiles with the aid of the coordinate perturbation method (Lösung ebener Unterschallprobleme an dicken Profilen mit Hilfe des Verfahrens der Koordinatenstörung). K. P. Mayer (Graz, Technische Hochschule, Graz, Austria). (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Delft, Netherlands, Apr. 6-9, 1970.*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 51, Sonderheft, 1971, p. T 159, T 160. 5 refs. In German.

The transformation of a planar, irrotational, isentropic subsonic flow from the plane of flow into another reference plane as discussed by Gretler (1967, 1968) is considered. Two systems of linear differential equations are obtained in place of the nonlinear elliptic differential equations. Two complex variables are introduced as new independent variables and the complex potentials and the complex velocities are used as dependent variables. A formula for the velocity distribution about an arbitrary profile is presented, and its application to a circular cylinder is discussed. G.R.

A71-31170 # Calculation of supersonic flows at a great distance from slender bodies of revolution at an angle of attack (Berechnung von Überschallströmungen weit entfernt von schlanken, angestellten Rotationskörpern). M. Schorling (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). (*Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Delft, Netherlands, Apr. 6-9, 1970.*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 51, Sonderheft, 1971, p. T 171-T 173. In German.

A steady, isentropic, irrotational flow of ideal gases without mass and heat sources is considered. A system of five scalar differential equations is obtained, and suitable coordinates with an orthonormal system of basis vectors are selected. New velocity components are defined, and a characteristic variable is introduced. A system of nonlinear, partial differential equations is derived and solved for large distances. G.R.

A71-31207 Detection capability of an ECM receiver versus direction capability of a radar. E. J. Chrzanowski (Westinghouse Defense and Space Center, Baltimore, Md.). *Microwave Journal*, vol. 14, May 1971, p. 58-60.

Study to determine the conditions required to assure that an electronic countermeasure (ECM) receiver on board an aircraft can detect the signals of a victim radar before that radar can detect the signals reflected from the aircraft. In the case of track breaking countermeasures, although the radar signal is detected before the radar detects the aircraft, the ECM can be held off until actual tracking of the aircraft by the radar is recognized. The study was made with the use of the radar range equation to determine the range of detection of the radar and the one-way Friis transmission formula to determine the detection range of the airborne receiver. It is shown that either the radar or the airborne receiver can detect first depending on the radar transmitter power and the difference between the detection levels of the radar and the airborne receiver. F.R.L.

A71-31209 # Alpha Jet. Johannes Spintzyk. *Dornier-Post* (English Edition), no. 1-2, 1971, p. 6-9.

Description of the Alpha Jet, a tandem two-seat trainer designed for both elementary and advanced training and usable also for close air support. It is of a swept-back, high-wing and low-set-tail configuration, powered by two fan jet engines, and has a fuselage-mounted tricycle landing gear. Good maintainability makes possible a turn around time between training missions of less than 15 minutes. Mission duration for low-altitude navigation training is 1 h 30 min. M.V.E.

A71-31212 # 'Kiebitz' system definition. Peter Heckel and Gerhard Kannamüller. *Dornier-Post* (English Edition), no. 1-2, 1971, p. 20-25.

Description of the system-definition phase and preliminary specifications of a tethered, ground-supplied, rotor-borne, and self-stabilized surveillance platform. A tethering cable, containing a fuel line and coaxial cables, connects the platform aloft with its mobile ground base, an armored personnel carrier. The platform is essentially a helicopter with an autonomous stabilizer but without any flight control system, whose engine is fuelled from the ground, and whose multisensor surveillance equipment makes possible its use for data acquisition, transmission and evaluation in fire and communications control and other reconnaissance tasks. M.V.E.

A71-31214 # Recent studies on STOL aerodynamics. Dieter Welte. *Dornier-Post* (English Edition), no. 1-2, 1971, p. 34-37.

Review of the results of recent studies in STOL aerodynamics pertaining to maximum lift augmentation in thick profiles through mechanical high-lift devices. Investigations of the effect of externally blown flaps led to a flap of superior performance and novel geometry, the so-called 'Coanda flap.' M.V.E.

A71-31274 # Application of holographic methods in the investigation of optical inhomogeneities in a gas flow. A. F.

A71-31276

Belozarov, A. I. Bivaizev, N. M. Spornik, and W. T. Chernich (State Committee on Science, Moscow, USSR). In: Applications of holography; Union Internationale de Physique Pure et Appliquée, International Symposium on Holography, Besançon, France, July 6-11, 1970, Proceedings (Applications de l'holographie; Union Internationale de Physique Pure et Appliquée, Symposium International d'Holographie, Besançon, France, July 6-11, 1970, Comptes Rendus).

Symposium co-sponsored by the Commission Internationale d'Optique and the Comité Français d'Optique. Edited by J.-Ch. Viénot, J. Bulabois, and J. Pasteur. Besançon, France, Besançon, Université, 1970. 5 p.

Experimental gas flow investigations were carried out in hypersonic wind tunnels using holographic arrangements based on the Mach-Zehnder interferometer and on a schlieren apparatus. Some features of the experimental procedures are described and the advantages of holographic techniques in the study of gas flows are demonstrated. O.H.

A71-31276 # Holographic interferometry by retrodiffusion (Interférométrie holographique par retro-diffusion). Jean-Marie Caussignac (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Applications of holography; Union Internationale de Physique Pure et Appliquée, International Symposium on Holography, Besançon, France, July 6-11, 1970, Proceedings (Applications de l'holographie; Union Internationale de Physique Pure et Appliquée, Symposium International d'Holographie, Besançon, France, July 6-11, 1970, Comptes Rendus).

Symposium co-sponsored by the Commission Internationale d'Optique and the Comité Français d'Optique. Edited by J.-Ch. Viénot, J. Bulabois, and J. Pasteur. Besançon, France, Besançon, Université, 1970. 4 p. 11 refs. In French.

Study of interferential holography as a means of making it possible to visualize fluid flows within aerodynamic wind tunnels. For the case of the gas turbine, only a retrodiffuser setup is practical. The setup uses a directional diffuser (Transflex; Scotchlite) in order to increase the luminous intensity of the object beam and thus reduce the posing time. Since the diffuser is an integral part of the wind tunnel, certain restrictions appear. Attention is given to problems connected with the diffuser, i.e., displacements and deformations. F.R.L.

A71-31324 # Analysis of combustion instability in aircraft engine augmentors. Donald M. Dix and George E. Smith (Northern Research and Engineering Corp., Cambridge, Mass.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-700.* 13 p. 9 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. AF 33(615)-67-C-1848.

The analytical model of oscillatory combustion incorporates in a readily identifiable way the loss and driving mechanisms important in augmentors. A perturbation method enables the local unsteady heat release and the boundary acoustic absorption to depend nonlinearly on the fluid oscillation amplitudes. The model thus indicates threshold and self-sustaining amplitude levels as well as resonant frequencies and pressure wave distributions. How design modifications like fuel redistribution and suppression devices alter the amplitudes can be examined. Results of parametric studies of two afterburners confirm the qualitative validity of the model and provide engineering insights into the sensitivity of augmentor instability. (Author)

A71-31325 # Propulsion systems for commercial STOL aircraft. G. S. Kelley and R. P. Gerend (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18,*

1971, AIAA Paper 71-746. 12 p. Members, \$1.50; nonmembers, \$2.00.

Analysis of candidate engines for STOL aircraft and their applications. Two alternatives for achieving a complex propulsion system necessary to develop a viable commercial STOL aircraft are emphasized: (1) the two-stream augmentor wing engine, and (2) the high-bypass-ratio, three-stream engine. The three-stream engine concept offers the possibility of reducing the complexity of other airplane systems as it would remove the requirement for separate blowing devices; however, the three-stream engine itself would be quite complex. Either a variable-pitch fan or in-flight thrust reversing would probably be required to maintain blowing air pressure on approach while forward thrust was modulated. As with the two-stream engine, the three-stream engine could be developed from an existing core, but the changes would be more extensive and would introduce greater engine development cost and risk. M.M.

A71-31327 * # Foam injection reduces jet noise. L. Manson and H. L. Burge (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-734.* 25 p. 15 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS 1-9426.

An analytical and experimental investigation of the sound absorbing qualities of water base foams was conducted. The investigation included measurements of sound absorption coefficients for both plane normal incidence waves and diffuse sound fields. The intrinsic acoustic properties of foam, e.g., the characteristic impedance and the propagation constant, were also determined. A mathematical model of the behavior of foams in a sound field was developed. It confirmed the hypothesis of resonance phenomena of individual bubbles coupled to each other and showed good agreement between the calculated values of mass and damping coefficient in the mechanical analog and the corresponding values as calculated using the experimental characteristic impedance and propagation constants of a foam. The sound emitted by a 1-inch diameter cold nitrogen jet was measured for subsonic (300 m/sec) and supersonic (442 m/sec) jets, with and without foam injection. Noise reductions up to 10 PNdB were measured. The application of foam injection to the practical problems of aircraft noise reduction during take-off and landing operations are briefly discussed. (Author)

A71-31360 # Horizontal range of visibility of lights on a landing strip (Gorizontálnaia dal'nost' vidimosti ognei na vzletno-posadochnoi polose). M. Ia. Ratsimor. In: Analysis and forecasting of meteorological conditions for aviation (Analiz i prognoz meteorologicheskikh uslovii dlia aviatsii). Edited by I. G. Pchelko. Leningrad, Gidrometeoizdat (Gidrometeorologicheskii Nauchno-Issledovatel'skii Tsentr SSSR, Trudy, No. 70), 1970, p. 9-18. In Russian.

Consideration of various methods of determining the runway visibility range of lights on a landing strip. A procedure for determining the representative light force, used in computational methods of determining the runway visibility range, is outlined. A brief description is given of a new instrumental method of determining the integral horizontal range of visibility of lights with the aid of a television arrangement with a near radius of action. A.B.K.

A71-31365 # Relation between stratosphere turbulence causing aircraft buffeting and the vertical distribution of meteorological parameters (Sviaz' turbulentsnosti v stratosfere, vyzvauiushchei boftanku samoletov, s vertikal'nym raspredeleniem meteorologicheskikh parametrov). G. S. Buldovskii. In: Analysis and forecasting

of meteorological conditions for aviation (Analiz i prognoz meteorologicheskikh uslovii dlia aviatsii). Edited by I. G. Pchelko. Leningrad, Gidrometeoizdat (Gidrometeorologicheskii Nauchno-Issledovatel'skii Tsentr SSSR, Trudy, No. 70), 1970, p. 79-92. 9 refs. In Russian.

Determination of the relation between aircraft buffeting of various intensities and the vertical distribution of meteorological parameters calculated from radiosonde data, using the results of instrumental measurements of turbulence in the lower stratosphere on specially equipped aircraft. In this case the main problem reduces to finding the critical values of these parameters, which optimally characterize the successfulness of a diagnosis of the presence or absence of aircraft buffeting. It is found that the successfulness of such a diagnosis is optimally characterized by the vertical wind vector shear, the Richardson number, and the change in the thermal stability from the underlying to the overlying layer (a change which characterizes the boundaries of the baroclinic layers). On the basis of a graph of the dependence of aircraft buffeting on a combination of two of these factors, a buffeting parameter K is obtained in terms of which a condition governing the presence or absence of buffeting is expressed. A.B.K.

A71-31366 # Dependence of aircraft buffeting in the stratosphere on the horizontal temperature and wind distribution (Zavisimost' boltanki samoletov v stratosfere ot gorizontalnogo raspredeleniia temperatury i vetra). G. S. Buldovskii. In: Analysis and forecasting of meteorological conditions for aviation (Analiz i prognoz meteorologicheskikh uslovii dlia aviatsii).

Edited by I. G. Pchelko. Leningrad, Gidrometeoizdat (Gidrometeorologicheskii Nauchno-Issledovatel'skii Tsentr SSSR, Trudy, No. 70), 1970, p. 93-104. 6 refs. In Russian.

Determination of the relation between aircraft buffeting of various intensities and meteorological parameters which take into account the horizontal temperature and wind distribution. The results of turbulence measurements in the stratosphere with the aid of a specially equipped aircraft are used for this purpose. The critical values of the above-mentioned parameters are determined, as well as the characteristics of successfulness of a buffeting diagnosis with the aid of these values. It is found that the optimal characteristic of the successfulness of a buffeting diagnosis is the horizontal wind shear along the flow. It is shown that an improvement in a buffeting diagnosis can be obtained by incorporating into the previously obtained buffeting parameter K the horizontal wind shears along and across the flow. A.B.K.

A71-31412 Bertin Aladin II - A project of a STOL transport aircraft (Bertin Aladin II - Projekt eines STOL-Transporters). Dietrich Seidl. *Flugrevue/Flugwelt International*, June 1971, p. 54-57. In German.

The French project Aladin II concerns a conventional design of a four-jet engined STOL intercity transport aircraft with low noise characteristics, capable of flying up to 100 passengers at very short distances (approximately 50 to 100 km). The takeoff run is 137 m, landing run about 200 m. Detailed technical and performance data are presented and discussed. O.H.

A71-31413 Latest civil V/STOL aircraft projects by Hawker Siddeley Aviation. I (Neueste zivile V/STOL-Flugzeugprojekte von Hawker Siddeley Aviation. I). T. K. Szlenkier (Hawker Siddeley Aviation, Ltd., Kingston-on-Thames, Surrey, England). *Flugrevue/Flugwelt International*, June 1971, p. 59-62, 71-74. In German.

An extensive description, including the latest modifications, is presented of the V/STOL lift fan airliner project HS 141 designed for intercity transport. The description covers the airliner's general features, weight and performance data, noise characteristics, and reliability criteria. Most recent STOL and RTOL project considerations are also discussed. O.H.

A71-31437 # Indigenously developed aluminium-magnesium alloy NS-6 to aircraft quality. S. Ramakrishnan and A. S. Ramakrishnan (Aeronautical Development Establishment, Bangalore, India). *Aeronautical Society of India, Journal*, vol. 23, Feb. 1971, p. 13-22. 12 refs.

The need for a medium strength, corrosion resistant and weldable alloy has been recognized by the aircraft industry. This alloy could be used in the fabrication of stores like jettisonable tanks, napalm containers and jet shroud pipes. Aluminium-magnesium alloy is the general choice for such designs involving welding process. The alloy containing 7% magnesium has found wide acceptance in foreign countries. This alloy is very difficult to produce in the form of sheets. As a first step, it was proposed to manufacture aluminium-5% magnesium alloy sheets. Hindustan Aluminium Corporation, Renukoot, UP, has successfully manufactured aluminium-magnesium alloy NS-6 sheets to the requirements of aircraft standards. This alloy has been tested and evaluated. The alloy sheets meet the requirements of dimensional tolerances, chemical composition, strength, formability, weldability and metallurgical examinations. Further evaluation of fatigue characteristics is being progressed. (Author)

A71-31439 # Making of wing models by tangent-milling. R. Sankar and S. Janardhan (National Aeronautical Laboratory, Bangalore, India). *Aeronautical Society of India, Journal*, vol. 23, Feb. 1971, p. 37-43.

Wings whose surfaces are developable have been milled on a jig-borer at the National Aeronautical Laboratory, Bangalore, employing tangential milling. In this process, the wing cross-section is approximated by a polygon which can be smoothed by hand-finish. The polygonal approximation itself is such that each side of the polygon is a tangent to the aerofoil. The aerofoil is defined by a finite set of points got from experiments or otherwise. These points are joined smoothly by using spline approximation to achieve continuity of first and second derivatives. The splines and the settings of the jig-borer (for tangential milling) were obtained on the NAL SIRIUS Computer. Each setting of the jig-borer consists of the cutter-height and two turnings of the turntable and the other about a fixed horizontal axis, so that the plane of milling becomes horizontal. The two angles of rotation and the cutter height depend upon the wing geometry besides some of the machine parameters. (Author)

A71-31440 # Production of wind tunnel models and balances at the National Aeronautical Laboratory, Bangalore. A. N. Kumar and H. C. Seetharam (National Aeronautical Laboratory, Bangalore, India). (*Aeronautical Society of India, Annual General Meeting, 20th, Bangalore, India, May 3-5, 1968.*) *Aeronautical Society of India, Journal*, vol. 23, Feb. 1971, p. 44-58. 30 refs.

This paper is an attempt to present the experience gained in the Model Shop of the Aerodynamics Division in the design, fabrication, inspection and calibration of test models and force measuring balances for use in the wind tunnels of the Division. Reference is made to some of the basic problems encountered in this type of work and a comprehensive bibliography provided. (Author)

A71-31461 # Three methods of cooling turbine rotors in aircraft engines (O trzech sposobach chłodzenia wirników turbin silników lotniczych). Jerzy Otyś and Stefan Szczecinski. *Technika Lotnicza i Astronautyczna*, vol. 26, Apr. 1971, p. 15-18. 9 refs. In Polish.

Investigation of the effects of three different methods for heat transfer from turbine rotor blades on the heat distribution in the rotor disk and on the disk's structural and endurance parameters. The methods considered involve heat removal by air (1) flowing over the disk surface, (2) passing through gaps between the blade stems, and (3) ducted radially through channels drilled along the blade axis. T.M.

A71-31462

A71-31462 # Study of aircraft spin (Badanie korkociagu samolotu). M. Łekowski and J. Petulski. *Technika Lotnicza i Astronautyczna*, vol. 26, Apr. 1971, p. 19-24. In Polish.

Description of common mistakes made in attempts at bringing an aircraft out of spin situations, and outline of procedures which should be followed in preparing, conducting, and evaluating spin tests. A test evaluation form is given which requires pilot comments on questions pertaining to stall characteristics, control actions in causing and alleviating a spin situation, and stability in particular flight maneuvers. Both inverted and erect spinning situations are considered. T.M.

A71-31463 # Comments on collision in air traffic (Uwagi o kolizji w ruchu lotniczym). Tadeusz Buczyłko. *Technika Lotnicza i Astronautyczna*, vol. 26, Apr. 1971, p. 26-29, 40. 15 refs. In Polish.

Description of probabilistic methods used to solve practical air traffic control and navigation problems. The theory of stochastic processes is explained in application to the incidence of approach, altitude, course, and speed errors which give rise to potentially dangerous situations. The increasing incidence of flight path intersections is traced to faulty flight altitudes caused by erroneous altimeter readings and poor pilot discipline in response to controller instructions. T.M.

A71-31517 An associative processor for air traffic control. Kenneth James Thurber (Honeywell Systems and Research Center, St. Paul, Minn.). In: American Federation of Information Processing Societies, Spring Joint Computer Conference, Atlantic City, N.J., May 18-20, 1971, Proceedings. Edited by Nathaniel Macon. Montvale, N.J., AFIPS Press (AFIPS Conference Proceedings. Volume 38), 1971, p. 49-59. 9 refs.

A new type of an associative processor which combines the bit slice and arithmetic processing capabilities with the input/output and equality search capabilities of a distributed logic associative processor is described. Because of these features, the system has the flexibility to solve the problems that associative processors can solve and do it in a more effective manner than any other processor using the same operation speeds. It is shown that the processor can be applied effectively to problems such as air traffic control. O.H.

A71-31522 # Aerodynamics of a twisted jet near a nozzle (Aerodinamika zakruchennoi strui vblizi sopla). R. B. Akhmedov, T. B. Balagula, and F. K. Rashidov. *Akademiia Nauk Uzbekskoi SSR, Izvestiia, Seria Tekhnicheskikh Nauk*, vol. 15, no. 2, 1971, p. 53-57. 10 refs. In Russian.

Results of a test of the effectiveness of the method of the equivalent problem of heat conduction theory in calculating twisted air jets generated by axial and axial-tangential blade swirlers. It is shown that with the types of swirlers used a calculation according to the method of the equivalent problem of heat conduction theory gives satisfactory convergence only for slightly twisted jets. In the case of highly twisted jets it is necessary to introduce into the theory a certain linear transformation. A.B.K.

A71-31531 # Study and application prospects of intermetallic compounds (Issledovaniia i perspektivy primeneniia intermetallicheskikh soedinenii). J. Westbrook (General Electric Co., New York, N.Y.). *Metallovedenie i Termicheskaiia Obrabotka Metallov*, no. 4, 1971, p. 74-80. 35 refs. In Russian. (Translation).

The history of development of structural materials based on intermetallic compounds is reviewed for a period up to September 1969. Special attention is given to the role played by intermetallic compounds in the development of superalloys for elements of gas turbines and other equipment working at high temperatures. Z.W.

A71-31532 # Jet noise excitation of an integrally stiffened panel. Mervyn D. Olson (British Columbia, University, Vancouver, Canada) and Garry M. Lindberg (National Aeronautical Establishment, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-585*. 11 p. 20 refs. Members, \$1.50; nonmembers, \$2.00.

The free vibrations and random response to jet noise of an integrally stiffened five bay panel have been studied both theoretically and experimentally. A finite element approach was used to represent the panel for both parts of the study, and the predictions were verified by measurements on a model panel integrally machined from solid aluminum stock. The comparison between predicted and measured vibration modes and frequencies revealed good correlation of frequencies while the correlation of mode shapes was only fair, especially for higher modes. The predicted modes and frequencies were used in a modal analysis of the panel's response to jet noise with a consistent finite element method being introduced to calculate the required cross spectral modal force terms. Quantitative agreement between predicted and measured rms stresses and displacements was realized, whereas only qualitative agreement was obtained for the associated spectra. (Author)

A71-31533 * # Low-speed jet noise from a 1.83-meter (6-ft) fan for turbofan engines. Gene L. Minner and Charles E. Feiler (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-586*. 8 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

The jet noise contribution to the far-field sound from a 1.83-meter-diameter fan has been determined for two simulated nacelle configurations. One nacelle had hard walls, while the other had acoustic liners on the wall and on inlet splitter rings. The jet velocities, typical of high-bypass-ratio fan engines, varied from 137 to 223 meters per second (450 to 730 ft/sec). The results of the study show that the acoustic liners effectively eliminate low-frequency noise from internal sources. Data from the lined configurations were found to be in good agreement with the eighth-power dependence on jet velocity. Data from the hard-wall configurations, because of the influence of internally generated noise, show higher noise levels and a weaker velocity dependence. The data are also about 6 decibels less than predicted by extrapolation of the SAE curve to the velocities present. This result may be due to the contribution of jet density in the SAE correlation, where jet density appears to the second power. The data were in better agreement with a correlation obtained for unheated jets. The shape of the measured spectra agreed well with the spectra published by the SAE when annulus height of the nozzle was used as the characteristic dimension in the Strouhal number. The directivity of the jet noise was examined and was found to be in good agreement with published results. (Author)

A71-31540 # Flap turbulent heating characteristics obtained from a hypersonic shock tunnel. B. S. C. Kim and T. W. Parkinson (McDonnell Douglas Astronautics Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-598*. 12 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

Summary of turbulent heating, skin friction, and pressure data on flaps from a test program conducted at Cornell Aeronautical Laboratory. Also presented are flap heating data correlations. Test conditions were: freestream Mach number of 7.8 to 13.3 and freestream unit Reynolds number of 3.3 million to 70.3 million. Flap deflection angles up to 30 deg were tested. Normalized flap heat flux is shown to be a strong function of freestream Mach number. The data correlated well with pressure interaction theory (Neumann and Burke, 1967) and flap peak heating data reported by Nestler (1968). Favorable data comparisons were also made with other published data. (Author)

A71-31543 * # Nonlinear effects of the drift of buoyant vortices. Robert C. Costen (NASA, Langley Research Center, Environmental and Space Sciences Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-604.* 8 p. Members, \$1.50; nonmembers, \$2.00.

A new equation is formulated for the motion of buoyant free vortices in an inviscid fluid. Such vortices have fluid in the core of lower density than the surrounding fluid. A criterion is given for such vortices to persist. A method is outlined for obtaining approximate solutions of the equation of motion, and results are presented for a number of cases. A horizontal buoyant vortex with positive circulation in an unbounded fluid subject to gravity drifts horizontally toward the left when viewed along its axis. Aircraft trailing vortices, if made buoyant by injection of hot gas into the vortex cores, are shown to approach each other as they descend, unless they are near the ground - in which case the ground effect dominates and makes them separate. Twin buoyant vortices of like sense revolve about each other with a slower revolution rate than nonbuoyant twin vortices. Formulas are presented for calculating each of these effects.

(Author)

A71-31544 * # Experimental determination of density and rotational temperature by an improved electron beam technique. D. C. Lillicrap (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-605.* 15 p. 18 refs. Members, \$1.50; nonmembers, \$2.00.

Investigation of the use of the electron beam fluorescence technique to measure rotational temperature and density for densities between 10 to the 21st and 10 to the 23rd molecules per cubic meter and temperatures from 78 to 300 K. The calculated rotational temperatures are too high and increase with density and electron beam current. This can be explained in terms of excitation of ground-state rotational level by low-energy secondary electrons which increase the population of the sparsely populated states at the expense of the highly populated states. An equation is derived for the relative rotational line intensities, and parameters governing the error in the rotational temperature are identified. All measurements are for the 0-0 band of the N₂(+) first negative system. The quenching of this band increases as the temperature is reduced below 300 K, in contrast to the trend at high temperatures. An iterative procedure, based on the temperature and quenching measurements, allows more accurate values of rotational temperature and densities to be obtained with the electron beam technique. The application of this procedure to high-speed aerodynamics is expected to be limited by the influence of flow velocity on the temperature measurements.

(Author)

A71-31547 # Sonic boom and turbulence interactions Laboratory measurements compared with theory. A. B. Bauer (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-618.* 14 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. FA-69-WA-2114.

A ballistic range has been used to fire projectiles for generating laboratory-scale sonic booms. The boom pressure signatures were recorded by means of two microphones after the signature wave forms were modified by traveling through turbulence in a large jet of air. The signatures showed the random and spiky nature that has been measured from full-scale sonic booms. More than 600 signatures and shadowgraphs of the shock structure were recorded. Jet turbulence measurements were used with the theoretical formulation of Crow to predict statistical results which are compared with a statistical analysis of the signatures. The analysis is also related to a wave diffraction parameter given by George.

(Author)

A71-31548 # Experimental investigation of N-wave interaction with topographic models. William Peschke (General Applied Science Laboratories, Inc., Westbury, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-619.* 15 p. Members, \$1.50; nonmembers, \$2.00. Contract No. FA-69-WA-2113.

An experimental program to study the time history of the surface pressure due to sonic boom wave interaction with several topographic configurations has been completed. The experiments were performed to validate the predictions of acoustic theory for simple configurations and to demonstrate that the NASA/GASL sonic boom simulator can be used to provide surface pressure data for topographic geometries which are not readily amenable to theoretical treatment. Results are presented for step, corner, overhang, cavity, and two-building models. The wave propagation history is described for some of the models and values of experimentally determined intensification factors are presented. The significance of the model results with respect to full-scale results is discussed.

(Author)

A71-31551 * # Observations of crosshatched wave patterns in liquid films. Philip R. Nachtsheim and Jack R. Hagen (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-622.* 6 p. 17 refs. Members, \$1.50; nonmembers, \$2.00.

This experimental approach, aimed at understanding the formation of crosshatched patterns in liquid films, eliminates differential sublimation or vaporization as a possible mechanism of pattern formation by introducing a liquid with an extremely low vapor pressure onto the surface of a model in a supersonic (cold) wind tunnel. The results of the investigation indicate that: (1) moving crosshatched patterns can be obtained without sublimation or vaporization; (2) the motion of the liquid film can be characterized in sufficient detail to permit comparison between experiment and theory; and (3) the observed waves are consistent with the findings of a linear stability analysis.

(Author)

A71-31554 # The near-field flow pattern of an inclined slender body of revolution. S. N. Chaudhuri and S. C. Prarahaj (Tennessee, University, Tullahoma, Tenn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-626.* 10 p. 11 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. FA-70-WA-2260.

In the present paper Whitham's far-field theory of supersonic flow pattern has been generalized for the near-field points of an inclined body of revolution. It is shown that the new F-function which describes the near-field flow pattern is dependent on the following besides the body geometry: the distance r from the axis of the body, the Mach number M , the angle of attack α and the azimuthal plane angle θ . Closed form results of the new F-function and the pressure signature for near-field positions have been obtained.

(Author)

A71-31555 # Noise generation by a rotating blade row in an infinite annulus. John A. Lordi (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-617.* 13 p. 16 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. AF 44(620)-69-C-0130.

Discrete-tone noise generation by high-speed fans and compressors has been studied by applying existing theories for the flow through a rotating blade row in an infinitely long annulus. McCune's analysis for the linearized, three-dimensional, compressible flow through a nonlifting blade row, and its recent extension to lifting blades, have both been used to find the acoustic disturbances

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produced by such flows. These analyses contain the cutoff condition for the duct acoustic modes, including the effect of through flow, and relate the amplitudes of the propagating modes to the blade thickness and loading. In the present work these relationships have been evaluated for some specific thickness and loading distributions to find the pressure and velocity fields away from the blade row. Methods have been developed to calculate the sound intensity flux upstream and downstream of the blade row and results are presented which demonstrate the influence of blade geometry and operating conditions on noise generation. (Author)

A71-31556 # Accelerated diffusion of wing tip vortices by heating. Alan Mironer (Lowell Technological Institute, Lowell, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-616.* 6 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

This paper describes the effects of heating on the vorticity diffusion rate in a gas vortex. The heating causes an outward radial convection and an increased kinematic viscosity which greatly enhances the overall rate of vorticity diffusion from the core. The coupled heat conduction and fluid dynamical equations which described the vortex heating process have been solved on a digital computer using a finite difference technique. For an initial temperature ratio between the outside induced region of the vortex and the core of 2:1, the vorticity diffusion rate is very nearly twice as fast as in a vortex with no heating present. (Author)

A71-31560 # The numerical calculation of steady transonic flows past thin lifting airfoils and slender bodies. J. A. Krupp and E. M. Murman (Boeing Scientific Research Laboratories, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-566.* 11 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

Solutions of the transonic small disturbance equation are presented for flow past thin lifting airfoils and slender bodies with M_{∞} less than 1, including cases with imbedded shock waves. The results are obtained numerically using a mixed finite difference relaxation method previously reported by the authors. Results are presented for four lifting airfoils at various angles of attack and are compared with shock free theory and experimental data. For the slender body case, comparisons with experiments are given for five geometries both with and without aft stings. The results are also compared with approximate theory. Discussion is given on the proper treatment of the boundary conditions, computing times and accuracies, and ranges of applicability of the small disturbance theory. (Author)

A71-31562 * # Numerical calculation of transonic flow about two-dimensional airfoils by relaxation procedures. J. L. Steger and H. Lomax (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-569.* 8 p. 18 refs. Members, \$1.50; nonmembers, \$2.00.

A successive overrelaxation procedure has been developed to treat the inviscid, fully nonlinear, potential equations governing compressible flow. The procedure is designed to compute embedded shock waves and adjust to the Kutta condition during the course of the iterations. Adjustment to the Kutta condition, convergence rate control and other data handling are accomplished in a practical fashion by means of interacting graphics provided by a cathode-ray tube coupled to the computer. The procedure has been applied to blunt-nosed, lifting airfoils in a subsonic free stream. Calculated results are compared to exact theories and experiment. (Author)

A71-31566 # Low area ratio thrust augmenting ejectors. Richard B. Fancher (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-576.* 9 p. 19 refs. Members, \$1.50; nonmembers, \$2.00.

Development of a synthesis of an ejector's internal flow phenomena, indicating that improved mixing and diffusion can significantly increase thrust augmentation. A companion ejector experiment designed for rapid mixing confirms the model's augmentation predictions and shows reasonable agreement with other flow characteristics. If properly designed, the resultant thrust augmentation ratio should be at least $0.025(A_{\text{sub } 3/A_{\text{sub } 0}}) + 1.075$ for $4 = A_{\text{sub } 3/A_{\text{sub } 0}} = 12$, where $A_{\text{sub } 3/A_{\text{sub } 0}}$ is the ejector's exit area to primary nozzle area. (Author)

A71-31567 # A visual flow investigation of an externally-blown-flap high lift system. M. W. M. Jenkins (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-577.* 14 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

Study of the flowfield about a 19-in. span externally-blown-flap powered transport model using multiple filament smoke streamlines. The extreme flowfields developed under powered conditions are shown by still photographs and movies in which the power induced near-wing-tip vortices are clearly identified. Vortex strengths are shown to depend on thrust coefficient, angle of attack, and flap deflection, with shedding points dependent on the location of the nearest outboard discontinuity in the wing trailing-edge system to the power source. On part-span flapped wings the vortices emanate from the flap tip with strengths influenced by aileron deflection. Inboard of the wing tips, the flaps deflect and spread the engine efflux forming a jet sheet and inducing large downwash angles behind the wing. At high flap deflections, the flap deflection equals 90 deg, wing tip vortices do not cleanly form, and considerable buffeting is evident. A significant reduction in effective aspect ratio occurs under powered conditions with an apparent 80% reduction at a thrust coefficient of 3.0. (Author)

A71-31568 # Recent developments in jet flap theory and its application to STOL aerodynamic analysis. M. L. Lopez and C. C. Shen (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-578.* 14 p. 21 refs. Members, \$1.50; nonmembers, \$2.00. Research sponsored by the Douglas Aircraft Independent Research and Development Program; Contract No. N 00014-71-C-0250.

Some new developments in three-dimensional jet-flap theory are presented, including a lifting line and a lifting surface theory. The first approach is based on a Trefftz-plane analysis, which calculates spanwise loading distributions for large aspect ratio wings with arbitrary jet momentum distribution. The second approach, using the elementary vortex distribution method, enables both spanwise and chordwise loading distributions to be calculated, for arbitrary wings with arbitrary jet momentum distribution. Application of these theories to analysis of several STOL systems, including the pure jet-flap, externally blown flap and augmentor wing are discussed. Comparisons are made with available experimental data. (Author)

A71-31569 # Hingeless rotor characteristics at high advance ratios. W. A. Kuczynski (Lockheed-California Co., Burbank, Calif.) and D. L. Sharpe (U.S. Army, Aeronautical Research Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-580.* 14 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

Development of a mathematical approach to the study of hingeless rotor characteristics at high advance ratios. The appropriate equations of motion are derived and expressed in the rotating reference frame. Rotor stability characteristics are examined, including the time variant aerodynamic coefficients utilizing matrix Floquet theory. Comparisons of theory with wind tunnel test results are reported. Experimental data were obtained over the range of blade flapping frequencies from 1.14 to 2.39 rotor angular velocity and rotor advance ratios from 0 to 2.15. The test model, a 7-1/2 foot, four bladed rotor, with blade Lock numbers of 3 and 5, including interchangeable root flexures, was tested in a 7 x 10 foot wind tunnel. (Author)

A71-31570 # Effect of temperature and shock structure on choked jet noise characteristics. C. D. Simcox (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-582.* 15 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.

Experimental investigation using axially symmetric convergent and convergent-divergent nozzles. Radiated noise fields of variously expanded nozzle conditions are considered, including subsonically (V to the 8th power) and supersonically (V cubed) convected quadrupole sources, screech, and broadband shock-related fields. The relative importance of each noise field and the effects of jet temperature are considered. Normalization parameters are critical in analyzing functional relations in jet noise data; two generally accepted parameters were found to give different physical interpretations. Results indicate strong shock influence on the noise of cold jets, with diminishing effects on heated jets. (Author)

A71-31571 # A computational technique for jet aerodynamic noise. M. J. Benzakein, C. Y. Chen, and P. R. Knott (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-583.* 7 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

A detailed computational technique for calculating the acoustic field of single and co-annular stationary and moving jets is presented. Lighthill's theory is used to obtain detailed spectral calculations by expressing the acoustic intensity equation explicitly in terms of turbulence intensity. The computer program calculates sound power level spectra as well as one third octave sound pressure level spectra along a given arc or a given sideline. The paper presents an extensive comparison of the analytical results with the experimental data obtained on cold and hot jet facilities. (Author)

A71-31572 * # Theoretical predictions of supersonic jet noise. S. P. Pao (Wyle Laboratories, Inc., Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-584.* 10 p. 19 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS 8-25893.

Application of a generalized theory of supersonic jet noise to the derivation of explicit analytical expressions for identifying jet noise mechanisms and to numerical calculations of high speed jet noise characteristics. This new theory is uniformly valid in the transonic and supersonic speed ranges, and it includes implicitly refraction and convection of sound through the jet flow. Given results include the transition from the U to the 8th power law to the U cubed law, differences in directivity for high and low frequencies, sound source distribution, noise spectrum, and the coupled effects of refraction and convection. The implications of these results and their correspondences with existing results in the literature are discussed. (Author)

A71-31573 # Broadband noise generation by airfoils in turbulent flow. L. W. Dean (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-587.* 6 p. Members, \$1.50; nonmembers, \$2.00. Contract No. FA-69-WA-2045.

A straightforward study of fan broadband noise generation mechanisms on engines and rotating test rigs is difficult for several reasons. There are a number of possible sources, such as boundary layer noise, flow separation noise, and interaction of random flow fluctuations with both moving and stationary airfoils, all having overlapping spectra. In addition, important parameters, such as the relative velocity on a blade from root to tip, take on a range of values at a single operating point. To investigate one mechanism in a controlled manner, a variety of stationary airfoils were placed in turbulent flow in an anechoic chamber. Measurements were made of the turbulence spectrum, surface pressure fluctuations, and the far field radiated sound. Overall sound pressure levels were found to be independent of airfoil chord and angle of attack and were proportional to the cube of mean flow speed. The acoustic spectra were found to scale in frequency in proportion to Sears' reduced frequency parameter. Relationships were obtained between the spectra of inflow turbulence and blade surface pressure, and between surface pressure and radiated sound spectra. (Author)

A71-31575 * # Time-dependent solutions of nonequilibrium airflow past a blunt body. C. P. Li (Lockheed Electronics Co., Houston, Tex.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-595.* 14 p. 13 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS 9-5384.

Calculation of the three-dimensional, inviscid, and adiabatic flow past an axisymmetric blunt body for a mixture of reacting gases using a time-dependent technique. The gas model of pure air is assumed to include the seven species: N₂, O₂, NO, N, O, NO(+) and e(-), at a state of thermodynamic equilibrium. Nonequilibrium phenomena of the airflow other than chemical reactions are not considered. The governing equations are written in a nonconservative, unsteady form for a region bounded on two sides by the shock and body. A two-step Lax-Wendroff difference scheme is used to approximate the equations in the shock layer. A modified Lax scheme using one-side difference formulas is employed for the calculations at the shock and body boundaries. Two time increments are used for stability and faster convergence. Several compilations of chemical rate constants are used to study their effects on the flow calculations. A sphere and an ellipsoid at an angle of attack are chosen as the test cases, and limited comparisons are made between this method and a method of integral relations. It has been found that second-order difference schemes are generally well suited to the nonequilibrium calculation and that sizable discrepancies result in the predicted mass fractions due to the use of different rate constants. (Author)

A71-31576 # Numerical solution for the three dimensional hypersonic flow field of a blunt delta body. P. D. Thomas, M. Vinokur, R. Bastianon, and R. J. Conti (Lockheed Research Laboratories, Palo Alto, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-596.* 12 p. 14 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the Lockheed Independent Research Program.

Development of an exact finite-difference solution for steady, inviscid, supersonic flow over smooth three-dimensional bodies. The method is applied to a blunt delta wing having straight leading edges and an elliptical cross section. Results are presented for angles of attack up to 30 deg in both perfect gas and equilibrium air at typical freestream conditions for Space Shuttle orbiter reentry. The effects of angle of attack on shock layer structure, on surface pressure

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distributions, and on surface streamline patterns are investigated. Marked variations are found in the structure of the entropy layer over different portions of the surface; the implications for boundary layer heat transfer analyses are discussed. (Author)

A71-31583 # Interference of wing and multi-propellers. L. Ting, C. H. Liu, and G. Kleinstein (New York University, Bronx, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-614.* 14 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Army-supported research.

A systematic procedure is presented for the analysis of the interference of wing with multipropellers based on the assumption that the radius of the propeller and the chord are of the same order and both are much smaller than the span. With the inverse of the aspect ratio as the small expansion parameter, the local two-dimensional solution for the sectional lift to angle of attack relationship is uncoupled from the outer three-dimensional solution in the spirit of Prandtl lifting line theory. As the plan form of the wing reduces to the lifting line, the stream behind the propellers reduces to a thin sheet of a jet carrying the sectional momentum gained across the propellers and supporting a pressure difference across the sheet. By representing the thin sheet of a jet as a vortex sheet, an integral equation is obtained. Several numerical examples are presented to demonstrate the versatility of the analysis. For the sake of comparison, a modified classical analysis is presented for the special case that the multipropellers are overlapping and the stream behind them is of uniform velocity and is confined inside a cylinder of elliptical cross section and the result shows that it overestimated the effect of propellers. From the systematic analysis a simplified analysis is obtained which is useful when the momentum gain across the propellers is not large. (Author)

A71-31593 Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings. Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li (MIT, Cambridge, Mass.). Cambridge, Mass., MIT Press, 1970. 415 p. \$6.95.

Symposium designed to provide a creative engineering environment for students, faculty, and working engineers from the aerospace industry. Among the topics treated are heat transfer, heat pipe applications, aircraft engine noise, flow measurements, the computing of geometric aircraft aerodynamic characteristics, flutter suspension systems, flutter-induced oscillation, helicopter stability, rigid rotor hub design, maneuver load relief, design problems in the Apollo program, the measurement of height and distance, and the Apollo Lunar Module.

F.R.L.

A71-31595 Aircraft engine noise. G. H. Cheney. In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 72-82.

Review of aircraft engine noise, with emphasis on the noise made by a commercial supersonic transport during takeoff, at which time the noise problem is most difficult and expensive. Noise is a subjective phenomenon that is difficult to define, measure and control. Empirical data from model tests of various geometric shapes of exhaust systems indicate that large amounts of suppression can be

achieved, but at the cost of large thrust losses and increased weight. Careful noise suppressor design work will be required to ensure that the least economic penalty is imposed on aircraft performance.

F.R.L.

A71-31597 Computing geometric airplane aerodynamic characteristics during the design process. R. E. Wallace (Boeing Co., Seattle, Wash.). In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 163-182.

It is the intention of this paper to review some aspects of airplane design associated with computing geometric aerodynamic characteristics in the preliminary and the detailed design processes necessary to evolve an airplane configuration. The thesis is that the geometry of an airplane is a basic engineering mode of conversation describing the item being conceived, designed, and evaluated during the creative period of the design process. Therefore, a major point of emphasis is the accuracy to which geometry must be described. Accuracy required in preliminary design is far less than that used in the intermediate development stages where significant and very detailed analyses are conducted with quite sophisticated computer methodology. Finally, the detailed design accuracy necessary to identify all the structure, the shapes of its elements, and the modes of fabricating the structure into the desired airframe integrity is shown to be quite exacting. The thread of geometry and its required accuracy in each design step is illustrated by examples. (Author)

A71-31599 Achieving helicopter stability with the Lockheed rotor system. R. W. Prouty. In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 218-237.

Achievement of helicopter stability with a relatively simple mechanism which involves coupling a gyro to a rotor with cantilevered blades. The replacement of the usual blade flapping hinges with flexible portions of the rotor hub has reduced maintenance and improved reliability of the rotor in addition to improving flying qualities. A side-by-side comparison of the stability of a conventional helicopter and of a helicopter with the Lockheed rotor system is made. Equations of motion for hovering helicopters of both the conventional type and the Lockheed type are established. A challenge which applies to large helicopters using the Lockheed system is to keep the period of the natural oscillation short without taking an excessive period in rotor weight.

F.R.L.

A71-31600 Maneuver load relief system. Donald L. Grande (Boeing Co., Commercial Airplane Div., Renton, Wash.). In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 238-242.

Synthesis of a maneuver load relief system, illustrating the magnitude of loads reduction that might be obtained. A large

variable-sweep-wing transport being designed for a 2.5-g maneuver load is considered. During the wings-forward flight condition, this maneuver requirement produces the bending moment that sizes the structure. A system is proposed to reduce this bending moment and allow a weight saving without compromising the maneuver capability of the aircraft. The feasibility of using the ailerons to reduce the moment at the wing pivot is studied. F.R.L.

A71-31601 Rigid rotor hub design. A. M. James. In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 243-250.

Discussion of rigid rotors, which differ from teetering or articulated rotors only in the hub area. The rigid rotor hub flapping stiffness, rather than being destroyed by hinges, is tailored to provide desirable dynamic characteristics. This tailoring of hub stiffness is instrumental in providing superior controllability to the rigid rotor. Since the hub acts as the spring which provides the moment required for high control power, the stiffness of the hub is of paramount importance. The hub structural strength in conjunction with hub length and fatigue strength are additional variants which must be considered in order to obtain the desired relation between stiffness and strength. F.R.L.

A71-31605 Study on the feasibility of a 'quiet' turbofan STOL. James DeLucas, Peter Fecanin, Paul Hooper, Marvin Kluttz, Kevin Mahar, Thomas Milkie, and Edward Uchno. In: Education in creative engineering; Massachusetts Institute of Technology, Symposium, Massachusetts Institute of Technology, Cambridge, Mass., April 16-19, 1969, Proceedings.

Symposium supported by the Boeing Co., the Grumman Aircraft Corp., the Lockheed Aircraft Corp., the North American Rockwell Corp., the TRW Systems Group, and the National Science Foundation. Edited by Y. T. Li. Cambridge, Mass., MIT Press, 1970, p. 337-355. 7 refs.

Examination of all possible solutions to the problem of the 'quiet' STOL, with reference to feasibility. This examination has taken account of both engineering and airline considerations. The former include structural, propulsive, and other technical aspects of STOL. The latter involve economy and passenger comfort and acceptance. Configurations considered were the low-loaded wing, flying wing, tilt wing, tilted jets, tilt pods, lift jets, fan-in-wing, and augmented-lift wing. The latter configuration was considered to be the most suitable. F.R.L.

A71-31636 # Compact and miniaturized heat exchangers (Echangeurs compacts et miniaturisés). R. Condamin. *Institut Français des Combustibles et de l'Energie and Institute of Fuel, Heat Exchangers Conference, Paris, France, June 15-18, 1971, Paper 15.* 7 p. In French.

The giantism of heat exchange and heat dissipation devices used in chemical plants is contrasted with their miniature scale in avionics, while the urgent quest for compactness common to both chemical plant and electronic equipment design is stressed. Recent advances in both fields, achieved mostly through extended heat transfer surface expedients, are reviewed. It is shown how these advances have raised the resistance to temperature and pressure, improved the compactness, and widened the application range of these heat-exchange devices. M.V.E.

A71-31677 # Effect of the concentration of oxygen dissolved in jet fuel on its antiwear properties (Vliianie kontsentratsii

kislороda, rastvorenного v reaktivnom toplive, na ego protivoznosnye svoistva). V. V. Sashevskii, V. V. Malyshev, V. P. Logviniuk, and B. A. Englin. *Khimiia i Tekhnologiiia Topliv i Masel*, vol. 16, no. 4, 1971, p. 42, 43. 9 refs. In Russian.

Industrial fuel T-7 was disoxygenated by scrubbing with nitrogen containing less than 1% oxygen. Samples of this fuel containing different amounts of oxygen were tested, using the method described by Bespolov et al. (1969). It was found that the wear of a plunger could be substantially reduced when the oxygen content was decreased down to about 0.6%. Z.W.

A71-31678 # Dependence of the antiwear properties of jet fuels on their content of nonhydrocarbon compounds (Zavisimost' protivoznosnykh svoistv reaktivnykh topliv ot soderzhaniiia v nikh neuglevodorodnykh soedinenii). B. A. Englin, B. F. Korobov, V. V. Sashevskii, S. M. Borisova, and M. D. Khaikin. *Khimiia i Tekhnologiiia Topliv i Masel*, vol. 16, no. 4, 1971, p. 43-46. 14 refs. In Russian.

Determination of the relation between the antiwear properties of different fuels and their viscosity and amounts of adsorption tar and mercaptans. It is shown that the antiwear properties are determined by the amount and the nature of the adsorption tar, and that they deteriorate with increasing amounts of tar. Z.W.

A71-31704 Calculation of the random vibration characteristics of a panel in the sound field of an exhaust jet. K. G. Valeev and V. E. Kvitka (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR). *(Akusticheskii Zhurnal*, vol. 16, Apr.-June 1970, p. 219-222.) *Soviet Physics - Acoustics*, vol. 16, Oct.-Dec. 1970, p. 184-186. Translation.

Development of an approximate method of calculating the probability characteristics of the stresses occurring during the vibration of flat panels in the acoustic field of a jet engine exhaust. Formulas are presented for determining the acoustic pressure distribution with the aid of third-of-an-octave or octave filters. As an example, the values of the stress intensity parameters for a rectangular flat skin panel loaded by an acoustic pressure from an exhaust jet are determined. A.B.K.

A71-31710 Investigation of the acoustical and gas-dynamical characteristics of a jet silencer. S. Iu. Krashennnikov, L. I. Sorkin, M. N. Tolstosheev, and O. V. Iakovlevskii. *(Akusticheskii Zhurnal*, vol. 16, Jan.-Mar. 1970, p. 88-95.) *Soviet Physics Acoustics*, vol. 16, July-Sept. 1970, p. 69-75. 8 refs. Translation.

Study of a jet noise muffler constructed in the form of a set of adapters located at the outlet section of a jet nozzle. In this case air or some other gas is blown through the adapters perpendicular to the engine exhaust jet. The experimentally obtained reduction in the maximum intensity of the noise level amounts to 4 to 5 dB. In studies on models significant changes in the structure of the exhaust jet, under the action of the injected gas are noted - namely, a reduction in the length of the initial section of the jet, an increase in the transverse dimensions of the jet, and other changes. A.B.K.

A71-31815 Advanced concepts of holographic nondestructive testing. Leonard A. Kersch (GCO, Inc., Ann Arbor, Mich.). *(American Society for Nondestructive Testing, National Spring Conference, Los Angeles, Calif., Mar. 8-11, 1971.) Materials Evaluation*, vol. 29, June 1971, p. 125-129, 140.

Discussion of new optical techniques used to examine laminate structures with greater resolution and flaw detectability. Additionally, it is shown how these new techniques greatly increase the inspection speeds of holographic nondestructive testing. In the area of vibrational analysis with holographic interferometry, a technique has been developed which allows the detection of vibrational

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amplitudes of the order of 10 to the minus 7th to 10 to the minus 8th cm. These new concepts are discussed, and the nondestructive testing possibilities are outlined. (Author)

A71-31873 Major Tu-144, Concorde differences cited. Donald E. Fink. *Aviation Week and Space Technology*, vol. 94, June 21, 1971, p. 36, 37, 39, 41, 43 (3 ff.).

The two aircraft are about the same size and are designed for essentially the same operational performance - Mach 2.0 cruise and a range from 4000 to 4500 mi, with a maximum payload from 100 to 130 passengers. Both aircraft are constructed from a mixture of light alloy honeycomb material and titanium. Wingspan of the Tu-144 is 90.7 ft compared with 83.1 ft on the Concorde. The Soviet aircraft is considerably shorter than the Concorde - 191 ft compared with 204 ft - but it has a higher gross weight - 395,000 lb compared with 385,800 lb. Major design differences are discussed starting with the droop nose. The four engines powering the Soviet aircraft are currently rated at 38,580 lb thrust each. The present engines for Concorde are rated at about 37,300 lb thrust each, but production versions of the aircraft will be equipped with the 38,055-lb-thrust Mk. 602 engines. G.R.

A71-31875 # French prototype of a time-frequency anti-collision system (Prototype français d'un système anticollision à temps fréquence). Jean Besson (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971.*) ONERA, GP no. 938, 1971. 29 p. 8 refs. In French.

Description of an anticollision system which can detect all potentially dangerous aircraft, evaluate the collision risk, determine the necessary evasive maneuver, and indicate the time to execute the maneuver to the pilot. In the time-frequency system described very stable atomic clocks make possible the participation of a large number of aircraft, measurement of distance and angular velocities, and the exchange of much information. F.R.L.

A71-31876 # Experimental noise facilities and aircraft noise reduction. T. J. Hargest (National Gas Turbine Establishment, Pyestock, Hants., England). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper.* 61 p. 30 refs.

The study of noise generated by an aircraft powerplant is discussed. Separate test facilities are required for studying fan noise, turbine noise, absorber performance and jet noise. Factors of jet noise are analyzed. Turbulence characteristics are investigated employing hot wire anemometers. A new approach makes use of the cross beam schlieren technique. The importance of the jet acoustic Mach number, the jet pressure ratio, the jet temperature ratio and the jet exit turbulence is emphasized. The Pyestock anechoic jet noise facility in the UK is described. Aspects of fan and compressor noise studies, turbine noise studies and full scale noise measurements are discussed. The Ansty facility anechoic chamber and questions of absorption development are considered. G.R.

A71-31877 # Studies of the emission and reduction of noise of the Concorde engines (Recherches sur l'émission et la réduction du bruit des propulseurs de Concorde). R. Hawkins (Rolls-Royce, Ltd., Bristol, England) and R. Hoch (SNECMA, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper.* 44 p. In French.

Brief review of the considerations which dictated the choice of the Olympus 593 turbojet for the Concorde and the different

functions which the total efflux of this engine must fulfill. The consequences resulting from this choice, with reference to the noise of the aircraft, led to undertaking a systematic analysis of the different acoustic sources which determine the overall noise during the critical takeoff and approach flight phases, beginning with acoustic measurements made around the engine when it is in a fixed position, and with the help of the Vulcan flying test bed and Concorde prototypes. The actions taken to reduce the noise of the engines are optimization of the functioning of the engines during approach and overflight at reduced thrust; reduction of internal engine noise sources; and attenuation of jet noise by a secondary downstream nozzle and the choice of a retractable silencer. F.R.L.

A71-31878 # Integrated system of control and command of aircraft (Système intégré de contrôle et de commande des avions). Marie-Jacques Jullien (Thomson - CSF, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper.* 21 p. In French.

Attempt to unite, in three centers of interest, information, controls, or commands necessary for pilotage. For the short term, this involves the vertical situation and the aerodynamic situation and the mechanics of flight. For the medium term, the horizontal situation (navigation), negotiation of modes of approximate position and power setting, and the choice of telecommunications, data link terminal, etc., are involved. F.R.L.

A71-31879 # Criteria for realization of aircraft noise reduction. Karl D. Kryter (Stanford Research Institute, Menlo Park, Calif.). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper.* 31 p. 20 refs.

On the basis of both theory and experimental data it appears that to predict from physical measures man's responses to noise, the noise should be measured every 1/2 second, and the average frequency-weighted level occurring each 1/2 second of its occurrence should be tabulated. Two ways have been developed for frequency-weighting the noise measured every 1/2 second. The relation of noise measurements to behavior of people is examined, and the relation between physical measures and subjective judgments of noise is considered, giving attention to the critical bandwidth of the ear and procedures and frequency weightings for obtaining units of PNL (perceived noise level) band spectra. A comparison of calculated and judged perceived noisiness is conducted. The ultimate limits of prediction accuracy and the pure-tone correction factor are discussed. G.R.

A71-31880 # Soundproofing of air inlets and fan exhausts (Insonorisation de prises d'air et de sorties de soufflante). A. Labussière and M. Janssen (Avions Marcel Dassault, Vaucresson, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper.* 69 p. In French.

Exposition of the soundproofing problem by demonstrating the various requirements for application of acoustical techniques and theories to aeronautical use. The acoustical aspect is first examined with reference to absorbent systems with resonant cavities. The problems of technological development of absorbent devices are considered, with emphasis on environmental conditions and the demands of the comportment of the material in fatigue. F.R.L.

A71-31881 # A simulator for studying the Concorde (Simulateur d'études du Concorde). M. Fretigny (Société Nationale Industrielle Aérospatiale, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès*

International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 13 p. In French.

The Concorde project has given rise to an important simulation programme which has been carried out mainly with the flight simulator at Toulouse. After giving some information on the aircraft flight control system and briefly describing the simulator, the author explains how it has been used to date and how it will be used in the future. (Author)

A71-31882 # Significance of jets with a moderate dilution rate in the reduction of STOL aircraft noise (L'intérêt des réacteurs à taux de dilution modéré pour la réduction du bruit des avions STOL). L. Duthion (Société Bertin et Cie., Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 13 p. In French.*

Consideration of the possibility of reducing helicopter jet noise by using engines with moderate dilution rate. The advantage of such engines over engines with a high dilution rate lies in the fact that the thrust produced is less sensitive to pressure losses. The need for blown flaps is indicated, preference being given to two-dimensional jets allowing homogeneous blowing over flaps of small area. Diagrams depicting an actual realization of such a project in the Aladin II four-engine jet aircraft are presented. A.B.K.

A71-31883 # Specific problems of modern aircraft simulation (Problèmes spécifiques relatifs à la simulation des avions modernes). J. Baradat. *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 11 p. In French.*

Review of the fundamental facts and of some statistical data pertaining to the safety, economy, and efficiency performance record of aircraft-simulating cockpit procedure trainers, and definition of some of their further development problems. Absence of real danger, the simulator's great advantage, is shown to constitute also its principal limitation in that no pilot in perilous flight conditions does undergo in an aircraft-simulating trainer any significant portion of the psychological strain and degradation he is likely to suffer in real flight. This stresses the need to simulate the pilot's flight environment as realistically as at all possible amid the growing complexity of modern aircraft. The thereby generated problems of further development of simulators are discussed. M.V.E.

A71-31884 # Methods of measurement and analysis of the noise of aircraft in flight (Méthodes de mesure et d'analyse du bruit des avions en vol). S. Auzolle (SNECMA, Paris, France) and J. Hay (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 31 p. In French.*

Discussion of methods of noise measurement and analysis, both for the purpose of general studies and to prepare aircraft for acoustic certification. The work described required study and development of specialized apparatus which makes it possible to control, on the ground, the synchronous recording of noise, aircraft path, and engine parameters, the acquisition of test data being carried out in the form of coded analog bands. Spectral analysis is accomplished in the laboratory by a real-time analyzer integrated into an automatic link, which presents the results in a form compatible with logical exploitation by computer. Systematic tests made it possible to calculate the test conditions necessary to obtain practical results: the number of overflights to be carried out, the paths to follow, and calibration of measurement links. F.R.L.

A71-31885 # The simulation installations of the Eurocontrol experimental center at Brétigny and the link with the Concorde (Les installations de simulation du centre expérimental Eurocontrol à Brétigny, et la liaison Concorde). Jacques Nouhant (EUROCONTROL, Centre Expérimental, Brétigny-sur-Orge, Essonne, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 9 p. In French.*

Description of the installations, with discussion of the relationship between the Brétigny simulator and the Concorde flight simulator at Toulouse. The Brétigny simulator comprises groups for computation, generation of radar signals, visual display, telecommunications, and operation. Since its inauguration in 1967, 20 exercises have been carried out. The messages originating from the Concorde simulator for use by the Brétigny computer comprise programs for reception, sampling, treatment, and supervision. F.R.L.

A71-31886 # Methods for using advanced simulation technology to increase efficiency in pilot training. James F. Smith and Duncan W. Simpson (Singer Co., Link Div., New York, N.Y.). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 16 p. 7 refs.*

Some advanced training techniques that have been devised for use with modern pilot training in flight simulator complexes, which have evolved from rapid development of increased computer capabilities, are discussed. Additional equipment capabilities that have been developed for this purpose, such as CRT display systems and automated briefings, are also considered. The role of the instructor, who has been thus relieved of much of his previous workload, is examined. O.H.

A71-31890 # Installations and test methods for studies of engine noise (Installations et moyens d'essais pour les recherches sur le bruit des propulseurs). Marc Pianko (Direction Technique des Constructions Aéronautiques, Service Technique Aéronautique, Paris, France). *Association Française des Ingénieurs et Techniciens de l'Aéronautique et de l'Espace, Congrès International d'Aéronautique, 10th, Paris, France, June 1-3, 1971, Paper. 38 p. In French.*

Review of test methods used to investigate urgent problems posed by acoustic certification of aircraft, and which provide industry with the opportunity to pursue the studies in order to attenuate engine noise as much as possible. The following problems were studied: jet silencing; the acoustic and mechanical problems of absorbent materials; compressor silencing; blower noise and characterization of rotor and propeller noise; general problems of acoustics; and psychoacoustic tests. The principal test methods are classified and described, as well as test materials and the quality of results obtained. F.R.L.

A71-31903 Shearing flows in a steady vortex around an airfoil activated by any motion (Sur les écoulements de cisaillement à tourbillon constant autour d'un profil animé d'un mouvement quelconque). Jacques Obala (Besançon, Université, Besançon, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques, vol. 272, no. 21, May 24, 1971, p. 1418-1420. In French.*

Consideration of a flow of a perfectly incompressible fluid parallel to a plane defined by absolute orthonormal axes, with unitary vectors, in which the fluid velocity remains parallel to one of the axes, but varies with the ordinate. This flow is assumed to be disturbed by the presence of a movable airfoil, the perturbation velocity being expressed by the gradient of a certain function. In the case of a certain plate, in constant circulatory motion, it can be shown that the torque of the aerodynamic forces is equivalent to two

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forces, one passing by the forward quarter and perpendicular to the plate, and the other passing by its center. F.R.L.

A71-31908 **Specific military problems of all-weather landing (Les problèmes spécifiques militaires de l'atterrissage tous temps).** A. Megard (Ministère des Armées, Service Technique des Télécommunications de l'Air, Paris, France). *L'Onde Electrique*, vol. 51, May 1971, p. 356-358. In French.

Some of the constraints superimposed on all-weather landing systems by dissimilar military (as against civilian) circumstances and requirements are considered. The implications of the needs for ground equipment mobility and insensitivity to untoward topographic environments (e.g., terrain obstacles disturbing radioelectric guidance signals) are discussed, along with differences in security concepts. M.V.E.

A71-31909 **ILS equipment of performance category III (Equipements I.L.S. de la catégorie de performance III).** P. Dautremont (Thomson - CSF, Département Aides à l'Atterrissage, Levallois-Perret, Hauts-de-Seine, France). *L'Onde Electrique*, vol. 51, May 1971, p. 359-365. In French.

The contributions to the ILS landing system, standardized at the 1949 Atlantic City Conference, that brought about its all-weather operation capability less than five years ago, are reviewed. Emphasis is given to the description of the French LS 371 equipment that incorporates the latest technological advances. Techniques employed in high-directivity antennas and transmission and control system redundancy are examined. It is pointed out how the application of solid-state technology made it possible to attain very high subsystem reliability levels. All this is shown to have resulted in a system accomplishing the originally envisioned ILS goal of zero-visibility, all-weather landing capability. M.V.E.

A71-31910 **SYDAC C-band system compatible with ILS (Le SYDAC, système en bande C compatible avec l'I.L.S.).** M. Ronsin (Thomson - CSF, Division Faisceaux Hertzien, Levallois-Perret, Hauts-de-Seine, France). *L'Onde Electrique*, vol. 51, May 1971, p. 366-371. In French.

An ILS system is described that operates in the C band and is called SYDAC. This system is compatible with conventional ILS systems and largely reduces the disadvantages associated with transmission patterns sensitive to ground reflection, lateral obstacles, and bulky ground installations concentrated for the sake of earthwork minimization. M.V.E.

A71-31911 **Flight tests of new systems (Essais en vol de nouveaux systèmes).** J. Vedrunes (Centre d'Essais en Vol, Brétigny-sur-Orge, Essonne, France). *L'Onde Electrique*, vol. 51, May 1971, p. 372-375. In French.

Flight tests of a model of the new SYDAC landing system performed at the Flight Test Center are discussed. The first phase of these tests pertaining to flight-related adjustments of the system has been successfully completed. The second phase of technical performance evaluation is presently in progress and so far proceeds satisfactorily. M.V.E.

A71-31912 **ILS reception system for category III landing performance (Ensemble de réception I.L.S. pour l'opération d'atterrissage de la catégorie III).** B. Durand and Cl. Lanilis (Thomson - CSF, Division des Télécommunications, Gennevilliers, Hauts-de-Seine, France). *L'Onde Electrique*, vol. 51, May 1971, p. 377-380. In French.

A system is described that makes it possible for aircraft to

receive ILS signals during the last phase of landing (starting at approximately 20 sec before touchdown) with a probability of catastrophic failure of one in a billion. This functional security that provides category III landing performance capability is achieved through measuring circuit redundancy and permanent automatic surveillance of incoming information. M.V.E.

A71-31913 **All-weather 'Sud Lear' landing system mounted on Air Inter Caravelle aircraft (Le système d'atterrissage tous temps 'Sud Lear' installé sur les Caravelle d'Air Inter).** P. Canova and M. Sentein (Air Inter, Lignes Aériennes Intérieures, Aéroport d'Orly, Val-de-Marne, France). *L'Onde Electrique*, vol. 51, May 1971, p. 381-384. In French.

The operation and performance of the all-weather 'Sud Lear' landing system used on Caravelle aircraft for their automatic landing at Orly, Toulouse, Bordeaux, and Lyon airports are described. Out of 2663 automatic landings attempted from November 1967 to February 1971, 2477 landings, or 93%, were successfully completed. M.V.E.

A71-31914 **The automatic pilot of the Airbus (Le pilote automatique de l'Airbus).** J. Pagnard, J. Bodin, and H. Salessy (Société Française d'Equipements pour la Navigation Aérienne, Vélizy-Villacoublay, Yvelines, France). *L'Onde Electrique*, vol. 51, May 1971, p. 385-390. In French.

An automatic flight control system is described that is being developed in multinational collaboration for the first large-capacity European aircraft, the Airbus. Its five integrant subsystems are: (1) the autopilot/flight director and yaw stabilizer, (2) the landing subsystem, (3) automatic throttle control, (4) trim control, and (5) self-test subsystem. The system's electromechanical subassemblies include a few computers. The development of the system's prototype is to be completed by September 1971, and the first production unit is to be delivered in the first quarter of 1973. M.V.E.

A71-31915 **Automatic landing system of the Concorde (Le système d'atterrissage automatique de Concorde).** R. Deque (Société Nationale Industrielle Aérospatiale, Toulouse, France). *L'Onde Electrique*, vol. 51, May 1971, p. 391-397. In French.

The automatic landing subsystem, the most meticulously studied component of the Concorde's automatic flight control system, is discussed from the viewpoints of its objectives, design, and certification tests. Its objectives culminate in an ultimate automatic landing capability with a horizontal visibility of only 150 ft. The design is illustrated in several diagrams and the interaction of the subsystem components briefly discussed. The certification is to be governed by Franco-British rules and to be based to a certain extent on probabilistic reliability demonstrations. Contemplated test methods are reviewed and illustrated by an example. M.V.E.

A71-31916 **Automatic approach for helicopters (L'approche automatique des hélicoptères).** D. Autechaud (Société de Fabrication d'Instruments de Mesure, Massy, Essonne, France). *L'Onde Electrique*, vol. 51, May 1971, p. 398-401. In French.

Some of the automatic flight control equipment for helicopters and, particularly, of ground approach guidance is reviewed. The described onboard equipment is shown to consist of the autopilot stabilizer, the localization system, the automatic ground-approach guidance coupler, and the flight director. As an example of ground equipment, the TALAR tactical landing approach radar is described. Tests conducted under turbulent weather conditions with an Alouette III helicopter, using the equipment described, are shown to have yielded satisfying results. M.V.E.

A71-31917 **Operational problems (Les problèmes opérationnels).** J. Mijonnet (Ministère des Armées, Service Technique des Télécommunications de l'Air, Paris, France). *L'Onde Electrique*, vol. 51, May 1971, p. 403-405. In French.

Study of the operational problems common to civil and military aviation. These involve the detection of cloud masses, use of landing aids, and detection of clear air turbulence. More specific military problems are low altitude flight and all-weather flight. All-weather flight imposes the use of radar as a means of detecting obstacles so that terrain following may be accomplished. Problems of pilotability and safety are considered. F.R.L.

A71-31918 **Frequency modulation radioaltimeter (Radio-altimètre à modulation de fréquence).** J. P. Landrot (Télécommunications Radioélectriques et Téléphoniques, le Plessis-Robinson, Hauts-de-Seine, France). *L'Onde Electrique*, vol. 51, May 1971, p. 406-410. In French.

Review of certain problems arising in the concept of radioaltimeters, which supplement the traditional pressure altimeters. Among the problems are the measurement of altitude independent of motions of roll and pitch, and immunity to the effects of fog. Modern radioaltimeters make it possible to effect altitude measurements with excellent precision, their range extending from zero feet to much higher altitudes. As is the case with much electronic gear, certain operational requirements are contradictory. Some solutions obtained by means of newly developed frequency modulation radioaltimeters are briefly explained. F.R.L.

A71-31919 **Obstacle avoidance radar for helicopters (Radar d'évitement d'obstacles pour hélicoptères).** G. Collot (Electronique Marcel Dassault, S.A., Saint-Cloud, Hauts-de-Seine, France). *L'Onde Electrique*, vol. 51, May 1971, p. 411-417. In French.

Description of a helicopter-borne radar which makes all-weather flight possible at a very low altitude. The equipment consists essentially of the radar itself, mounted in the nose of the helicopter, its function being to explore the air space within which the flight is to take place. There is also a display, installed in the cockpit, the forward face of which includes all the operational controls. Obstacles can be avoided by overflying them, turning around them, or by braking. Because the K band is used the radar can detect isolated objects such as pylons or high tension cables. Some experimental flight results are discussed. F.R.L.

A71-31920 **Meteorological radars and their applications (Les radars météorologiques et leurs applications).** G. Bouy (Ministère des Armées, Service Technique des Télécommunications de l'Air, Paris, France). *L'Onde Electrique*, vol. 51, May 1971, p. 418-420. In French.

Review of applications of on-board radars, generally used in the detection at a distance of major cloud formations which could affect air safety. Such meteorological radars, of the classic pulse type, are of reasonable cost and this, coupled with their good reliability and ease of operation, leads to examination of possible applications for other purposes. Among these are navigational aids and determination of ground reference points at great distances, surveillance of relief, study of sea targets, and use as landing aids and beacons. F.R.L.

A71-31942 * **An approximate root locus method in the S plane for sampled-data systems.** Joseph S. Koziol, Jr. (NASA, Electronics Research Center, Cambridge, Mass.). *IEEE Transactions on Automatic Control*, vol. AC-16, Feb. 1971, p. 101, 102.

An approximate S plane is derived from the W plane for analyzing sampled-data systems. Constant frequency and constant damping-ratio loci are first mapped onto the W plane. A simple

transformation of the W-plane coordinates to S-plane coordinates is then constructed, and sampling frequency boundaries are specified wherein interpretation in the W plane becomes identical to that in the S plane. Hence S-plane results can be obtained quickly for those system frequencies within the specified boundaries. (Author)

A71-32019 # **On the flutter of cylindrical membranes at high supersonic Mach numbers.** Peter Crimi (Avco Corp., Avco Systems Div., Wilmington, Mass.). *ASME, Transactions, Series E - Journal of Applied Mechanics*, vol. 38, June 1971, p. 557-559. 6 refs. Contract No. AF 04(710)-68-C-0289.

Analysis of the aeroelastic stability of a cylindrical membrane in high supersonic or low hypersonic flows. Because the dynamic system has a simple analytic representation it was possible to obtain a tractable flutter formulation while retaining a realistic aerodynamic model. Specifically, the classical piston approximation of Hayes and Lighthill was rigorously applied to calculate the unsteady aerodynamic loading on a deforming cylinder. F.R.L.

A71-32127 **A note on the effect of ground absorption in the measurement of aircraft noise.** M. E. Delany and E. N. Bazley (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). *Journal of Sound and Vibration*, vol. 16, June 8, 1971, p. 315-322. 13 refs.

It is shown that results of available theoretical analyses of the far-field sound pressure due to a simple source above an absorbing plane are capable of simple interpretation, and that certain published experimental values of excess attenuation obtained from measurements near the ground are consistent with such results. The effects of changing various parameters are demonstrated and estimates made of the errors likely to be incurred if effects of ground absorption are ignored when determining normalized values of the noise of aircraft. (Author)

A71-32133 **On finite amplitude spinning acoustic modes and subsonic choking.** C. K. W. Tam (MIT, Cambridge, Mass.). *Journal of Sound and Vibration*, vol. 16, June 8, 1971, p. 393-405. 13 refs.

The propagation of the wave modes in an annular duct is studied. The usual frequency dispersion relation of linear theory is extended to include the nonlinear effect of amplitude dispersion. A perturbation procedure in which the frequency, wavenumber, and amplitude relation is represented by a power series in the energy density or the square of the wave amplitude is described. It is found that nonlinear effects are not negligible for wave modes of moderate amplitude. The phenomenon of 'subsonic choking' of these waves due to finite amplitude effect is investigated. The physical aspects of this phenomenon are also discussed. G.R.

A71-32134 **New observations on tone generation in fans.** J. S. B. Mather, J. Savidge (Rolls-Royce, Ltd., Hucknall, Notts., England), and M. J. Fisher (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 16, June 8, 1971, p. 407-418. 5 refs.

This paper presents a theory to describe the generation of discrete tone noise by the aerodynamic interaction of rotor and stator rows in turbo-machinery when the rotor blades are not precisely identical. Experimental data, taken from measurements of the far-field of a number of free vortex transonic compressors, confirms the predictions of the theory and shows that this type of interaction may be expected to occur in all fans and compressors in current aero-engines. (Author)

A71-32167 **A Japanese 3-d radar for air traffic control.** Masaru Watanabe, Tetsuo Tamama, and Nobuharu Yamauchi (Mitsubishi Electric Corp., Amagasaki, Japan). *Electronics*, vol. 44,

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June 21, 1971, p. 68-72.

An air traffic control radar is described that can supply simultaneously range, azimuth, and elevation information for an indefinite number of targets by continuous searching. Its altitude-determining accuracy can assure a vertical separation between aircraft of 1000 ft or even 500 ft depending on antenna configuration. Other system parameters for airport surveillance include: a 60 nautical mile range for a target cross section of 10 sq m; an elevation coverage of 0.5 to 30 deg; S-band frequency; 1-megawatt transmitting power; antenna rotation of 15 rpm; detection probability of 90%; height-finding probability of 50%; and a false-alarm rate of one in ten billion. M.V.E.

A71-32240 Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971. 100 p. Members, \$19.50; nonmembers, \$25.

The papers attempt to show how air transportation can be a good neighbor to social and natural surroundings. Attention is given to problems of aircraft noise, aircraft and airports as sources of pollution, and airport planning. Various preventive and remedial measures are discussed. These may be legal or procedural, or may be dealt with in aircraft and engine design. The plenary session reviewed the results obtained by workshops on noise sources, noise interfaces, the noise receiver, air pollution sources, distribution and effects, noise regulations and legal aspects, air pollution regulations and legal aspects, and environmental planning and community action. F.R.L.

A71-32241 The generation and suppression of aircraft noise. A. L. McPike (Douglas Aircraft Co., Long Beach, Calif.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 5-10.

Review of the jet aircraft as a noise source, with an assessment of the reductions in jet aircraft noise which may be possible for both current and future aircraft. Major emphasis is on the engines, which are the actual generators of airport community noise. Attention is also given to aircraft operational characteristics which influence generation and transmission of noise. While technology has been developed that can achieve a significant reduction in the turbomachinery noise of some turbofan engines, no satisfactory method has yet been demonstrated that will satisfactorily reduce jet exhaust noise. F.R.L.

A71-32243 Status report on aircraft and airports as sources of pollution. G. P. Sallee (American Airlines, Inc., New York, N.Y.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2.

New York, Society of Automotive Engineers, Inc., 1971, p. 21-27.

The sources of pollution from aircraft and airports are reviewed with emphasis placed on the industries' current understanding of the magnitude and control technology applicable to such sources. The progress of industry activity in reducing pollution from aircraft is presented including ongoing research directed at defining the impact, source strength, and applicable control technology. The unknowns and areas where research is needed and not currently under way are identified. (Author)

A71-32244 * The dispersion of pollutants from aircraft. James A. Fay and John B. Heywood (MIT, Cambridge, Mass.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 28-39.

16 refs. Grant No. NGR-22-009-378.

Two aspects of the dispersion of pollutants from aircraft are reviewed. The first is the dispersal of aircraft exhaust emissions in the vicinity of airports; the second is the dispersal of exhaust trails in the upper atmosphere. Techniques available for modeling this dispersal and how they might be applied to the airport problem are discussed. Field studies of airport pollution are then reviewed to assess current pollutant levels around airports and the aircraft's contribution to those levels. The possibility of contrail formation from jet emissions at high altitude is then considered and the effect of uncertainties in the trail mixing processes evaluated. (Author)

A71-32245 Legal aspects of aircraft noise and sonic boom in the United States. Warren Christopher. In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 46-53.

Discussion of federal legislation and regulations as they relate to aircraft noise abatement, with emphasis on the comprehensive and pervasive federal scheme. Attempts by state and local bodies to control aircraft annoyances through altitude, noise level, and curfew ordinances are summarized. The power of an airport proprietor with reference to enforcement of aircraft noise abatement measures is discussed, as well as the availability of injunction and damage suits in dealing with aircraft noise. Attention is given to the needs for and obstacles to land use planning for aircraft noise abatement purposes. The legal bases for claims for damages based upon sonic boom are considered. F.R.L.

A71-32246 Regulation of pollutant emissions from aircraft - Today and tomorrow. William H. Megonnell (Environmental Protection Agency, Air Pollution Control Office, Rockville, Md.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 54-57.

Discussion of regulation of aircraft emissions, a problem that began with the introduction of jets. At airports, aircraft pollutant emission densities are similar to those from other operations in surrounding cities. As other emissions become controlled, aircraft emissions will become proportionately more significant. Low-smoke combustors are being installed voluntarily by airlines, but only after suits were filed by several state air pollution control agencies. Similar voluntary action is expected to solve the fuel-dumping problem. Federal preemption of aircraft emission regulations invalidates state control and regulations will be published in 1971. F.R.L.

A71-32247 Airport planning for environmental quality. Robert F. Bacon (FAA, Airport System Planning Div., Washington, D.C.). In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2.

New York, Society of Automotive Engineers, Inc., 1971, p. 58-63.

Consideration of the numerous problems involved in planning for environmental quality. Airport operators are concerned that the multitude of environmental protection laws and policies will prevent solving the airport dilemma. In some cases minimizing the adverse effects of the environmental changes and the employment of unique impact lessening techniques may not produce an acceptable solution in the eyes of a substantial number of citizens. The role of the area-wide planning agency, and the FAA's planning grant program are discussed. A typical environmental study is outlined, and the FAA's environmental responsibilities are considered. F.R.L.

A71-32248 Planning for compatibility of aircraft and environment. Robert C. Einsweiler. In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 64-70.

Exploration of aircraft/environment compatibility, with discussion of the decision-making process. Four sets of different viewpoints are examined which cause those involved in airport decisions to talk past each other or fail to agree on the meaning and importance of selected facts. These viewpoint sets are comprehensive-functional, federal-local, gainers-losers, and public-private. Based on these considerations, actions are suggested to be taken in three phases of the decision-making process: (1) airport system planning including airport site location, (2) airport master planning and development, and (3) airport operation. F.R.L.

A71-32249 Communities act to reduce the impact of jet aircraft noise. William Goedike. In: Society of Automotive Engineers and U.S. Department of Transportation, Conference on Aircraft and the Environment, Washington, D.C., February 8-10, 1971, Proceedings. Part 2. New York, Society of Automotive Engineers, Inc., 1971, p. 71-78.

This paper describes what communities have done and can do to reduce the impact of aircraft noise. Specifically, the historical action of Hempstead, New York, the Ten Point Program of Inglewood, California, and the International Airport development at Kansas City, Missouri, are outlined in some detail. Also, the paper presents an integrated plan for achieving a reasonable noise environment in the future. The plan is based on establishment of nationwide goals, on improved communication and decision making between communities and airports, and on a new concept of economic incentives which makes noise pollution a cost factor in industry decision making. (Author)

A71-32280 # Flow field interactions induced by under-expanded exhaust plumes. R. C. Boger, H. Rosenbaum, and B. L. Reeves (Avco Corp., Avco Systems Div., Wilmington, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-562.* 11 p. 14 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. AF 04(701)-68-C-0293.

Experiments have been conducted on a slender cone at Mach 10 with a highly underexpanded exhaust plume to determine the flow field interactions, including the separation pattern and the influence upon aerodynamic coefficients. The experimental results show that the plume induces preferential separation on the leeward side and that this can result in destabilizing aerodynamic forces. The experiments suggest a straightforward analytical model to predict the extent of separation on the cone and the reattachment of the separated boundary layer on the plume boundary. This model has been checked against the experimental results, and is used to predict the plume-induced separation pattern at angle of attack. (Author)

A71-32281 # Ground effects in STOL operation. L. B. Gratzler and A. S. Mahal (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-579.* 14 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

The effects of operation near the ground are of primary importance in determining the takeoff and landing characteristics of STOL aircraft. A study is presented which compares the results of theoretical analysis with those of wind tunnel tests using a fixed ground plane with blowing boundary layer control as well as the moving belt ground plane. These results are used to define the characteristics of STOL lifting systems near the ground to serve as a basis for an examination of limitations imposed on STOL operation.

Variations in aircraft design parameters and operating techniques are explored to indicate ways of reducing the adverse effects of ground proximity and providing desirable airplane characteristics near the ground. (Author)

A71-32284 * # Wind tunnel tests of a wing-installed model VTOL lift fan with coaxial drive turbine. S. Lieblein, J. A. Yuska, and J. H. Diedrich (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-742.* 38 p. 40 refs. Members, \$1.50; nonmembers, \$2.00.

This paper presents a summary of principal results obtained from crossflow tests of a 15-in.-diameter lift fan installed in a wing in the NASA, Lewis Research Center, 9- by 15-foot V/STOL Wind Tunnel. The basic objective of the investigation was to determine lift fan behavior in the crossflow environment and to define the principal factors affecting fan performance. The fan stage was designed for a pressure ratio of 1.28 at a corrected tip speed of 980 ft/sec. The unique feature of the fan is a compact drive turbine coaxially mounted within the hub section of the fan. This arrangement provided for coaxial exhaust streams. Tests were run with and without exit louvers over a wide range of tunnel air speeds, fan speeds, and wing angle of attack. The results presented herein provide a comparatively complete picture of the basic features of the internal flow in a lift fan in crossflow. In addition to presenting data on the internal reactions to inflow distortion, the paper points to the added importance of back pressure effects in influencing fan performance. In this particular fan, flow separation on the inlet bellmouth did not appear to be a serious problem for crossflow operation. (Author)

A71-32286 # Prediction of nitric oxide formation in turbojet engines by PSR analysis. D. T. Pratt, B. R. Bowman, C. T. Crowe, and T. C. Sonnichsen (Washington State University, Pullman, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-713.* 15 p. 32 refs. Members, \$1.50; nonmembers, \$2.00.

The primary zone of a gas turbine combustor is modeled as an adiabatic, micromixed, perfectly-stirred reactor (PSR), followed by a plug-flow reactor with distributed mass addition to simulate the secondary zone. A complete reaction mechanism is employed for the combustion of premixed gaseous methane and air, since the concept of 'pre-flame' and 'post-flame' reactions is not applicable to micromixed PSR or homogeneous volume burning. Combustor geometries and operating conditions representative of current aircraft engines are assumed. Predicted NO levels are compared with experimental values obtained from the literature, and with predicted levels from more complex models. It is concluded that at design point operation, the micro-PSR model predicts NO concentrations as well as or better than more complex models. (Author)

A71-32289 * # Gas turbine combustor modeling for calculating nitric oxide emissions. John B. Heywood (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-712.* 9 p. 16 refs. Members, \$1.50; nonmembers, \$2.00. NSF Grant No. GK-15409; Grant No. NGL-22-009-378.

Two aspects of models used to predict nitric oxide formation in gas turbine combustors are examined. At typical combustor primary zone conditions, the validity of assuming O, OH, H, and O₂ in equilibrium in the burnt gas where most of the NO is formed is assessed. The effect of assuming N in steady state, or in equilibrium, and the effect of additional reactions in the NO kinetic scheme are evaluated. The techniques which have been used to model the flow are summarized, and the importance of including nonuniformities in

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gas temperature and composition and a distribution of residence times are reviewed. It is shown that nonuniformities in the flow must be included before satisfactory agreement with exhaust measurements over a wide range of engine loads can be obtained. The effects of variations in mean primary zone equivalence ratio, engine compressor pressure ratio, and mean residence time are discussed.

(Author)

A71-32294 # The sailplane. F. X. Wortmann (Stuttgart, Universität, Stuttgart, West Germany). (*Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.*) *Aero Revue*, June 1971, p. 303-305.

Two-dimensional wind-tunnel tests were conducted with an airfoil fastened between the tunnel walls to investigate the applicability of the variable chord concept in sailplane designs. Preliminary results of the tests indicated that the trailing edge of the airfoil tended to develop flutter when the dynamic pressure and the angles of attack reached certain levels. Suggestions are given as to how the variable chord concept with sails can be made beneficial to soaring.

V.Z.

A71-32298 # Influence of the end play on the dynamic strength of axial-flow-turbine rotor blades (Vliianie oseвого zazora na dinamicheskuiu prochnost' rabochikh lopatok osevykh turbin). A. A. Moiseev, Iu. I. Mitiushkin, S. A. Alekseev, and V. I. Filatov. *Energomashinostroenie*, vol. 17, Mar. 1971, p. 12-15. 9 refs. In Russian.

The dynamic bending stresses induced by aerodynamic forces in rotor blades are studied experimentally. It is found that in the case where the nozzle guide vanes are set radially with respect to the trailing edges, an increase in the end play will appreciably reduce the aerodynamic load on the rotor blades and the dynamic bending stresses in the cylinders in the plane of rotor rotation in the case of resonance vibrations. In the case where the concave side of the nozzle guide vanes is inclined to the turbine axis at an angle of 10 deg with respect to the mean diameter radius, an increase in the end play has only a slight effect on the dynamic bending stresses, but is substantial in the case of resonance vibrations.

V.P.

A71-32303 # Flow studies at accelerating grids in a wind tunnel and in an axial-flow turbine (Strömungsuntersuchungen an Beschleunigungsgittern im Windkanal und in der Axialturbine). Siegfried Wegel. Darmstadt, Technische Hochschule, Fakultät für Maschinenbau, Dr.-Ing. Dissertation, 1970. 124 p. 47 refs. In German.

The aim of this doctoral thesis is to determine whether the parameters measured for straight bucket grids in a wind tunnel are suitable for calculating the efficiency of axial-flow turbine stages. To this end, the parameters of the plane and secondary flows past cascades of a certain bucket profile were measured in a wind tunnel. Buckets of the same profile were then used as the stator and rotor blading of an experimental two-stage axial-flow turbine. The measured data are analyzed and compared.

V.P.

A71-32307 # Calculation of the flow field about thick rectangular wings with control surfaces and near the ground - Numerical lifting surface procedure (Zur Berechnung des Strömungsfeldes um dicke Rechteckflügel mit Rudern und in Bodennähe - Ein numerisches Tragflächenverfahren). Wolfram Klaar. Darmstadt, Technische Hochschule, Fakultät für Maschinenbau, Dr.-Ing. Dissertation, 1970. 156 p. 30 refs. In German.

A method of calculating incompressible potential flow past thick lifting bodies is developed in this doctoral thesis. Flows of this type were produced by assuming a source distribution and a vortex distribution in the mean chamber plane of the wing, and the distribution intensities were approximated, with the aid of a

finite-element technique, by traverses in the span and chord directions of the wing. The kinematic flow condition is satisfied at arbitrary terminal points on the wing surface with the aid of the minimum rms error method. The method proposed yields the complete velocity vector at all terminal points.

V.P.

A71-32373 Parachute research in the Federal Republic (Fallschirmforschung in der Bundesrepublik). Uwe Beckmann. *Deutscher Aerokurier*, vol. 15, June 1971, p. 412-415. In German.

Description of areas in which research is being performed in the Federal Republic to produce high-performance and high-reliability parachutes of various types. A lag in this field in the Federal Republic is noted in comparison with certain other countries. The nature of the stretching shock and the filling shock occurring during the opening of a parachute is explained, noting the significance of these phenomena in the design of parachutes. The difficulty of obtaining accurate data for calculating these shocks is indicated. The importance of obtaining accurate data concerning the material properties is stressed, noting that the porosity of the material, as well as its strength, has a great effect on the filling shock. A need for studies of static stability of parachutes is cited. Problems occurring during jumps at low altitudes are considered, as well as the danger of mishaps due to entanglements.

A.B.K.

A71-32432 Grinding high temperature alloys. Donald E. Burgbacher (GE Manufacturing Equipment Development Laboratory, West Lynn, Mass.). *Society of Manufacturing Engineers, East Central Engineering Conference, Cincinnati, Ohio, Jan. 19-21, 1971, Paper MR 71-802*. 11 p. Members, \$1.50; nonmembers, \$2.00.

Description of the grinding operations performed on blades and vanes in the high pressure turbine section of a jet engine. High nickel alloys, René 77 and René 80, are used in both Stage I and II turbine blades and Stage II high pressure vanes. A cobalt-base alloy, X-40, is used in the slightly hotter Stage I vanes. The alloys are becoming more difficult to machine and more sensitive to surface alterations that can result in an absence of surface integrity. Grinding processes were developed that will minimize the alterations and thereby produce the desired surface integrity. Testing, operating conditions, and coolant application are discussed.

F.R.L.

A71-32435 Assuring integrity of L-1011 high strength steel parts. L. E. Gatzek, G. F. Poulos, R. T. Elliott, E. R. Sprague, and E. L. Skipworth (Lockheed-California Co., Burbank, Calif.). *Society of Manufacturing Engineers and American Society for Metals, Western Metal and Tool Conference and Exposition, Los Angeles, Calif., Mar. 8-12, 1971, SME Paper EM 71-706*. 20 p. Members, \$1.50; nonmembers, \$2.00.

Study of undetected anomalies in high strength steels which can originate in the course of fabrication. To control them, critical aspects concerning procurement, production, and inspection were reviewed. Steels in the low alloy high strength category include D6AC, H-11, Tricent, 300M, 4340, and 4330. When processed correctly to strength levels ranging from 220 to 280 ksi, these materials are characterized by superior strength-to-density ratios, toughness, and fatigue resistance. However, if process variables and controls are lax, high-strength steels may exhibit brittle behavior and be susceptible to crack propagation. An audit plan is described which has shown itself to be an effective and efficient control system.

F.R.L.

A71-32436 Advanced manufacturing techniques for new generation aircraft. Alfred G. Jones (North American Rockwell Corp., Los Angeles, Calif.). *Society of Manufacturing Engineers and American Society for Metals, Western Metal and Tool Conference and Exposition, Los Angeles, Calif., Mar. 8-12, 1971, SME Paper MR 71-725*. 14 p. Members, \$1.50; nonmembers, \$2.00.

Discussion of new and improved techniques for the fabrication of advanced structural components and assemblies to meet specifications as economically as possible. New generation aircraft emphasize the structural requirements of light weight, high strength, and heat resistance. An extensive manufacturing development effort to meet long-range concept requirements and more immediate aircraft fabrication needs is described. A selected, representative group of advanced techniques, applicable to new generation aircraft currently in the design or fabrication stages is briefly discussed in general terms. F.R.L.

A71-32437 **Advanced ultrasonic inspection system for the Lockheed L-1011 adhesive bonded fuselage panels.** C. E. Searles and K. E. Kleinberg (Lockheed-California Co., Burbank, Calif.). *Society of Manufacturing Engineers and American Society for Metals, Western Metal and Tool Conference and Exposition, Los Angeles, Calif., Mar. 8-12, 1971, SME Paper IQ 71746.* 12 p. Members, \$1.50; nonmembers, \$2.00.

Description of an automated ultrasonic inspection system. The system is capable of inspecting flat and contoured adhesively bonded panels up to 80 in. wide and 45 ft long. The system uses the through-transmission technique with ten sets of transducer/water squirter assemblies. The transducer/squirter assemblies are indexed vertically after each successive pass along the length of the panel. A ten-channel multiplexing circuitry activates the search units in rapid sequence, permitting the use of many transducers with a single ultrasonic scope, providing a faster inspection with less mechanical motion. A one-fifth scale dry paper recording is provided simultaneously on a remotely driven, platen-type X-Y recorder. M.M.

A71-32519 **Calculation of aircraft noise duration.** J. L. Muller (South African Council for Scientific and Industrial Research, National Mechanical Engineering Research Institute, Pretoria, Republic of South Africa). *Journal of Sound and Vibration*, vol. 16, June 22, 1971, p. 581-592. 9 refs.

This paper considers the problem of calculating the effective noise duration at any specific observation point during an aircraft fly-past. Existing proposals are reviewed and the results of alternative methods of calculation are compared with each other and with analyses of actual noise history recordings. (Author)

A71-32520 **Acoustic radiation from aerofoils with turbulent boundary layers.** B. D. Mugridge (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 16, June 22, 1971, p. 593-614. 6 refs. Research supported by the Ministry of Technology.

The acoustic radiation from aerofoils with turbulent boundary layers has been examined. A simple theory is presented for the calculation of the radiation if the aerofoil force fluctuations are known. The forces are estimated from the aerofoil steady drag coefficient and the theory is used to calculate the radiation from a stationary test aerofoil and from two single-stage axial flow fans. The theory predicts the measured radiation with reasonable accuracy. (Author)

A71-32523 **Automation in air traffic control.** C. Van den Tweel (Hollandse Signaalapparaten, Hengelo, Netherlands). *Shell Aviation News*, no. 395, 1971, p. 6-9.

Review of procedures for routine data handling in ATC, a field in which a computer can be very useful. An Automated Flight Plan Processing System (FPPS) and a Radar Data Processing System (RDPS) are described. The Signaal Automatic Control System (SATCO) in use at Schiphol airport comprises a duplicated computer system. It calculates and updates flight plan and clearance data, distributes and displays basic and updated information by means of printed strips as well as automatic displays, and makes conflict

searches. A new system, Signaal Automatic Radar Processing (SARP) is being developed. The processing of radar information, the display of labels, overlapping labels, the two-color PPI, and the electronic data display (EDD) are discussed. F.R.L.

A71-32524 **Engine performance monitoring - The Pan Am approach.** Harold J. Moss (Pan American World Airways, Inc., New York, N.Y.). *Shell Aviation News*, no. 395, 1971, p. 16-21.

Discussion of performance monitoring as a means of jet engine troubleshooting. The relationship between certain key performance parameters provides clues to engine conditions which make it possible to schedule deteriorated engines for removal before they malfunction. Examples of malfunctions that can be analyzed through performance monitoring of the JT3D engine are cited. The procedure, however, cannot tell much about bearings and seals, and should be used in conjunction with other maintenance programs such as oil consumption monitoring. F.R.L.

A71-32528 # **Holography and its application in aeronautics and astronautics (Golografiia i ee primeneniye v aviatsii i kosmonavtike).** V. Frolov and Iu. Soluianov. *Aviatsiia i Kosmonavtika*, May 1971, p. 44, 45. In Russian.

The history of imaging by reconstructed wave fronts is reviewed, and the holographic transmission of images through the troposphere using lasers as a light source is discussed. The advantages of using three-dimensional information provided by holograms in aircraft navigation, space missions, and astronomic experiments are outlined. V.P.

A71-32544 # **Surface liquid film characteristics - An experimental study.** Harris Gold, James H. Otis, Jr., and Robert E. Schlier (Avco Corp., Avco Systems Div., Wilmington, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 4th, Palo Alto, Calif., June 21-23, 1971, Paper 71-623.* 14 p. 30 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. AF 33(615)-69-C-1656.

Photographic and heat transfer data were obtained of two-dimensional surface coolant liquid (water) films on a wedge model with supersonic ($M_{sub} \approx 2$) turbulent air flow. The test program was conducted in Tunnel B of the von Kármán Gas Dynamics Facility (VKF), AEDC. Surface liquid film profile distributions, which were obtained by a light absorption technique, showed that the mean film thickness and the standard deviation from the mean were relatively constant along the length of the wedge in the streamwise direction. As the surface pressure was increased the gas-liquid interface changed from a 'pebble-like' structure to a 'regular spanwise vortex' pattern. At the same time the ratio of the standard deviation from the mean to the mean film thickness decreased. This implies that the liquid film is more stable as the dynamic pressure of the gas increases which is in contradiction to existing subsonic turbulent air flow data. Heat transfer data were obtained both with and without liquid coolant injection. In all cases, as long as there was a surface liquid film present, the heat transfer rates were reduced to essentially zero and the measured model wall temperatures and liquid plenum chamber temperatures were equal for all times. (Author)

A71-32566 * **Sonic boom.** Wallace D. Hayes (Princeton University, Princeton, N.J.). In: Annual review of fluid mechanics. Volume 3. Edited by Milton Van Dyke, W. G. Vincenti, and J. V. Wehausen. Palo Alto, Calif., Annual Reviews, Inc., 1971, p. 269-290. 48 refs. Grant No. NGL-31-001-119.

The solution for the flow about an aircraft moving at supersonic speed is also an acoustic solution, and the linearized theory of supersonic flow is consistent with linearized acoustic theory. Of

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particular interest for the problem of sonic boom is the establishment of the asymptotic behavior of the solution in the wave system emanating from the aircraft. Sonic-boom propagation follows linear geometric acoustics. Nonlinear distortion effects are investigated. Other subjects discussed include focusing and caustics, effects of turbulence, and questions of optimization and reduction of sonic boom. G.R.

A71-32571 A gas generator with a high power-to-mass ratio (Générateur de gaz à rapport de puissance sur masse élevé). Alain Verneau (Société Bertin and Cie., Paris, France). *Entropie*, Mar.-Apr. 1971, p. 23-39. 16 refs. In French.

Results of a parametric study undertaken in order to determine the most favorable solutions for obtaining a maximum thrust/weight ratio in the range from 100 to 200 dekanewtons. After choosing a certain number of thermodynamic cycles, many succinct sizings were carried out for turbojets of various types, drawing upon advanced, but already tested solutions. The conclusions of this study resulted in a thrust/weight ratio of 7 for a 150 dekanewton thrust. This corresponds to a single-flow turbojet consisting of a centrifugal compressor with a pressure ratio of 6, an annular reverse flow combustion chamber, and an axial two-stage turbine with strongly cooled blades. The mass flow rate is 2 kg/sec, the temperature at the turbine inlet is 1230 C, and the rotation speed is 56,000 rpm. An appreciable weight reduction is achieved by elimination of the oil circuit through the use of hydrostatic fuel bearings fed in parallel with the injectors by means of a small centrifugal pump mounted at the shaft end. A.B.K.

A71-32650 Sidelooking radar (Seitensicht-Radar). F. Rockstuhl (Telefunken AG, Ulm, West Germany). *Internationale Elektronische Rundschau*, vol. 25, June 1971, p. 153, 154. In German.

Such fundamental concepts peculiar to sidelooking radar as synthetic aperture, pulse compression, and optical data correlation are reviewed. The significance in this context of the Doppler effect is pointed out. The dissimilarities of the sidelooking-radar image from conventional radar images and those of aerial photography are described. A number of technical problem areas is examined, along with the ways and means used or contemplated for overcoming the difficulties involved. The potential range of attainable results is briefly discussed. M.V.E.

A71-32688 # Concorde, Airbus, and Mercure confront the demands of air transport (Concorde, Airbus et Mercure face à la demande du transport aérien). B. Latreille (Secrétariat Général à l'Aviation Civile, Paris, France). *L'Aéronautique et l'Astronautique*, no. 28, 1971, p. 12-14. In French.

Discussion of the roles of the supersonic long-range Concorde, the medium-range high capacity Airbus, and the short-range 150-seat Mercure. The conditions under which these programs were launched are reviewed, and the international cooperation involved is discussed. It is considered that these products of the French aviation industry should be supplemented by a STOL aircraft and a new engine which will be quiet, have low fuel consumption, be easy to maintain, and have a thrust of about 25,000 lb. F.R.L.

A71-32690 # Behavior of the Concorde in flight (Comportement en vol de Concorde). Jean Pinet (Société Nationale Industrielle Aérospatiale, Toulouse, France). *L'Aéronautique et l'Astronautique*, no. 28, 1971, p. 25-32. In French.

Evaluation of the 394 flying hours, 92 of which were supersonic, which have been accumulated by Concordes 001 and 002. The flight regimes explored were substantially those established for normal use of the aircraft. Performance was considered to be outstanding at all points. The success of the Concordes is attributed

to good all-round design, and exhaustive ground testing in the laboratory, on special test benches, and with flight simulators. F.R.L.

A71-32692 # The M 56 - An engine meeting an economic need (Le M 56 - Un moteur répondant à une nécessité économique). J. Delacroix (Délégation Ministérielle pour l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 28, 1971, p. 49-54. In French.

Description of a SNECMA-designed third-generation commercial turbofan engine which features low specific fuel consumption and low noise levels, producing a thrust in the 10-ton range. The engine is intended for medium-capacity airliners on routes where traffic will not require jumbo jets and where operating cost and high noise levels rule out present-day transport aircraft. F.R.L.

A71-32694 # The helicopters of Aérospatiale (Les hélicoptères de l'Aérospatiale). R. Mouille (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France). *L'Aéronautique et l'Astronautique*, no. 28, 1971, p. 82-93. In French.

Discussion of the many and varied models of helicopters produced by Aérospatiale. Among them are the Alouette II and III Astazou and their variants, the Navy and civil Super-Frelon, the Puma, and the Gazelle. The latter helicopter features a rear rotor housed within the vertical fin. Performance data and structural details are given. Tendencies in the concept and construction of modern helicopters, including hybrids and convertibles, are considered. F.R.L.

A71-32695 # The Bréguet declutchable silencer for jet engines (Silencieux débrayable Bréguet pour moteurs à réaction). Georges Bruner (Société Bréguet-Aviation, Vélizy-Villacoublay, Yvelines, France). *L'Aéronautique et l'Astronautique*, no. 28, 1971, p. 100-106. In French.

Description of a silencer intended to attenuate jet noise during takeoff. It is based on the principle of dilution of the exhaust gases by intake of outside air which automatically leads to a reduction of the velocity of the gases, the principal source of noise propagation. The gas flow is also sectioned into several portions, which favors noise attenuation. The system consists of a number of corridor-like ducts which project into the gas flow during takeoff, and are retracted in cruise. Laboratory and full-scale tests demonstrated considerable noise reduction at the cost of a small loss of thrust (about 1.5 per cent). F.R.L.

A71-32700 An evaluator for the number of operationally ready aircraft in a multilevel supply system. Craig C. Sherbrooke (Information Transfer Corp., Santa Monica, Calif.). *Operations Research*, vol. 19, May-June 1971, p. 618-635. 8 refs.

An analytical model has been developed that evaluates the expected number of aircraft not operationally ready at a random point in time because of supply (NORS). The model was developed for application to the F-111 aircraft for a multilevel problem, where demand on a first-level line replaceable unit (LRU) eventually causes second-level demands for one or more modules that are components of the LRU. The model is for a single base. Since it is evaluative in nature, the inputs include item stock levels as well as item demand rates, average repair times, and resupply times. An optimization model to determine stock levels that minimize the number of NORS aircraft subject to a budget constraint would be preferable to the evaluation model. It is shown, however, that an optimization model is not mathematically tractable because the criterion function is not separable into independent item calculations. M.V.E.

A71-32711 Linear model of 2-shaft turbojet and its properties. G. S. Mueller (Sir George Williams University, Montreal, Canada). *Institution of Electrical Engineers, Proceedings*, vol. 118,

June 1971, p. 813-815.

A linear model of a 2-shaft turbojet is developed, and general conditions for stability, observability and controllability (pointwise-state and left-halfplane), as well as for a stable configuration of feedback loops are found. From partially theoretical, partially experimental data, numerical values of model parameters are found. (Author)

A71-32715 The effect of the Mach number on the compressor characteristics (Machzahleinfluss auf die Verdichtercharakteristik). Wilhelm Dettmering and Klaus Grahl (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 145-150. 9 refs. In German.

A well-known calculation method of part load for subsonic axial compressor stages is enlarged so that it is applicable for highly loaded transonic compressor stages. The compressibility influence is determined by means of empirical corrections at the measured three-dimensional grid characteristics, considering partly the relative flow conditions for a blade wheel grid; the guide wheel corrections are analogous. The effectiveness of Mach number correction is shown by a comparison of the compressor characteristic calculated in uncorrected and corrected manner with the available measured values of two transonic compressor stages. (Author)

A71-32716 Investigations regarding the effectiveness of effusion cooling of turbine blades (Untersuchungen zur Wirksamkeit der Effusionskühlung von Turbinenschaukeln). Norbert Scholz and Dietmar K. Hennecke (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 151-158. 17 refs. In German.

Initially, a calculation procedure is developed which is based on known methods of boundary layer theory and, with the utilization of certain empirical relations, permits to determine the local heat transfer at the profile contour of an effusion cooled turbine blade. With this procedure, parametric studies with a given turbine blade are made, relating to the blade surface roughness, the resistance to flow of the porous wall layer, the distribution of the cooling air pressure, and the amount of effused air. Finally, the performance gains that may be achieved with an effusion cooled turbine as against the previous convection cooling method are demonstrated on the example of a turbojet engine. (Author)

A71-32717 The mixture of gas and air jets in jet propulsion systems - Significance and interpretation (Die Mischung von Gas und Luftstrahlen in Strahltriebwerken - Bedeutung und Auslegung). Albrecht Hartmann (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 158-163. 6 refs. In German.

At the current state of engine development an improvement in specific consumption or an increase in thrust concentration can only be obtained with relatively great effort, for instance, by improving partial efficiencies and increasing the turbine inlet temperature by using better blade materials and introducing more efficient cooling techniques. Jet mixing is a relatively simple matter and results in a remarkable improvement in efficiency. By means of the gasdynamic energy transport in jet engines the noise of the discharged gas jets can be reduced. This possibility will play a part in the design of future 'low noise' cruise and lift engines in connection with the mechanical energy transport and other noise reducing methods. (Author)

A71-32718 Investigations regarding ignition aids for supersonic diffusion flames at the boundary of the self-ignition range (Untersuchungen über Zündhilfen für Überschall-Diffusionsflammen am Rande des Selbstzündungsbereichs). Friedemann Suttrop (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt,

Institut für Luftstrahltriebwerke, Porz-Wahn, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 163-168. In German.

Results of experiments on thermal self-ignition of hydrogen diffusion flames in supersonic flows are reported where ignition is aided by precombustion. Especially prereactions which are induced catalytically prove to favor ignition conditions. As far as scramjet propulsion is concerned, one can hope to extend the application range of thermal self-ignition and thus to avoid losses as they are caused by the well-known auxiliary devices for flame stabilization. (Author)

A71-32719 Aerodynamic flame stabilization - Experimental investigations and possibilities of utilization (Aerodynamische Flammenstabilisierung - Experimentelle Untersuchungen und Anwendungsmöglichkeiten). Walter Alvermann and Rolf Ulken (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Luftsaugende Antriebe, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 168-173. 8 refs. In German.

A brief survey on experiments made so far on aerodynamic flame stabilization is given. In this case, a region within a combustion chamber is produced by secondary air jets directed obliquely toward the main flow in which a flame can burn permanently. The described investigations on model combustion chambers enable statements on an appropriate design and arrangement of the stabilization devices and additionally give information on the behavior of the main flow disturbed by the secondary jets. Further in a theoretical investigation the application of the aerodynamic flame stabilization in the secondary flow of a turbofan engine is studied. Characteristic data are defined which make possible a comparison with the mechanical flame stabilization used so far. (Author)

A71-32720 Possibilities for thrust determination in an aircraft (Möglichkeiten für eine Schubbestimmung im Flugzeug). Heinz Dissen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Luftsaugende Antriebe, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, Apr. 1971, p. 173-179. 6 refs. In German.

Several possibilities of application of thrust determination in an aircraft are shown. Thrust indication can be employed during the test phase of an aircraft but also later for engine monitoring, engine and flight control and, finally, for flight optimization. Indirect thrust measuring methods are described and the relation between measurement parameters and thrust is presented. The sensitivity of measurement errors of the methods are considered. Finally, the problems of a direct thrust measurement are raised and the requirements to the engine mounting necessary for it are reported. A direct thrust measurement is most easily expected to solve the described set of problems. (Author)

A71-32723 # The importance of precision landing guidance to aerospace transportation. F. B. Pogust (Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Deer Park, N.Y.) (*Canadian Aeronautics and Space Institute, Congress and Exposition, Montreal, Canada, Nov. 16-18, 1970.*) *Canadian Aeronautics and Space Journal*, vol. 17, June 1971, p. 237-240.

Discussion of three vital needs of aviation that can be served by better landing guidance. These are (1) more landing locations that can be operated during marginal weather conditions, (2) increased landing capacity at all existing airports, and (3) the recognized, but unfulfilled, requirement for an acceptable landing guidance system for STOL aircraft. The landing guidance system that will serve these three situations uses the microwave scanning beam technique. Such a system operates at a frequency high enough that the beam patterns

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can be carefully controlled into narrow fan shapes. These flat fans of energy can be made to sweep on a regular basis through arcs in the angular sectors of desired coverage. Such systems have been successfully built and tested. F.R.L.

A71-32724 # Low-speed aerodynamic testing of VTOL models - A method for the compensation of wind-tunnel interference effects. U. W. Schaub and R. W. Bassett (National Research Council, Div. of Mechanical Engineering, Ottawa, Canada). *Canadian Aeronautics and Space Journal*, vol. 17, June 1971, p. 245-249.

Description of a simple method that can be used as a first approximation to estimate 'equivalent' free air approach velocity and angle of attack by use of measured control pressures with the model under test conditions (in an unknown air stream) and a prior calculation of the same pressure orifices in a known air stream. The proposed method is restricted to steady, inviscid low-speed flows and simple models for which the flow over the pressure orifices is basically similar for both the known and unknown stream conditions. The accuracy of the approximation of determining the equivalent free air conditions depends entirely on the degree of flow similarity, and is consequently expected to be much better for two-dimensional blockage effects on two-dimensional models than for three-dimensional blockage effects on three-dimensional models. F.R.L.

A71-32784 # Aerodynamic design of VTOL propellers (Zur aerodynamischen Auslegung von VTOL-Propellern). P. Ebeling (Verenigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Entwurfsprobleme von V/STOL-Propellern und Rotoren, Stuttgart, West Germany, May 6, 1971, Paper DGLR 71-017*. 37 p. 15 refs. In German.

Consideration of possible solutions to a number of problems arising in the aerodynamic design of propellers, particularly for use in VTOL aircraft. Optimal blade configurations for a given operational state are suggested, and the use of numerical optimization procedures in propeller design is described. A method of calculating the propeller air forces is outlined. The possibility of cyclic control of the XC142 experimental propeller is demonstrated. A.B.K.

A71-32785 Meeting propulsion needs of future high performance V/STOL. Arthur H. Jackson (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Entwurfsprobleme von V/STOL-Propellern und Rotoren, Stuttgart, West Germany, May 6, 1971, Paper DGLR 71-018*. 73 p.

Research aimed at developing propulsion systems to match specific takeoff, hover, and cruise thrust requirements of subsonic STOL and V/STOL vehicle configurations considered to have the best chances for meeting future needs. Various propeller blade structures are evaluated for high-speed, tilt-wing turboprop V/STOL aircraft. Topics considered include materials selection, weight control, cyclic pitch control tests, noise reduction, and thrust and power characteristics of selected propeller designs. The development of very high pressure ratio fans for future high-speed quiet STOL aircraft is discussed, and comparisons are made between turbofan and propfan concepts envisioned for the future. Noise characteristics, aircraft gross weight penalties, and thrust characteristics of prototype designs are described. T.M.

A71-32786 # Methods for developing the adaptability of VTOL propellers (Methoden zur Entwicklung der Anpassungsfähigkeit von VTOL-Propellern). R. Huber and J. Wimbauer (Verenigte Flugtechnische Werke - Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Sym-*

posium über Entwurfsprobleme von V/STOL-Propellern und Rotoren, Stuttgart, West Germany, May 6, 1971, Paper DGLR 71-023. 21 p. 6 refs. In German.

Consideration of a number of alternative possibilities for improving the performance of propeller-driven VTOL aircraft. A comparative evaluation is made of the features of variable camber propellers, variable diameter propellers, counterrotating propellers, and propellers with blowing devices (either trailing edge blowing or blade tip blowing). The use of blade tip blowing is regarded as the most cost-effective solution to the problem considered, since it offers a decisive improvement in the static thrust of VTOL propellers without great development risk. Also, it provides a possibility of noise reduction through a lowering of the peak Mach number while compensating for the power loss by means of the blowing. A.B.K.

A71-32787 # Some selected problems inherent in rotor-protected recovery systems (Einige ausgewählte Probleme bei rotor-gestützten Bergesystemen). Helmut Stöcklin and Herbert Zimmer (Dornier AG, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Entwurfsprobleme von V/STOL-Propellern und Rotoren, Stuttgart, West Germany, May 6, 1971, Paper DGLR 71-020*. 54 p. 8 refs. In German.

A special rotor designed by Dornier AG for recovery of unmanned flight vehicles which makes it possible to navigate the vehicle during its entire flight and which ensures its high-precision landing is described. During normal flight, the unit has the function of a conventional tail unit and performs therefore control functions of all kinds; propulsion in this phase is accomplished conventionally by propellant gas passing through an integrated jet exhaust nozzle. During the transition phase preceding the rotor landing flight, the unit works as a self-rotating propeller. During the landing phase, it works as a conventional driven tail unit. A simulation method is described by means of which the aerodynamic force distribution and the values of thrust and moment during the transition phase can be calculated. O.H.

A71-32849 # Use of satellites for air traffic control. B. Lancrenon (Engins MATRA S.A., Vélizy-Villacoublay, Yvelines, France). *Deutsche Gesellschaft für Luft- und Raumfahrt, British Interplanetary Society, Société Française d'Aéronautique, and Associazione Italiana di Aerotecnica, European Space Symposium, 11th, Berlin, West Germany, May 24-26, 1971, Paper*. 22 p.

An ATC system is to provide communication channels between aircraft and ground control stations, and in addition is to serve as a means of aircraft localization. The optimization of communication service is considered. Safe operation of air traffic in a high density traffic zone, such as the North Atlantic, requires a knowledge of the position of an aircraft within 1 n mi. This accuracy may be obtained by using two satellites which, for the Atlantic Ocean, would be positioned at 20 deg and 60 deg longitude west. Subjects discussed include satellite configuration, launch vehicle selection, antennas, questions of satellite replacement, and system life. G.R.

A71-32877 # Experiments of flat delta wings and waveriders up to angles of incidence and Mach numbers suitable for lifting re-entry. L. Davies, R. F. Cash, J. D. Regan, J. E. G. Townsend, and A. Catley (Royal Aircraft Establishment, Teddington, Middx., England). In: *International Shock Tube Symposium, 8th, Imperial College of Science and Technology, London, England, July 5-8, 1971, Preprints*.

Symposium sponsored by the Imperial College of Science and Technology, the U.S. Air Force, the Royal Society, the Central Electricity Generating Board, the Gas Council, and the Shell Grants Committee. London, Imperial College of Science and Technology, 1971. 10 p. 11 refs.

A comparison has been made of the aerodynamic performance of flat delta wings and waveriders over a range of incidences from 0 to 60 degrees, and for Mach numbers 8.6, 12.2 and 20. Included in

these tests were some experiments on the NASA Hyper-3 configuration with a caret-wing undersurface. The results are compared with various theories, and it is found that in all cases the caret wing has a higher lift coefficient than the flat delta wing. The significance of this is also discussed. (Author)

A71-32879 # Free flight stability measurements in the longshot tunnel. K. R. Enkenhus, B. E. Richards (Von Kármán Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium), and S. Culotta (Von Kármán Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium; Palermo, Università, Palermo, Italy). In: International Shock Tube Symposium, 8th, Imperial College of Science and Technology, London, England, July 5-8, 1971, Preprints.

Symposium sponsored by the Imperial College of Science and Technology, the U.S. Air Force, the Royal Society, the Central Electricity Generating Board, the Gas Council, and the Shell Grants Committee. London, Imperial College of Science and Technology, 1971. 21 p. 17 refs.

Review of all free-flight static and dynamic stability tests on various lightweight cone-shaped models carried out in the longshot tunnel at Mach numbers from 15 to 23, with Reynolds numbers per ft from 6,000,000 to 1,300,000, respectively. The motion of the models was recorded using a multiple spark light source to expose successive images on either a single photographic plate, or on a strip of high-speed cine film. The lift, drag, moment, and damping coefficients were calculated by a matching technique using numerical integrations of the equations of motion to reconstruct the motion of the models, taking into account time- and space-dependent changes in the test section conditions. The results are compared with Newtonian theory and data from other facilities. It is concluded that the techniques employed provide a relatively simple and accurate method of obtaining static and dynamic aerodynamic coefficients at hypersonic speeds. (Author)

A71-32918 # Diffraction of strong shock waves in a shock tube. T. V. Bazhenova, L. G. Gvozdeva, V. S. Komarov, and B. G. Suchov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). In: International Shock Tube Symposium, 8th, Imperial College of Science and Technology, London, England, July 5-8, 1971, Preprints.

Symposium sponsored by the Imperial College of Science and Technology, the U.S. Air Force, the Royal Society, the Central Electricity Generating Board, the Gas Council, and the Shell Grants Committee. London, Imperial College of Science and Technology, 1971. 10 p. 8 refs.

Experimental study of shock-wave diffraction on plane-walled convex corners in air, nitrogen, and carbon dioxide for Mach numbers ranging from 2 to 10. Some new phenomena observed in the shock-wave diffraction pattern are attributed to the interaction between the secondary shock wave and the slipstream. The shape of the shock wave has been found to depend on the incident shock Mach number and on the wall angle. The shock Mach number near the wall is independent of the type of gas. With increasing shock Mach numbers and wall angles, the shock wave first forms a kink, then changes into the Mach reflection pattern, and finally becomes almost regular reflection. T.M.

A71-32987 * Aeroelastic stability of plates and shells - An innocent's guide to the literature. E. H. Dowell (Princeton University, Princeton, N.J.). In: Instability of continuous systems; International Union of Theoretical and Applied Mechanics, Symposium, Herrenalb, West Germany, September 8-12, 1969, Proceedings.

Symposium co-sponsored by the Bundesministerium für Wissenschaft und Forschung, the Kultusministerium des Landes Baden-Württemberg, and the Universität Karlsruhe. Edited by Horst Leipholz. Berlin, Springer-Verlag, 1971, p. 65-77. 29 refs. NASA-supported research.

A guide is provided to the literature on panel flutter with the intention of making the accomplishments in the field available to less expert readers, thereby attracting new workers to the remaining unresolved problems. It is also intended to show how techniques developed for panel flutter may be more widely applied to other physical problems involving the stability or instability of nonlinear nonconservative systems. Attention is confined to the literature on the flat plate. In principle, however, the methods discussed apply also to curved plates or shells. V.P.

A71-32988 Stability of structures under stochastic disturbances. S. T. Ariaratnam (Waterloo, University, Waterloo, Ontario, Canada). In: Instability of continuous systems; International Union of Theoretical and Applied Mechanics, Symposium, Herrenalb, West Germany, September 8-12, 1969, Proceedings.

Symposium co-sponsored by the Bundesministerium für Wissenschaft und Forschung, the Kultusministerium des Landes Baden-Württemberg, and the Universität Karlsruhe. Edited by Horst Leipholz. Berlin, Springer-Verlag, 1971, p. 78-84. 5 refs. National Research Council of Canada Grant No. A-1815.

Some stability problems of elastic structures subjected to randomly fluctuating external loads are examined. Examples of such loads are those generated by jet and rocket engines, earthquakes, wind gusts, and so forth. These loads cannot be adequately described by deterministic time functions alone, and stability analysis must be based on statistical methods. Moreover, even in cases where the loading is principally deterministic, it may be more realistic to investigate the stability of a structure by imparting a random perturbation to the loading in addition to the perturbations to the initial state employed in the conventional approach. The problems studied deal with parametric instability and dynamic snapping. The discussion of parametric instability problems is limited to the linearized equations and broadband excitation. Problems of dynamic snap-through are studied on the basis of a single degree of freedom model of the structure. V.P.

A71-33013 Stability of an oscillating wing in the subsonic range (Zur Stabilität des schwingenden Tragflügels im Unterschallbereich). F. Wille (Freiburg, Universität; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Freiburg im Breisgau, West Germany). In: Instability of continuous systems; International Union of Theoretical and Applied Mechanics, Symposium, Herrenalb, West Germany, September 8-12, 1969, Proceedings.

Symposium co-sponsored by the Bundesministerium für Wissenschaft und Forschung, the Kultusministerium des Landes Baden-Württemberg, and the Universität Karlsruhe. Edited by Horst Leipholz. Berlin, Springer-Verlag, 1971, p. 302-310. 9 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

Calculation of the aerodynamic forces on an oscillating thin wing with control surfaces in a two-dimensional compressible subsonic flow. The calculation is based on a kernel function method given by Küssner (1967), as well as on a number of numerical procedures employed by the author (1968) and Küssner and Wille (1968). It is shown how the results obtained can be used to determine the degrees of freedom for which flutter can occur. A.B.K.

A71-33019 Non-conservative effects produced by thrust of jet engine. A. Petre (București, Institutul Politehnic Gheorghe Gheorghiu-Dej, Bucharest, Rumania). In: Instability of continuous systems; International Union of Theoretical and Applied Mechanics, Symposium, Herrenalb, West Germany, September 8-12, 1969, Proceedings.

Symposium co-sponsored by the Bundesministerium für Wissenschaft und Forschung, the Kultusministerium des Landes Baden-Württemberg, and the Universität Karlsruhe. Edited by Horst Leipholz. Berlin, Springer-Verlag, 1971, p. 344-348.

A71-33035

Consideration of nonconservative effects occurring during vertical takeoff due to an interaction between aerodynamic and elastic forces. In the case of vertical takeoff the aerodynamic forces on the wing vanish, and the wing becomes a simple cantilever beam assumed to be loaded at the free end by a constant transverse force attached to it and oriented in the direction of the highest rigidity. To solve this problem, the well-known differential equations for bending and torsion of such a beam are investigated.

A.B.K.

A71-33035 Efficiency of protection and heat exchange in the injection of air into the turbulent boundary layer of an air stream through a preceding porous section. P. N. Romanenko and A. Ia. Voloshchuk (Moskovskii Lesotekhnicheskii Institut, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 8, Sept.-Oct. 1970, p. 1025-1031.) *High Temperature*, vol. 8, Sept.-Oct. 1970, p. 957-962. 8 refs. Translation.

Theoretical and experimental study of heat transfer during the two-flow mixing process when air as a coolant is injected into the turbulent boundary layer of a high-temperature air flow past a plane surface through a porous plate inserted in the surface. The efficiency of this cooling technique in shielding plane surfaces from heating is discussed. The various factors and parameters affecting the shielding effect are analyzed. The cases where a boundary layer is absent or present upstream from a porous air inlet are considered. Procedures are described for heat transfer calculations in such cooling systems. Suggestions are given for promoting the shielding effect.

V.Z.

A71-33225 # Some aspects of the design of aircraft steering systems. A. Cameron-Johnson. *Aircraft Engineering*, vol. 43, June 1971, p. 7-10.

Analysis of oversteering effects in the nose wheels of aircraft in order to draw conclusions regarding the optimum geometric arrangement of a noseleg design. An equation is developed from which the torque required to balance the steering reaction moment is found. The task of designing the steering system will accordingly be eased by selecting a number of critical conditions for study. Comments are made concerning tire behavior, which is not predictable on the basis of rigid physical or mathematical laws, but changes from type to type and from make to make.

F.R.L.

A71-33226 # First lightweight disc brakes for a civil airliner. I. L. Stimson (Dunlop Co., Ltd., Coventry, England). *Aircraft Engineering*, vol. 43, June 1971, p. 12-14.

Discussion of Concorde wheel and brake problems, which revolve around the factors of weight and volume. The approach is to design to the lowest weight, but at the same time ensure that the wheel and brake are suitable for installation on both the fixed axle and the telescopic extending axle; that changes of type of heat pack can be accomplished without undue expense and inconvenience; and that the design is capable of being developed to give increased component lives. For the Concorde, the designs chosen for study were disk brakes of structural beryllium, segmented beryllium, and structural carbon.

F.R.L.

A71-33285 The teenage dilemma (Or, the prematurity years of a jet transport are the hardest). Fred A. Maxam and Ken Plewes (Boeing Co., Commercial Airplane Group, Renton, Wash.). In: *Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.* Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and

Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 2-10.

Reliability implications of the Boeing 747 program are reviewed, calling the adolescent years of the aircraft a 'teenage dilemma' in which economic pressures of flying and improving are in conflict. The reliability considerations covered include problem detection and identification, parts fabrication and installation, turnaround programs for modifications, severity index, malfunction reporting and repair methods, and airline operating variables. It is recommended that plans for future programs include careful considerations of the developments occurring during the prematurity phase.

V.Z.

A71-33286 Optimizing R & M in the airline support cycle. O. T. Fleig (American Airlines, Inc., New York, N.Y.). In: *Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.*

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 11-14.

Considerations are given concerning a sound allocation of effort and money to obtain the best results for the lowest cost in aircraft reliability and maintenance. Experiences with the DC-10 and Lockheed are reviewed in an attempt to find a basis for a rational tradeoff. The existence of a point of diminishing returns in R & M optimization of the airline support cycle is discussed. The difficulty of determining this point in the context of the many involved factors is noted as an obstacle to determining the optimal approach.

V.Z.

A71-33287 Reliability and maintainability - Their role in life cycle costs. Thomas J. Richert (Eastern Air Lines, Inc., Miami, Fla.). In: *Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.*

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 15-17.

General discussion of the meaning of reliability and maintainability as concepts in life cycle costs as applied to airline operations. High risk and ultraconservative design practices are considered to be examples of the cost of excess. Excessive maintainability is shown to increase costs because ineffective corrective actions decrease the available reliability and increase the expenditures for maintenance resources such as labor and materials. It is also pointed out that failures and their corrections affect income through public awareness and that high reliability and maintainability levels are essential to airline profitability.

V.Z.

A71-33297 DC-10 dispatch reliability - A new challenge for flight test. C. L. Stout (Douglas Aircraft Co., Long Beach, Calif.). In: *Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.*

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 100-103. 6 refs.

Methods of assuring component and subcontractor reliability prior to the flight test are discussed, using the concept of dispatch reliability as a criterion during the design and development phase of DC 10 manufacturing. A review is made of the development of a Failure Mode and Effects Analysis List and the subsequent Behavioral Objectives for Flight Officer Training and Evaluation Standardiza-

tion List to identify all the possible normal and abnormal aircraft operation modes prior to the first flight of aircraft. The Fault Isolation Analysis Program, the inflight FEF1 system, and the ground maintenance support system are also covered. The influence of these combined systems on the flight test program is explained and their impact on the direct maintenance costs of domestic flights is assessed. V.Z.

A71-33298 Evaluation of flight mission severity in cumulative damage. In: Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971. Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 104-113. 8 refs.

Discussion of an approach to obtaining information on the effects of cumulative damage mechanisms - Low Cycle Fatigue and Creep/Stress Rupture - which may escape detection by usual nondestructive testing techniques in the aircraft gas turbine industry. Essential in the new approach is the maintaining of close links between prediction, testing and field experience in the design stage of turbine manufacturing with particular attention to critical components, metallurgical relationships and computer software. This approach is designed as a more effective alternative to the present 'Hot Section Analyzer' approach in improving the prediction of component reliability in 'real' severe flight mission situations with cumulative damage. V.Z.

A71-33306 Life cycle costing applied in evaluating alternative short take-off and landing (STOL) aircraft and tracked air cushion vehicles (TACV) as modes of transportation. Craig H. Langwost (Grumman Aerospace Corp., Bethpage, N.Y.). In: Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 231-235. 7 refs.

Description of a concept selection and optimization methodology in which life cycle costs are included in evaluating alternative STOL and TACV system types and designs. This methodology entails selection of concepts upon economic factors and then optimizing alternative solutions within the concepts. Analyses of the variables makes possible determination of the optimum sizes, types, and numbers of vehicles required to operate a transportation system. STOL and TACV system costs and profits are compared, leading to the conclusion that either of the systems will satisfy the requirements of relieving traffic congestion and being profitable. F.R.L.

A71-33307 Role of life cycle costing in fleet planning decisions. W. C. Messecar (Pan American World Airways, Inc., New York, N.Y.). In: Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 236-240.

Description of a systems approach to flight equipment decisions based on four major problem elements: revenue, cost, investment, and passenger/cargo service. Each proposed aircraft retirement or purchase is evaluated as to its impact on these four elements. Life cycle costs are accounted for in both the operating cost and

investments required for flight equipment and related ground equipment. Examples of the relative importance of these cost elements in current flight equipment decisions are given, as well as examples on the importance of these costs in considering various service alternatives for a single aircraft type. F.R.L.

A71-33314 The use of a computer for predictions of MTTR of equipments supported by automatic test equipment. R. E. Hilton, Jr. (Radiation, Inc., Melbourne, Fla.). In: Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971.

Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 329-337. Contract No. N 00019-68-C-0449.

Description of a computerized program developed to predict elements of repair time for building blocks of the Versatile Avionic Ship Test (VAST) when these building blocks are tested as units under test (UUT). The prediction is based upon an analysis of the diagnostic software employed to isolate faults within the UUT. The program can be used for hardware which is designated to be tested by VAST and meets the requirements for VAST compatibility. The program can also be used for equipment designed to be tested by other automatic testing equipment (ATE) provided the diagnostic software logic for the UUT is described in a flow diagram similar to the diagnostic flow charts of the program design data of AR-9. F.R.L.

A71-33342 # Lift coefficient of an oscillating airfoil (Součinitel vztlaku na kmitajícím profilu). Vlastimil Rezek. *Zpravodaj VZLÚ*, no. 6, 1970, p. 5-12. 5 refs. In Czech.

A method of measuring unsteady flow in the compressible flow region and a technique for evaluating measurement records are presented. The results of measurements are compared with theory which is generalized for an arbitrary point of rotation of the oscillating airfoil. Measurements were carried out for $M = 0.4$ and 0.5 , at frequencies of 20, 30, and 40 Hz. The local lift coefficient has been determined from the measured pressure distribution along the airfoil. Semiconductor pressure gages were directly built into the NACA 0012 airfoil and used to measure the pressure on one of its sides. For this reason, the local lift coefficient has been evaluated only for the basic airfoil position - i.e., oscillating about an angle of attack of zero deg. O.H.

A71-33343 # Fatigue properties of aircraft structures (Únavové vlastnosti leteckých konstrukcí). Václav Kahánek. *Zpravodaj VZLÚ*, no. 6, 1970, p. 13-22. 8 refs. In Czech.

Fatigue properties which are mostly described in technical literature by stress-N (cycles) curves or High's diagrams are analyzed. Criteria for deciding which of the different curves are to be used for new aircraft structures are recommended, taking into account the severity of the notches present. Corrections for curve conversions to take into account other mean stresses and fatigue limits are presented. For trainer aircraft, the life estimate is derived as a function of the basic stress during horizontal flight, and as a function of the static factor of safety at the critical point of the structure. O.H.

A71-33344 # Designing a jet engine combustion chamber (K návrhu spalovací komory proudového motoru). Oldřich Schůrek. *Zpravodaj VZLÚ*, no. 5, 1970, p. 5-12. In Czech.

A technique for the preliminary determination of leading dimensions of a jet engine combustion chamber and of the necessary air supply is described. The technique consists in analyzing design parameters of a number of existing combustion chambers with good

A71-33345

performance characteristics. Four different typical combustion chamber systems are considered and their comparison is made using certain preselected geometrical criteria. It is shown that these criteria fit all the combustion chamber systems examined very closely. Using these criteria, the basic shape of a combustion chamber can be preliminarily determined. O.H.

A71-33345 # Dynamic stress of rotor blades of aircraft axial compressor stages with a low hub/diameter ratio (Dynamické namáhání oběžných lopatek stupňů leteckých axiálních kompresoru o malém nábojovém průměru). Zdenek Hujecek. *Zpravodaj VZLU*, no. 5, 1970, p. 13-21. 9 refs. In Czech.

The influence of the hub/diameter ratio on tuning of fixed rotor blades of axial compressor stages is examined. It is shown that in the case of a small hub/diameter ratio of a stage, the rotor blades resonate with the lowest harmonics of the blade revolutions. A decrease of the dynamic stress of the blades then becomes a serious problem; it can be solved primarily by suitable tuning and increased attenuation. A sliding-friction pin point is applicable only when the circumferential velocities are low. For velocities up to 300 m per sec, blades with a rolling-friction pin point are preferable. An elastic suspension and supplementary structural attenuation is suggested for the blades. A method for choosing the suitable size of a compressor stage with regard to tuning of its blades is proposed. O.H.

A71-33350 At Saint-Louis, French and German technicians reproduce 'bangs' and 'superbangs' at will (A Saint-Louis, les techniciens français et allemands reproduisent à volonté 'bangs' et 'superbangs'). *Air et Cosmos*, vol. 9, June 26, 1971, p. 24, 25, 27. In French.

Description of a 'bang generator,' basically a shock tube 189 m long, which can reproduce both in amplitude and duration the bangs of actual military aircraft and future SST aircraft. The apparatus consists of a test chamber, an absorber fitted with vents, a high pressure generator portion, and an expansion tube. In operation the high pressure portion is charged with compressed air. When the desired pressure is reached a paper membrane which closes the end of this portion is broken by combustion initiated by a network of resistance wires through which an electric current is passed. The resultant sound wave passes through the test chamber and dissipates itself in the absorber. The apparatus will make it possible to test the effects of the bang on audition, equilibrium, vision, and various other physiological processes. F.R.L.

A71-33376 Influence of the effects of rarefaction and of angle of attack on a three-dimensional obstacle placed in a rarefied hypersonic flow (Influence des effets de raréfaction et d'incidence sur un obstacle tridimensionnel placé dans un écoulement hypersonique raréfié). Jean Allègre, Didier Lartigue, and Marie-Françoise Scibilla (CNRS, Laboratoire d'Aérodynamique, Meudon, Hauts-de-Seine, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques*, vol. 272, no. 23, June 7, 1971, p. 1526-1529. In French.

Study of the effects of rarefaction and angle of attack by placing a delta wing in a flow with a Mach number of 8.1 and a pressure of 70 microns of mercury. The flow was obtained in a continuously functioning wind tunnel the Reynolds number of which was 2200 cm. At high angles of attack, taking account of the simultaneous increase of pressure, the gap between the experimental points observed and those obtained by the theory of oblique shock diminished. F.R.L.

A71-33403 An iterative, experimental and analytical method for determining dynamic characteristics of a weakly damped elastic body (Ein iteratives, experimentell-rechnerisches Verfahren zur Bestimmung der dynamischen Kenngrößen eines schwach

gedämpften elastischen Körpers). Helmut Wittmeyer (Saab-Scania AB, Linköping, Sweden). *Zeitschrift für Flugwissenschaften*, vol. 19, June 1971, p. 229-241. 10 refs. In German.

A new technique is described which is considered to be an improvement of the conventional static vibration test generally used in aircraft design. Its objective is to examine the excitation of the complex natural modes of a damped structure. The force groups which generate these complex natural modes in the case of periodic excitations are found by an iteration procedure in which experiment and theory alternate. The conventionally sought (real) natural modes of the undamped structure and the pertaining dynamic characteristics are then determined by a subsequent calculation. The technique is only little sensitive to errors of measurement. Its practical application is illustrated. O.H.

A71-33405 Influence of the aspect ratio on the instability and nonminimum phase effects of the longitudinal motion of aircraft (Einfluss der Flügelstreckung auf Instabilität und Allpasseffekte der Flugzeuglängsbewegung). Gunther Schänzer (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 19, June 1971, p. 247-250. 5 refs. In German.

In some aircraft disturbance and control transfer functions, a negative value of the expression $c_{sub A} - c_{sub W}$, in which $c_{sub A}$ denotes the lift coefficient and $c_{sub W}$ the drag coefficient, is shown to lead to phugoid instability and undesirable nonminimum phase effects. Parameters are discussed that are responsible for the negative sign in this expression. O.H.

A71-33407 Effect of program parameters on the fatigue life of heat-resistant material subjected to fatigue loading. V. N. Kufaeu and A. D. Pogrebniak (Akademiia Nauk Ukrainkoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR). (*Problemy Prochnosti*, vol. 2, July 1970, p. 17-21.) *Strength of Materials*, July 1970, p. 622-626. 5 refs. Translation.

Investigation of the durability of the heat-resistant EI 617 alloy, used for turbine blades, at elevated temperatures and under unsteady operational conditions. It is found that a decrease of step number in the program diagram with a simultaneous increase of the stress amplitude results in reduced durability of the alloy. The sequence of stresses adopted in the program diagram exerts a substantial effect on the durability. Depending on this sequence, the sum of relative durabilities can change from 0.43 to 1.70. A 'resonance' stress spectrum results in much more extensive material damage than during normal operation. Z.W.

A71-33416 The design of helicopter powerplants. H. C. Dabbadie (Turboméca S.A., Bordes, Basses-Pyrénées, France). *Aeronautical Journal*, vol. 75, June 1971, p. 379-381.

Advances accomplished in the design of gas turbine power plants for helicopters over the last twenty years are illustrated in a brief review of Turboméca helicopter engines from the first 140-hp to the latest 2000-hp power units. Some of the contributions of metallurgy and turbine design advances to improved engine characteristics are discussed, along with current and future development trends. M.V.E.

A71-33417 The sound of rotorcraft. J. W. Leverton (Westland Helicopters, Ltd., Yeovil, Somerset; Southampton, University, Southampton, England). *Aeronautical Journal*, vol. 75, June 1971, p. 385-397. 38 refs.

The general characteristics of the sound produced by rotorcraft are reviewed, with special emphasis on rotor noise. The relative importance of rotational (discrete frequency) noise and broadband noise is discussed, and narrow-band analysis results are examined that show the changes in spectral content attending variations in lift and tip speed. Measurements are also included that demonstrate the impulsive nature of rotor noise. The results of a recent full-scale test

of rotor noise directivity are compared with those of a model rotor and with directivity data derived from theory. Current prediction methods are summarized and their limitations pointed out. Some problems of rotor noise measurement are examined, and a special instrumentation set designed to overcome the difficulties involved is briefly discussed. M.V.E.

A71-33418 **The Ansty Noise Facility - Its design, instrumentation and future commitments.** J. L. Flintoff (Rolls-Royce, Ltd., Bristol, England). *Aeronautical Journal*, vol. 75, June 1971, p. 397-406. 10 refs.

Description of the noise research facility designed to investigate problems associated with fan and multistage compressor sound radiation. The design and absorptive characteristics of the facility's anechoic chamber, its power drive, test control, and sound recording systems are described, along with the real-time narrow-band-noise analysis system. The trend toward on-line acquisition of noise and aerodynamic data is discussed in the light of recent instrumentation advances. Subsonic and supersonic fan noise test results are presented, together with an interpretation of the buzz saw phenomenon. A brief review of programmed major research projects shows the flexibility of the test facility's power-speed envelope. M.V.E.

A71-33419 **The noise of rotorcraft and other VTOL aircraft - A review.** I. C. Cheeseman (Southampton, University, Southampton, England). *Aeronautical Journal*, vol. 75, June 1971, p. 406-412. 25 refs.

Noise characteristics and sources of V/STOL aircraft are discussed, along with the implications of noise reduction to acceptable levels. Noise prediction methods for various classes of aircraft are briefly reviewed and some noise reduction possibilities outlined. An attempt is made to show the penalties that could be incurred in designing to a fixed noise level. M.V.E.

A71-33420 **Aerodynamic loading induced on a two-dimensional wing by a free vortex in incompressible flow.** G. J. Hancock (Queen Mary College, London, England). *Aeronautical Journal*, vol. 75, June 1971, p. 413-416.

The loading is estimated on a two-dimensional wing at zero incidence at low speeds in incompressible flow. The loading is induced by a free vortex. A series solution, based essentially on a power series in terms of the strength of the vortex, is set up. Assuming that the velocities induced by the free vortex near the wing are small, the first two terms in the series solution are sufficient to indicate the loading. M.V.E.

A71-33442 **Synthesis of optimal control of an aircraft on the active phase.** V. Z. Bukreev. (*Kosmicheskie Issledovaniia*, vol. 8, Nov.-Dec. 1970, p. 846-854.) *Cosmic Research*, vol. 8, Nov.-Dec. 1970, p. 777-784. Translation.

Discussion of the problem of optimal synthesis of the angle of attack which will transfer any point in space to a point of maximum velocity. A solution to the problem is obtained with the aid of a required synthesizing function taken in the form of an approximating polynomial. It is shown that by using such a function, the problem of determining the angle of attack can be reduced to the Cauchy problem for a system of ordinary differential equations. The solution of the Cauchy problem defines the coefficients of an interpolation polynomial, which give (in the time period under consideration) the required function and, thereby, the angle of attack. V.P.

A71-33457 **The Westland Lynx.** John Speechley (Westland Helicopters, Ltd., Yeovil, Somerset, England). *VertiFlite*, vol. 17, June 1971, p. 2-6.

The Lynx exists in two basic variants - an Army utility, a multipurpose role for the British Army, and a naval, small-ship antisubmarine surface-search and strike helicopter. The concept of the Lynx is a reliable twin-engined, sophisticated, and fast helicopter. New technology has been introduced with the express purpose of achieving a high degree of reliability and low-maintenance demands. The principal areas of new technology include the nonarticulated rotor head, the application of conformal gearing to the transmission, stainless steel main rotor blades, the application of solid state electronics to the duplicated autostabilizer and automatic pilot facilities, and the new Rolls-Royce two-spool modular-concept power plant. G.R.

A71-33469 **Economics of propulsion systems for air transport. II.** David Huddie. *Esso Air World*, vol. 23, no. 5, 1971, p. 119-124.

Examination of the contribution of the propulsion system to operating economics. Direct operating costs account for more than half the total, and their downward trend is due to the greatly increased use of gas turbine engines and the bypass concept in particular. First cost, specific weight, fuel consumption, and maintenance cost are the primary parameters by which the engine manufacturer can affect the direct operating cost. The maintenance cost of an engine covers subsidiary aspects such as parts cost, maintenance labor, overhaul, maintainability, reliability, resistance to ingestion damage, salvage, and repair of parts. Engine reliability and traffic delays, and launching cost and market requirements are discussed. F.R.L.

A71-33470 **Canada has a word for it - STOL.** Tom Weissmann. *Esso Air World*, vol. 23, no. 5, 1971, p. 137-140.

Discussion of Canadian research and experiment leading to the development of safe, fast, and economic fixed-wing civil STOL aircraft. The DHC-7 'Quiet STOL' uses four gas turbine engines to drive large diameter propellers which combine with high-lift slotted flaps to give STOL performance with a low noise level. The augmentor wing concept, which makes use of a jet-powered lift-augmentor system based on the use of flown flaps is examined. The DHC-5 Caribou is being fitted out with two Rolls-Royce Spey engines and a suitable duct installation to test the concept. F.R.L.

A71-33475 **Fluidic systems design.** C. A. Belsterling. New York, Wiley-Interscience, 1971. 245 p. 103 refs. \$13.95.

Description of analytical procedures for the design of control systems using both analog and digital fluidic devices. The methods described pertain to gases, compressible liquids, and incompressible fluids; they are applicable to systems used in aircraft, spacecraft, land vehicles, automatic machines, computers, and tracking devices. Operating principles and component characteristics are described for vented and closed jet-interaction amplifiers, vortex amplifiers, boundary layer control amplifiers, impact modulators, wall attachment amplifiers, turbulence amplifiers, axisymmetric focused jet amplifiers, and passive logic devices. Analog and digital sensors, logic networks, and actuators are outlined. Static, large-signal, dynamic, and small-signal performance characteristics are examined at frequencies up to a level where the physical dimensions of the circuit approach the signal wavelength. Test methods and instrumentation, terminology, units, and graphical symbols are explained. T.M.

A71-33536 # **Operational dissipation of supercooled fog using liquid propane.** Larry Vardiman, Everett D. Figgins, and Herbert S. Appleman (USAF, Air Weather Service, Scott AFB, Ill.). *Journal of Applied Meteorology*, vol. 10, June 1971, p. 515-525. 5 refs.

This paper describes the equipment, the theory, and the results of an operational fog-dissipation system installed at Fairchild AFB, Washington, during the winter of 1969-70. An array of stationary ground dispensers was employed to determine the effectiveness of such a system for providing operational support to aircraft landings and take-offs. Usable clearing followed 25 of 29 seeding operations conducted to bring field conditions above minima. In 17 cases the clearings were conclusively the result of fog seeding. Natural clearing appeared to be at least partially responsible in the eight other cases. Seeding failed to produce usable results in four cases in which the temperature was 31 F or higher. In an additional five cases preventive seeding was carried out when initial conditions were above minima. In these cases no attempt was made to evaluate the results due to the uncertainty in knowing the conditions which would have occurred without seeding. A total of 68 aircraft departures and 35 landings were made possible during the project. (Author)

A71-33542 Emulsion and alkaline cleaning in the aircraft industry. J. L. Cody (Rohr Corp., Chula Vista, Calif.). *American Society for Metals, Materials Engineering Congress and Exposition, Cleveland, Ohio, Oct. 19-22, 1970, Paper C 70-4.3.* 19 p. Members, \$1.50; nonmembers, \$3.00.

Review of some of the cleaning agents, processes, and techniques applied to aircraft components in the course of their forming, fabricating, and assembly phases of manufacture. Several alloys of steel, titanium, and aluminum are shown to require different cleaning processes for removing various soils and contaminants. Cleaning processes and sequences usually employ a combination of different methods to obtain the desired cleanliness level. The use of emulsion and alkaline cleaning for various metal structures in the aircraft industry represents two of the basic procedures in the cleaning sequence. Diphasic, stable, and unstable emulsion cleaners and emulsifiable solvents are discussed, along with aqueous, electrolytic, spray, and soak-tank alkaline cleaning agents and techniques. Special steel, titanium, and aluminum cleaning sequences are reviewed.

M.V.E.

A71-33579 # Antiwear properties of jet fuels (Protivoiznosnye svoistva reaktivnykh topliv). I. V. Rozhkov, B. A. Englin, and E. S. Churshukov. *Khimiia i Tekhnologija Topliv i Masel*, vol. 16, no. 5, 1971, p. 55-60. 26 refs. In Russian.

Laboratory methods of evaluating the antiwear properties of jet fuels are described, together with the dependence of these properties on the fuel fractional composition and various physicochemical characteristics. The operational features of various friction test machines are outlined, and curves show the wear of components operating in the fuel as a function of dissolved oxygen, resin content, amount of heteroorganic compounds, and temperature. Electron work function measurements are discussed, together with the fabrication and use of antioxidation agents and other additives. T.M.

A71-33596 # Solution of the problem of an arbitrary-planform wing moving near a screening surface (Reshenie zadachi o kryle proizvol'noi formy v plane, dvizhushchemsia vblizi ekrani-ruiushchei poverkhnosti). S. D. Ermolenko and A. V. Rovnykh. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 5-14. In Russian.

The problem for the flow around the wing is solved in a nonlinear formulation, using a vortex model in which the wing is replaced by a system of oblique, horseshoe-shaped vortices. The attached portions of the vortices are located in the chord plane, and the free portions form certain angles with this plane which are determined from a condition for the coincidence of the vortex and the local velocity vector at the trailing edge of the wing. Aerodynamic characteristics are calculated for individual sections and for the wing as a whole. Comparisons are made with the linear theory and with experimental data for wings of different planforms over wide ranges of attack angles and distances between the trailing edge and the screen surface. The solution obtained can be applied to wings

moving both near the ground and near a smooth water surface, since it is shown that the latter can be treated as a solid wall without causing significant error. T.M.

A71-33604 # Design of 'prolonged lifetime' structures (Raschet konstruktivnoi 'povyshennoi zhivuchesti'). S. G. Muganlinskii. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 53-59. 9 refs. In Russian.

Description of a possible approach to the design of prolonged lifetime structures on the basis of the fatigue characteristics of individual elements in the structure. A probabilistic design method is developed for the example structures of monocoque and multispar wings. The proposed method makes it possible to determine the excess static strength of the structure or the number of individual elements required to ensure a given lifetime with a prescribed probability of catastrophic failure. T.M.

A71-33606 # The air flow behind a blade swirler in the flame tube of a gas turbine engine combustion chamber (Tehenie vozdukhza za lopatochnym zavikhrilem v zharovoi tube kamery sgoraniia GTD). G. M. Gorbunov, A. V. Peshkov, I. L. Khristoforov, and M. V. Emmil'. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 63-68. 6 refs. In Russian.

Consideration of certain features of the swirling flow in the forward part of a gas turbine engine combustion chamber. Among the factors examined are the shape of the jet emerging from the swirler, the static pressure distribution, and the turbulence intensity. A simplified model of a blade swirler is employed to shed light on the problem of matching the geometrical parameters of the front structure of the combustion chamber. The jets emerging from the interblade channels are shown to form the surface of a single-sheet hyperboloid. The shape of the generatrix of this hyperboloid is calculated, and the pressure distribution along this generatrix is determined. A.B.K.

A71-33607 # Determination of the gas temperature in the afterburners of bypass and turbojet engines which ensures a minimum specific fuel flow rate (Opredelenie temperatury gazov v forsazhnoi kamere dvukhkonturnykh i turboreaktivnykh dvigatelei, obespechivaiushchei minimal'nyi udel'nyi rashkod topliva). N. V. Pervyshin. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 69-77. In Russian.

Consideration of the dependence of the specific fuel flow rate on the degree of thrust augmentation at large flight Mach numbers in the case of bypass and turbojet engines with afterburners. Expressions are obtained for the thrust and fuel flow rate in bypass and turbojet engines with afterburners, and equations are derived for the afterburner gas temperatures corresponding to a minimum specific fuel flow rate. The effect of the flight speed and engine parameters on the optimal value of the afterburner gas temperature is ascertained. A.B.K.

A71-33609 # Effect of the ejection capacity of jets in the mixing zone on the peripheral nonuniformity of the gas temperature field at the outlet of the combustion chamber of a gas turbine engine (Vliianie ezheksionnoi sposobnosti strui v zone smesheniia na okruzhnuiu neravnomernost' temperaturnogo polia gaza na vykhode iz kamery sgoraniia GTD). Iu. A. Spiridonov and A. V. Talantov. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 86-93. 7 refs. In Russian.

Study of the effect of processes in the mixing zone on the peripheral nonuniformity of the gas temperature field at the outlet of a gas turbine engine combustion chamber in the presence of a fixed elongation of the gas collector and a temperature field inhomogeneity in the primary zone. An analysis is made of the effect

of the disruptive capacity of the jets on the peripheral nonuniformity of the gas temperature field at the combustion chamber outlet. A scheme for mixing of parallel jets in a channel of circular cross section is considered in order to explain the appearance of a singular point and the nature of the dependence of the disruptive capacity on the peripheral nonuniformity in the neighborhood of the singular point. A study is made of the effect of the jet momentum on the peripheral nonuniformity of the gas temperature field. A.B.K.

A71-33615 # A method of analytical design of blade cascades of axial-flow gas turbines (Metod analiticheskogo proektirovaniia profili lopatok oseykh gazovykh turbin). B. M. Aronov. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 129-136. 9 refs. In Russian.

Outline of a method of designing the contours of blade cascades forming arrays with convergent channels. A sequence for designing the contours of a blade cascade and verifying the characteristics of the array is suggested - namely, determination of the blade back spiral, formation of the inlet section of the blade back, construction of the inlet section of the blade face, formation of the outlet section of the blade face, calculation of the geometrical characteristics of the cascade, correction of the throat of the array, and channel verification and cascade correction. A.B.K.

A71-33617 # Calculation of the flow behind nozzles of given geometry (K raschetu potoka za soplami zadannoi geometrii). M. K. Matsutova. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 143-149. In Russian.

Determination of the gas parameters behind a nozzle arrangement with cylindrical bypasses at the blade roots and at various points along the periphery of the blades. It is recommended that the equation of radial equilibrium for the cross section beyond the nozzle array be written in a form which makes it valid not only for wide blades or blades with increasing α sub 1 angle but also for narrow blades or blades with decreasing α sub 1 angle. Using this equation, the law of change in the velocity along the radius is determined for the case of cylindrical streamlines. A.B.K.

A71-33621 # Calculation of the parameters of an aircraft angle of attack limiter (Raschet parametrov ogranichitelia uglov ataki samoleta). G. M. Trakhtenberg. *Aviatsionnaia Tekhnika*, vol. 14, no. 1, 1971, p. 160-166. In Russian.

Description of an automatic system for warning an aircraft pilot of an impending stall. The control law of a limiter designed to prevent an aircraft from exceeding the critical angles of attack is determined. The design of an aircraft angle of attack limiter is shown in conjunction with a kinematic diagram of the wiring required for controlling the longitudinal motion of the aircraft. A simultaneous solution is obtained for the nonlinear differential equations describing the dynamics of the aircraft and the angle of attack limiter. A.B.K.

A71-33721 # A technique which combines modified pattern search methods with composite designs and polynomial constraints to solve constrained optimization problems. B. F. Houston and R. A. Huffman (LTV Aerospace Corp., Dallas, Tex.). *Naval Research Logistics Quarterly*, vol. 18, Mar. 1971, p. 91-98. 5 refs.

Discussion of a method of selecting design parameters which optimizes a specific measure (aircraft design example: minimum weight, maximum mission effectiveness) and guarantees designated levels of response in specified areas (such as combat ceiling, acceleration time). The method employs direct search optimization applied to a nonlinear functional constrained by nonlinear surfaces. The composite design technique is combined with regression methods to determine adequate surface representations with a minimum of required data points. A sensitivity analysis is conducted at the optimum set of design parameters to test for uniqueness. G.R.

A71-33875 Future of structural alloys in airframes. *SAMPE Journal*, vol. 7, June-July 1971, p. 23-25.

Summary of a panel discussion on future developments in the use of aluminum, titanium, and beryllium alloys for airframe structures. It is stressed that more attention should be paid to techniques for synthesizing desired structures and for anticipating failure. Needed improvements in the structural efficiency of titanium alloys require solutions to problems of heat treatment and stress relieving. NDT techniques must be developed to determine required treatment levels. Materials evaluation programs are considered from the viewpoint of safely applying new materials to airframes. T.M.

A71-33993 # Procedure for studying the vibrations of plane cascades of turbomachines in high-temperature gas flows (K metodike issledovaniia kolebani ploskikh reshetok turbomashin v vysokotemperaturnykh gazovykh potokakh). A. A. Kamirer and N. Ia. Nastenko (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR). *Problemy Prochnosti*, vol. 3, May 1971, p. 111-113. In Russian.

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.

A71-34001 # In-flight flow research on a fighter type aircraft. N. G. Wages (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-762*. 13 p. 28 refs. Members, \$1.50; nonmembers, \$2.00.

Measurements of wing chordwise pressures, skin friction, trailing edge boundary profiles and tuft flow patterns were made on a model F-4D aircraft in transonic flow. Data were obtained for level and stabilized turns at constant angle of attack just above buffet onset between Mach 0.8 and 0.95 at 25,000 and 35,000 ft altitudes. Additional data were obtained for several wind-up turns at maximum angle of attack. Multiple shocks were found to exist on the wing. Regions of separated flow were defined and the local skin friction was obtained by the boundary layer rake and a yaw-Preston tube device. Chordwise pressure distributions were studied for the effects of Reynolds number, Mach number, and angle of attack. Theoretical and flight test comparisons of the pressure distributions and boundary layer history over the wing were also investigated. Calculations using a three-dimensional potential flow method developed by Woodward and a two-dimensional Weber-Sinnott method transformed to corresponding three-dimensional conditions, were compared with a measured flight pressure distribution. The experimental pressure distributions were also used in boundary layer calculations by a compressible finite difference method and an integral method in order to generate boundary layer histories. The calculated boundary layer profiles at the trailing edge were compared with the measured profiles. Limited wind tunnel data were also compared with flight results. (Author)

A71-34002 # Air superiority with controlled configured fighters. R. B. Jenny, F. M. Krachmalnick, and S. A. LaFavor (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-764*. 10 p. Members, \$1.50; nonmembers, \$2.00.

Potential benefits that accrue to air superiority fighters by integrating automatic feedback control system technology into the design have been studied using the F-4 as the baseline configuration.

A71-34003

Configuration changes and reduced static stability margins were investigated along with the use of unconventional control surfaces. Results indicate that reductions in trim drag from reduced tail-off static stability are significant at maneuvering load factors. Maneuverability improvements are achieved by reduction in drag and structural loads, and by improved controllability. These concepts enhance air superiority, and by application throughout the design can result in a smaller, lighter, and more economical fighter. (Author)

A71-34003 # Problem feedback for design improvement of Naval Airborne weapons systems. A. J. Armbrust (U.S. Navy, Naval Air Rework Facility, San Diego, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-765.* 13 p. Members, \$1.50; nonmembers, \$2.00.

An outline is presented of the activities of the Naval Air Rework Facility at North Island, the primary mission of which is to provide Fleet support through the rework of combat first line aircraft, engines, and components. The presentation spans the various technical disciplines, with the intent of providing clarifying feedback of operational performance to help eliminate future costly defects and to accomplish a higher degree of reliability. Actual cases are discussed in detail, illustrating specific chronic critical problem trends that show up during maintenance or repair or as the findings of accident or incident investigations. O.H.

A71-34004 # The new military flying qualities specification - A valid design tool. C. C. Brady, J. Hodgkinson (McDonnell Aircraft Co., St. Louis, Mo.), and R. K. Wilson (USAF, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-766.* 13 p. 21 refs. Members, \$1.50; nonmembers, \$2.00.

MIL-F-008785A (USAF), a recent revision to the Flying Qualities Military Specification, has been evaluated by conducting a detailed comparison of its requirements with quantitative data and qualitative pilot comments from available flight tests of the McDonnell Douglas F-4. Relevant F-4 data were available to evaluate a total of 77 individual requirements. This paper presents some of the more significant results by illustrating the validations conducted on selected requirements, either substantiated or otherwise. It is concluded that this revision to the Flying Qualities Specification is a significant improvement, in most areas, over its predecessor. (Author)

A71-34005 *# VTOL aircraft control power costs. Myron A. Hoffman (California, University, Davis, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-768.* 8 p. 18 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-05-004-051.

The problem of assessment of the penalties on the VTOL aircraft gross weight and direct operating costs (DOC) as a result of additionally installed power for control purposes is examined. In order to assess how important the cost of control power is, three computer programs have been written which design three types of VTOL transports and compute the DOCs. The calculations indicate that the DOC is increased by only about 0.5% for a 1% increase in available control power. Results are also obtained which indicate what improvements in airframe and engine technology are required to offset the cost increases due to various control power safety margins. O.H.

A71-34006 # Methodology for structural optimization of STOL aircraft vertical stabilizers. Bertram C. Wollner (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics*

and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-769. 7 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

A method is described for selecting the optimum vertical surface configuration for STOL transport configurations, based upon structural weight and performance requirements. A minimization technique, using the Fiacco-McCormick penalty function is used to obtain a solution based upon minimization of an objective function. Design loads for the vertical surface are considered to be defined by the requirement for trim under an engine failure condition. Since structural weight is configuration sensitive, the optimum surface is defined by this condition. Variables include maximum surface deflection and control surface chord ratios. Structural strength requirements are established for a range of configurations typical of STOL aircraft designs. Structural weight is defined in terms of applied load, stabilizer configuration and relevant design parameters. This relation defines an objective function which is minimized in determining the optimum stabilizer configuration based upon structural weight. The system derived is solved using the SLUMT algorithm of Fiacco and McCormick with the Powell direct search technique for constrained nonlinear optimization. (Author)

A71-34007 # An in-flight investigation of lateral-directional dynamics and roll control power requirements for the landing approach. G. Warren Hall and Edward M. Boothe (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-771.* 10 p. 5 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. AF 33(615)-69-C-1664.

Lateral-directional handling qualities and roll control power requirements for executive jet and military Class II 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. It was found that the ranges of lateral-directional dynamics investigated do not establish a limiting crosswind value. Roll control power requirements were determined from pilot control usage data and an investigation of the effects of limited roll control power. Available roll control power can establish a limiting crosswind component. A detailed comparison with MIL-F-8785B(ASG) requirements generally shows the present requirements to be too conservative in the landing approach phase. (Author)

A71-34008 # An approach to stall/spin development and test. Collet E. McElroy and Patrick S. Sharp (USAF, Flight Test Center, Edwards AFB, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-772.* 13 p. 13 refs. Members, \$1.50; nonmembers, \$2.00.

Operational experience with maneuvering-type aircraft has indicated that previous approaches to design development and flight test have not sufficiently emphasized the requirements of departure resistance and spin avoidance. A new approach to stall/post-stall testing, utilized on a recent F-4E stall/near stall investigation which influenced new design and demonstration specifications, is presented. Observations are made concerning mass distribution and high angle-of-attack aerodynamic design features as they relate to the post-stall characteristics of various maneuvering-type aircraft. Design and test guide-lines are presented in a systematic approach which stresses the requirement for good stall/post-stall characteristics. (Author)

A71-34009 # Harrier development from the flight test point of view. J. F. Farley (Hawker Siddeley Aviation, Ltd., Kingston-on-Thames, Surrey, England). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle,*

Wash., July 12-14, 1971, Paper 71-773. 11 p. Members, \$1.50; nonmembers, \$2.00.

Harrier flight testing is traced from the first flight of the P.1127 prototype in 1960 through the Kestrel Tripartite squadron aircraft of 1965, up to the Harrier release to RAF service in 1969. It is shown that while the V/STOL development problems were novel for a close support jet strike aircraft, they were in fact easily overcome. By contrast the problems that were met in the conventional flight envelope were considerable and involved much flying and redesign.

O.H.

A71-34010 # Development of the F-15 integrated data system. Robert D. Samuelson and Eugene J. Zehr (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-774.* 10 p. Members, \$1.50; nonmembers, \$2.00.

The F-15 integrated data system is designed to provide final flight test data within 24 hours after flight. Major elements of this system, including the airborne instrumentation, preflight checkout system, and the data processing system, are integrated by a ready-access computerized data file. The airborne equipment includes a central unit memory that is loaded from a preflight console. Both preflight setup of the airborne instrumentation and processing of the flight tape are accomplished through a common set of punched cards. System development involves both ground and flight tests to assure a fully developed system prior to first flight of the F-15.

(Author)

A71-34011 # Potential new methods of atmospheric turbulence prediction with design criteria updating benefits for gust sensitive aircraft. James D. Yost, Wayne B. Jackson, and L. Wayne Salter (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-775.* 11 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

New atmospheric turbulence prediction techniques have been developed to define both the existence and magnitude of turbulence. These empirical methods were developed from the vast amount of recorded atmospheric turbulence data in several forms. Early data from aircraft response to turbulence was collected, primarily by NACA, onboard Civil Transport Aircraft. Recently, the gust probe method has been used in a number of programs to define atmospheric turbulence magnitude under a variety of conditions. These atmospheric turbulence environment data used in empirical prediction techniques provide potential improvement in gust design criteria and in avoidance planning of high risk flight regions.

(Author)

A71-34012 # The application of elasto-plastic notch stress analysis to improve cumulative damage predictions. John M. Potter (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-776.* 8 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

A new combination of the Neuber elastoplastic notch relation and material property data is proposed and investigated for a general graphic analysis of notch residual stress level. The technique is applied to 2024-T4 aluminum alloy. The resulting stress analysis is shown to accurately reflect notch stress levels by comparison with published notch stress levels. Life to failure predictions based on the graphically derived notch stress levels compare very favorably with constant stress amplitude notched coupon results. Application of the method of spectrum loading to demonstrate quantitative fatigue life effects of overloading and ground-air-ground cycles are discussed.

(Author)

A71-34013 # Techniques for predicting the structural vulnerability of combat aircraft to ballistic impact. Jay Meiselman (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), G. Thomas Burch, Jr., and John G. Avery (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-777.* 16 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.

Presented are results of a combined analytical and experimental program to develop a model capable of predicting the effects of projectile impact on aircraft structure. The model provides information on target penetration, damage size and structural response following impact, and predictions of the projectile postimpact state. Target penetration is represented by a ballistic limit equation, while the damage size is bounded by a pair of empirical curves. Structural response predictions are provided for both fracture at time of impact (impact fracture) and residual strength of impact-damaged targets (residual static fracture). Projectile postimpact state is described in terms of trajectory and structural configuration. The model was developed for small-arms ammunition, and provides good prediction for .30, .50 caliber, and 20 mm projectiles on aircraft materials such as 7075-T6, 2024-T3, 2024-T81 aluminum, and 6Al-4V titanium.

(Author)

A71-34014 # Advanced composites - The aircraft material of the future. H. C. Schjelderup and D. M. Purdy (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-779.* 8 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

Details are presented on why structural weight saving is important to improved performance transport aircraft. After assessing the value of saving weight, the pacing items of design concepts, service experience, manufacturing methods, and quality assurance are discussed. A new class of recently developed materials, advanced composites, is shown to open the possibility of significant reduction in the structural weight. Among them, in particular, graphite/epoxy is shown to be a strong candidate to displace aluminum as the prime aircraft structural material.

O.H.

A71-34015 # The performance benefits derived for the supersonic transport through a new approach to stability augmentation. W. T. Kehrer (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-785.* 10 p. Members, \$1.50; nonmembers, \$2.00.

The U.S. SST has derived substantial benefits in performance and operational safety as a result of development of a stability augmentation system (SAS) that achieves the reliability of basic structure. This system, termed 'hard SAS' (HSAS), is used to back up the normal SAS. It has permitted a further aft placement of the operational center-of-gravity (cg) range than could otherwise be considered. The resulting savings in aircraft weight and drag have netted 225 mi of range improvement plus reduced takeoff and landing speeds and reduced community noise. Improved operational safety also results from the integration of the HSAS concept into the flight control system. HSAS makes it also possible to decelerate, descend, and land, with the cg remaining at the supersonic cruise location, in the event of failure to transfer aft tank fuel forward. Also, HSAS provides safe handling qualities throughout the flight envelope, and a safe control in the event of shut-down of all SAS channels.

O.H.

A71-34016 # Longitudinal analysis of two CCV design concepts. B. T. Kujawski, Jerry E. Jenkins, and D. C. Eckholdt (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper*

A71-34018

71-786. 11 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

Results are presented of an investigation into the longitudinal control requirements due to simultaneous application of relaxed static stability (RSS) and maneuver load control (MLC). Two Control Configured Vehicle (CCV) design concepts - i.e., concepts involving the application of advanced flight control techniques to permit the relaxation of certain traditional design constraints - are considered. A previously described dynamic response criterion is applied first to a fighter-type aircraft, with the exception that the duration of the maneuver is selected based on the short period response requirements for acceptable handling qualities. The approach to MLC was modified to include directly the effects of induced drag. This provided improved capability to investigate the tradeoffs between wing-root-bending alleviation, drag, and longitudinal trim change. As a result of the new approach, improved solutions were found for a bomber configuration previously investigated. O.H.

A71-34018 # **Advanced data acquisition systems in support of the DC-10 flight test program.** C. L. Stout (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-788.* 6 p. 7 refs. Members, \$1.50; nonmembers, \$2.00.

Innovations introduced by the Douglas Aircraft Company to improve both the speed and accuracy of the DC-10 test program are described. It is shown that the achievement of major objectives of this test program in advance of established schedules has been made possible primarily by the use of time-saving facilities and services incorporated in the company's new Engineering Development Center. A data acquisition and processing system, which is part of the Data Center, provides real-time monitoring and rapid assessment and reduction of flight test data. During test flights, the Data Center is manned by a supervisory Engineering Pilot, data monitors, data analyzers, data plotters, and communication technicians. Each test aircraft can telemeter 800 channels of information to the Data Center. A company-owned Category II instrument landing system, used in conjunction with a unique ground-based laser tracking system, provides the capability for automatic flight control optimization and accurate aircraft flight path and performance assessment. O.H.

A71-34019 # **A lateral directional oscillation problem in a conventional STOL aircraft.** M. Sivan (Israel Aircraft Industries, Ltd., Lod Airport, Israel). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-792.* 7 p. Members, \$1.50; nonmembers, \$2.00.

Unpleasant lateral directional oscillations of small amplitude were detected during an early flight test phase of a new 12,500 lb, twin turboprop STOL aircraft with non-powered control circuits. A combined effort (wind tunnel tests, flight tests, analog simulation and numerical calculation) was performed to understand the phenomena. This was traced to a limited cycle oscillation of the rudder, due to interaction between aerodynamic hinge-moments and friction. This limited cycle rudder oscillation caused aircraft oscillations in lateral directional plane. The problem was solved by changing the aerodynamic characteristics of the rudder balance. The paper presents briefly the specific aircraft data, flight test and simulation procedures. The limited cycle oscillations are discussed in their specific appearance in aircraft control circuits. Comparison between approximate theory and actual experience is given. The specific case is described as an example. (Author)

A71-34020 # **Inertially augmented approach and landing systems.** R. J. Pawlak (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-795.* 14 p.

12 refs. Members, \$1.50; nonmembers, \$2.00. FAA-sponsored research.

A spectrum of automatic landing system designs which utilize inertial navigation system derived translational state information has been developed and analyzed by simulation of a transport aircraft operating with the current instrument landing system. The landing performance improvement predictions and system implementation requirements of each design will be presented and compared. The hardware mechanization and extensive flight testing of one particular design of the spectrum studied will be described. Flight results will be presented which verify the simulation models used and validate the significant level of performance improvement predicted to be attainable through use of inertial augmentation concepts. (Author)

A71-34021 * # **Three-dimensional, minimum-time turns for a supersonic aircraft.** J. K. Hedrick and A. E. Bryson, Jr. (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-796.* 9 p. 9 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGL-05-020-007.

Using an energy-state approximation, altitude, bank angle, and thrust programs are determined which minimize the time required for a particular aircraft capable of speeds up to M 2 to turn through a specified heading angle and reach a specified energy. Charts of bank angle and altitude are given as functions of energy and heading-angle-to-go. Significant savings in time are thus obtained compared to turns using simpler implementations such as constant altitude, constant velocity, and/or constant bank angle. O.H.

A71-34023 # **The optimization of man-powered aircraft.** John H. McMasters (Purdue University, West Lafayette, Ind.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-798.* 13 p. 25 refs. Members, \$1.50; nonmembers, \$2.00.

The existing man-powered aircraft (MPA) designs and operational problems encountered by those aircraft which have flown are briefly reviewed. Theoretical aspects of MPA design are discussed, and the state-of-the-art in technology relevant to MPA design is described. Finally, two examples which demonstrate the nature of the tradeoffs in the British Kremer Competition MPA design are presented. O.H.

A71-34024 # **Some matters influencing the future of aviation.** R. L. Lickley (Hawker Siddeley Aviation, Ltd., Kingston-Thames, Surrey, England). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-799.* 11 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

Technical, financial and environmental constraints are discussed in the context of future developments in aviation. The topics include constraints on the manufacturer and purchaser, design, development and test costs, noise, airport locating, and multinational aircraft designs such as the M.R.C.A. and the A.300B Airbus. Unification of international efforts in aircraft designs is urged. V.Z.

A71-34025 # **The case against engine-out flight training.** T. G. Foxworth and H. F. Marthinsen (Air Line Pilots Association, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Design and Operations Meeting, 3rd, Seattle, Wash., July 12-14, 1971, Paper 71-793.* 19 p. 31 refs. Members, \$1.50; nonmembers, \$2.00.

Because almost all fatal training accidents of air carrier jets involved engine-out operations, this paper examines those factors which led to these accidents including minimum control speed certification requirements and training procedures. Human factors

involved in the conduct of engine-out operations are discussed. Certification and operation requirements of military and foreign authorities are compared with those of the FAA. It is concluded that if changes are not introduced into either the certification requirements or the training procedures, engine-out training in the aircraft must be discontinued if similar accidents are to be eliminated in the future. (Author)

A71-34079 **Carousel IV in the 747.** B. J. Calvert (British Overseas Airways Corp., London Airport, Hounslow, Middx., England). *Flight International*, vol. 100, July 1, 1971, p. 16, 17.

Discussion of the Carousel IV inertial navigation system which consists of the inertial navigation unit (INU), the battery unit (BU), the mode selector unit (MSU), and the control and display unit (CDU). The information which can be displayed is track and ground speed, heading and drift angle, cross-track error and track angle error, position (in latitude and longitude), any of the stored waypoints (in latitude and longitude), distance and time to go, wind velocity, and desired track and status (progress of alignment or malfunction). Carousel IV's accuracy history has been encouraging, and the reliability rate is highly satisfactory. F.R.L.

A71-34100 **The 'bang' of supersonic aircraft (Le 'bang' des avions supersoniques).** J.-C. Wanner (Direction Technique des Constructions Aéronautiques, Service Technique Aéronautique, Paris, France). *Air et Cosmos*, vol. 9, July 3, 1971, p. 24-26. In French.

Summary of research work conducted in France on supersonic bangs. It is concluded that, if a number of conditions are observed, that bang of a transport aircraft flying at Mach 2 will be very weak, hence flights over inhabited areas appear feasible. However, transonic aircraft flying between Mach 1 and 1.2 may generate violent bangs. F.R.L.

A71-34101 **Hawker Siddeley Aviation's latest civil V/STOL aircraft projects. II (Neueste zivile V/STOL-Flugzeugprojekte von Hawker Siddeley Aviation. II).** T. K. Szlenkier (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). *Flug Revue/Flugwelt International*, July 1971, p. 35-38, 43-46. In German.

The recently presented review of Hawker Siddeley's projects is continued with a description of a STOL aircraft with mechanical flaps. A summary is also given of Hawker Siddeley's research work on STOL jet aircraft conducted until the end of 1970. Detailed attention is then given to a STOL transport aircraft with lift fan engines, referred to as Project No. 147. Its design parameters are discussed in terms of weights and flight performances, noise levels, and safety and comfort standards. A comparison with other STOL designs is also given. Finally, development activities concerning the Hawker Siddeley's V/STOL wind tunnel are reviewed, some problems inherent in V/STOL economy and operation are considered, and some arguments in favor of fan STOL and V/STOL systems are presented. O.H.

A71-34123 # **An electronically scanned aircraft antenna for satellite navigation (Antenne avion à balayage électronique pour la navigation par satellite).** J. Roger (Thomson - CSF, Division Radars de Surface, Bagneux, Hauts-de-Seine, France). *Revue Technique Thomson - CSF*, vol. 2, Dec. 1970, p. 533-550. In French.

Description of experiments made with a cruciform slot-array antenna designed to equip aircraft for satellite-controlled navigation aid (Project Dioscures). A description is given of a bench model of the antenna in which the array consisted of sixteen slots arranged in cruciform fashion to radiate circularly polarized waves. A.B.K.

A71-34149 * # **A comparative study of three axisymmetric inlets for a hypersonic cruise mission.** Daniel P. Bencze and Norman E. Sorensen (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Aircraft*, vol. 8, July 1971, p. 516-522. 11 refs.

Examination of the relative merits of three different axisymmetric inlet systems suitable for turboramjet-powered hypersonic cruise vehicles. The differences among the three inlets were centered in their off-design airflow characteristics, and these differences were in turn reflected in the spillage and cowl drags of each inlet. To achieve these different airflow characteristics, two of the configurations utilized a forward translating cowl to achieve a reduction in contraction ratio, while the third utilized a forward translating centerbody. The comparisons were based on the range performance of a blended-body, hydrogen-fueled, Mach number 6.0 cruise vehicle. The forward translating centerbody system was found to be superior. With this system, the vehicle achieved 13.6% greater range than with either of the two forward translating cowl systems. A parametric study was then performed to determine the vehicle's range sensitivity to various inlet performance parameters for the vehicle configured with the forward translating centerbody inlet. The parameters investigated included the inlet total-pressure recovery, the performance of the boundary-layer bleed system, the inlet transonic airflow capability, and the cowl pressure drag. Although no single inlet performance item had a dominant influence on the vehicle's range capability, taken collectively, the effect of improving the various aspects of inlet performance can be substantial. (Author)

A71-34150 # **General instability of eccentrically stiffened cylindrical panels.** George J. Simitzes (Georgia Institute of Technology, Atlanta, Ga.). *Journal of Aircraft*, vol. 8, July 1971, p. 569-575. 17 refs.

General instability of eccentrically stiffened thin cylindrical panels under the action of three types of applied loads is investigated. The three loads are uniform axial compression, uniform hoop compression or lateral pressure, and uniform shear. The analysis is based on a small-deflection theory for orthotropic shells which includes effects of stiffener eccentricity. Stiffener spacing is assumed to be sufficiently small (smeared technique), the stiffener geometry is taken to be uniform, and the skin-stiffener connection is assumed to be monolithic. The Galerkin procedure is employed to solve the buckling equations of the stiffened panels for the case of classical, simply supported boundaries. Critical loads were calculated from the resultant equations for two geometries: unstiffened isotropic panel and typical panel of the C-141 fuselage. Effects of stiffener eccentricity, panel aspect ratio, and the curvature parameter are shown in graphical form. When the initial curvature is set to zero, the results are applicable to flat rectangular simply supported plates. Finally, the C-5A Galaxy fuselage geometry was checked and shown to be safe for general instability failure. (Author)

A71-34151 # **Advantage of testing aircraft rotor models with sharply deflected wakes in water.** Theodore R. Goodman and August F. Lehman (Oceanics, Inc., Plainview, N.Y.). *Journal of Aircraft*, vol. 8, July 1971, p. 585, 586. 8 refs.

Correct simulation of rotor lift characteristics at much less wall interference and availability of a bubble technique for rendering tip vortices are the advantages shown to render the use of a water tunnel preferable to that of a wind tunnel in testing helicopter rotor models. A further advantage is the possibility of using a considerably smaller tunnel test section in relation to the size of the model in water than in air. M.V.E.

A71-34152 **Dogfighter-plus.** Michael Pelehach, Joseph Rees, and Robert W. Kress (Grumman Aerospace Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 12-17.

Eight specific design configurations were evaluated before settling on the current F-14 version with podded engines and a high

A71-34153

variable-sweep wing. The evolution of the selected design version is described in terms of major improvements incorporated in the development program. A convergent-divergent iris nozzle was selected to increase supersonic maximum afterburner thrust at no penalty in cruise fuel flow. Additional improvements included closer positioning of the nacelles, forward shift of the fuselage depth, increased wing area, reduced wing aspect ratio, addition of the Mach Sweep Programmer, incorporation of direct lift control for carrier approach, and improved treatment of wing-nacelle relationships.

T.M.

A71-34153 **A fighter in half the time.** Frank G. Edwards, Sam Fletcher, and Joseph Hannan (Grumman Aerospace Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 17-20.

Description of the program, facilities, and instrumentation used in structural, powerplant, avionics, performance, and carrier suitability tests of the F-14 aircraft. Early stages of flight testing are scheduled to be performed in Calverton, N.Y. Dynamic performance testing at this facility will reduce test time requirements by providing data in one flight that previously took five flights to obtain. Inflight refueling will be used to further reduce the number of development flights. Flight test instrumentation is built around a new PCM system, and telemetered data will be processed by computers and displayed in real time. A laser ranging theodolite is to be used. Tests at Point Mugu, Calif., provide for evaluation of subsystems in dynamic flight conditions, playback of special flight-test situations for ground evaluation and resolution, and integration of selected subsystems before installation in the F-14. Specific tests to be performed are discussed in detail.

T.M.

A71-34154 **Most reliable and supportable aircraft ever.** Ed Dalva, Emerson Fawkes, and Dean Swain (Grumman Aerospace Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 21-25.

The integrated logistics support program for the F-14 aircraft involves management of the integration of all support elements within themselves and with the weapons system or equipment requirements in order to maximize operational readiness at optimum cost. Support elements to be integrated include (1) maintainability and reliability, (2) planned maintenance, (3) support equipment, (4) spares and repair parts, (5) transportation and handling, (6) technical data, (7) facilities, (8) personnel and training, (9) contract maintenance, (10) funding, and (11) management data. The management control measures for this program are outlined, together with the main aspects of cooperation with the U.S. Navy.

T.M.

A71-34155 **Truer, deadlier punch.** Alexander D. Alexandrovich, Robert S. Mullaney, and Joseph Rodriguez (Grumman Aerospace Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 26-29.

Description of the avionics systems used for weapons control in the F-14 fighter aircraft. The aircraft's armament includes short- and long-range air-to-air missiles, air-to-ground rockets, guided and unguided bombs, and a gun. Multiple targets can be tracked (track-while-scan function), and the sighting aids consist of visual, optical, IR, radar, TV, and other systems. Ground mapping, terrain avoidance, IFF, and rendezvous radar functions are available, while the navigational aids include inertial navigation, TACAN, ADF, central air data computer, and a radar altimeter. Communications systems are detailed, together with onboard checkout equipment. The survival capabilities of the F-14 are outlined in terms of redundancy features, armor, and automatic fault detection.

T.M.

A71-34156 **Cornered composites and tamed titanium.** Ira Grant Hedrick, Larry Mead, and William Rathke (Grumman Aero-

space Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 30-37.

Description of industrial processes used to fabricate difficult-to-form titanium and composite components for the F-14 aircraft. An advanced hot-forming process was developed that permits forming of titanium sheet metal parts from developed flat pattern blanks in one operation without initial cold preforming. This was accomplished by incorporating a die-cushion system in the lower bed of each of two conventional, four-column hydraulic presses, and by adding an electrically heated platen. Two new C-frame hot-forming presses are described, together with chemical milling operations. The use of electron beam welding to join major airframe elements is explained, and skin fabrication procedures are detailed. A boron composite wing box structure is discussed in terms of the basic fabrication procedures utilized.

T.M.

A71-34157 **Fast, quality production at low cost.** Corwin H. Meyer, Bill Lamberta, and Joseph L. Cipp (Grumman Aerospace Corp., Bethpage, N.Y.). *Grumman Horizons*, vol. 9, 1970, p. 38-43.

The philosophy governing product manufacturing for the F-14 aircraft aims at speeding up the work flow by reducing the scope and number of tasks in final assembly and by placing them farther back in the subassembly buildup. The aircraft will be built on a modular basis. Each major structural component of the aircraft will be a self-contained unit, completed as an end-product configuration. Each major module will be assembled and tested in its own area so that upon completion, it will be functionally ready for joining and final assembly. Built-in producibility features which help attain minimum manufacturing cost include modular airframe construction, cast canopy frames, a split cockpit section, a flat-walled fuselage centerbody, a simple hinged wing flap, limited use of machined titanium bulkheads, an integrated wire termination system, high-density harnessing, selective equipment locations, an electronic data automation system, and automatic circuit checkout.

T.M.

(AD-721155; MTP-7-3-064) Avail: NTIS CSCL 1/3

Procedures are specified for evaluating the effectiveness of visible and infrared searchlights mounted on fixed and rotary wing aircraft during tactical support army missions. Author (GRA)

STAR ENTRIES

N71-26920# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

A WIND TUNNEL INVESTIGATION OF THE FORCES ACTING ON AN EJECTOR IN FLIGHT Final Report

Brian Quinn Dec. 1970 97 p refs

(AD-721192; ARL-70-0141) Avail: NTIS CSCL 20/4

The lift and drag forces experienced by an ejector in a wind tunnel were measured and correlated with the geometry and static performance of the device. Lift forces in excess of three times the total static thrust are readily obtained at moderate tunnel speeds and with very little penalty in increased drag. Whereas the primary mass flowing to the ejector remained constant, pressure surveys at the exit plane of the ejector indicated a reduction in total pressure with increasing tunnel speed. Author (GRA)

N71-26802# Federal Aviation Administration, Washington, D.C.
TRANSPORTATION AND COMMUNITY VALUES

John H. Shaffer 16 Apr. 1971 38 p Conf. held at Warrenton, Va., Mar. 1969; sponsored by NAS-NRC

Avail: NTIS

An overview is presented of the problems of transportation as they relate to community values. The information contained is based on a study of the social problems associated with the construction of new surface transportation facilities. Since a large degree of commonality exists in the social implications and community involvement considerations for the construction of surface transportation facilities and those for air facilities, the material is applicable to, and in part oriented towards, the airport development problem. Two community airport cases are included as illustrations of successful community planning and local/Federal Government cooperation. D.L.G.

N71-26951# Advisory Group for Aerospace Research and Development, Paris (France).

SMALL GAS TURBINES FOR HELICOPTERS AND SURFACE TRANSPORT

May 1971 141 p refs

(AGARD-LS-46-71) Avail: NTIS

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N71-26952# Army Materiel Command, Washington, D.C. Ground Mobility Div.

MILITARY AND CIVILIAN NEEDS FOR SMALL GAS TURBINES

Donald D. Weidhuner /n AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 11 p

Avail: NTIS

The most important consideration in the selection of a power plant for any application is to maximize return on investment, or to maximize cost effectiveness; it must be indicated that the small gas turbine can yield more return or profit while satisfying

N71-26804# Radio Technical Commission for Aeronautics, Washington, D.C.

A NEW GUIDANCE SYSTEM FOR APPROACH AND LANDING, VOLUME 1

18 Dec. 1970 80 p

(DO-148-Vol-1) Avail: NTIS; RTCA Secretariat, Suite 655, 1717 H St., N.W., Washington, D.C. 20006 \$10.00

Recommendations for a new microwave scanning landing guidance system (LGS) are presented. The recommendations are based on the results of a three-year effort involving the distillation of operational and technical requirements, current and prospective technology, and system and economic analyses. The proposed system, encompassing a major single concept with two end branches, is a highly flexible building block system designed to meet the needs of minimum-requirement general aviation users on the one hand, and full-scale all-weather automatic landing and multiple closely spaced runway environments on the other. The recommended LGS provides for guidance information that may be expected to have a high order of integrity, both in terms of accuracy and reliability of the information transmitted and detected. A complete description of the system is given along with the specific technical characteristics of the provisional signal format with its two branches. A summary of operational requirements, and recommendations for follow-on actions are included. D.L.G.

N71-26895# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

AIRBORNE SEARCHLIGHTS Final Report

26 Feb. 1971 19 p refs

N71-26953

operational requirements, than other engines, or its choice cannot be justified. The critical requirements of the propulsion systems for helicopters, vehicles, marine craft, electrical power generation, and total energy systems for buildings are discussed, and the engine characteristics necessary for the turbine to be the preferred choice are indicated. Installation requirements and ancillary components, exhaust emission levels and certain other technical goals are specified. Small gas turbines are arbitrarily considered to be less than 2,000 HP or less than 10 lb/sec airflow. Author

N71-26953# United Aircraft of Canada, Longueuil (Quebec).
THE STATE OF THE ART OF SMALL GAS TURBINE ENGINES FOR HELICOPTERS AND SURFACE TRANSPORT

H. H. Langshur and B. J. Palfreeman *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 16 p refs

Avail: NTIS

The current technical and market status of below 1000 SHP turboshaft engines, as applied to helicopters and surface transport are reviewed. Major data are given for the successful engines and comparisons of salient design features are made. Engines now in development are discussed. On the basis of an industry survey, advances to be expected in a 1980 helicopter engine are described and the expectations are critically reviewed. 1980 surface transportation engines are treated similarly, though in less technical detail. The main challenges for the engine designer and manufacturers in the surface transport field are brought out. Author

N71-26954# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).

CYCLES OF A GAS TURBINE [CYCLES DE TURBINES A GAZ]

P. Alesi and R. Laurens *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 11 p *In* FRENCH

Avail: NTIS

The power of a gas turbine is defined by the following four parameters: air flow; overall pressure ratio, turbine inlet temperature, and components efficiencies. The flow depends directly on turbomachine geometry whereas the compression rate is a cyclic variable. The temperature in front of the turbine is also a cyclic variable but its value is limited by cooling problems of the turbine materials. Compression output and loss are functions of geometry at each cycle stage before flow clearance is minimized through increased compression. It is concluded that the power of a gas turbine is primarily determined by its thermodynamic cycle and its geometrical shape. Transl. by G.G.

N71-26955# Kloeckner-Humboldt-Deutz A.G., Oberursel (West Germany).

ANALYSIS OF SMALL GAS TURBINE ENGINE COMPONENTS

Erwin Schnell *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 23 p refs

Avail: NTIS

Aircraft gas turbines are to be developed for lowest weight and smallest volume; therefore they are built without utilization of the exhaust heat but for high pressure ratios. For vehicle gas turbines, however, the specific fuel consumption is the determining factor and therefore the heat exchanger is an essential component of the engine. For small gas turbine engines cooled turbine blades can only be used to a limited extent. In certain cases higher efficiencies can be expected with radial turbines than with axial turbines having unfavorable aspect ratios. Two shaft engines (having

a free power turbine) compete with single shaft engines; auxiliary attachments (hydraulic torque converter or hydrostatic transmission) render the single shaft engine feasible to be used for traction purposes. Author

N71-26956# Rolls-Royce, Ltd., Watford (England). Small Engine Div.

INDUSTRIAL AND TECHNOLOGICAL PROBLEMS OF SMALL GAS TURBINES FOR HELICOPTERS AND GROUND TRANSPORT

R. M. Lucas *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 13 p

Avail: NTIS

After considering why a small engine needs to rotate fast, and be made of integral rather than built up parts, some of the consequent vibratory problems are discussed with the conclusion that methods of introducing damping into the system are required. Fuel system limitations due to dirt being the same size for big and small engines limit the use of scaled down large engine designs. Contamination of compressors by foreign objects is similarly more pronounced. A number of workshop problems special to small size are considered and shown to respond to the use of suitable techniques. Finally a glance at some of the costs which don't scale, indicate proportionately high launching costs. Author

N71-26957# Brussels Univ. (Belgium).

APPLICATION TO POWER GENERATION

Andre L. Jaumotte *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 25 p refs *In* FRENCH and ENGLISH {

Avail: NTIS

The applications of gas turbines of low power (below 500 kW) in the fields of aeronautics, industry and space are reviewed and the advantages and drawbacks of gas turbines in comparison with Diesel engines are discussed. The use of small turbines for the combined production of electric and thermal energy is considered. The thermodynamic characteristics of the total energy system are described and a few examples of industrial applications given. Possibilities offered by the use of gas turbines in space research, especially as regards the production of the energy required on board exploration vehicles are outlined. Author

N71-26958# Atelier de Construction d'Issy-les-Moulineaux (France).

FUTURE DEVELOPMENTS OF SMALL GAS TURBINES [DEVELOPPEMENTS FUTURS DES PETITES TURBINES A GAZ]

Jean Melchior *In* AGARD Small Gas Turbines for Helicopters and Surface Transport May 1971 35 p *In* FRENCH and ENGLISH

Avail: NTIS

Light engines with powers ranging between 300 and 1500 hp will be essentially used for the propulsion of ground vehicles, that is for industrial applications. 1.5 kg of weight per hp. should satisfy most users. A lower weight will be appreciated, of course, but not at any cost. Fuel consumption, in particular, will remain an important item in the cost of operation. Besides, the air intake, filtering, sound-proofing and exhaust devices are costly and bulky. Since they are proportional to the air flow rate, they will be three times larger for a turbine than for a diesel engine. The cost per hp. of present diesel engines remains an objective for the gas turbine to reach. Now, this cost should still decrease considerably with high super-charging simultaneously with the weight per hp., which should reach 1 kg/hp. in the near future. The essential asset of the turbine is its extremely light weight, which is however counterbalanced by the heat recovery device. Author

N71-26970# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Flugfunk und Mikrowellen.

RADAR AND RADIONAVIGATION: A BIBLIOGRAPHICAL STUDY [RADAR UND RADIONAVIGATION: EINE LITERATURSTUDIE]

Wolfgang Reinhardt Dec. 1970 52 p refs In GERMAN; ENGLISH summary

(DLR-MITT-70-21) Avail: NTIS; ZLDI Munich: 13.70 DM

Guided by papers published during the last two years an attempt is made to point out the highlights of the technological development of radar and radionavigation for aviation and to predict further development of these fields for the years to come. Critical comments are made on the development of primary and secondary radar systems on board and ground-based, the aeroplane navigation in the close-range of airports and in the long-range on the flight route as well as on the possibility of traffic control by means of satellites across the oceans. Author (ESRO)

N71-26985# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EXPERIMENTAL INVESTIGATION OF A LARGE SCALE, TWO-DIMENSIONAL, MIXED COMPRESSION INLET SYSTEM: PERFORMANCE AT SUPERSONIC CONDITIONS, M = 1.55 TO 3.2

Norman D. Wong and Warren E. Anderson Washington Jun. 1971 62 p refs

(NASA-TN-D-6392; A-3770) Avail: NTIS CSCL 04D

A large-scale, variable-geometry inlet model with a design Mach number of 3.0 was tested at Mach numbers from 1.55 to 3.2. Variable features of the inlet for off-design operation are an adjustable-height ramp system and a translating cowl. Experimental results for a diffuser and boundary-layer bleed configuration which was optimized at the design Mach number are presented. Overall performance was high with throat-mounted vortex generators, which were effective in reducing flow distortion in the subsonic diffuser at the higher Mach numbers. Author

N71-27002# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT DETERMINED ACCELERATION AND CLIMB PERFORMANCE OF AN F-104G AIRPLANE FOR USE IN AN OPTIMUM FLIGHT PATH COMPUTER PROGRAM

Robert T. Marshall Washington Jun. 1971 37 p refs

(NASA-TN-D-6398; H-636) Avail: NTIS CSCL 01B

A flight-test investigation was conducted to determine the standard-day performance characteristics (excess thrust, fuel flow, and climb potential) at maximum afterburner power for an F-104G airplane. The tests were conducted at Mach numbers from 0.5 to 2.0 and at altitudes from 5000 feet (1524 meters) to 50,000 feet (15,240 meters). The standard-day excess thrust and fuel-flow data obtained from the investigation were used to define a computer model of the performance of the test airplane. In addition, the climb-potential (specific excess power) data obtained from the flight tests were compared with the available predicted climb-potential data. From the comparisons, it was found that the predicted data for the average F-104G airplane did not represent the performance of the test airplane as accurately as required for the computation of meaningful flight trajectories. Therefore, to compute meaningful flight trajectories for the test airplane, the flight-derived model should be used. Author

N71-27003# Lockheed-Georgia Co., Marietta.

THE CALCULATION OF THREE DIMENSIONAL TURBULENT BOUNDARY LAYERS ON HELICOPTER ROTORS

J. G. Hicks and J. F. Nash Washington NASA May 1971 67 p refs

(Contract NAS2-5652)

(NASA-CR-1845) Avail: NTIS CSCL 01B

The three-dimensional turbulent boundary layer on a helicopter rotor was investigated analytically. The method of Nash, which takes into account crossflows and crossflow derivatives, was modified to include the effects of centrifugal and Coriolis forces. The technique was quasi-steady in the sense that the blade was assumed to be frozen at any given azimuthal position. Calculations were performed on an NACA 0012 section and an advanced airfoil for a range of azimuthal positions and two advance ratios. Cases were also run in which spanwise derivatives, and spanwise velocities and derivatives were neglected, corresponding to flows over infinite yawed wings and to two-dimensional flows, respectively. For cases where the rotor was at high incidence, the calculation method predicted early separation. Investigations of this condition led to the conclusion that the omission of the effects of time-dependence was probably responsible for the pessimistic estimates of the separation boundaries. Author

N71-27004# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.

COMPUTATIONAL STUDIES OF THREE-DIMENSIONAL TRANSONIC SHEAR FLOW: WORK IN PROGRESS

David A. Oliver and Panagiotis Sparis Washington NASA May 1971 36 p refs

(Grant NGL-22-009-383)

(NASA-CR-1816; GTL-101) Avail: NTIS CSCL 20D

The structure of three-dimensional transonic shear flow in a turbomachine cascade is examined in the context of a time dependent computer experiment. A transonic inlet Mach number profile along the span of the blade is incident on the cascade. This profile leads to the development of shocks located at the blade tip which weaken along the span of the blade and merge with the sonic surface. The static pressure rise across these tip shocks is effectively communicated across the passage to the hub end where it results in a deceleration of the hub flow which remains totally subsonic. The inlet stagnation pressure profile is manifested as a static pressure gradient at the blade leading edge which then induces strong cross flows along the span. The flow at the supersonic portion of the blade, however, expands to a much lower pressure than the pressure at the subsonic hub end so that this cross flow eventually reverses back towards the tip near the trailing edge. Author

N71-27010# Booz-Allen Applied Research, Inc., Bethesda, Md.
A HISTORICAL STUDY OF THE BENEFITS DERIVED FROM THE APPLICATION OF TECHNICAL ADVANCE TO CIVIL AVIATION. VOLUME 1: SUMMARY REPORT AND APPENDIX A (DETAILED CASE STUDIES): JOINT DOT-NASA CIVIL AVIATION RESEARCH AND DEVELOPMENT POLICY STUDY

Feb. 1971 176 p refs

(Contract DOT-OS-00020)

(NASA-CR-1808; DOT-TST-10-2-Vol-1) Avail: NTIS CSCL 01B

The benefits to the nation resulting from the application of technical advances to civil aviation are determined. The technical advances that occurred since 1945 and the funds expended on aeronautical R and D are identified. The applications of the advances to civil aircraft and flight related systems are determined. Criteria for determining the benefits of civil aviation are established and quantified where possible. A general methodology for relating the advances and the benefits was developed through the impact of technical advances on the performance of the aircraft and flight related systems. Specific methods were used to relate each benefit criterion to advances. These methods were applied to form detailed case studies and, as a result, some modifications to the methods are proposed. Author

N71-27011

N71-27011*# Booz-Allen Applied Research, Inc., Bethesda, Md.
A HISTORICAL STUDY OF THE BENEFITS DERIVED FROM APPLICATION OF TECHNICAL ADVANCES TO CIVIL AVIATION. VOLUME 2: APPENDICES B THRU I

Feb. 1971 416 p refs

{Contract DOT-OS-00020}

(NASA-CR-1809; DOT-TST-10-3-Vol-2) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01B

The appendices for a historically based analysis of aeronautical research and development are presented. A summary of aeronautical R and D; the aeronautical R and D effort; capsule histories of research areas; and categories of aircraft in terms of performance are included as well as a discussion of methods used to compute noise and pollution contributions of aeronautical systems. Application of input/output analysis to the determination of gross national product and employment contributions of the air transport and civilian aircraft manufacturing industries; a description of the method developed to relate the gross national product contribution of civil aviation to technical advances; and tabular presentation of selected data representing the benefits of civil aviation are also given. J.M.

N71-27028*# Wyle Labs., Inc., Huntsville, Ala.

ANALYTICAL PROPERTIES OF NOISE GENERATING MECHANISMS IN A SUPERSONIC JET EXHAUST FLOW

S. P. Pao Washington NASA May 1971 62 p refs

(Contract NAS8-25893)

(NASA-CR-1848; WR-71-6) Avail: NTIS CSCL 20D

Explicit analytic expressions for studying noise generating mechanisms and detailed formulas for numerical computations were derived, following the generalized supersonic turbulent jet noise theory. In a supersonic jet, both the shear noise and the self noise sources remain equally effective. For both types of sources, there are three principal modes of sound radiation, two Mach modes (S.1) and (S.2), which follow the U(3) law, and a pure acoustic mode, (S.0), which follows the U(8) sequence set ((1-M cos theta)sq + alpha sq M sq) to the minus 2.5 power dependence. These solutions are markedly different in their analytical structure. The transition between the U(8) law and the U(3) law, acoustic efficiency for all Mach numbers, source distribution, and the coupled effect of refraction and Doppler shift are discussed in detail. Some preliminary results of noise directivity and spectrum are also given. Author

N71-27034# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Raumfahrt-Aerodynamik.

THE SECOND TEST SECTION OF THE AVA HYPERSONIC LOW DENSITY WIND TUNNEL: DESCRIPTION AND OPERATIONAL BEHAVIOR [DIE ZWEITE MESSSTRECKE DES HYPERSONISCHEN VAKUUMWINDKANALS DER AVA-BAUBESCHREIBUNG UND BETRIEBSVERHALTEN]

G. Hefer Sep. 1970 73 p refs In GERMAN; ENGLISH summary (DLR-FB-70-42; AVA-FB-70-23) Avail: NTIS; ZLDI Munich: 23,10 DM

The second test section of the hypersonic low density wind tunnel has been put into operation. This facility, operating with air and having a test section diameter of 40 cm allows Mach numbers between 10 and 22. The stagnation temperature can be varied from 400 to 1200 K, the stagnation pressure from 0.2 to 20 atmospheres, yielding a test section mean free path between 0.01 and 1 mm. The test facility is described and the operational behavior, investigated by extensive calibration measurements, is dealt with. Author (ESRO)

N71-27035# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Raumfahrt-Aerodynamik.

INVESTIGATION OF A LIQUID NITROGEN COOLED NOZZLE OF THE HYPERSONIC LOW DENSITY WIND TUNNEL [ERPROBUNG EINER MIT STICKSTOFF GEKUEHLTEN DUESE DES HYPERSONISCHEN VAKUUMWINDKANALS]

G. Hefer and K. Kienappel Sep. 1970 36 p refs In GERMAN; ENGLISH summary

(DLR-FB-70-41; AVA-FB-7024) Avail: NTIS; ZLDI Munich: 11,10 DM

In order to extend the test range of the first test section of the hypersonic low density wind tunnel to lower Reynolds numbers this facility has been equipped with a liquid nitrogen cooled nozzle. Extensive pitot pressure surveys have been made to investigate the influence of liquid nitrogen cooling on the test section flow field. It is shown that with this new nozzle much lower test section Reynolds numbers can be achieved. Author (ESRO)

N71-27038# Advisory Group for Aerospace Research and Development, Paris (France).

THE CHARACTERIZATION AND APPLICATION OF MATERIALS

May 1971 151 p refs

(AGARD-LS-51-71) Avail: NTIS

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N71-27044# Forgeal, Issoire (France).

NEW BASIS OF CLASSIFICATION AND SELECTION OF ALUMINUM ALLOYS [NOUVEAUX CRITERES DE CARACTERISATION ET DE SELECTION DES ALLIAGES D'ALUMINIUM]

J. Tigeot In AGARD The Characterization and Appl. of Mater. May 1971 28 p refs In FRENCH and ENGLISH

Avail: NTIS

Aluminium alloys are the material most widely used in modern airframe construction since, even where they are designed to fly at around Mach 2.5, military aircraft do not hold these speeds long enough for the temperature increase due to airflow to affect the performance of the light alloys involved. The aluminium alloys most frequently used are: aluminium/copper/magnesium alloys, or aluminium/zinc/magnesium/copper alloys. Reviewed are attempts to improve the normal mechanical properties of alloys, refine assessment of the susceptibility of an alloy to brittle fracture, obtain greater understanding of corrosion performance, and determine fatigue performance. Author

N71-27045# Societe Trefimetaux, Argenteuil (France).
**CHARACTERIZATION, SELECTION AND USE OF TITANIUM
 BASE ALLOYS [CARACTERISATION, SELECTION ET
 UTILISATION DES ALLIAGES DE TITANE]**

R. Syre *In* AGARD The Characterization and Appl. of Mater. May 1971 46 p refs *In* FRENCH and ENGLISH

Avail: NTIS

The advantages of titanium alloys are based primarily on their mechanical property/density ratio developed by addition of alloying elements and heat treatments. Alloy selection for the two major applications (airframes and jet engines) is based on stringent characterization criteria, such as fracture toughness, stress corrosion resistance and fatigue strength, in addition to creep resistance, low cycle fatigue strength and thermal stability for jet engine design. Fasteners, hydraulic tubings and castings provide new areas of application for titanium. Engineering properties vary strongly with the alloy microstructure. Author

N71-27060# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Raumfahrt-Aerodynamik.

CALIBRATION OF A MACH-7 NOZZLE FOR THE FIRST TEST SECTION OF THE AVA HYPERSONIC WIND TUNNEL [EICHUNG EINER MACH-7-DUESE FUER DIE ERSTE MESSSTRECKE DES HYPERSONISCHEN WINDKANALS DER AVA]

G. Hefer Sep. 1970 38 p refs *In* GERMAN; ENGLISH summary (DLR-FB-70-43; AVA-FB-70-22) Avail: NTIS; ZLDI Munich: 11,70 DM

In the first test section of the low density wind tunnel the hypersonic flow is produced by expanding the test gas in a conical nozzle, yielding a Mach number of approximately 20. Retaining the test section diameter of 0.25 m, the Mach number has been decreased to approximately 7 by increasing the nozzle throat area. The attainable test range is estimated and the first flow field measurements in the nozzle and in the test section are presented. Author (ESRO)

N71-27088* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

HIGH SPEED FLIGHT VEHICLE CONTROL Patent

Robert W. Rainey, inventor (to NASA) Issued 16 Mar. 1971 4 p Filed 30 Jun. 1969 Cl. 244-90; Int. Cl. B64c9/02 (NASA-Case-XLA-08967; US-Patent-3,570,789; US-Patent-Appl-SN-837830) Avail: US Patent Office CSCL 01C

A vehicle is described having supersonic and hypersonic flight capabilities equipped with a pair of elevons on the aft end of the body and disposed with hinge lines swept forward relative to the aircraft centerline at an angle less than 90 deg.

Official Gazette of the U.S. Patent Office

N71-27096# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

THE EFFECT OF STEADY TAILPLANE LIFT ON THE SUBCRITICAL RESPONSE OF A SUBSONIC T-TAIL FLUTTER MODEL

D. J. Mc Cue, R. Gray, and D. A. Drane London Aeron. Res. Council 1971 37 p refs Supersedes RAE-TR-68081; RAE-TR-68295; ARC-30732; ARC-31363 (ARC-R/M-3652; RAE-TR-68081; RAE-TR-68295; ARC-30732; ARC-31363) Copyright. Avail: NTIS; HMSO: £ 1; BIS: \$3.60

An aeroelastic model of an aircraft T-tail has been tested in a low speed wind tunnel. The purpose of the program was firstly to check the validity of a method for calculating the aerodynamic

forces acting on a T-tail oscillating about zero mean incidence. The secondary purpose was to measure the effect of tailplane incidence on aeroelastic behavior, and to develop a method of calculation to take account of steady lift on the tailplane in the evaluation of flutter and subcritical response. The results of the tests and of the calculations are presented and it is shown that theory and experiment are in broad agreement, although accurate experimental data becomes difficult to obtain under certain conditions. Author (ESRO)

N71-27097# Aeronautical Research Council (Gt. Brit.).
THE TIME-VECTOR METHOD FOR LATERAL STABILITY INVESTIGATIONS

K. H. Doetsch (RAE, Farnborough, Engl.) 1970 53 p refs Supersedes RAE-TR-67200; ARC-29897 (ARC-R/M-3631; RAE-TR-67200; ARC-29897) Copyright. Avail: NTIS; HMSO: £ 1.40; BIS: \$5.40

Using the time vector method, each equation of motion of an aircraft can be represented by a closed vector polygon, the shape and size of which conveys useful information about the mode of motion under consideration. A graphical method for constructing these polygons is presented and a mechanized system of vector calculators is described in detail. Because of the availability of digital computers, the main use of the method now is in the interpretation of results obtained by computers, giving improved physical insight into aircraft lateral behavior. This application has proved to be particularly fruitful in relation to automatic control phenomena. Several examples are given. Author (ESRO)

N71-27109# National Aerospace Lab., Amsterdam (Netherlands).
EXPERIMENTAL DETERMINATION OF LATERAL-DIRECTIONAL STABILITY AND CONTROL DERIVATIVES IN NON-STEADY FLIGHTS

H. A. Mooij 31 Feb. 1970 71 p refs Sponsored by Neth. Aircraft Develop. Board (NLR-TR-70038-U) Avail: NTIS

Different methods are investigated for the determination of stability and control characteristics from measurements in non-steady flight. The data reduction methods which were applied comprised various techniques in the time domain as well as in the frequency domain. It is found that a reliable determination of all derivatives requires an all-in error level of the measured primary quantities of 0.1 percent or less. Author (ESRO)

N71-27149# National Physical Lab., Teddington (England) Aerodynamics Div.

ON THE STATIC PERFORMANCE OF TWO-DIMENSIONAL INTAKES WITH MOMENTUM INJECTION IN THE FORM OF BOUNDARY-LAYER CONTROL BY BLOWING

N. Gregory London Aeron. Res. Council 1971 59 p refs Supersedes NPL-AERO-SR-006; ARC-29888 (ARC-R/M-3656; NPL-AERO-SR-006; ARC-29888) Copyright. Avail: NTIS; HMSO: £ 1.50; BIS: \$5.40

An incompressible design method is given for calculating intakes in which the lip is a constant-pressure surface at zero forward speed. Static performance is examined by a onedimensional theory and two reasons for separation distinguished. When separation is reduced in extent or prevented by blowing, experiments showed maximum increases of 2% in efficiency of total pressure recovery, without optimization of slot width or intake shape. In other cases, the effect of blowing on performance is in theory small, and in practice adverse. Author (ESRO)

N71-27155# Center for Naval Analyses, Arlington, Va. Inst. of Naval Studies.

A FORECAST OF AIR TRAVEL DEMAND AND AIRPORT

N71-27161

AND AIRWAY USE IN 1980

Arthur S. Devany and Eleanor H. Garges Jan. 1971 49 p refs
(Contract N00014-68-A-0091)
(AD-720732; Rept-163; INS-72-71) Avail: NTIS CSCL 1/2

The demand for air travel between 581 pairs of domestic cities, which comprise 60 percent of total U.S. domestic air travel, is analyzed and forecast to the year 1980. An assessment of operating economies of new wide-body aircraft and alternative trip times likely to be experienced by future air travelers is made to generate assumptions regarding the structure of future fares and trip times by distance. These assumptions are combined with income and population projections for each city and an estimated demand function to forecast levels of passenger travel between each pair of cities. Airline flights between these pairs of cities are projected under 2 patterns of service that may evolve with the further introduction of wide-body jets into commercial service.

Author (GRA)

N71-27161# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Aerodynamik.

MEASUREMENT OF THE WIND TUNNEL TURBULENCE BY THE HOTWIRE METHOD AND REDUCTION OF WIND TUNNEL OSCILLATIONS [MESSUNG DER WINDKANALTURBULENZ NACH DER HITZDRAHTMETHODE UND BESEITIGUNG VON WINDKANALSCHWINGUNGEN]

H. Eckelmann Sep. 1970 69 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-39; AVA-FB-70-21) Avail: NTIS; ZLDI Munich: 21.30 DM

Turbulence level measurements in a subsonic wind tunnel were carried out. For this purpose a new transistor hot wire anemometer was developed.

Author (ESRO)

N71-27196# Army Foreign Science and Technology Center, Charlottesville, Va.

THE AIR CUSHION IN INDUSTRIAL TRANSPORTATION

V. M. Xhoykhet 22 Feb. 1971 48 p refs Transl. into ENGLISH from the publ. 'Vozdushnaya Podushka v Promyshlennom Transporte' Moscow, Znaniye Press, 1970

(AD-721254; FSTC-HT-23-495-71) Avail: NTIS CSCL 1/3

The theory and operation of air cushion vehicles and othe application of the ground effect are discussed. Off-highway ACVs and air cushion assisted trailers for hauling heavy machinery are described along with such specialized topics as the use of ACVs in icy, desert and swampy areas.

Author (GRA)

N71-27206# Naval Civil Engineering Lab., Port Huename, Calif.
AIRFIELD PAVEMENT CONDITION SURVEY, USNAS, POINT MUGU, CALIFORNIA

D. J. Lambiotte and R. B. Brownie Feb. 1971 96 p refs
(AD-720319; NCEL-TN-1148) Avail: NTIS CSCL 13/2

The results of a condition survey of the airfield pavements at the U. S. Naval Air Station, Point Mugu, California are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of the individual asphaltic concrete and portland cement concrete pavement facilities. Additional evaluation efforts included photographic coverage of defect types, preparation of the construction history of the station, compilation of data on current aircraft traffic and aircraft types using the station, performance of runway skid resistance tests, and a study of the requirements for future pavement evaluation efforts.

Author (GRA)

N71-27208# Air Force Systems Command, Washington, D.C. Director of Labs.

AIR FORCE RESEARCH OBJECTIVES, 1971 Annual Report

ETHEL GAMER, ed. Mar. 1971 63 p refs
(AD-720905; DL-71-1) Avail: NTIS CSCL 5/1

The publication is intended to stimulate researchers in free-world colleges, universities, and nonprofit and industrial organizations to participate in the Air Force research program. By delineating the various facets of the four major divisions (Physical Sciences, Engineering Sciences, Environmental Sciences, and Life Sciences) of the Defense Research Sciences, and by describing in detail the specific fields where additional research is required, it is hoped to encourage outstanding members of the free-world scientific community to play a part in fulfilling Air Force research needs.

Author (GRA)

N71-27220# Johns Hopkins Univ., Baltimore, Md. School of Hygiene and Public Health.

STUDIES OF THE BIRD/AIRCRAFT COLLISION PROBLEMS Final Report

William J. L. Sladen Mar. 1971 16 p refs
(Grant AF-AFOSR-1573-68)

(AD-720889; AFOSR-TR-71-0732) Avail: NTIS CSCL 1/2

It is concluded that the Whistling Swan is an important potential hazard to aircraft during spring and autumn migrations when large concentrations fly at predictable times during a relatively short period. Migration is on a narrow front 100-150 miles wide in the eastern flyway. While enroute they may encounter bad weather causing them to land in unusual stopover places or return to point of departure. Data from radio tagged swans indicate spring migration is a succession of 250 to 700 mile flights interspersed with 10 to 25 day resting periods. Local movements during the winter may be restricted or extensive--the latter is hazardous for small aircraft. Further research needs are documented.

Author (GRA)

N71-27320 Lehigh Univ., Bethlehem, Pa.
ON THE RESPONSE OF AIRCRAFT TO MULTIDIMENSIONAL TURBULENT INPUTS

George Trevino (Ph.D. Thesis) 1969 162 p
Avail: Univ. Microfilms Order No. 70-10623

A method is given for determining an approximation to the exact power spectrum of any response of a space-dependent system moving through a multidimensional homogeneous random field. It is shown that the method is equivalent to the approximation of a sine wave by the sum of a constant, straight line, parabola, etc., depending on the order of the approximation. The exact problem is solved for the case of a uniform beam moving through a random pressure field and it is shown that the accuracy of the approximation to the exact power spectrum depends upon the ratio of the dimensions of the beam to a well-defined length parameter of the input. The method is applied to the case of a B-52 airplane flying through atmospheric turbulence and it is shown that the caliber of the results obtained with the approximation is, not only dependent upon the ratio of the airplane dimensions to the scale of turbulence, but also upon the sensitivity of the airplane to certain deterministic inputs.

Dissert. Abstr.

N71-27333# Aeroanautical Research Associates of Princeton, Inc., N.J.

THEORETICAL AND EXPERIMENTAL STUDY OF THE DECAY OF ISOLATED VORTICES Progress Report, Feb. 1969 - Feb. 1971

Coleman Du P. Donaldson, Roger D. Sullivan, and Richard S. Snedeker Feb. 1971 34 p refs
(Contract F44620-69-C-0089)

(AD-720852; ARAP-TM-71-2; AFOSR-TR-71-0733) Avail: NTIS CSCL 20/4

The report reviews the program in progress which is aimed at increasing an understanding of the decay of the trailing vortex systems behind aircraft. The program concerns a study of the effect of turbulent shear on the decay of a single vortex. The ultimate aim of the program is the development of a method by which the effects of turbulence, whether introduced initially in the center of a vortex or contained in the fluid in which the vortex is formed, could be calculated. The program consists of two parts. The first part is directed towards the development of analytical tools for the prediction of the effects of turbulence. The second part is an experimental program designed to obtain data against which the computational techniques may be checked. Author (GRA)

N71-27354# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY AND CONTROLLABILITY OF SUPERSONIC AIRCRAFT

V. Lutskii et al 4 Dec. 1970 10 p Transl. into ENGLISH from *Aviatsiya i Kosmonavtika* (Moscow), no. 12, 1969 p 12-22 (AD-721027; FTD-HC-23-598-70) Avail: NTIS CSCL 1/3

In distinction from the subsonic aircraft in which the system of longitudinal control was quite simple and the favorable conditions of controllability fully assured a rigid kinematic coupling of the control stick with the elevator, the control system on supersonic machines is more complex; it includes hydraulic control boosters, automatic loading units, trimmer effect mechanisms and elements increasing the operational reliability. In modern fighters, an adequate effectiveness of the horizontal tail empennage at supersonic flight modes is achieved only in the presence, in the control system, of a fully rotatable control surface, i.e. of a controlled stabilizer. On the supersonic aircraft having limited maneuverability, longitudinal controllability is provided by the elevator and by a stabilizer which is adjustable during flight. Author (GRA)

N71-27364* National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

CONSTANT FREQUENCY OUTPUT TWO STAGE INDUCTION MACHINE SYSTEMS Patent

Mahmoud Riaz, inventor (to NASA) Issued 23 Mar. 1971 9 p Filed 21 Nov. 1968 Cl. 322-32; Cl. 321-61; Cl. 321-64; Int. Cl. H02p9/42

(NASA-Case-ERC-10065; US-Patent-3,571,693;

US-Patent-Appl-SN-777818) Avail: US Patent Office CSCL 09E

A system employing double-induction machines is described which is capable of providing constant-frequency electrical power from a variable speed drive or of operating as a controlled speed motor from a constant-frequency source. The disclosed system employs two polyphase, wound-rotor induction machines mounted on the same shaft having their rotor windings connected in a reverse phase sequence and their stator windings interconnected by means of a direct-current link-type of static frequency changer. Official Gazette of the U.S. Patent Office

N71-27428# Federal Aviation Administration, Washington, D.C. Office of Aviation Medicine.

PHYSICIAN PILOT-IN-COMMAND FLIGHT ACCIDENTS, 1964 - 1970

Albert Cierebiej, Stanley R. Mohler, and V. Geniese Stedman Mar. 1971 9 p refs

(FAA-AM-71-9) Avail: NTIS

It was reported in 1966 that the prevalence of fatal aircraft accidents among physician pilots during 1964 and 1965 was four times that of general aviation pilots. There was a marked drop in the total number of fatal accidents among physician pilots during

the years 1966, 1967, 1968 but an increase in 1969 and further increase in 1970. Among all general aviation pilots, there has been a steady decline in fatal accidents since 1968. Author

N71-27429# National Transportation Safety Board, Washington, D.C.

FATIGUE FAILURE OF METAL COMPONENTS AS A FACTOR IN CIVIL AIRCRAFT ACCIDENTS

William L. Holshouser and Ruth D. Mayner 1971 22 p Presented at 6th ICAF Symp., Miami Beach, Fla., 12-14 May 1971; sponsored by Intern. Comm. on Aeron. Fatigue Avail: NTIS

Fatigue failures associated with accidents occurred most frequently in landing gear components, followed in order by power plant, propeller, and structural components in fixed wing aircraft and tail rotor and main rotor components in rotorcraft. In a study of 230 laboratory reports on failed components associated with the cause of accidents, fatigue was identified as the mode of failure in more than 60 percent of the failed components. The most frequently identified cause of fatigue, as well as most other types of material failures, was improper maintenance (including inadequate inspection). Fabrication defects, design deficiencies, defective material, and abnormal service damage also caused many fatigue failures. Four case histories of major accidents are included as illustrations of some of the factors involved in fatigue failures of aircraft components. Author

N71-27602# Aeronautical Research Labs., Melbourne (Australia) **TURBULENT BOUNDARY LAYERS IN COMPRESSIBLE FLOW AND THEIR INTERACTIONS WITH NORMAL SHOCK WAVES: A SURVEY AND PROPOSED INVESTIGATION**

W. H. Schofield Oct. 1970 36 p refs (ARL/ME-321) Avail: NTIS

Work on the development of compressible turbulent boundary layers is reviewed. It appears that significant gaps exist in the available data and techniques for dealing with compressible turbulent boundary layers in zero pressure gradient; no detailed work was found which relates to the shock free supersonic adverse pressure gradient case. The separation of a supersonic boundary layer will probably differ markedly from that of the simpler incompressible layer. Normal shock wave boundary layer interaction is considered with particular reference to the instability problems of supersonic air intakes. A nondimensional grouping of variables is proposed with which it is hoped to characterize the behaviour of the post interaction flow in the subsequent subsonic adverse pressure gradients. A program of experimental work is proposed to determine the limits of interaction strength and subsonic pressure gradient necessary to retain fully attached flow in the subsonic diffuser. Author

N71-27664*# Douglas Aircraft Co., Inc., Long beach, Calif.

A DEMONSTRATION PROGRAM PLAN UTILIZING COMPOSITE REINFORCED METALS FOR THE DC-8 HORIZONTAL STABILIZER STRUCTURE Final Report

P. T. Sumida Jun. 1971 147 p refs

(Contract NAS1-9953)

(NASA-CR-111913; MDC-J5119) Avail: NTIS CSCL 01C

A feasibility study was performed and demonstration programs prepared to demonstrate the application of boron-epoxy reinforced 7075-T6 aluminum structure on the DC-8 aircraft. Preliminary design and feasibility studies were conducted on five candidate DC-8 structural components prior to selection of the horizontal stabilizer for detailed study. Weight savings of eight percent (based on the structural box) were estimated. The recommended demonstration program proposes four additional phases: (1) advanced development tests; (2) detail design and analysis; (3) fabrication

N71-27673

of two flight and one test stabilizer; and (4) static proof, ground vibration, fatigue, and ultimate strength tests. In addition, a two year (minimum) flight service period for two horizontal stabilizers on airline DC-8s is planned. An alternate demonstration program proposes two additional phases culminating in the in-flight service experience of a single horizontal stabilizer on an airline DC-8 for approximately one year. Author

N71-27673*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

BLOWN FLAP NOISE RESEARCH

R. G. Dorsch, E. A. Krejsa, and W. A. Olsen 1971 19 p refs Presented at the Seventh Propulsion Joint Specialists Conf., Salt Lake City, 14-18 Jun. 1971; sponsored by the Am. Inst. of Aeron. and Astronaut. and the Soc. of Automotive Engr. (NASA-TM-X-67850; E-6355) Avail: NTIS CSCL 01A

Noise data were obtained with models of both internally and externally blown jet-flaps of the type currently being developed for STOL aircraft. The principal tests were conducted with an augmentor-wing model and with an externally-blown double-slotted-flap model. Secondary tests were conducted with a jet flap model. The interaction between the jet and the flap assembly caused both redirection and generation of noise. The data were extrapolated to representative full scale STOL airplane flap systems. It is shown that with a quiet engine the blown flap noise can be the major contribution to the total aircraft noise. Suppression techniques are proposed. Author

N71-27674# Sandia Corp., Albuquerque, N.Mex.

FLAP EFFICIENCY AT HYPERSONIC SPEEDS. THEORETICAL AND EXPERIMENTAL FLAP INVESTIGATION [ETUDE THEORIQUE ET EXPERIMENTALE DE L'EFFICACITE DE GOUVERNES EN HYPERSONIQUE]

Rene Ceresuela et al 8 Mar. 1971 49 p refs Transl. into ENGLISH from Aeronaut. Astronaut. (Paris), no. 18, 1970 p 15-28 (SC-T-71-3016; ONERA-TP-814) Avail: NTIS

The heating rate and efficiency of a flap are governed at hypersonic speeds by the compression process of the thick turbulent boundary layer on it. The theoretical investigation of such compression raises two approaches. One is the integration of the boundary layer equations, coupled with equations for the external flow, and the other describes, by the method of characteristics, the boundary layer as a rotational inviscid flow. The computed values are compared with test results obtained at Mach 10, at Reynolds numbers of over 20×10 to the 6th power. The method of characteristics yields findings that check remarkably well with the compressions measured on deflected flaps; the resulting flap efficiencies are reduced by 30% as compared to those predicted from a simple oblique shock computation. Author

N71-27679# Goodyear Tire and Rubber Co., Goodyear, Ariz. Aviation Products Div.

THE DESIGN, DEVELOPMENT, AND FLIGHT TESTING OF FIRE SUPPRESSANT VOID FILLER FOAM KITS FOR VARIOUS TACTICAL ARMY AIRCRAFT Final Technical Report, Jul. 1968 - Oct. 1970

William M. Willisford Oct. 1970 40 p (Contract DAAJ01-69-C-0039(3G)) (AD-719711; APR-301; USAAVSCOM-TR-70-16) Avail: NTIS CSCL 1/2

Fifteen (15) various Army aircraft were examined to determine if a fire suppressant, void filler foam kit could be designed for each of them that would fill the void space surrounding the lower hemisphere of the fuel tank; thus reducing the susceptibility of the aircraft to fire from incendiary rounds. If the examination indicated

that a kit was feasible, a kit was designed, fabricated, installed, and flight tested. No adverse flight characteristics were discovered with any of the foam kits installed. Each of the kits designed will serve the purpose for which it was intended. Author (GRA)

N71-27707*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

WIND TUNNEL TESTS OF A WING INSTALLED MODEL VTOL LIFT FAN WITH COAXIAL DRIVE TURBINE

S. Lieblein, J. A. Yuska, and J. H. Diedrich 1971 38 p Presented at the Seventh Propulsion Joint Specialists Conf., Salt Lake City, 14-18 Jun. 1971; sponsored by the Am. Inst. of Aeron. and Astronaut.

(NASA-TM-X-67854; E-6359) Avail: NTIS CSCL 01A

A summary is presented of principal results obtained from crossflow tests of a 15-in. diameter lift fan installed in a wing in a 9 by 15 ft V/STOL wind tunnel. The basic objective was to determine lift fan behavior in the cross flow environment and to define the principal factors affecting fan performance. The fan stage was designed for a pressure ratio of 1.28 at a corrected tip speed of 980 ft/sec. The unique feature of the fan is a compact drive turbine coaxially mounted within the hub section of the fan which provided for coaxial exhaust streams. Tests were run with and without exit louvers over a wide range of tunnel air speeds, fan speeds, and wing angle of attack. The results presented provide a comparatively complete picture of the basic features of the internal flow in a lift fan in crossflow. Back pressure effects in influencing fan performance are discussed. In this particular fan, flow separation on the inlet bellmouth did not appear to be a serious problem for crossflow operation. Author

N71-27713*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF A BRAYTON CYCLE POWER CONVERSION SYSTEM USING A HELIUM XENON GAS MIXTURE

Alfred S. Valerino and Lloyd W. Ream 1971 16 p refs Proposed for presentation at the 1971 Intersociety Energy Conversion Eng. Conf., Boston, 3-6 Aug. 1971; sponsored by the Soc. of Automotive Engr.

(NASA-TM-X-67846; E-6339) Avail: NTIS CSCL 10A

A Brayton power conversion system was operated in an ambient environment with a gas mixture of helium and xenon. The system was operated at a compressor inlet temperature of 80 F through a compressor discharge pressure range from 20 to 45 psia and through a turbine inlet temperature range from 1300 to 1600 F. Results of system and component performances through the operating range of parameters are discussed. Results of the investigation indicated a net engine efficiency (excluding heat losses from the heat source) of approximately 30 percent at a compressor discharge pressure of 45 psia and a turbine inlet temperature of 1600 F. The gross power output measured at the alternator terminals for this condition was 13.2 kW. Author

N71-27715# National Physical Lab., Teddington (England) Aerodynamics Div.

SUBSONIC THEORETICAL LIFT-CURVE SLOPE, AERODYNAMIC CENTRE AND SPANWISE LOADING FOR ARBITRARY ASPECT RATIO, TAPER RATIO AND SWEEPBACK

H. C. Garner and Sandra M. Inch London Aeron. Res. Council 1971 49 p refs Supersedes NPL-AERO-1317; ARC-32143

(ARC-CP-1137; NPL-AERO-1317; ARC-32143) Copyright. Avail: NTIS; HMSO: 65p; BIS: \$2.60

Solutions by lifting-surface theory are tabulated for 64 planforms with systematic variation in aspect ratio, taper ratio, and sweepback. The accuracy of existing data sheets is examined. With the aid of sonic theory and the usual similarity rules, alternative graphical presentations of the new data are discussed. A simple relationship between trailing-vortex drag and spanwise center of pressure is accurate to about 1%.
Author (ESRO)

N71-27716# National Physical Lab., Teddington (England). Aerodynamics Dept.

SOME OBSERVATIONS ON VORTEX SHEDDING AND ACOUSTIC RESONANCES

M. Gaster London Aeron. Res. Council 1971 16 p refs
Supersedes NPL-AERO-1311; ARC-31829
(ARC-CP-1141; NPL-AERO-1311; ARC-31829) Copyright. Avail:
NTIS: HMSO: 25p; BIS: \$1.00

Studies on vortex shedding from cylinders and plates show that very powerful resonances can be produced, but that these are determined by the dimensions of the wind tunnel.
Author (ESRO)

N71-27756# National Aeronautical Lab., Bangalore (India).
WHIRL FLUTTER OF FLAPPED BLADE ROTOR SYSTEMS

K. V. Krishna Rao and Sundararajan Oct. 1969 40 p refs
(NAL-TN-18) Avail: NTIS

With a view to understand the whirl flutter phenomenon in flapped blade rotor systems and also to shed some light in bridging the gap between theoretical and experimental results, the equations of motion of an idealised mathematical model of a multibladed rotor system were formulated. Generalized aerodynamic forces were obtained from quasi-steady blade element theory. These equations were linearised and solved for a symmetric case. The stability boundaries for different hinge offsets of the blades are presented as a nacelle frequency parameter for neutral instability against the blade flapping frequency parameter. It was found that for a particular value of the flapping frequency parameter, which is a function of blade hinge offset and restraint spring constant at the flapping hinge, the nacelle frequency parameter required for neutral instability is minimum. From the results it is shown that an optimum flapping hinge position from the whirl flutter point of view can be determined. Low speed wind tunnel experiments were performed on a simplified model with different hinge offset conditions. Both 10 per cent and 13.6 per cent hinge offsets resulted in backward whirl flutter as predicted by theory.
Author

N71-27807# Environmental Technical Applications Center (Air Force), Washington, D.C.

UNITED STATES NAVAL WEATHER SERVICE WORLD-WIDE AIRFIELD SUMMARIES. VOLUME 10, PART 3: EUROPE (ALPS AND SOUTHWEST EUROPE)

Apr. 1970 408 p

(AD-720708) Avail: NTIS HC\$6.00/MF\$0.95 CSCL 4/2

The volume provides climatological summaries for airfields and climatic areas in the Alps and S. W. Europe. Summaries are arranged according to numbered climatic areas, and by increasing WMO Station Index Numbers within the climatic areas.
Author (GRA)

N71-27830# Environmental Technical Applications Center (Air Force), Washington, D.C.

US NAVAL WEATHER SERVICE WORLD-WIDE AIRFIELD SUMMARIES. VOLUME 10, PART 4: EUROPE (MEDITERRANEAN)

Apr. 1971 389 p

(AD-721160) Avail: NTIS HC\$6.00/MF\$0.95 CSCL 4/2

The volume is part of a series of compilations which is world-wide in scope. It consists of climatological summaries for selected airfields and for the climatic areas in which they are located. The volume provides climatological summaries for airfields and climatic areas in the Mediterranean.
GRA

N71-27986# Sandia Corp., Albuquerque, N.Mex. Exploratory Systems Dept. 1.

ON THE USE OF MODELING IN A STRUCTURAL RESPONSE PROBLEM

D. E. McGovern and S. Thunborg, Jr. Mar. 1971 17 p refs
(SC-RR-70-880) Avail: NTIS

A typical problem in the design of an air transportable weapon container is to establish its ability to withstand ground impacts resulting from aircraft crash or midair breakup. In such problems modeling theory can be used to reduce vehicle size, so that data can be obtained and interpreted with more ease and less expense. Validity of the application of modeling theory to this type of problem has been verified by the testing of sets of units differing in size by a factor of four. The test units were impacted on steel slabs at speeds from 80 to 600 ft/sec, and the resultant damage and dynamic impact responses were compared. Results show that modeling of impact response can be used to develop a full size design.
Author (NSA)

N71-27987# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOME FEATURES OF THE DEVELOPMENT AND COMBUSTION OF A GAS JET IN THE CIRCULATION ZONE BEHIND A STABILIZER

V. A. Khristich et al 23 Jan. 1971 22 p refs Transl. into ENGLISH from Teoriya i Prakt. Szhiganiya Gaza, Tr. Nauchn. Tekhn. Soveshch. (Moscow), v. 3, 1967 p 283-295
(AD-721026; FTD-MT-24-314-70) Avail: NTIS

As a result of the conducted analysis the basic characteristics of development and burning of a gas jet in the turbulent wake behind a stabilizer are clarified and the working relationships which make it possible to estimate the length of the spray along a stabilizer and the conditions of the stability of its burning are obtained. On the basis of these data a procedure has been developed for the calculation and design of jet gas burners, making it possible to create gas burners which guarantee highly intensive and stable combustion of gas fuel over a wide range of loads and air surplus factors.
Author (GRA)

N71-28008*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EXPERIMENTAL INVESTIGATION OF THE USE OF SLOTTED TEST SECTION WALLS TO REDUCE WALL INTERFERENCE FOR HIGH LIFT MODEL TESTING

Kalman J. Grunwald Washington Jun. 1971 73 p refs
(NASA-TN-D-6292; L-6884) Avail: NTIS CSCL 20D

An investigation of various test-section configurations with slotted sidewalls, both slotted and open lower boundaries, and slotted and closed upper boundaries was carried out in a small wind tunnel. Additional variables investigated include slot width and slot length. A full-span, jet-flap model with an aspect ratio of 4.0 was tested in a large test section to obtain essentially free-air conditions and in a small test section with closed walls as well as slotted walls to obtain a measure of the effectiveness of the slotted-wall configurations in reducing the wall effects. The model was also fitted with a horizontal tail to obtain a measure of the wall effects and the effectiveness of the slotted walls in reducing these wall effects at the tail. The results of the investigation indicated that the use of test-section configurations with three and four slotted walls resulted in large reductions in the wall-interference effects.
Author

N71-28009

N71-28009*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF SPANWISE VARIATION OF GUST VELOCITY ON ALLEVIATION SYSTEM DESIGNED FOR UNIFORM GUST VELOCITY ACROSS SPAN

L. Keith Barker Washington Jun. 1971 23 p refs
(NASA-TN-D-6346; L-7693) Avail: NTIS CSCL 20D

An analytical study was made of the effectiveness of a gust-alleviation system in turbulent air. The system consisted of a vane mounted ahead of the wing to sense vertical gust velocity and of flaps driven in response to the vane deflection to reduce the accelerations induced by the gusts. The primary purpose of the study was to examine the effectiveness in two-dimensional turbulence (spanwise variation of gust velocity) of a system which was designed on the basis of one-dimensional turbulence (no spanwise variation of gust velocity). The results of the study indicated that the performance, as measured by the percent reduction in the mean-square lift on the wing, is about the same whether the turbulence is one- or two-dimensional, when the system is designed on the basis of optimum alleviation in one-dimensional turbulence.

Author

N71-28010# Royal Aircraft Establishment, Farnborough (England).
CONDITIONS FOR THE CONSTRUCTION OF GLIDERS WITH A LIFT-DRAG RATIO OF 100
[KONSTRUKTIONSBEDINGUNGEN FUER SEGELFLUGZEUGE MIT EINER GLEITZAHL VON 100]

L. Sienecnik Feb. 1971 39 p refs Transl. into ENGLISH from German report
(RAE-LIB-Trans-1565) Avail: NTIS

Optimum lift coefficient and the most favorable aspect ratio are determined analytically. Results suggest that gliders, of lift-drag ratio approaching 100, may be considered. A treatment is given of the probable nature of the laminar-turbulent boundary at various pressure gradients and vanishing level of turbulence of the flow. The theory of the stability of the boundary layer on the wall and in a free stream serve as a basis for this treatment, as well as measurements on various bodies. A velocity distribution is developed suitable for profile design with a constant boundary-layer form parameter. Together with the earlier results, new conclusions are reached. Most conspicuous is the high lift coefficient which can be achieved with a laminar boundary layer at low Reynolds number. Airframe weight is then determined, under simplified conditions, as a constant times span times aspect ratio plus a second constant; this is more true, the greater the aspect ratio of the wing. A similarity relationship for the torsional stiffness, describes stiffness as inversely proportional to the wing area; assuming that the wing skin thickness is determined by the bending strength. Author

N71-28021*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLIGHT TESTS OF CROSS, MODIFIED RINGSAIL, AND DISK-GAP-BAND PARACHUTES FROM A DEPLOYMENT ALTITUDE OF 3.05 km (10000 FT)

Clinton V. Eckstrom and Harold N. Murrow Washington Jun. 1971 58 p refs
(NASA-TM-X-2221; L-7389) Avail: NTIS CSCL 01C

Eleven parachute flight tests were conducted to obtain low-altitude deployment and performance data on cross, modified ringsail, and disk-gap-band parachutes that had previously, been flight tested at earth altitudes above 30.5 km (100,000 ft). Parachute details, flight test conditions, opening loads, and performance data are presented for each of the flight tests. For seven of the flight tests, structural load data are presented as obtained from miniature load cells installed at various points in the suspension lines and canopy of each of the three parachute configurations. Author

N71-28041*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPARISON OF SIMPLEX AND DUAL-ORIFICE FUEL NOZZLES WITH AMBIENT AND HEATED FUEL IN AN ANNULAR TURBOJET COMBUSTOR

Donald F. Schultz, Jerrold D. Wear, and Porter J. Perkins Washington Jun. 1971 36 p refs
(NASA-TN-D-6355; E-5999) Avail: NTIS CSCL 21E

A full scale annular combustor was operated with simplex fuel nozzles of three flow ranges and with dual orifice fuel nozzles. The dual orifice nozzles provided combustion efficiencies within 2 to 3 percent of the peak values obtained with any of the simplex atomizers. A wide range of operating conditions including altitude relight, simulated takeoff, Mach 2.7 cruise, and Mach 3.0 cruise were studied. Measurements were made of combustion efficiency, pattern factor, flame radiation, smoke emission, and response to rapid increase in fuel flow. Fuel heated to 300 F (423 K) was used in many of the tests; heated fuel usually increased combustion efficiency. Author

N71-28055# Grumman Aerospace Corp., Bethpage, N.Y. System Sciences Section.

EMPIRICAL OPTIMIZATION OF ANTENNA ARRAYS

S. Blank Jun. 1971 67 p refs
(RE-409) Avail: NTIS

A technique developed to optimize the performance of antenna arrays under realistic, on the vehicle conditions, is described. This technique permits free choice of optimality criteria and design parameters and is applicable to both planar and nonplanar arrays with geometric constraints. The investigation resulted from an initial study of the antenna array problem under the assumption of idealized free-space conditions. An experimental-computational approach to the solution of this problem was formulated in which powerful n-dimensional optimum search methods are applied to experimental data obtained from carefully scaled models of the vehicle and antenna array configuration. The optimization algorithm provides a new design for the antenna array that is then used in the scale model, and the process develops in an iterative fashion. The necessary laboratory setup and data processing techniques used to test the feasibility of this approach are discussed. Experimental results showing encouraging improvements have been obtained on an array of eight elements both with and without an aircraft model. These results indicate that the algorithmic procedure is both stable and convergent. Author

N71-28057# Chesapeake Coll., Wye Mills, Md.

PROCEEDINGS OF THE FIRST THROUGH NINTH MEETINGS OF THE MECHANICAL FAILURES PREVENTION GROUP

W. T. Sawyer 1 Apr. 1971 248 p refs Meetings held Apr. 1967 - Nov. 1969

(Contract N00014-69-C-0108)

(AD-721359; MFPG-3) Avail: NTIS CSCL 20/11

The report presents collected and edited proceedings (minutes) of the first nine meetings of the Mechanical Failures Prevention Group. The reported proceedings are individually indexed. Organization, Problem definition; Agency program definition, Contractor progress reports; Bearing failures, General field survey; General field survey, Spectrographic oil analysis; Airborne failure prediction systems, Contractor progress reports; Detection, diagnosis, and prognosis of mechanical failure; Failure mechanisms as identified with helicopter transmissions; Critical failure problem areas in the aircraft gas turbine engine; and Examination of potential reduction of mechanical failure through design methodology. GRA

N71-28063# Royal Aircraft Establishment, Farnborough (England).
THE EFFECT OF ALTITUDE ON ARC LENGTH IN 200

VOLT ac AND dc SYSTEMS

R. F. Sims and R. L. A. McKenzie Nov. 1969 6 p
(RAE-TR-69259) Copyright. Avail: NTIS

The maximum length of a sustained arc was investigated for air pressures equivalent to altitudes of up to 95000 ft (29000 m) with 200 V ac and dc systems. With a dc supply the maximum length varied from 1/2 in (12.7 mm) at sea level to 8 in (203 mm) at 75000 ft (23000 m) or more. With an ac supply no sustained arcing occurred with any gap down to 1/16 in (1.6 mm) even at altitudes of up to 80000 ft. Author

N71-28077*# National Aeronautics and Space Administration
Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS ON A WING HAVING NACA 4415 AIRFOIL SECTIONS WITH TRAILING-EDGE FLAPS SET AT 0 DEG AND 40 DEG

Arthur W. Carter Washington Jun. 1971 74 p refs
(NASA-TM-X-2225; L-7568) Avail: NTIS CSCL 01A

An investigation was made in the Langley 300-MPH 7- by 10-foot tunnel through a range of free-stream dynamic pressures and through a range of angles of attack to determine the chordwise pressure distributions on a wing having NACA 4415 airfoil sections with flaps set at 0 deg and deflected down 40 deg. The unswept, untapered wing had an aspect ratio of 6 and full-span 30-percent-chord slotted flaps. The results of the investigation are presented as curves of chordwise pressure distributions at the 25-percent-semispan wing station. Tabulated pressure data are also presented as well as the longitudinal aerodynamic characteristics of the model corresponding to the pressure data. Author

N71-28124*# Chesapeake Coll., Wye Mills, Md.

PROCEEDINGS OF THE MECHANICAL FAILURES PREVENTION GROUP (14th)

W. T. Sawyer 27 Feb. 1971 55 p refs Meeting held at Los Angeles, 25-26 Jan. 1971

(Contract N00014-69-C-0108)

(AD-721355; MFPG-2) Avail: NTIS CSCL 20/11

Report is given of three half-day discussions by a group of technical specialists of the topic Advances in Decision-Making Processes in Detection, Diagnosis, and Prognosis of Mechanical Failures. Emphasis in the ten prepared major talks was placed upon criteria used to make diagnostic decisions and how the results were evaluated and applied in practice. A panel session was devoted to the specific area Use of (Sonic) Vibration Sensing for Diagnostics. Brief reports of new programs or newly recognized problem areas were made. Audience discussions are reported. Author (GRA)

N71-28128*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

FEASIBILITY STUDY OF JET-FUEL-COOLED PLUG NOZZLE FOR AFTERBURNING TURBOJET

Francis S. Stepka and Rene E. Chambellan Washington Jun. 1971 36 p refs

(NASA-TM-X-2304; E-6022) Avail: NTIS CSCL 21E

A conceptual design for a fuel-cooled plug nozzle is presented. Factors affecting cooling, fuel coking, construction, and strength were considered. Results indicate that the total available engine fuel flow was sufficient to restrict the maximum temperature of the metal contacting fuel to 817 K (1010 F) or less. Even at this maximum temperature, coking of cooling tubes is not expected to be significant for at least 100 hours of engine operation, based on experimental results of others with low-oxygen-content jet fuel flowing in heated tubes. Author

N71-28129*# National Aeronautics and Space Administration.
Marshall Space Flight Center, Huntsville, Ala.

AERODYNAMIC PROPERTIES OF ROUGH SPHERICAL BALLOON WIND SENSORS

George H. Fichtl, R. E. De Mandel (Lockheed Missiles and Space Co.), and S. J. Krivo (Lockheed Missiles and Space Co.) Washington Jun. 1971 30 p refs

(NASA-TN-D-6373; M-169) Avail: NTIS CSCL 04B

A first-order theory of the fluctuating lift and drag coefficients associated with the aerodynamically induced motions of rising and falling spherical balloon wind sensors is developed. The equations of motion of a sensor are perturbed about an equilibrium state in which the buoyancy force balances the mean vertical drag force. It is shown that to within first-order in perturbation quantities the aerodynamic lift force is confined to the horizontal, and the fluctuating drag force associated with fluctuations in the drag coefficient acts along the vertical. The perturbation equations are transformed with Fourier-Stieltjes integrals and the resulting equations lead to relationships between the power spectra of the aerodynamically induced velocity components and the spectra of the horizontal lift and drag coefficients. Theory shows that the first-order Fourier components of the horizontally induced lift force lead the horizontally induced velocity vector, and that the induced vertical drag lags the induced vertical velocity for rising balloons and leads the falling balloons. The phase angles of the induced lift and drag associated with frequency ω of the Jimsphere balloon are functions of the Reynolds number. Author

N71-28130*# General Applied Science Labs., Inc., Westbury, N.Y.
MIXING CHAMBER DESIGN STUDY

F. W. Lipfert, ed. Mar. 1971 165 p refs

(Contract NAS2-5708)

(NASA-CR-114286; GASL-TR-751) Avail: NTIS CSCL 14B

The design concepts and experimental verification of the critical component for a unique aerothermo test facility are described. This component is a mixing chamber, which, in order to allow a wide range of wind tunnel operating conditions, from high Reynolds number supersonic flow to true temperature hypersonic flow, provides for mixing of three separate air streams: arc jet, storage heater air (1000 R < T < 4460 R), and cold air. This mixing chamber project entailed the following major tasks: (1) Theoretical predictions of mixing characteristics in order to find the best injection configurations and initial velocity levels. Calculations were made for both frozen and equilibrium flows. (2) A scaled test program to verify the actual mixing characteristics over a limited range of conditions. Two test programs were conducted; one with heated helium to simulate the high enthalpy jet, and one using a 4 mw arc jet. (3) Design of the mixing chamber and ancillary hardware which were required for coupling to the arc jet and air heater. (4) Systems operation, design, and analysis to insure proper and safe operation of the facility in all of its various modes. Author

N71-28161*# McDonnell-Douglas Co., St. Louis, Mo.

AN EXPERIMENTAL INVESTIGATION OF HIGH AMPLITUDE PANEL FLUTTER

H. P. Kappus, C. E. Lemley, and N. H. Zimmerman Washington NASA May 1971 129 p refs

(Contract NAS8-21250)

(NASA-CR-1837) Avail: NTIS CSCL 20K

Panel flutter tests were conducted in the 1.1 to 1.4 Mach number range for flat, rectangular, aluminum panels clamped on four sides. The panel flutter boundary was defined as a function of the primary variables, Mach number, in-plane compression load, and pressure differential across the panel. Minimum flutter onset dynamic pressures occurred between Mach 1.3 and 1.4. Panel buckling lowered the flutter onset dynamic pressure by about a factor of four over the no-load condition. A pressure differential as

N71-28189

little as 0.1 psi raised the flutter onset dynamic pressure by 50 percent. Maximum panel surface stresses of about 11,000 psi were measured at the panel trailing edge during a deep flutter penetration run. The maximum stress conditions were maintained for over 200,000 panel oscillation cycles without panel failure. Author

N71-28189# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT: US CIVIL AVIATION. ISSUE NUMBER 1: 1970 ACCIDENTS

[1971] 515 p

(NTSB-BA-71-1) Avail: NTIS HC\$6.00/MF\$0.95

Selected aircraft accident reports are presented, in brief format, for accidents occurring in U.S. civil aviation operations during the calendar year 1970. A random selection of 894 general aviation and 16 air carrier accidents are included. The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of flight, pilot certificate, injuries, and causal factors. Author

N71-28216# Waldo and Edwards, Inc., Redondo Beach, Calif.
THE US COMMUTER AIRLINE INDUSTRY: ITS CURRENT STATUS AND FUTURE OUTLOOK

Nov. 1970 50 p refs

(Contract DOT-W1-71-0871-1)

(AD-718871; Rept-70-109) Avail: NTIS CSCL 5/3

The report is meant to provide an analysis of the current status and future outlook for the air taxi industry from the operational, financial and market standpoint. Financial aspects are emphasized. The purpose is to provide information which will permit FAA to assess the impact of the industry on the aviation facilities system and to determine the extent to which air taxi operations should be taken into account in aviation facilities planning criteria. Author (GRA)

N71-28217# Stanford Research Inst., Menlo Park, Calif.
VISIBILITY MEASUREMENT FOR AIRCRAFT LANDING OPERATIONS Final Report, 26 Sep. 1969 - 30 Sep. 1970

Ronald T. H. Collis, William Vizee, Edward E. Uthe, and John Oblanas 30 Sep. 1970 149 p refs

(Contracts F19628-70-C-0083; DOT-FA70WAI-178)

(AD-716483; AFCRL-70-0598) Avail: NTIS CSCL 4/1

An experimental pulsed neodymium lidar system was modified and calibrated to obtain accurate data on atmospheric extinction properties in fog and low cloud conditions. The objective was to establish the theoretical and practical basis of a system for measuring slant visibility conditions for aircraft landing operations. To operate in conditions of fog and low cloud the lidar systems dynamic range was extended to 50 DB by using a two-stage receiver system. In addition, the transmitter and receiver beams were made coaxial to make close-range observations. Author (GRA)

N71-28222# Techtran Corp., Glen Burnie, Md.
NOISE REDUCTION IN A TURBULENT JET BY THE METHOD OF REPEATED AIR INJECTION [SNIZHENIE SHUMA TURBULENTNOI STRUI METODOM VDUVA VTORICHNOGO VOZDUKHA]

B. N. Melnikov et al Washington May 1971 7 p refs Transl. into ENGLISH from Samoletostr. Tekh. Vozdush. Flota (USSR), no. 18, 1970 p 28 30

(Contract NASw-2037)

(NASA-TT-F-13667) Avail: NTIS CSCL 01B

Experiments prove that if air is injected normal to the jet axis at the boundary of the jet, optimal exit velocity profiles can be obtained which lower acoustic power emission. Expressions are derived for the flow parameters in a turbulent axisymmetrical gas jet. Application of this technique results in a noise level reduction of approximately 21 dB. Author

N71-28241# Systems Technology, Inc., Hawthorne, Calif.
AN ANALYSIS OF NAVY APPROACH POWER COMPENSATOR PROBLEMS AND REQUIREMENTS Final Report

S. J. Craig, R. F. Ringland, and I. L. Ashkenas Mar. 1971 303 p refs

(Contract N62269-70-C-0172)

(AD-722025; STI-TR-197-1) Avail: NTIS CSCL 17/7

Analyses of the current Navy Approach Power Compensator System (APCS) ARE MADE FOR MANUAL AND Automatic Carrier Landing System (ACLS) operations. Major problem areas are identified and these are correlated with the changes in the aircraft dynamic characteristics resulting from incorporation of the current APCS concept, which uses angle of attack, normal acceleration, and elevator deflection as input signals to control thrust. Root causes and basic limitations are developed using open and closed-loop servo analysis techniques to study the combined pilot/APCS/aircraft system and the automatic control situation (i.e., ACLS). Particular attention is given to developing literal approximate expressions to connect APCS and basic airframe parameters. Basic APCS design implications and compromises are implied from these expressions. A critique is given of APCS specifications and test procedures as presently employed during carrier suitability evaluation. Author (GRA)

N71-28274# Army Electronics Command, Fort Monmouth, N.J.
ANALYTIC COMPARISON OF HELICOPTER HOVER CONTROL SYSTEMS

R. John Niemela, Jr. (M.S. Thesis - Penn. Univ.) Dec. 1970 63 p refs

(AD-721728; ECOM-3367) Avail: NTIS CSCL 1/3

The effectiveness of an attitude feedback and a translational velocity feedback flight control system are assessed for their ability to provide positional stability and reduce the pilots task at hover. The significance of helicopter hover dynamics is discussed with respect to positional stability. The helicopter pilot is viewed as a control element to provide positional stability at hover in the presence of wind gusts. The velocity feedback control is compared with the attitude feedback and found to have a significantly lower mean squared positional error and to require less pilot effort. The frequency of exceeding a specific value of positional error and its relation to the power spectral density of positional error is discussed. Author (GRA)

N71-28275# Boeing Co., Seattle, Wash. Vertol Div.
AN INVESTIGATION OF NOISE GENERATION ON A HOVERING ROTOR

H. Sternfold, R. H. Spencer, and J. O. Schairer Jan. 1971 367 p refs

(Contract DAHC04-69-C-0087)

(AD-721312; AROD-8704-2-E) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 20/1

This report presents the results of a program of helicopter rotor noise measurement. The program was carried out using a 60-foot diameter CH-47B 3-bladed rotor on the Boeing-Vertol engineering rotor whirl tower. The primary objectives were: to obtain acoustical data over a frequency range wide enough to define all elements of rotor noise under well-documented ambient conditions, to measure the tip vortex position with respect to a trailing blade

using high-speed cameras and smoke to visualize the tip vortex and to relate blade-vortex separation distance to noise level, to determine the propagation characteristics of rotor noise, and to evaluate two current analytical procedures for predicting rotor noise against the measured data. Tipspeeds ranged from 600 to 900 fps and thrusts ranged from 6300 to 32,000 pounds (disk load 2.2 to 11.3 pounds per square foot).
Author (GRA)

N71-28315*# Pratt and Whitney Aircraft, East Hartford, Conn.
HIGH-LOADING LOW-SPEED FAN STUDY. 3: DATA AND PERFORMANCE SLOTTED BLADES AND VANES AND ROTOR TIP TREATMENT

K. G. Harley, J. Harris, and E. A. Burdsall Jul. 1971 281 p refs

(Contract NAS3-10483)

(NASA-CR-72895; PWA-3899) Avail: NTIS CSCL 20E

A single-stage fan with a tip speed of 1000 ft/sec, a pressure ratio of 1.5 and a hub to tip ratio of 0.392 was tested from 65 to 110% of design speed to determine the effect of various design features on performance, stall characteristics, and noise. The tests were conducted with both uniform and radially distorted inlet flow. Stator-hub slit suction was used to improve the stator performance. The rotor and stator slots improved both the pressure rise and the efficiency of part speed. With stator hub (and tip) slots, the stall flow was repeatable and agreed with the minimum value obtained without slots. Rotor tip treatments were applied mainly during tip radially distorted inlet flow tests where the rotor tip rather than the stator hub caused the stage to stall. Use of a honeycomb structure in the case over the rotor tips in combination with vortex generators improved the stall margin by as much as ten percentage points but caused about a seven-point reduction in overall efficiency. The addition of the honeycomb over the rotor blade tips increased the blade passing frequency noise levels 5 to 10 dB.

Author

N71-28338# Dynasciences Corp., Blue Bell, Pa.
STABILITY AND CONTROL HANDBOOK FOR COMPOUND HELICOPTERS

E. K. Garay and E. Kisielowski Feb. 1971 675 p refs

(Contract DAAJ02-69-C-0023)

(AD-722250; DCR-314; USAAVLABS-TR-70-67) Avail: NTIS CSCL 1/3

The handbook contains analytical methods and stability data for determining the dynamic stability and control characteristics of generalized single-rotor compound helicopter configurations. The methods use calculation procedures which are considerably simplified through the extensive use of information presented in graphs and charts. These charts are applicable to articulated, teetering, and hingeless rotor systems and cover a range of flight conditions from hover to high forward speeds. The charts for low forward speeds were obtained from the rotor performance data based on classical rotor theory. However, the high-speed charts exclude the major assumptions of classical theory and include blade compressibility, stall, reverse flow, large inflow ratios, etc. The information presented is suitable for extensive digital and analog computer studies as well as for rapid manual computations such as required for preliminary design applications.
Author (GRA)

N71-28363*# National Aeronautics and Space Administration, Washington, D.C.

THIRD CONFERENCE ON SONIC BOOM RESEARCH

Ira R. Schwartz, ed. 1971 431 p refs Conf. held at Washington, D.C., 29 - 30 Oct. 1970

(NASA-SP-255) Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The current status of sonic boom research is reviewed and critical areas of supersonic and hypersonic transport operations

are pointed out. Prediction methods for sonic boom generation and propagation consider the effects of supersonic transport shape, atmospheric turbulence, and overland operation at low supersonic speeds to minimize overpressure impact.

N71-28364*# Aeronautical Research Inst. of Sweden, Stockholm.
NONLINEAR EFFECTS ON SONIC BOOM INTENSITY

M. Landahl, I. Ryhming, and P. Lofgren In NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 3 15 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Application of a coordinate perturbation to the second order solution for axisymmetric flow makes it possible to analyze nonlinear effects on sonic boom and to assess the accuracy of the first order theory. This extension of Whitham's principle to second order is used to approximate the flow field within a distance of one body length of a slender configuration. It also applies at large distances for nonaxisymmetric flow expressed in cylindrical coordinates when a third, angular, variable is used as well. The second order solution is used to determine the effect of a small perturbation on a nonaxisymmetric flow. A simple approximation is used to show small errors in the calculation scheme to build up a nonlinear flow field through step-by-step small perturbations.
G.G.

N71-28365*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

NUMERICAL SOLUTIONS FOR THE COMPLETE SHOCK WAVE STRUCTURE BEHIND SUPERSONIC EDGE DELTA WINGS

Harvard Lomax and Paul Kutler In its 3d Conf. on Sonic Boom Res. 1971 p 17 - 25 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Numerical finite difference methods carried out on a digital computer coupled to a cathode ray tube were used to simulate flow fields for a variety of wings, bodies, and their combinations. A distance asymptotic procedure was employed to solve the three dimensional hyperbolic, steady flow equations for the conical shapes and nonconical flow field calculations were performed for the three dimensional flow behind a lifting delta wing. This shock capturing technique for computing the coalescing shock field surrounding wing-body combinations was effective if calculations were monitored by real-time reaction to visual displays.
G.G.

N71-28366*# Princeton Univ., N.J.
THEORETICAL PROBLEMS RELATED TO SONIC BOOM

W. D. Hayes, J. H. Gardner, D. A. Caughey, and F. B. Weiskopf, Jr. In NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 27 31 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The passage of a sonic boom through a caustic is analyzed by using a simple variant of the transonic flow equation. A Lax Wendroff algorithm is applied to describe the flow field and the pressure levels near a symmetric airfoil in transonic flow, with the flow subsonic at infinite. There is a single shock; the outer point of the shock disappears into the elliptic region and the foot of it on the airfoil is regarded as a nonanalytical point in the flow field.
G.G.

N71-28367*# Cornell Univ., Ithaca, N.Y.
THE EFFECTS OF ATMOSPHERIC INHOMOGENEITIES ON SONIC BOOM

A. R. George In NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 33 57 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

N71-28368

The effects of atmospheric turbulence on sonic boom signatures were simulated by calculating the relationship between shock thickness and its turbulent field. It is shown that there is an effective dissipation of energy due to scattering. G.G.

N71-28368*# Cornell Univ., Ithaca, N.Y.

PERTURBATIONS BEHIND THICKENED SHOCK WAVES

Kenneth J. Plotkin *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 59 66 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Turbulence effects on sonic boom signatures cause the appearances of random spikes and wiggles behind the shock waves. Calculations based on the decay of first scattered waves through further scattering show that the perturbations have a finite maximum near the shock front and this this maximum is of the same order as the shock overpressure. Approximations found that the maximum perturbations immediately behind the shock vary only moderately with turbulent intensity. G.G.

N71-28369*# Columbia Univ., New York.

ANALYSIS OF THE MULTIPLE SCATTERING OF SHOCK WAVES BY A TURBULENT ATMOSPHERE

W. J. Cole and M. B. Friedman *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 67 74 refs Prepared in cooperation with Bell Telephone Labs., Inc., New York

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A nonperturbative multiple scattering theory is used to predict shock thickening and fluctuation intensity of sonic boom pressure signatures superimposed on the basic N-shape pattern. Coupling between the intensity of the fluctuations and the continuously thickening shock profile is considered in the scatter propagation of an acoustic wave in a random medium. G.G.

N71-28370*# Columbia Univ., New York.

UNIFORM WAVEFRONT EXPANSIONS FOR DIFFRACTED AND FOCUSING WAVES

M. K. Myers *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 75 86 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Asymptotic approximations to the linear solutions valid near a wave front are developed that are free of anomalous singularities and can be used to predict diffracted as well as focusing wave propagation in sonic boom technology. Appropriate straining of coordinates yields a first approximation to the exact solution of the problem. Detailed structures of the linear potential fields for both wave propagations are obtained by using a set of equations of motion in which the nonlinear effects are known to be nonsingular throughout the field. G.G.

N71-28371*# Cornell Univ., Ithaca, N.Y.

NONLINEAR ACOUSTIC BEHAVIOR AT A CAUSTIC

R. Seebass *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 87 - 120 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A formal analytical solution of the transonic flow equation is reported that describes the nonlinear acoustic behavior at a caustic in terms of a linear equation for a special incoming signal with finite rise time. Except for the maximum amplitude of the reflected signal, the simple linear solution gives an adequate description of pressure signatures in sonic booms predictions. G.G.

N71-28372*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

UNIFORM APPROXIMATIONS FOR SHOCKS GENERATED BY THIN NONLIFTING RECTANGULAR WINGS

M. B. Friedman (Columbia Univ.) and S. Davis *In its* 3d Conf. on Sonic Boom Res. 1971 p 123 132 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A uniform approximation in the ray form is derived to develop flow fields and shocks produced by the leading edge of an almost planar wing of rectangular planform and symmetrical airfoil section at zero angle of attack. The presence of sharp corners in the planform and the finite span produce diffraction-like effects from the wingtips and a symmetrical disturbance field with regions of rapid variations more than one direction at various locations. Comparison of far field shock strength predictions based on the uniform approximation and those based upon the equivalent body approximation show good agreement for regions directly below and to the side of the wing. In the near field region directly below the wing where the plane shock dominates, the two predictions differ for the larger aspect ratio. The magnitude of the difference between the two predictions depends upon the scale distance at which the near field effects tend to disappear because of tip and cone interactions. G.G.

N71-28373*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A PRELIMINARY INVESTIGATION OF SONIC BOOM WAVEFORMS NEAR FOCUSING RAY SYSTEMS

Sanford S. Davis *In its* 3d Conf. on Sonic Boom Res. 1971 p 133 - 146

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The characteristics of cusped shock waves are studied by using the analogy between steady supersonic flows and unsteady two dimensional flows. In this analogy, a thin wing is used to induce a cusped shock wave in the flow field. The characteristics of the shock wave in the vicinity of the cusp are investigated both analytically and experimentally. The solution is expressed directly as an integral over a distribution of elementary sources on the wing planform. The behavior of the singularities of this linear solution at and near the cusp is inferred directly by the confluence of the three neighboring roots corresponding to the intersection of the leading edge of the wing and the trace of the Mach forecone from the field point. This transparent form of the linearized solution, when expressed in a geometrical acoustics coordinate system, is used in conjunction with Whitham's hypothesis to obtain a uniformly valid first approximation to the exact nonlinear disturbance field. Author

N71-28374*# Massachusetts Inst. of Tech., Cambridge.

SOME ATTEMPTS TO THEORIZE ABOUT THE ANOMALOUS RISE TIMES OF SONIC BOOMS

Allan D. Pierce *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 147 - 160 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Sonic boom distortion by atmospheric turbulence produces anomalous rise times of acoustic waveforms; larger rise times are developing when the distance from the ground track is increased. The physical mechanisms by which the turbulence creates spiked or rounded waveforms or anomalously large rise times are attributed to refraction, focusing, and wave front folding as integral parts of the distortion process. G.G.

N71-28375*# New York Univ., N.Y.

STUDIES IN THE DIFFRACTION OF A PULSE BY A THREE DIMENSIONAL CORNER

Lu Ting and Fanny Kung *In* NASA, Washington 3d Conf. on

Sonic Boom Res. 1971 p 161-180 refs
16-02)

(Grant NGL-33-016-119)

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Sonic boom effects on three dimensional structural corners are approximated by progressing incident plane waves of an N-shape waveform. A solution for the diffraction of a plane pulse through decomposition of the N-wave is formulated and applied to the corner problem. The governing flow equations and the finite difference method used to solve the boundary conditions and to obtain a three dimensional conical solution, as well as the use of the conical solution for the computation of pressure distributions on surfaces due to a N-wave of any waveform and at any incident angle are discussed. G.G.

presented. The effects of aircraft acceleration and flightpath angle are accounted for in the theory. Deformation of the waveform is described by the use of waveform parameters rather than through the use of a Whitham F-function. This approach provides for a simpler, more intuitive, and more compact theory for the propagation of weak pressure waves. Author

N71-28379*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A NEAR AND FAR FIELD ANALYSIS OF THE SONIC BOOM EMITTED BY NONLIFTING RECTANGULAR WINGS

Sanford S. Davis *In its* 3d Conf. on Sonic Boom Res. 1971 p 219-226 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The results of an experimental investigation into the shock wave characteristics of a finite, rectangular wing have generally confirmed the predictions of the uniform theory. The existence of rapid variations in near field spanwise strengths and the subsequent smoothing effect of the tip core interactions have also been verified by the experiment. The equivalent body theory, while giving erroneous results in the near field, predicts the characteristics of the far field sonic boom below the wing quite well. In fact, the predictions of the uniformly void theory reduce to the equivalent body theory in the far field region below the wing. It is shown that near field effects cannot affect the far field signature below the wing in a radical manner and that the equivalent body theory can be expected to give a good approximation to the flow at these large distances. Author

N71-28380*# New York Univ., N.Y.

COUPLED ELASTIC AND ACOUSTIC RESPONSE OF ROOM INTERIORS TO SONIC BOOM

S. Slutsky and L. Arnold *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 227-240 refs Sponsored by FAA

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The time history of acoustic response within architectural structures due to sonic boom transients and aspects of signature that strongly influence undesirable internal acoustic response are studied. A convolution integral is used to relate the forcing signature response relationship in terms of the system transfer function. This transfer function is determined experimentally using scaled models as well as analytically. An inexpensive sonic boom generator was constructed, and input-output responses were recorded and converted to digital data. Transfer functions were computed and used to calculate responses to modified forcing signatures. Measured and calculated responses agree very well. It is concluded that this technique can be used to investigate a large variety of transient response problems as well as the coupled elastic-acoustic systems studied in the present program. Author

N71-28381*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASUREMENTS OF SONIC BOOM SIGNATURES FROM FLIGHTS AT CUTOFF MACH NUMBER

Domenic J. Maglieri, David A. Hilton, Vera Huckel, Herbert R. Henderson, and Norman J. McLeod *In its* 3d Conf. on Sonic Boom Res. 1971 p 243-254 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Sonic boom measurements have been obtained from flight experiments of aircraft operating at cutoff Mach numbers to define the sonic boom pressure field at the shock wave extremity. The experimental results provide an indication of the depth and width of the focus region and a description of the pressure field near the shock extremity. U-shape or caustic signatures resulting in overpressure enhancement were observed at the shock wave

N71-28376*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PRELIMINARY NUMERICAL INVESTIGATION OF SONIC BOOM AT THRESHOLD MACH NUMBERS

Thomas J. Coakley *In its* 3d Conf. on Sonic Boom Res. 1971 p 181-191 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The threshold Mach number at which the sonic boom just reaches the ground is simulated by mathematically modeling a real flow problem where the incoming wave or disturbance is represented by a given flow deflection angle at the lower streamwise boundary of the channel. A uniform flow is assumed in the channel initially at which time the incoming disturbance angle is introduced impulsively. The resulting wave system propagates to the upper wall where it is reflected. The governing flow equations and the finite difference scheme used to solve the boundary conditions are discussed. The flow equations are Euler's inviscid equations expressed in conservation law form. The perfect gas law is assumed and the total energy is expressed as a function of pressure, density, and velocity. G.G.

N71-28377*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL STUDIES OF SONIC BOOM PHENOMENA AT HIGH SUPERSONIC MACH NUMBERS

Odell Morris *In its* 3d Conf. on Sonic Boom Res. 1971 p 193-203 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Results of recent sonic boom wind tunnel studies have been reviewed for several model configurations over a wide Mach number range. Comparisons of experimental and theoretical pressure signatures calculated by use of techniques derived from the work of Whitham and Hayes show good agreement for the complex airplane model configuration as well as for the simple body shapes in the lower Mach number and lower lift range. However, results of the high Mach number tests for the simple body and wing model configurations show that the theoretical methods for predicting the pressure signatures appear to be only qualitatively correct at the high Mach numbers. In general, it is shown that the agreement between theory and experiment decreases with both increasing Mach number and increasing lift coefficient. Author

N71-28378*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EXTRAPOLATION OF WIND TUNNEL SONIC BOOM SIGNATURES WITHOUT USE OF A WHITHAM F-FUNCTION

Charles L. Thomas *In its* 3d Conf. on Sonic Boom Res. 1971 p 205-217 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A method for extrapolating near field sonic boom pressure signatures through a variable atmosphere with winds has been

N71-28382

extremities, and the highest measured levels are on the order of three times the nominal N-wave overpressures associated with operations at higher supersonic Mach numbers. The shock wave was found to be quite sensitive at its extremity to local atmospheric conditions. Good qualitative agreement with theory was obtained regarding the extent of the subsonic, sonic, and supersonic flow fields and their associated overpressure signature shapes. Author

N71-28382*# New York Univ., N.Y.

AIRPLANE CONFIGURATIONS FOR LOW SONIC BOOM

Antonio Ferri *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 255-275 refs
(Grant NGL-33-016-119)

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

Supersonic transport (SST) configurations selected from the point of minimizing sonic booms are investigated. It is indicated that for a total length of 300 ft and total initial weight of the same order as the present U.S. SST designs, sonic booms having shock pressure rise of the order of 0.5 lb/sq ft can be obtained. Values as low as 0.3 lb/sq ft are possible for airplanes designed for cross country flights. Author

N71-28383*# New York Univ., N.Y.

OBSERVATIONS ON PROBLEMS RELATED TO EXPERIMENTAL DETERMINATION OF SONIC BOOM

Antonio Ferri and Huai-Chu Wang *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 277-284

(Grant NGL-33-016-119)

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The use of experimental data permits obtaining sonic boom signatures at some distance from the body when the theory applies. However, wind tunnel irregularities and support interference influence the results unless these effects are taken into consideration. Three dimensional effects are important. Author

N71-28384*# Aeronautical Research Inst. of Sweden, Stockholm.

A NEW METHOD FOR DETERMINING SONIC BOOM STRENGTH FROM NEAR FIELD MEASUREMENTS

M. Landahl, I. Rymming, H. Sorensen, and G. Drougge *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 285-295 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A new method for determining the F-function based on accurate wind tunnel measurements of the flow inclination angles along a cylindrical surface that circumscribes the wind tunnel model has been presented. The new method seems to be quite feasible and has so far been used to predict the F-function to second order for a simple body of revolution. The complete mapping of a three dimensional flow field produced by an SST like configuration is being carried out in the wind tunnel. Author

N71-28385*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

A PRELIMINARY REPORT ON SHOCK COALESCENCE

Raymond M. Hicks and Charles L. Thomas *In its* 3d Conf. on Sonic Boom Res. 1971 p 297-305 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A parametric study is conducted to determine the effects of six pressure signature parameters on the rate of coalescence of the nose and wing shocks of a wing-body type of pressure signature. Definite trends of shock coalescence with each parameter are shown and it is clear that many combinations of the six parameters can be used to reduce sonic boom by retaining a near

field signature to large distances from the aircraft. One example is given to show that a reduction in sonic boom can be realized by decreasing the pressure ahead of the wing shock. A relation between certain signature parameters and aircraft geometry is indicated. Author

N71-28386*# Aerophysic Research Corp., Bellevue, Wash.

APPLICATION OF MULTIVARIABLE SEARCH TECHNIQUES TO THE DESIGN OF LOW SONIC BOOM OVERPRESSURE BODY SHAPES

D. S. Hague and R. T. Jones *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 307-323 refs

(Contract NAS2-4880)

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The use of relatively unconventional configurations produces significant maximum overpressure reductions in the mid-field. These configurations involve slope of area discontinuities, in the configuration 0 deg equivalent area distribution, and probably a canard arrangement. Solutions have been determined by the application of multivariable search techniques to a numerical model of the mid-field overpressure problem. It is recommended that the feasibility of employing a multiple arc distribution for an SST configuration is examined, possibly using the overall system design techniques developed by Petersen and Gregory. These configuration design techniques are also well suited to the multivariable search process. Author

N71-28387*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

STATUS OF RESEARCH ON BOOM MINIMIZATION THROUGH AIRSTREAM ALTERATION

David S. Miller *In its* 3d Conf. on Sonic Boom Res. 1971 p 325-340 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

The application of heat field concepts to the sonic boom minimization problem is considered. Results indicate that finite rise time signatures are theoretically obtainable but require the creation of a carefully controlled heat field extending far ahead of and behind the airplane. An illustrative example for a representative SST configuration at cruise speed was treated. For a typical SST at cruise speed, it is estimated that, with direct burning, the bow and tail shock elimination could be accomplished with 60 percent additional fuel. Author

N71-28388*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

MEASURED AND CALCULATED SONIC BOOM SIGNATURES FROM SIX NONAXISYMMETRIC WIND TUNNEL MODELS

H. L. Runyan, H. R. Henderson, O. A. Morris, and D. J. Maglieri *In its* 3d Conf. on Sonic Boom Res. 1971 p 341-350 refs

Avail: SOD \$2.00; NTIS HC \$6.00/MF \$0.95 CSCL 20A

A wind tunnel experiment using six models has been conducted at M = 2.7 to study the growth of the pressure field as a function of distance from the model. The models consisted of two delta and four rectangular planforms including one model with side plates. The measured sonic boom pressure signatures are compared with calculated signatures based on the two- and three-dimensional flow theories. The results indicated a rapid transition from two dimensional flow characteristics to the three dimensional characteristics measured in the tests. In general, good agreement was obtained between the measured and calculated pressure field. The notable exception occurred for a model for which two dimensional flow was forced to exist within the confines of side

plates. For that model, good agreement was obtained using two dimensional flow theory, particularly at the smallest distance of about one body length. At the farthest measurement point, five body lengths, better agreement was obtained using three dimensional flow theory. Author

N71-28389*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VARIABILITY OF SONIC BOOM SIGNATURES WITH EMPHASIS ON THE EXTREMITIES OF THE GROUND EXPOSURE PATTERNS

Harvey H. Hubbard, Domenic J. Maglieri, and Vera Huckel *In its* 3d Conf. on Sonic Boom Res. 1971 p 351 359 refs

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

Sonic boom exposure patterns near their lateral extremities, particularly with regard to atmosphere induced variability, are investigated. A review of pertinent measurements and atmospheric refraction experiments shows that overpressures generally decrease and rise times are generally greater as lateral distance from the ground track increases. Overpressure variability is greater at locations 10 to 13 miles laterally from the ground track than for locations on the track for a range of Mach numbers and altitudes. The maximum measured overpressure values at 10 to 13 miles off the track for a range of altitudes and Mach numbers are of the same order of magnitude as those measured on the track. Author

N71-28390*# Boeing Scientific Research Labs., Seattle, Wash.
FINITE DIFFERENCE CALCULATION OF THE BEHAVIOR OF A DISCONTINUOUS SIGNAL NEAR A CAUSTIC

R. Seebass, E. M. Murman, and J. A. Krupp *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 361 371 refs

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

Sonic boom overpressure signature predictions in the vicinity of a caustic are performed by extension to the caustic problem of a technique developed for transonic flows. This technique and some recent calculations are described. The goal of such calculations is to be able to theoretically predict pressure signatures such as those measured during flight tests where the reflected and incident signal have combined to produce large overpressure. Although the pressure signatures that occur in practice are essentially N-waves, it is clear that if the behavior of a single shock wave near a caustic can be calculated, then the behavior of more complex signatures there can also be calculated. Author

N71-28391*# Cornell Univ., Ithaca, N.Y.
THE ACCURACY OF THE LANDAU-WHITHAM SHOCK STRENGTH RULE IN SOME NEAR FIELD SITUATIONS

A. R. George and W. K. Van Moorhem *In* NASA, Washington 3d Conf. on Sonic Boom Res. 1971 p 373 384 refs

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

Several important effects in the near field for sonic boom problems are discussed. The Landau Whitham rule of simple pressure addition is seen to fail locally when waves reaching a shock are near the critical angle to it. The singularity occurring at the intersection of a conical flow field and a shock are canceled by reflected waves from the shock for finite Mach number shocks. However, the higher order terms necessary to determine the behavior at this point are not found by this technique. The propagation of waves through a nonuniform region before reaching a shock affects the strength of the waves and, therefore, the strength of the shock after its intersection with the wave. Regions of two dimensional flow bounded by a shock and three dimensional

waves are eliminated as the three dimensional waves propagate across the region. All of these effects produce significant variations in near field shock strengths. Author

N71-28392*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ON THE EXTRAPOLATION OF MEASURED NEAR FIELD PRESSURE SIGNATURES OF UNCONVENTIONAL CONFIGURATIONS

Joel P. Mendoza and Raymond M. Hicks *In its* 3d Conf. on Sonic Boom Res. 1971 p 385 -392 refs

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

Nose bluntness, large values of lift, and large Mach number have adverse effects on the prediction of sonic boom characteristics. A technique of extrapolating measured near field overpressure data from one altitude to larger altitudes circumvents many of the weaknesses of the Whitham theory. A number of cases are presented for which the Whitham theory either is not applicable or yields results that differ widely from the measured data. The extrapolation technique accurately predicts the sonic boom characteristics of the different configurations studied herein. Application of the extrapolation technique to overpressure data measured at Mach numbers as large as 4.63 can be made with some measure of confidence. Sonic boom levels of configurations producing strong shocks are accurately estimated. Author

N71-28393*# National Aeronautics and Space Administration, Washington, D.C.

PANEL AND OPEN CONFERENCE DISCUSSIONS

In its 3d Conf. on Sonic Boom Res. 1971 p 395-412 ref

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

The effects of aircraft shape, size, and operating conditions on sonic boom generation and propagation and of the way in which flight path variations and atmospheric conditions affect the propagation are outlined. Expected nominal overpressures are predicted by the use of current theoretical techniques, and the effects of atmospheric turbulence and inhomogeneities are estimated on the basis of statistical data from flight tests. Sonic boom minimization through aircraft shaping decreases overpressure levels to feasible supersonic flight conditions. G.G.

N71-28394*# National Aeronautics and Space Administration, Washington, D.C.

GENERAL REMARKS

In its 3d Conf. on Sonic Boom Res. 1971 p 413 441 refs

Avail: SOD \$2.00; NTIS HC\$6.00/MF\$0.95 CSCL 20A

From results of numerous sonic boom tests of a wide range of wing-body configurations, it has been found that the available theoretical methods based on first order theory for calculating lift and sonic boom have limitations at moderately high Mach numbers that are sufficiently restrictive to compromise to some extent the effectiveness of these methods for low boom configuration research. Basic design problems encountered in transforming an optimum area distribution for low boom to equivalent lifting airplane configurations constitute calculation of vehicle lift distribution, accurate prediction of the F-function at higher supersonic Mach numbers, and lack of agreement between first order theory and experiments. G.G.

N71-28409# Naval Postgraduate School, Monterey, Calif.
A METHOD FOR THE SIMULATION OF A HELICOPTER IN

N71-28411

A TACTICAL ENVIRONMENT USING RAND'S TACTICS PROGRAM

Robert Alex Maier (M.S. Thesis) Mar. 1971 69 p refs
(AD-721567) Avail: NTIS CSCL 9/2

The TACTICS computer program developed by the RAND Corporation has the capability of simulating three-body, three-dimensional tactical situations. This study investigates the problem of using the TACTICS program when one of the bodies is to have the characteristics of a helicopter. The difference between the forces acting on a helicopter and the forces assumed by the TACTICS program are discussed, and a method to simulate the helicopter is presented. The basic idea of this method is to 'fly' a hypothetical fixed-wing aircraft with parameters which enable it to perform like a helicopter. The programming required to simulate several basic helicopter maneuvers is discussed, and two examples of a helicopter in a tactical environment are presented.

Author (GRA)

**N71-28411# Naval Postgraduate School, Monterey, Calif.
THE APPLICATION OF HOLOGRAPHIC INTERFEROMETRY TO THE DETERMINATION OF THE FLOW FIELD AROUND A RIGHT CIRCULAR CONE AT ANGLE OF ATTACK**

Ravi Chandar Jagota (M.S. Thesis) Dec. 1970 151 p refs
(AD-721543) Avail: NTIS CSCL 20/4

The report extends the use of holography to the study of density fields around opaque bodies as would normally be encountered in wind tunnel experiments. The density field around a 10 degree half-angle cone at zero and ten degree angle of attack was investigated in a supersonic wind tunnel. In these experiments, the finite fringe method for the production of interferograms was, for the first time, applied to holographic interferometry. The density field obtained from the reduction of the interferograms was found to agree with that obtained from an analytical solution of the governing equations. The computer program used for the reduction of the interferograms was evaluated for the effect of the presence of the cone and the shock wave and was found to yield stable and accurate results.

Author (GRA)

**N71-28422# Naval Civil Engineering Lab., Port Hueneme, Calif.
AIRFIELD PAVEMENT CONDITION SURVEY, USNAS CECIL FIELD, FLORIDA**

D. J. Lambiotte and R. B. Brownie Mar. 1971 95 p
(AD-721325; NCEL-TN-1155) Avail: NTIS CSCL 1/5

The results of a condition survey of the airfield pavement at the U. S. Naval Air Station, Cecil Field, Florida are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of the individual asphaltic concrete and portland cement concrete pavement facilities. Additional evaluation efforts included photographic coverage of defect types, preparation of the construction history of the station, compilation of data on current aircraft traffic and aircraft types using the station performance of runway skid resistance tests, and a study of the requirements for future pavement evaluation efforts.

Author (GRA)

**N71-28423# Naval Civil Engineering Lab., Port Hueneme, Calif.
AIRFIELD PAVEMENT CONDITION SURVEY, USNAS WILLOW GROVE, PENNSYLVANIA**

D. J. Lambiotte and L. J. Woloszynski Feb. 1971 77 p
(AD-721324; NCEL-TN-1153) Avail: NTIS CSCL 1/5

The results of a condition survey of the airfield pavements at the U. S. Naval Air Station, Willow Grove, Pennsylvania are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of individual asphaltic concrete and portland cement concrete pavement facilities. Additional evaluation efforts included

photographic coverage of defect types, preparation of the construction history of the station pavements, compilation of data on current aircraft traffic and aircraft types using the station, and a study of the requirements for future pavement evaluation efforts.

Author (GRA)

**N71-28424# Naval Civil Engineering Lab., Port Hueneme, Calif.
AIRFIELD PAVEMENT CONDITION SURVEY, USNALF CHARLESTOWN, RHODE ISLAND**

D. J. Lambiotte and L. J. Woloszynski Feb. 1971 71 p
(AD-721323; NCEL-TN-1152) Avail: NTIS CSCL 1/5

The results of a condition survey of the airfield pavements at the USNALF Charlestown, Rhode Island, are presented. The survey established statistically-based condition numbers (weighted defect densities) which were direct indicators of the condition of the individual asphaltic concrete pavement facilities. Additional evaluation efforts included photographic coverage of defect types, preparation of the construction history of the station, compilation of data on current aircraft traffic and aircraft types using the station, performance of runway skid resistance tests, and a study of the requirements for future pavement evaluation efforts.

Author (GRA)

**N71-28434# Army Electronics Command, Fort Monmouth, N.J.
SKID MOUNTED THERMOELECTRIC POWER SOURCE**

Andrew Herchakowski Feb. 1971 24 p refs
(AD-721887; ECOM-3397) Avail: NTIS CSCL 10/2

A Skid Mounted Thermoelectric Power Source System for use with AN/TRN-26 Beacon Set is described. The system is comprised of three Thermoelectric Generators PP-6075()/U (20 ampere 28 V dc power source), a Battery, Storage BB-607()/U (a nickel-cadmium, vented type), a control panel and a collapsible skid mount. The skid mount thermoelectric power source system is to provide a portable 1.5 kW power source to supply the power required for the AN/TRN-26 Beacon Set when required to be made operational at the end of an air strip under emergency conditions.

Author (GRA)

N71-28507# Southampton Univ. (England). Inst. of Sound and Vibration.

THEORETICAL STUDY OF HIGH FREQUENCY HELICOPTER ROTOR ROTATIONAL NOISE Final Technical Report, Mar. 1969 - 31 Aug. 1970

H. K. Tanna Sep. 1970 107 p refs
Grant DA-ERO-591-70-G001)

(AD-721661; ISVR-CR-70/3; ARDG(E)-E-1406) Avail: NTIS CSCL 20/1

The investigation deals with the radiation of rotational noise due to fluctuating forces on the rotor blades of a helicopter, with particular emphasis on studying the effects of chordwise and spanwise differential-pressure profiles. The variation of profiles with azimuth was studied as a possible source of higher harmonic rotational noise. The investigation is more useful at high tip Mach numbers, (>0.6), when rotational noise becomes subjectively more important than broadband noise; high forward speeds, when some peculiar loading profiles and their fluctuations with azimuth are observed; and higher frequencies of the acoustic spectra, where the wavelength of the sound radiated is comparable to the blade chord. Previous theories were modified to include the chordwise and spanwise differential pressure profiles. Computer programs were written to compute the r.m.s. value of m th harmonic of sound pressure at any observer position using rotor geometry and operating conditions, field point position relative to the rotor centre, and rotor blade differential-pressure at several chordwise and spanwise stations. A detailed study of the available measured aerodynamic loading data was carried out and it appears that the variation of chordwise blade loading profiles alone accounts for a significant part of the high-frequency rotational noise from helicopter rotors.

Author (GRA)

N71-28576# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.

INFLUENCE OF FUEL SLOSH UPON THE EFFECTIVENESS OF NITROGEN INERTING FOR AIRCRAFT FUEL TANKS
Technical Report, 1 Apr. -3 Jun. 1970

Edwin E. Ott and Robert A. Lillie Feb. 1971 34 p refs
 (AD-721675; AFAPL-TR-70-82) Avail: NTIS CSCL 21/4

Tests were conducted to determine the influence of sloshing fuel within an aircraft fuel tank upon the effectiveness of nitrogen inerting. These tests were performed in a closed combustion chamber partially filled with JP-8 fuel. The fuel was severely agitated by a rocking motion of the chamber. The flammability of the tank ullage at various concentrations of air, nitrogen, and fuel vapor was tested by exposure to an electric arc. The sloshing fuel did not alter the maximum concentration of oxygen that could be allowed for inerting of all fuel vapor concentrations. For JP-8 fuel vapor exposed to an electric arc this maximum allowable oxygen concentration was found to be 12% by volume. Slosh did extend the flammable region for oxygen concentrations greater than the maximum allowable for inerting. These conclusions, it is believed, are valid for any mode or level of fuel agitation that may be experienced by aircraft fuel tanks. Author (GRA)

N71-28577# Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.

EFFECTS OF CORROSION AND ANTI-ICING INHIBITORS ON THE WATER COALESCING CHARACTERISTICS OF MILITARY STANDARD FILTER/COALESCER ELEMENTS
Final Report

Shirley B. Boulware Feb. 1971 40 p
 (AD-722231; USAMERDC-1996) Avail: NTIS CSCL 21/4

The report covers a study of the effects of seven corrosion inhibitors and corrosion/anti-icing inhibitor combinations on the coalescing characteristics of the DOD-type filter coalescer elements used to decontaminate liquid hydrocarbon fuels. The corrosion inhibitors are specified for use in military jet fuels. The report concludes that: The corrosion and corrosion/anti-icing combination inhibitors did not produce adverse effects on the ability of military standard filter/coalescer elements to remove 1-percent water from JP-5 fuel that had been treated with fullers earth. The free-water content of the fuel passed through the filter/coalescer elements during the 1-percent water injection tests ranged from 0 to 4.4 ppm, which is within specification limits. The WSIMs of the inhibited JP-5 fuel during the tests were between 16 and 88. The low, free-water content did not correlate directly with the relatively low WSIMs. The WSIM cannot be used solely to determine the ability of a military standard filter/coalescer element to decontaminate inhibited JP-5 after it has been treated with fullers earth. However, the WSIM does give an indication of the ability of a filter/coalescer element to decontaminate uninhibited JP-5. Author (GRA)

N71-28578# Purdue Univ., Lafayette, Ind. Jet Propulsion Center.
STUDIES OF SLURRY FUELED PROPULSION SYSTEMS
Semiannual Progress Report

Cecil F. Warner and H. Lawrence Dyer Feb. 1971 30 p refs
 (Contract N00014-67-A-0226-0013)
 (AD-721665; TM-71-4; SAPR-2) Avail: NTIS CSCL 21/4

A one-dimensional equilibrium thermochemistry program, originally written for air-augmented rockets, was modified to accommodate calculations for a boron slurry fuel. The program was used for the prediction of combustion temperature, product species, and air specific impulse values as a function of total equivalence ratio. The results of the modified program are shown to be in good agreement with similar results from two other equilibrium programs. Subsequent calculations were made to obtain design parameters for an experimental facility to investigate the combustion phenomena of a boron slurry fuel. Cold flow experimental tests were conducted

to evaluate potential slurry injector designs. An air atomizer injector was designed that produced good initial dispersion of the slurry fuel, at a desirable flow rate, and for an acceptable pressure drop across the injector. An approach to the design of combustor cans for burning slurry fuel is presented. Author (GRA)

N71-28580# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Hypersonic Research Lab.
CONFIGURATION OPTIMIZATION OF A CLASS OF HYPERSONIC CRUISE VEHICLES

Richard C. Walker (Ph.D. Thesis - Air Force Inst. of Tech.) Dec. 1970 141 p refs
 (AD-721471; ARL-70-0342) Avail: NTIS CSCL 20/4

An optimization of air breathing hypersonic cruise vehicles was performed in order to determine basic configuration characteristics and performance trends. A distinctive feature of the investigation is that prediction techniques such as the method of characteristics were used to determine the flow field surrounding the vehicle; therefore, any interaction between the aerodynamic and propulsive flow fields is accounted for in a fundamental manner. The general class of vehicles considered in the study cruise in the Mach 8-12 speed regime, utilize a hydrogen fueled supersonic combustion ramjet engine, and can be geometrically characterized as two-dimensional wedgelike shapes. Configurations were optimized for maximum cruise range as determined from the Breguet range equation which incorporates a measure of the aerodynamic, propulsive, and volumetric efficiencies of a configuration. A generalized configuration model was defined by a discrete parameters which transformed the variational problem to a static or discrete optimization problem. The direct method of function optimization, utilizing search algorithms such as random point and adaptive creaper techniques, was employed to determine the value of the parameters defining the optimum configuration for cruise at design Mach numbers of 8, 10, and 12. The design parameter space in the vicinity of the optimum point was explored to show performance sensitivity. Author (GRA)

N71-28592# Chesapeake Coll., Wye Mills, Md.
PROCEEDINGS OF THE 10th MEETING OF THE MECHANICAL FAILURES PREVENTION GROUP

W. T. Sawyer, ed. 13 Apr. 1971 44 p Conf. held at Palo Alto, Calif., 21-22 Jan. 1970
 (Contract N00014-69-C-0108)
 (AD-721912; MFPG-4) Avail: NTIS CSCL 20/11

Report of three half-day discussions by a group of technical specialists examining the potential for detection, diagnosis, and prognosis of mechanical failure. Emphasis was placed upon the utility of vibration analysis methods in five of eleven prepared talks. Extensive audience discussions are reported. GRA

N71-28646# Meteorology Research, Inc., Altadena, Calif.
AIRCRAFT PROBING OF HAILSTORMS Final Report, Fiscal Year 1969

Robin E. Williamson 14 Jan. 1969 31 p Prepared for S. Dak. School of Mines and Tech.
 (Grant NSF GA-935)
 (MRI-69-FR-841) Avail: Issuing Activity

The feasibility of using a manned armored North American T-28B aircraft to explore hail breeding zones of severe storms was investigated. Wing panels with various thicknesses of armor were tested in facilities capable of projecting ice balls up to three inches in diameter, at speeds up to 500 ft per second. It was concluded that the theoretical method developed for determining the necessary thickness of armor gives valid results, and that it is feasible to modify an aircraft for this task. F.O.S.

N71-28685

N71-28685# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AIR TRAFFIC CONTROL Quarterly Technical Summary Report, 1 Nov. 1970-31 Jan. 1971
Herbert G. Weiss 15 Feb. 1971 17 p
(Contract F19628-70-C-0230)
(AD-721463; ESD-TR-71-16) Avail: NTIS CSCL 17/7

The Lincoln Laboratory Air Traffic Control program includes investigations related to the development of improved surveillance and communications capability to support the needs of the automated air traffic control system. Recent work on the beacon system and on tracking studies is reported. Technical studies on Fourth Generation Air Traffic Control System Concepts are reported. New studies, on the Discret Address Beacon System (DABS) COMMENCED. A technical development plan for the DABS is being prepared; its scope is described. The simulation studies and system planning of an airborne traffic situation display which will provide pilots with a suitably edited and formatted display of traffic information in the terminal area are continuing. Field testing is proceeding on a prototype laser warning system which has been designed to alert the tower controllers at Logan Airport of the presence of a ship with a tall mast in the shipping channel which crosses the approach path to Runway 4R. GRA

N71-28686 Iowa State Univ. of Science and Technology, Ames.
APPLICATION OF CYCLIC RELAXATION PROCEDURES TO TRANSONIC FLOW FIELDS
Joseph Leo Steger (Ph.D. Thesis) 1969 157 p
Avail: Univ. Microfilms Order No. 70-13636

The equations of motion for an isentropic, compressible fluid with dependent variables of stream function and density are written in finite difference form. The resulting large system of nonlinear, algebraic equations is then solved in the subsonic and transonic regime by the method of relaxation as adapted for use on digital computers. An investigation of the cyclic iterative technique revealed that this relaxation scheme has convergence criteria analogous to those of a system of linear, first-order, time-dependent differential equations. Subsequently, reliance on this analogy led to the development of numerical techniques which yield a stable, eigenvalue structure at the sonic-line for the system of equations considered. The procedure has been used to calculate the transonic flow field over symmetric airfoils by prescribing the boundary conditions on the perimeter of a coarse, uniform, finite difference network. Transonic results have been obtained with the aid of a cathode ray display system that allows the operator to interact with the computer. Dissert. Abstr.

N71-28832*# Translation Consultants, Ltd., Arlington, Va.
STUDY OF THE SHORT TERM CREEP OF THE OT-4 ALLOY IN HIGH SPEED AIR FLOWS UNDER AERODYNAMIC VIBRATIONS [ISSLEDOVANIYE KRATKOVREMENNOY POLZUCHESTI SPLAVA OT-4 V SKOROSTNYKH VOZDUSHNYKH POTOKAKH PRI NALICHII AERODINAMICHESKIKH KOLEBANIY]
I. N. Bogachev et al Washington NASA Jun. 1971 11 p
refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Metal'y (Moscow), no. 5, Sep. Oct. 1970 p 137 142
(Contract NASw-2038)
(NASA-TT-F-13658) Avail: NTIS CSCL 11F

The equipment, and a technique for testing mechanical properties and the erosion resistance of metallic materials exposed to a high-speed air flow are described. Special attention is given to the role of vibrations induced in specimens under different test conditions. It is found that the short-term creep behavior of the OT-4 alloy is completely different from that in still air. A statistical analysis is made of random stress caused by aerodynamic vibrations under different test conditions. Some regularities in stress

distribution are determined with flow rate, angle of attack, and temperature taken into consideration. It is concluded that the creep properties of the OT-4 alloy are much less affected by vibrations than by corrosion and erosion attributable to high-speed air flow. Author

N71-28861*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF WING-BODY AND LIFTING-BODY CONFIGURATIONS OF HYPERSONIC CRUISE AIRCRAFT AT MACH 2.30 TO 4.63
Lloyd S. Jernell Washington July 1971 81 p refs
(NASA-TM-X-2287; L-7229) Avail: NTIS CSCL 01B

An investigation has been conducted to determine the effects of wing area and body-cross-section ellipticity ratio on the aerodynamic characteristics of a series of delta-planform wing-body configurations representing some of the principal features of a hypersonic cruise aircraft. The effects of body cross-section shape were also investigated for several lifting-body configurations. Data were obtained at angles of attack to approximately 24 deg for angles of sideslip of 0 deg and 3 deg. The Reynolds number was 9.8 million per meter (3×10 to the 6th power per ft). Author

N71-28872*# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.
IN-FLIGHT USE OF TRAVERSING BOUNDARY-LAYER PROBES
Edwin J. Saltzman Washington Jul. 1971 32 p refs
(NASA-TN-D-6428; H-640) Avail: NTIS CSCL 14B

Two prototype traversing boundary layer pitot probes were demonstrated in flight. A motor operated, screw driven type of probe was used on two jet aircraft for defining boundary layers at profile edge Mach numbers from 0.5 to 2.2. The other type of traversing probe was motor driven through a Scotch yoke mechanism and was operated on several flights of the X-15 airplane. The highest free stream Mach number reached during this series of flights was 5.6. The mechanical and electrical features of these probes are described, and photographs and conceptual drawings are included. Problems encountered during the development of the devices are described, and the solutions that were found are explained. Boundary layer profile data are presented in several forms, and local friction coefficients derived from the profile through a Clauser type of determination are shown. Author

N71-28882*# Stanford Research Inst., Menlo Park, Calif.
A STUDY OF THE STRUCTURE OF JET TURBULENCE PRODUCING JET NOISE
D. C. Wooten, C. E. Wooldridge, A. J. Amaro, and G. R. Plapp Washington NASA Jul. 1971 83 p refs
(Contract NASw-1938)
(NASA-CR-1836) Avail: NTIS CSCL 04D

The turbulent structure 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, at two different levels of core turbulence. A digital data reduction program was used to calculate auto- and cross-correlations of axial velocity fluctuations and the power spectral densities. Convection velocities were measured using the overall hot wire signals and using signals that were digitally filtered for band-passes about center frequencies of 0.875, 3.5, and 8.5 kHz. The convection velocities of the lower frequency components of the signals were lower and varied more slowly with radial position than the convection velocities of the higher frequency components and of the overall signal. Thus the large eddies which correspond to the low frequency components are convected at roughly a constant velocity across the shear layer

which is about 0.6 of the jet velocity. This corresponds to the convection speed of coherent pressure fluctuations that have been observed across the jet core. This observation supports 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

N71-28883*# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif. EXPERIMENTAL ATMOSPHERIC ABSORPTION VALUES FROM AIRCRAFT FLYOVER NOISE SIGNALS

Dwight E. Bishop, Myles A. Simpson, and David Chang (Allied Res. Associates, Inc.) Washington NASA Jun. 1971 75 p refs (Contract NAS1-8168)

(NASA-CR-1751; Rept-1868) Avail: NTIS CSCL 20A

A detailed analysis of the noise recorded on the ground during a series of 20 aircraft flyovers by two aircraft (a four-engine turbojet transport and a four-engine piston transport) during a single day of field measurements has been conducted to obtain experimental values of sound absorption. Noise levels recorded at five positions under and to the side of the flight path together with radar tracking data and meteorological information obtained on the surface and aloft were acquired during the field tests. Differences in one-third octave band noise levels observed at different ground positions for the same angle of radiation from the aircraft were utilized to obtain sets of absorption values which are compared to calculated values of sound absorption using both surface and altitude measurements of temperature and humidity. Author

N71-28891*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

THE EFFECT OF THERMOCOUPLE ATTACHMENT BY SPOTWELDING AND BY ADHESIVE BONDING ON FATIGUE BEHAVIOR OF Ti-13V-11Cr-3Al AND Ti-6Al-4V

L. A. Imig Washington Jul. 1971 26 p refs

(NASA-TM-X-2288; L-7575) Avail: NTIS CSCL 11F

An experimental investigation was conducted to evaluate the effect of spotwelded or adhesively bonded thermocouples on the fatigue behavior of two titanium alloys suitable for use in high-speed airplanes: Ti-13V-11Cr-3Al in sheet form and Ti-6Al-4V in plate form. The effects of the thermocouple attachments were evaluated by comparing the results of constant-amplitude fatigue tests of specimens with thermocouples with those for plain specimens. The fatigue strengths at 10 to the 7th power cycles of specimens with spotwelded thermocouples were between one-fifth and one-third of the fatigue strengths of plain specimens for all test conditions. Specimens with thermocouples attached by adhesive bonding had fatigue strength equal to that of plain specimens. Author

N71-28927# Air Force Systems Command, Wright-Patterson AFB, Ohio, Foreign Technology Div.

UNSTEADY FLOW AROUND AND AEROELASTIC VIBRATION IN TURBOMACHINE CASCADES

G. S. Samoilovich 23 Feb. 1971 541 p refs Transl. into ENGLISH of the book "Nestatsionarnoe Obtekanie i Aerouprugie Kolebaniya Reshetok Turbomashin" Moscow, Izd-Vo Nauka, 1969 p 1-444

(AD-721959; FTD-HC-23-242-70) Avail: NTIS CSCL 21/5

Methods of calculating, and experimental results of research on, unsteady flow in aerodynamic cascades of turbomachines are set forth. The conditions of excitation and damping of blade vibration in compressible and incompressible fluid flow are considered. The theoretical methods are based upon a model of an ideal fluid. The incoming stream may be inhomogeneous and have vortices due to the influence of a preceding cascade. The experimental results

pertain to determination of the dynamic stresses brought about by stream inhomogeneity in the turbomachine, as well as to determination of the unsteady aerodynamic forces which excite and damp blade vibrations. Consideration is given to the origination of cascade flutter and the effect of inhomogeneity of an aerodynamic cascade. The experimental research methods are described. Author (GRA)

N71-28946*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

INLET-ENGINE-NOZZLE WIND TUNNEL TEST TECHNIQUES

D. N. Bowditch 1971 29 p refs Proposed for presentation at 38th Meeting of the Propulsion and Energetics Panel of the Advisory Group for Aero Res. and Develop., Sandeford, Norway, 13-17 Sep. 1971

(NASA-TM-X-67870; E-6416) Avail: NTIS CSCL 21E

Experimental investigations of the inlet, engine and exhaust nozzle of a supersonic propulsion system have been made. Exhaust nozzle results are presented which compare wind tunnel and flight results and assess the accuracy of flight measurements. Comparisons are also presented for nozzle performance obtained with a cold jet, a powered turbojet simulator, and a solid jet boundary simulator. The effect of the local boundary layer on nozzle performance is also discussed. The need for good dynamic measurements during inlet engine testing is illustrated for transients such as inlet unstart and engine stall. Also, the transient nature of inlet distortion and its effect on the engine is presented for two different operating conditions. Author

N71-28947*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PROPULSION SYSTEMS TRENDS

James F. Dugan, Jr. 17 Jul. 1971 34 p refs Presented at a Systems Oriented Workshop on US Air Transportation, Tullahoma, Tenn., 20 Jun.-17 Jul. 1971; Sponsored by Tenn. Univ. Space Inst.

(NASA-TM-X-67871; E-6420) Avail: NTIS CSCL 21E

Propulsion systems as they exist today and some trends that are anticipated for aircraft that might be flying in the 1980's are presented. The number one trend for commercial engines is to quiet them to a level no louder than the normal background noise level of the environment in which they will operate. In military engines that are not so severely noise constrained, the possibility of stoichiometric gas turbine engines is within reach and will probably come into being whenever a military requirement provides sufficient motivation to develop such an engine. Very high bypass ratio engines are likely to find application in V/STOL aircraft while the evolution of variable geometry inlets and exhaust nozzles receives its impetus from supersonic airplanes. Both supersonic and V/STOL aircraft are prime candidates for digital computer control systems that will integrate the control of the propulsion system, the airplane, and its flight path. Author

N71-29011*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

OPTIMIZATION OF ENGINES FOR A MACH 0.98 TRANSPORT WITH LOW TAKEOFF AND APPROACH NOISE LEVELS

Gerald A. Kraft and John B. Whitlow, Jr. Jun. 1971 57 p refs

(NASA-TM-X-67865; E-6407) Avail: NTIS CSCL 21E

A parametric engine study was made for a Mach 0.98 advanced technology transport using the supercritical wing. A 1978 year of first flight was assumed for the 300 passenger airplane which had a takeoff gross weight of 386,000 pounds. The engine that gave the greatest range generated too much noise. When noise constraints were used, the best fan pressure ratio was

N71-29023

as high as duct jet noise would allow. A noise goal of 106 PNdB could be met with a 500 nautical mile range penalty using 7 PNdB machinery noise suppression. A noise goal of 86 PNdB could be met at a range penalty of 650 miles if 40 PNdB of machinery noise suppression is available. This penalty could be reduced if a light weight jet noise suppressor was used. Author

N71-29023*# Tracor, Inc., Austin, Tex.

COMMUNITY REACTION TO AIRPORT NOISE. VOLUME 1

Washington NASA Jul. 1971 97 p refs

(Contract NASw-1549)

(NASA-CR-1761; T-70-AU-7454) Avail: NTIS CSCL 01C

A study is presented of the relationships of large numbers of variables--physical, psychological, and social--with community reaction to the noise of aircraft around international airports in large U.S.A. cities. The seven major airports involved were Logan International-Boston, O'Hare International-Chicago, Dallas International-Dallas, Stapleton International-Denver, Los Angeles International-Los Angeles, Miami International-Miami, and Kennedy International-New York. Author

N71-29128* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

MECHANICALLY LIMITED, ELECTRICALLY OPERATED HYDRAULIC VALVE SYSTEM FOR AIRCRAFT CONTROLS Patent

John V. Foster, inventor (to NASA) Issued 11 Aug. 1959 7 p Filed 3 Oct. 1958 Cl. 121-38

(NASA-Case-XAC-00048; US-Patent-2,898,889;

US-Patent-App-SN-765264) Avail: US Patent Office CSCL 01C

A surface control system has been designed which incorporates the advantages of both a mechanical operated control valve and an electrically controlled hydraulic servo valve. In general, this has been accomplished by a configuration in which a pilot's override linkage and the mechanical control valve are mechanically independent of the electrically controlled hydraulic servo valve. The system includes an hydraulic actuator having a movable member, a cylinder articulated to the control surface, the cylinder having tandem chambers in which are disposed a pair of double acting tandem pistons, anchored to the aircraft structure. Both sides of each piston is connected to a cognizant mechanical control valve for porting pressurized fluid from a single servo valve to either side of the corresponding piston depending on the desired motion of the actuator and the control surface.

Official Gazette of the U.S. Patent Office

N71-29187*# General Electric Co., Cincinnati, Ohio. Advanced Technology Programs Dept.

EXPERIMENTAL QUIET ENGINE PROGRAM. VOLUME 1, PHASE 1: ENGINE DESIGN REPORT

15 Mar. 1970 366 p refs

(Contract NAS3-12430)

(NASA-CR-72967) Avail: NTIS CSCL 21E

The design of three full-scale fans, each containing low noise features are presented with bypass fan engine designs. The relative merits of low-loading versus low-speed fan designs are discussed including the effects of fan blade numbers and rotational speed on its harmonics. Materials selected for the fan designs and low pressure turbines are outlined along with the methods of stress and vibration analysis. J.M.

N71-29188*# General Electric Co., Cincinnati, Ohio. Advanced Technology Programs Dept.

EXPERIMENTAL QUIET ENGINE PROGRAM. VOLUME 2,

PHASE 1: ENGINE DESIGN REPORT

15 Mar. 1970 305 p refs

(Contract NAS3-12430)

(NASA-CR-72967) Avail: NTIS CSCL 21E

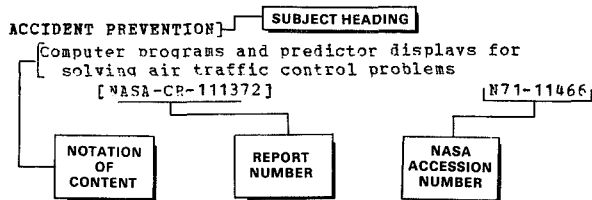
Low pressure turbine rotor, stator, frame, and exhaust nozzle designs are presented for low noise turbofan engines. Thermal and mechanical stress analyses and turbine thrust balance and parasitic flow analyses are summarized. Quiet engine bearings, seals, controls and accessories, and configuration designs are included. Installation aerodynamics and performance are detailed as well as model and full-scale acoustic and engine tests and instrumentation. J.M.

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SEPTEMBER 1971

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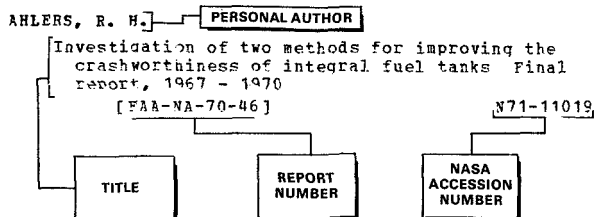
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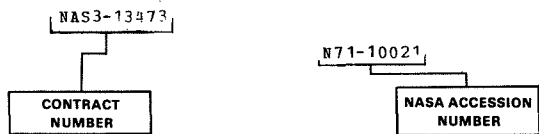
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