

*N73-24998*  
NASA SP-7037 (29)



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# AERONAUTICAL ENGINEERING

**A SPECIAL BIBLIOGRAPHY  
WITH INDEXES  
Supplement 29**

**MARCH 1973**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

## ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges:

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# AERONAUTICAL ENGINEERING

## A Special Bibliography

### Supplement 29

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 February 1973 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. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 410 reports, journal articles, and other documents originally announced in February 1973 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

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

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

Three indexes—subject, personal author, and contract number—are included.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies are available at \$5.00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche<sup>(1)</sup> are available at the rate of \$1.00 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is \$1.00. Please refer to the accession number, e.g., A73-10468, when requesting publications.

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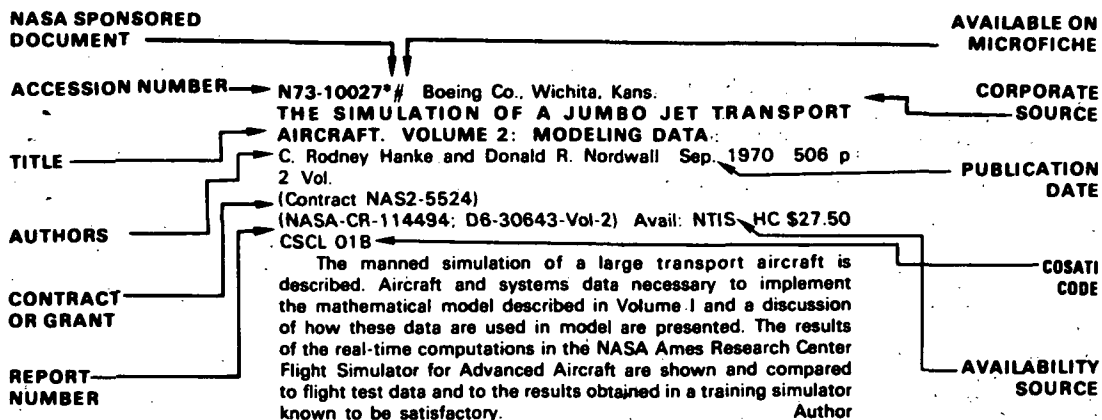
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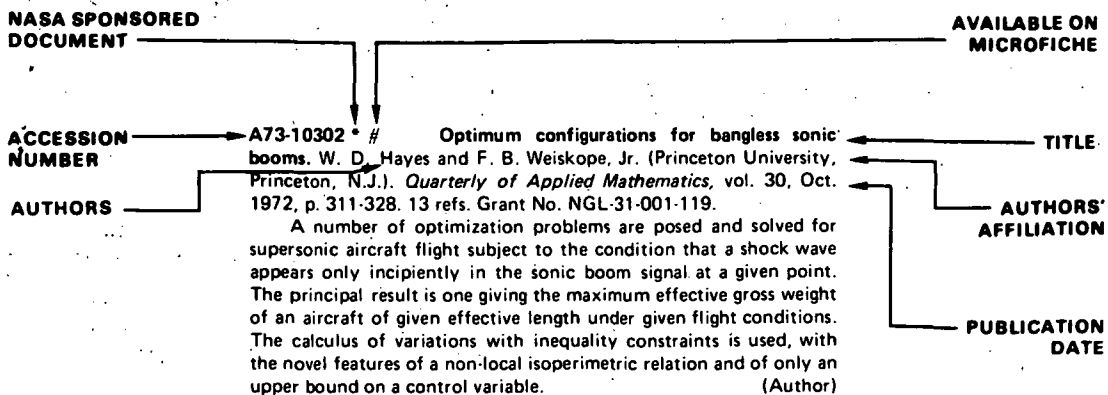
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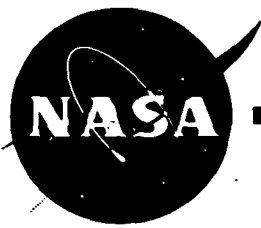
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## TYPICAL CITATION AND ABSTRACT FROM IAA





# AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 29)

MARCH 1973

## IAA ENTRIES

**A73-12915** Experimental investigation of the frequency response of a planar rigid airfoil (Experimentelle Untersuchung des Frequenzgangs eines ebenen starren Tragflügels). H. Knauss and G. Schwarz (Stuttgart, Universität, Stuttgart, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 20, Oct. 1972, p. 380-383. In German.

**A73-12916** A procedure for the barometric altitude control in the case of hovering devices and helicopters (Ein Verfahren zur barometrischen Höhensteuerung von Schwebegeräten und Hubschraubern). E. Herpfer and J. T. Heynatz (Dornier System GmbH, Friedrichshafen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 20, Oct. 1972, p. 383-387. In German.

A simple procedure for the automatic altitude control of VTOL vehicles and helicopters is presented and confirmed by experimental results which is based on measuring the static pressures at several positions in a circular arrangement in a plane closely below the rotor plane of the vehicle and on averaging these pressures. The mean pressures prove to be independent of disturbance influences such as gusts, transient flight attitudes and the rotor downwash. The horizontal air and/or wind velocity results as the only parameter which is to be eliminated by means of a specific calibration curve.

(Author)

**A73-12952** # The problems of aeronautical acoustics (Les problèmes d'acoustique aéronautique). P. A. Liénard (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 1. Budapest, Akademiai Kiado, 1971; p. 1-16. 7 refs. In French.

Aeronautical acoustic problems involve noise in aircraft interiors, stresses in the structures, external noise near aircraft, especially in inhabited areas around airports and, with the advent of the supersonic aircraft, the problem of the 'sonic boom'. The general characteristics of aerodynamic noise are discussed, as well as modification of the equation of propagation in a turbulent fluid, and its solution. First applications of the equation to various aircraft are studied. Attention is given to antinnoise legislation and regulation, recent studies, and future prospects.

F.R.L.

**A73-12956** # Inlet sound power of axial compressors. S. N. Kuznetsov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2.

Budapest, Akademiai Kiado, 1971, p. 289-292. 5 refs. Design and experimental data on the sound power of the inlet noise were compared for the compressors of several stationary gas turbine plants. It appears that in spite of the different reactions of the first stages of several full-scale compressors, the parameter K (the dimensionless similarity criterion) changes insignificantly. F.R.L.

**A73-12957** # On evaluation of aircraft noise around airbases by factor analysis. G. Nishinomiya (Japan Broadcasting Corp., Tokyo, Japan). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2. Budapest, Akademiai Kiado, 1971, p. 313-316.

In application of the method of factor analysis to aircraft noise, the observed variables such as noise level dB(A) are assumed to be expressible in terms of a number of factors such as type of aircraft, distance from runway, and state of flight. It is shown that aircraft noise level may be expressed by these three items with accuracies of an onboard computer and a radar with a range of up to 350 km.

A.B.K.

**A73-12959** # Attenuation of airplane /747/ air-conditioning noise in lined and unlined ducts. A. G. Jhaveri (Washington, University, Seattle, Wash.). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2. Budapest, Akademiai Kiado, 1971, p. 353-356.

The problems of acoustical noise generation, propagation, and attenuation in both lined and unlined straight cylindrical ducts, as well as 90 deg bends, within the cabin air-conditioning distribution system are studied. It was found to be possible to double the existing airflow velocity in the Boeing 747 air-conditioning ducts without violating cabin sound level criteria. It is possible to attenuate excess noise by lining a fraction of the duct's length with acoustical foam material, and by proper choice of R/D values for the 90-deg bends upstream of the straight cylindrical ducts.

F.R.L.

**A73-12961** # An experimental study on noise reduction of axial flow fans. S. Suzuki and Y. Kanemitsu (Ebara Manufacturing Co., Ltd., Tokyo, Japan). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2. Budapest, Akademiai Kiado, 1971, p. 373-376.

An experimental study was made on the influence of a forward inclined rotor, of an inclined stator, and of the airfoil section on the reduction of noise generated by an axial flow fan. It is shown that efficiency will be raised and noise level lowered by inclining the rotor. Noise level will be most effectively lowered when the forward inclination angle is 15 deg. Inclination of the stator is also effective, and the primary rotating noise has been decreased by 5 dB at 45 deg of the inclining angle. Efficiency can be improved and noise level reduced by careful choice of rotor airfoil section, and by adoption of the design of the free vortex type as a flow pattern.

F.R.L.

**A73-12964** \* # Supersonic jet noise suppression using coaxial flow interaction. D. S. Dosanjh and J. C. Yu (Syracuse University, Syracuse, N.Y.). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2.

Budapest, Akadémiai Kiado, 1971, p. 441-444. 5 refs. Grant No. NGL-33-022-082.

The scope of investigations conducted with coaxial interacting supersonic jet flows covers (1) acoustic measurements in both the far noise field and near noise field, (2) surveys of mean flow properties and fluctuating pressures, optical visualization of interacting jet flows, the associated flow and shock structure changes and the noise field, (3) the effects of different geometrical parameters of the coaxial nozzles, and (4) thrust measurements. It is shown that the flow interaction between two suitable controlled interacting coaxial supersonic axisymmetric jet flows results in substantial noise reduction based on equivalent thrust considerations. This flow interaction technique appears to be potentially an attractive approach for suppression of noise from supersonic jet exhausts. F.R.L.

**A73-12967 #** The scattering characteristics of a sonic boom at the passage through a turbulent layer (Das Streuverhalten eines Überschallknalles beim Durchgang durch eine turbulente Schicht). F. Obermeier and G. Zimmermann (Max-Planck-Institut für Strömungsforschung, Göttingen, West Germany). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2. Budapest, Akadémiai Kiado, 1971, p. 457-460. 5 refs. In German.

Computations of the pressure as a function of time conducted by Witham (1950) for the sonic boom are considered. The computations showed the existence of a wave consisting of two compressive shocks. The calculation had been performed on the basis of idealized conditions. Deviations of the real temporal pressure relationship from the ideal relations obtained by Witham are discussed, giving attention to a broadening of the shock and to statistical fluctuations of the sonic boom parameters. Phase changes in the wave were further investigated by studying the scattering of an ideal wave in a suitable model atmosphere, giving attention to low and high frequencies. G.R.

**A73-12968 #** Air jet as acoustic lens or waveguide. H. S. Ribner, M. E. Wang, and K. Y. Leung (Toronto, University, Toronto, Canada). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2.

Budapest, Akadémiai Kiado, 1971, p. 461-464. Research supported by the National Research Council of Canada and U.S. Air Force.

Description of an experiment intended to determine whether an air jet acts as a converging lens for upstream-moving waves. This experiment was prompted by an earlier one - aimed at explaining the heart-shaped pattern of jet noise - whose result indicated that a jet acts as a diverging lens for downstream-moving waves. The latest experiment shows a converging-lens effect for upstream-moving waves, causing a 'focusing' enhancement of up to 15 dB. M.V.E.

**A73-12969 #** Noise from free jets and airfoils in jets. W. C. Meecham (California, University, Los Angeles, Calif.). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2. Budapest, Akadémiai Kiado, 1971, p. 465-468.

Using Lighthill's (1952) classical theory of aerodynamic sound, a simple source theory of acoustic radiation is developed. A comparison of theoretical predictions based on this source theory with some meaningful experimental data shows encouraging agreement. M.V.E.

**A73-12974 #** On the importance of the wake for the noise of an obstacle placed in a flow (Sur l'importance du sillage pour le bruit d'un obstacle placé dans un écoulement). L. Gaudriot and G. Comte-Bellot (Ecole Centrale Lyonnaise, Lyon, France). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2. Budapest, Akadémiai Kiado, 1971, p. 501-504. 6 refs. In French.

The analysis presented starts from Lighthill's (1952) theory on the origin of aerodynamic noise and the correlative mathematical explanation brought by Ffowcs Williams (1969) by means of generalized functions. For a stationary obstacle, it is known that this point of view leads to two types of noise sources, i.e., bipolar sources related to aerodynamic forces and localized at the surface of the obstacle, and quadrupolar sources located in the wake of the obstacle, and generally considered as presenting a negligible effect in relation to the previous ones. However, by introducing a control surface which encloses the wake, and on which equivalent sources accessible to measurement can be caused to appear, the importance of these quadrupolar sources can be shown. Application of the study to fan noise is suggested. F.R.L.

**A73-12975 #** Separated flow noise. F. R. Fricke (Southampton, University, Southampton, England). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2. Budapest, Akadémiai Kiado, 1971, p. 505-508. 16 refs.

Measurements of rms wall pressures and pressure spectra in subsonic separated flows are presented, along with relations between these values and other flow variables such as the position of the separated flow, transducer diameter, blockage, and boundary layer properties before separation. A flow model is presented that offers some promise of help in predicting rms wall pressure fluctuations from flow properties. M.V.E.

**A73-12976 #** An investigation of the near wake properties which lead to the generation of vortex shedding sound from airfoils. C. E. Hanson (Technical University of Norway, Trondheim, Norway). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2.

Budapest, Akadémiai Kiado, 1971, p. 509-512. Navy-supported research.

The vortex shedding sound levels were investigated in a symmetric airfoil section and a cambered airfoil section in the open-jet test section of a low-noise low-turbulence wind tunnel. The airfoils had blunt, splitter-plate or notched leading edges and were equipped with condenser microphones and pressure taps for measuring the oscillating base pressure. Hot-wire anemometer probes were used for measuring the velocity profiles in the wakes. Three types of shear layer velocity fluctuations with different peak behaviors were observed on the airfoils, depending on the flow velocity and airfoil leading edge parameters. The occurrence of marked changes in the mean wake velocity profiles when the pressure spectrum bandwidth was wider is discussed. V.Z.

**A73-12977 #** Noise exposure around an airport. J. Igarashi and G. Nishinomiya (Tokyo, University, Tokyo, Japan). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2. Budapest, Akadémiai Kiado, 1971, p. 513-516.

Noise level measurements at 150 locations around the Osaka airport are discussed. Effective Continuous Perceived Noise Levels (ECPNL) are given for eight aircraft types. A noise level area contour map and a diagram of noise duration allowance vs aircraft distance are given for the airport. V.Z.

**A73-12978 #** Techniques for determining the noise zones in the vicinity of the central Berlin-Schönefeld airport, and related problems (Methodik und Probleme bei der Bestimmung von Lärmzonen in der Umgebung des Zentralflughafens Berlin-Schönefeld). J. Hilscher (Zentralinstitut für Verkehrsmedizin, Berlin, East Germany). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings, Volume 2.

Budapest, Akadémiai Kiado, 1971, p. 517-520. In German. Theoretical considerations are given regarding the determination

of a set of parameters which are essential in defining the noise zones around this airport. Preliminary results are given for the relation between sonic boom and aircraft distance, for different aircraft types as sources of noise, for noise levels under current take-off procedures, and for the effects of meteorological and topographic factors on noise propagation in the airport area. V.Z.

**A73-12979 #** The influence of background noise on disturbance due aircraft. D. M. Waters and C. G. Bottom (Loughborough University of Technology, Loughborough, Leics., England). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2. Budapest, Akademiai Kiado, 1971, p. 521-524. 6 refs.

The procedures and results of a recent social survey examining the problem of combined aircraft and traffic noise are reviewed. Correlations with various noise exposure units are examined. The results indicate some influence of traffic background noise on both annoyance due to aircraft and the overall dissatisfaction due to aircraft and traffic. The use of a unit in the form of noise pollution level seems to offer the possibility of a promising method for predicting dissatisfaction due to combined noise sources. M.V.E.

**A73-12981 #** Aerodynamic noise and alternating loads in an idealized turbine stage. F. J. Legerer (Waterloo, University, Waterloo, Ontario, Canada). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 2. Budapest, Akademiai Kiado, 1971, p. 549-551.

From Imbach's (1971) flow computation method for two cascades in relative motion, a modified method is derived for the calculation of aerodynamic noise and alternating loads in an idealized turbine stage. The modification reduces the numerous numerical results Imbach's method yields to the most relevant parts only, namely, noise spectrum and alternating loads acting on the blades. M.V.E.

**A73-12988 #** Sound propagation in sheared flow in a duct with transverse temperature gradients. P. Mungur and D. Tree (Southampton, University, Southampton, England). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 4. Budapest, Akademiai Kiado, 1971, p. 349-352. Research supported by the Science Research Council of England.

A wave equation is derived for the sound propagation in sheared flow in a duct with transverse temperature gradients. The results obtained are an extension of a previous analysis to include a temperature gradient. Solutions with no limitation on the frequency are obtained by numerical integration. V.P.

**A73-12993 #** Reproduction of sound propagation in the standard atmosphere (Nachbildung der Schallausbreitung durch die Standardatmosphäre). O. Zadrazil (Karlova University, Prague, Czechoslovakia). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 4. Budapest, Akademiai Kiado, 1971, p. 409-412.

In German.

The acoustic field of an aircraft is calculated with allowance for the atmospheric sound absorption, assuming a mean air temperature of 15 C and a mean relative humidity of 70%. Frequency bands below 250 Hz are neglected. Once the frequency spectrum is calculated for a distance of say 100 m from the source, the acoustic field can be determined for distances of 200, 400, 800, 1600, 3200, 6400, 12,800 m with the aid of a special device. For other distances, the values must be interpolated. The decrease in the sound-pressure frequency-band level (in dB) is given in a table. V.P.

**A73-13026** Age control of elastomers by ANA Bulletin No. 438. P. A. House (USAF, Materials Laboratory, Wright-Patterson

AFB, Ohio). In: Non-metallic materials selection, processing and environmental behavior; Proceedings of the Fourth National Technical Conference and Exhibition, Palo Alto, Calif., October 17-19, 1972. Azusa, Calif., Society of Aerospace Material and Process Engineers, 1972, p. 281-293.

Buna N elastomers have been age-controlled by ANA Bulletin No. 438 for many years. Data on elastomers obtained from shelf aging studies and from crashed aircraft show that such age control is unnecessary. ANA 438 is in the process of being canceled and age control on seal materials will be eliminated. Age control will be retained on hose. (Author)

**A73-13039** A study of environmental degradation of adhesive bonded titanium structures in Army helicopters. R. F. Wegman, M. J. Bodnar (U.S. Army, Picatinny Arsenal, Dover, N.J.), and W. C. Hamilton (Gillette Research Institute, Inc., Washington, D.C.). In: Non-metallic materials selection, processing and environmental behavior; Proceedings of the Fourth National Technical Conference and Exhibition, Palo Alto, Calif., October 17-19, 1972. Azusa, Calif., Society of Aerospace Material and Process Engineers, 1972, p. 425-432. Army-supported research.

**A73-13048** Organization and management for adhesive bonding aircraft structures. F. B. Yarborough (Lockheed-Georgia Co., Marietta, Ga.). In: Non-metallic materials selection, processing and environmental behavior; Proceedings of the Fourth National Technical Conference and Exhibition, Palo Alto, Calif., October 17-19, 1972. Azusa, Calif., Society of Aerospace Material and Process Engineers, 1972, p. 553-561. 14 refs.

A survey conducted of six bonding facilities showed that there was unanimous agreement that close coordination between all disciplines of Bonded Structures was essential. The study revealed that the lack of proper coordination between Production, Tooling, Engineering, and Planning was the chief contributor to discrepancies and schedule delays. A plan for ensuring proper coordination with each organization to keep the fabrication of components on schedule, of high quality, and within the predicted cost parameters is presented. (Author)

**A73-13050** Selection process for a structural adhesive system for application of the L-1011 aircraft. E. R. Crilly (Lockheed-California Co., Burbank, Calif.). In: Non-metallic materials selection, processing and environmental behavior; Proceedings of the Fourth National Technical Conference and Exhibition, Palo Alto, Calif., October 17-19, 1972. Azusa, Calif., Society of Aerospace Material and Process Engineers, 1972, p. 579-604. 8 refs.

In selecting an adhesive system for the L-1011, aircraft lap shear and climbing drum peel strength criteria were established to meet structural requirements. Using these criteria as a starting point, an extensive laboratory test program was established to evaluate existing and newly formulated materials. In this phase the use of corrosion inhibiting primers was also investigated. Following this, a shop development phase was inaugurated to evaluate the effect of shop variables and to evaluate the most promising systems under shop conditions. In these shop trials, progressively larger panels were bonded, culminating in the bonding of full-scale simulated panels using the two remaining candidate adhesive systems. Simultaneously, numerous structural tests were run on joints and typical panels, and a correlation between climbing drum peel strength and the shear buckling characteristics of panels was established. (Author)

**A73-13062** Subsonic aircraft noise: A solution by the wider application of today's new engines. M. J. T. Smith (Rolls-Royce, Ltd., Derby, England). *Esso Air World*, vol. 25, no. 1, 1972, p. 7-10.

Questions of the toleration of aircraft noise by the public are considered, giving attention to the concept of the noise contour. The

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end of the aircraft noise problem is realized only when the area of the critical contour is contained within the confines of the airport. Approaches for achieving this objective are based on the use of quiet engines and improved operational techniques. It is pointed out that at present there are advanced technology engines capable of powering subsonic aircraft which could gradually replace the existing fleets of noisy jet aircraft. Such a reequipment program would lead to a reduction of noise exposure areas by at least a factor of five. A further halving of exposure area could be accomplished with suitable development work directed at a further reduction of engine noise.

G.R.

**A73-13070 #** lak-40 - Comfortable travel on 'country routes' (Jak-40 - Reisekomfort auf den 'Dorfstrecken'). K.-H. Eyermann. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 8, no. 8, 1972, p. 356-363. In German.

Description of the lak-40 - a short-haul (865 to 1600 km), twin-jet aircraft designed particularly for service in isolated areas of the USSR and capable of landing at small airfields without concrete runways. The lak-40 features bypass jet turbines, rear-mounted engines, and a T tail section coupled with the conventional large-aspect-ratio delta wing, all-surface landing gear, and ease of maintenance of the Li-2 and IL-14 propeller aircraft which it replaces. The lak-40 can take off from airstrips only 340 to 360 meters long, has takeoff and landing speeds of 160 and 150 km/hr, respectively, and has a fast climbing ability. The lak-40 is equipped with all the instrumentation required for all-weather flight, including an onboard computer and a radar with a range of up to 350 km.

A.B.K.

**A73-13071 #** Determination of the navigational regime for flight over fixed points during the landing maneuver (Ermittlung des navigatorischen Regimes für den Überflug fixierter Punkte während des Landemanövers). D. Oehme (Gesellschaft für Internationale Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 8, no. 8, 1972, p. 364-370. In German.

Consideration of the determination of a number of parameters which are vital for the successful execution of a landing approach and landing. The problems of correctly choosing the approach speed and determining the required thrust are discussed, as well as problems connected with the improvement of the thrust control. Calculations are presented for variation of the flight speed over fixed points in the second part of the landing approach and for variation of the navigational and aerodynamic parameters during the landing approach. Finally, the possibilities of thrust linearization are considered.

A.B.K.

**A73-13072 #** Comparison of modern aircraft engines with other power plants used in transportation (Vergleich moderner Flugzeugtriebwerke mit anderen im Verkehrswesen eingesetzten Antriebsanlagen). E. Schesky (Dresden, Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 8, no. 8, 1972, p. 371-377. In German.

Comparison of the most important features and parameters characterizing the internal-combustion engines commonly used in land, water, and air transportation. The engines used in the three above-mentioned types of transportation are compared with respect to the design of the power plant and the propulsion principle employed, the drag encountered and the required power output, the efficiency and specific mass of the power plant, the running time, and the reliability. Finally, a comparison is made between the power plant of a modern bypass turbojet engine and other power plants used in transportation.

A.B.K.

**A73-13074 #** Flight-mechanical analysis of various flight states of conventional aircraft. VII - Mechanical principles: Rigid

body dynamics (Flugmechanische Analyse verschiedener Flugzustände konventioneller Flugzeuge. VII - Mechanische Grundlagen: Dynamik des starren Körpers). F. Seidler (Dresden, Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 8, no. 8, 1972, p. 400-410. In German.

Consideration of the equations of motion of an aircraft regarded as a system of rigid bodies executing rotational motions relative to each other. Considering these bodies (mainly the propellers and rotors of gas turbine engines) as axisymmetric bodies executing gyroscope motions, it is shown that the gyroscopic moments which appear in the equations of motion of the aircraft in the presence of such bodies can be described by the relations previously found by the author for the rotational motion of a rigid body about a fixed point. A rotational momentum theorem is derived for force-free gyroscopes with three degrees of freedom. A detailed study is then made of the forced precession of gyroscopes. Finally, it is shown how the effect of a rotating rotor can be taken into account in the equations of motion for the rotational motion of the aircraft. A.B.K.

**A73-13167 #** On sound generated aerodynamically (Strömungsmechanisch erzeugter Lärm). P. Koltzsch (Zentralinstitut für Arbeitsschutz, Dresden, East Germany). (*Zentralinstitut für Mathematik und Mechanik and Mathematische Gesellschaft, Konferenz für Mechanik, Berlin, East Germany, Oct. 13-15, 1971.*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 52, Oct. 1972, p. T 382-T 389. 19 refs. In German.

Sources of aerodynamically generated sound include compressors, exhaust openings of pneumatic devices, machines using compressed air as source of energy, safety valves, jet propulsion systems, propellers, and rockets. The aerodynamic processes responsible for the generation of sound are considered together with the theoretical principles of aerodynamic sound generation. The basic theory proposed by Lighthill (1952, 1954) is discussed, giving attention to monopole, dipole, and quadrupole sonic sources. Other subjects explored include the inhomogeneous wave equation, sonic power, and turbulence models. Power laws regarding the acoustic field of compact three-dimensional sound-radiating flows are presented for sonic pressure and sonic power.

G.R.

**A73-13169 #** Problems regarding the use of electronic data processing for the calculation of diagonal cascades in turbomachines (Probleme beim Einsatz der EDV zur Berechnung von Diagonalgittern in Turbomaschinen). H.-E. Peters (Deutsche Akademie der Wissenschaften, Zentralinstitut für Mathematik und Mechanik, Berlin, East Germany). (*Zentralinstitut für Mathematik und Mechanik and Mathematische Gesellschaft, Konferenz für Mechanik, Berlin, East Germany, Oct. 13-15, 1971.*) *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 52, Oct. 1972, p. T 402-T 407. In German.

**A73-13228** Probabilistic aspects of fatigue; Proceedings of the Symposium, Atlantic City, N.J., June 27-July 2, 1971. Symposium sponsored by the American Society for Testing and Materials. Edited by R. A. Heller (Virginia Polytechnic Institute, Blacksburg, Va.). Philadelphia, American Society for Testing and Materials (ASTM Special Technical Publication, No. 511), 1972. 208 p. \$19.75.

A new method for the statistical evaluation of constant stress amplitude fatigue-test results is discussed, together with regression models for the effect of stress ratio on fatigue-crack growth rate, a comparison of scatter under program and random loading, and an investigation of the fatigue life and the residual strength of a wing panel for reliability purposes. Other topics considered include a method for estimating the median fatigue limit for very small up-and-down quantal response tests and for S-N data with runouts, a reliability approach to the fatigue of structures, an application of the Monte Carlo technique to fatigue-failure analysis under random loading, and the random fatigue of 2024-T3 aluminum alloy under two spectra with identical peak-probability density functions.

G.R.

**A73-13233** Investigation of fatigue life and residual strength of wing panel for reliability purposes. S. Eggwertz (Flytekniska Forsöksanstalten, Stockholm, Sweden). In: Probabilistic aspects of fatigue; Proceedings of the Symposium, Atlantic City, N.J., June 27-July 2, 1971. Philadelphia, American Society for Testing and Materials, 1972, p. 75-105. 32 refs. Research supported by the Styrelsen for Teknisk Utveckling.

About 20 sheet panels of 2024-T3 aluminum have been fatigue tested until cracks of various lengths appeared, using a flight-by-flight load program. The fatigue panels had four rows, with four small strips of the same sheet material in each row. The strips were attached to the sheet by two rivets, forming 32 stress concentrations in each panel. After fatigue cycling, the strips were replaced by continuous stringers and the residual tensile strength of the panels was determined. The mean of the logarithm of the number of flights to crack initiation amounted to 4.43, that is, 27,000 flights, while the standard deviation was 0.17. The relationship between the residual strength of the stiffened panel and the critical crack length shows rather little stochastic variation. When the residual strength is plotted vs the crack propagation time, however, the scatter does not seem to be negligible. (Author)

**A73-13246 #** Modern methods of clock comparison (Moderne Methoden des Zeitvergleichs). G. Hemmleb and F. Buckbesch (Deutsche Akademie der Wissenschaften, Zentralinstitut Physik der Erde, Potsdam, East Germany). *Wissenschaftliche Zeitschrift*, vol. 21, no. 3, 1972, p. 603-605. In German.

Review of the various methods which can be used for clock comparisons, and results of clock comparisons actually performed with one of these methods. Brief descriptions are given of the methods of clock comparison with the aid of short-wave, ULF, and VLF signals, the Loran-C and Omega methods, the use of atomic clocks flown by aircraft from station to station, and, finally, a method involving the use of television synchronizing pulses. A detailed account is given of the procedure by which measurements are performed and processed in the so-called TV method, and some results of clock comparisons by this method are presented. A.B.K.

**A73-13272** Applying surface integrity principles in jet engine production. G. Bellows (General Electric Co., Evendale, Ohio). *Metals Engineering Quarterly*, vol. 12, Nov. 1972, p. 55-58. 9 refs.

Surface integrity machining practices are used to improve component integrity. However, emphasis on surface integrity often brings the reaction that costs will increase and producibility decrease. While the lower, more gentle finishing operations needed to promote surface integrity take time, selective application of these practices can reduce total costs. Only those surfaces of a component that are highly stressed or critical for some application reason need attention. Surfaces of noncritical parts can have relaxed specifications, which are generally less costly to meet. This paper presents four case histories in which cost reductions resulted from the application of surface integrity principles. (Author)

**A73-13308 \*** Optimum performance of static propellers and rotors. J. C. Wu, R. K. Sigman (Georgia Institute of Technology, Atlanta, Ga.), and P. M. Goorjian (U.S. Army, Air Mobility R & D Laboratory, Moffett Field, Calif.). In: Southeastern Conference on Theoretical and Applied Mechanics, 6th, Tampa, Fla., March 23, 24, 1972, Proceedings. Tampa, S. C. Kranc, University of South Florida, 1972, p. 229-252. 13 refs. Army-supported research; Contract No. NAS2-6340.

A criterion for the optimum performance of static propellers and hovering helicopter rotors is developed. Numerical results are presented for the optimum radial distributions of circulation and inflow at the propeller disk and relating the optimum power coefficient and the figure of merit to the thrust coefficient. It is

shown that the present theory, which fully accounts for the effect of slipstream rotation, predicts optimum distributions of circulation and inflow that differ significantly from those based on approximate methods. (Author)

**A73-13350** Aircraft power pack is mounted on lift-out tray. H. A. Avey (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *Hydraulics and Pneumatics*, vol. 25, Nov. 1972, p. 86-89.

Description of the hydraulic system used in the de Havilland Twin Otter aircraft to operate the wing flaps, wheel brakes, nosewheel steering, and ski retraction actuators (if fitted). The system operates at a nominal pressure of 1500 psi and uses MIL-H-5606 mineral-base hydraulic fluid. The hydraulic power supply is provided by a single self-contained power pack mounted on a single tray for easy removal from the fuselage structure beneath the flight compartment floor. Attention is given to electric controls of the pump drive motor, reserve power accumulators, hydraulic reservoir design, pressure relief valves, and the hydraulically driven systems. T.M.

**A73-13386 #** United States SST electrical power system evaluation. W. A. Crossgrove, H. L. Ernst, and A. W. Schmidt (Boeing Co., Commercial Airplane Group, Renton, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1055*. 9 p. Members, \$1.50; nonmembers, \$2.00.

Completion and testing of the electrical power system designed for the SST is included in a test program which began in May 1972 and is currently in its final phase. The system under test is uniquely designed to ensure continued power to flight-critical functions. It consists of four variable-speed constant-frequency ac sources and a dual-channel standby system. Test results reveal the need for design refinements to improve endurance and electrical performance. Identification of these problem areas will allow design refinements prior to system application. (Author)

**A73-13387 \* #** Integrated engine-generator for aircraft secondary power. R. R. Secunde (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1056*. 9 p. 15 refs. Members, \$1.50; nonmembers, \$2.00.

The integrated engine-generator concept consists of an electric generator located inside a turbojet or turbofan engine and both concentric with and driven by one of the main engine shafts. The electric power-conversion equipment and generator controls are conveniently located in the aircraft. When properly rated, the generator serves as an engine starter as well as a source of electric power. The available generating capacity permits use of electrically driven engine accessories. This reduces or eliminates the need for an external gearbox on the engine, thereby simplifying the engine and nacelle assembly and increasing aircraft design flexibility. The nacelle diameter can then be decreased, resulting in less aerodynamic drag and reduced takeoff gross weight. (Author)

**A73-13390 \* #** Nuclear powerplants for mobile applications. J. L. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1061*. 34 p. 64 refs. Members, \$1.50; nonmembers, \$2.00.

Mobile nuclear powerplants for applications other than large ships and submarines will require compact, lightweight reactors with especially stringent impact-safety design. This paper examines the technical and economic feasibility that the broadening role of civilian

nuclear power, in general, (land-based nuclear electric generating plants and nuclear ships) can extend to lightweight, safe, mobile nuclear powerplants. The paper discusses technical experience, identifies potential sources of technology for advanced concepts, cites the results of economic studies of mobile nuclear powerplants, and surveys future technical capabilities needed by examining the current use and projected needs for vehicles, machines, and habitats that could effectively use mobile nuclear reactor powerplants.

(Author)

**A73-13391 # Engine technology for large subsonic nuclear powered aircraft.** F. L. Robson and G. T. Peters (United Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1062.* 9 p. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-71-C-1872.

Results of a technology review of the propulsion system of a large subsonic nuclear-powered aircraft. Low to moderate bypass ratio turbofan engines of 60,000 lb static thrust utilizing technology currently available in the JT9/CF6 jumbo-jet engines are the most suitable for use in a large subsonic aircraft. Such engines could be used with either gas-cooled or liquid-metal-cooled reactors. The analysis leading to selection of this type of engine is described, and conceptual design layouts of two engines are presented. (Author)

**A73-13396 # An altitude test facility for large turbofan engines.** P. F. Ashwood (National Gas Turbine Establishment, Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1069.* 10 p. Members, \$1.50; nonmembers, \$2.00.

The Altitude Test Facility at the NGTE has been progressively developed over many years and now includes a test cell capable of testing large turbofan engines over a wide range of simulated flight conditions. The cell enables steady-state performance measurements to be undertaken and slam accelerations and throttle chops made to determine engine response and behaviour during rapid transients. Icing, freezing fog and tropical rain conditions can also be simulated. The paper gives a description of the cell and defines its basic test capability. The methods used to measure the basic engine performance parameters and the techniques for calibrating the measurement systems and defining their degrees of precision are described. The descriptions are illustrated by examples from typical test programmes. (Author)

**A73-13403 # Computerized engine tester.** H. P. Shay (General Electric Co., Aerospace Electronic Systems Dept., Utica, N.Y.) and J. Russell (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1080.* 9 p. Members, \$1.50; nonmembers, \$2.00.

A unique approach to in-aircraft engine analysis is implemented with a portable self-contained, easily operated computerized engine analyzer. A cassette tape resident program controls the complete engine health test beginning at operator initiation. Dynamic engine data is received from a remote portable aircraft mounted signal conditioner box. Processing of the parameters include previous test delta change comparison, and pre-stored minimum engine limit GO/NO-GO indications. After the two minute test, results are presented to the operator on digital display and/or punched engine health cards. Improvements of engine test techniques will be evaluated after completion of a 20 engine test program. (Author)

**A73-13404 # Instrumentation for an engine diagnostic system.** W. L. Stevens (Rosemount, Inc., Minneapolis, Minn.). *American*

*Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1081.* 9 p. Members, \$1.50; nonmembers, \$2.00.

The operational approach used for diagnostic instrumentation on the J85 engines installed in the T38 is unique. Engine mounted instrumentation has been reduced to relatively small and inexpensive devices. The bulkier and costlier items are minimized by providing 'quick attach/detach' (QAD) methods of coupling engine located sensors to portable signal conditioners and transducers. Measurements are made under ground level static aircraft conditions, at military power setting. These facts were instrumental in selection of the sensors to achieve the desired accuracy. Since the program has been evolutionary, alternative instrumentation methods have been explored. The methods finally selected and the hardware utilized will result from the information gained during the current 20 engine operational test program. (Author)

**A73-13405 # Gas path analysis applied to turbine engine condition monitoring.** L. A. Urban. *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1082.* 9 p. Members, \$1.50; nonmembers, \$2.00.

An approach is presented to turbine engine gas path analysis and monitoring, which permits the isolation of single or simultaneous multiple engine faults, with a quantitative assessment of their relative severity. The software approach is described, showing features of its mathematical development and thermodynamic justification. Measurable engine parameters are treated as dependent variables, changes in which are mathematically interrelated to changes in component performance brought about by physical engine faults. Typical results are presented from real programs, wherein engine data were analyzed to provide meaningful and verified diagnoses of single and multiple engine faults. (Author)

**A73-13406 # Integrated engine diagnostics and displays for Navy aircraft of the 1980's.** P. F. Piscopo (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1084.* 6 p. Members, \$1.50; nonmembers, \$2.00.

**A73-13416 # Method for increasing wind tunnel Mach number for large-scale inlet testing.** E. A. Latham and N. E. Sorensen (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1096.* 6 p. Members, \$1.50; nonmembers, \$2.00.

**A73-13417 # A method of testing full-scale inlet/engine systems at high angles of attack and yaw at transonic velocities.** R. L. Palko (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1097.* 8 p. Members, \$1.50; nonmembers, \$2.00. Contract No. F40600-72-C-0003.

**A73-13419 # Statistical analysis of distortion factors.** J. L. Jacocks (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1100.* 7 p. Members, \$1.50; nonmembers, \$2.00. Contract No. F40600-73-C-0004.

A brief survey of the statistical properties of total pressure fluctuations and distortion factors at the compressor-face station of aircraft inlets demonstrates the fundamental randomness of various



distortion factors. The peak instantaneous distortion is shown to be inconsistent and not reliable as an indicator of inlet performance since the observed peak is dependent on data acquisition time. An alternate procedure is developed utilizing extreme-value statistics to provide dependable estimates of the maximum inlet distortion levels to be expected in a probabilistic sense. Experimental data from several inlet tests are used to demonstrate applicability of this technique. (Author)

**A73-13420 # Aircraft aftbody/propulsion system integration for low drag.** C. E. Swavely and J. F. Soileau (United Aircraft Corp., Pratt and Whitney Aircraft Div., West Palm Beach, Fla.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1101.* 12 p. Members, \$1.50; nonmembers, \$2.00.

Discussion of the results from three experimental afterbody drag programs intended to establish drag prediction techniques and to provide a basis for evaluation of nozzle afterbody installations. Several identified factors in low-drag configurations are summarized, and guidelines are recommended for the design of low drag, single and twin jet afterbodies. M.V.E.

**A73-13426 # Aft-end design criteria and performance prediction methods applicable to air superiority fighters having twin buried engines and dual nozzles.** E. R. Glasgow and D. M. Santman (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1111.* 15 p. 23 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F33657-70-C-0511.

**A73-13427 # Implementing the design of airplane engine exhaust systems.** D. Bergman (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1112.* 10 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

Results are shown of a study conducted to aid in the design and the performance analysis of engine nozzles. Specifically, the interference effects of exhaust plumes on external drag are evaluated for several nozzle aftbody shapes at various plume conditions. Empirical data from wind tunnel tests on isolated exhaust nozzles at high subsonic Mach numbers, plus other drag data, are correlated into a parametric set of curves pertaining to a wide range of nozzle aftbody geometries. The use of plume interference factors in arriving at airplane drag and nozzle thrust-minus-drag levels is illustrated, as well as a method whereby nozzle analytical flowfield results can be adjusted to account for true plume effects. (Author)

**A73-13428 \* # Nacelle-airframe interference at low supersonic Mach numbers.** D. P. Benzke (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1113.* 11 p. 13 refs. Members, \$1.50; nonmembers, \$2.00.

The aerodynamic interference between the propulsion system and airframe for a low supersonic transport with wing-mounted nacelles is examined. Both a flowfield analysis and the equivalent body approach were used to predict the interference lift, drag, and pitching moment as functions of nacelle size, shape, and position. The results indicate that the interference lift and pitching moment, as well as drag, must be included in the analysis to properly assess the interference effects. In addition, the performance of the basic wing was found to play an important role in determining the effectiveness of the interference lift in reducing the net installation drag. Based on

a conservative prediction, the interference effects can reduce the installed propulsion system drag to 40% of the isolated drag of the nacelles. Furthermore, including the interference effects in the optimization of the engine cycle from a thermodynamic and weight standpoint can result in a considerable reduction in the net propulsion system weight fraction (fuel plus engines) while increasing the optimum engine bypass ratio of a typical transport vehicle. (Author)

**A73-13429 # Powered model wind tunnel investigation to determine performance trends with nacelle location.** D. L. Motycka, V. J. DiSabato, and J. E. McCall, Sr. (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1114.* 6 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

**A73-13430 # A unified theory of inlet/engine compatibility.** H. C. Melick, Jr. and W. E. Simpkin (Vought Aeronautics Co., Dallas, Tex.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1115.* 17 p. 23 refs. Members, \$1.50; nonmembers, \$2.00.

Description of an analytical technique for predicting the effect of inlet-produced distortion on engine compressor stability. Predicted engine stall resulting from pressure and temperature distortion is verified by comparison with test results. The technique makes it possible to identify compressor design and inlet flow variables important to compatible operation over the operating range of interest. M.V.E.

**A73-13431 # A new approach to distortion induced compressor stall - Vorticity maps.** C. Farmer, M. Iverson, and A. Fuhs (U.S. Naval Postgraduate School, Monterey, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1116.* 18 p. 79 refs. Members, \$1.50; nonmembers, \$2.00.

Discussion of the present state of knowledge on distortion-induced stall, and description of an analytical basis for vorticity representation of distortion. Analyses of several stall events are presented, and the interplay between vorticity and compressor internal aerodynamics is examined. M.V.E.

**A73-13445 \* # Bleed system design technology for supersonic inlets.** J. Syberg and J. L. Koncsek (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1138.* 9 p. 7 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS2-6643.

A boundary layer bleed system design procedure for supersonic inlets, with emphasis on the selection of bleed hole geometry, is described. Available experimental bleed hole performance data, coupled with bleed drag calculations, show that holes with shallow inclination are superior to holes normal to the surface in terms of overall inlet performance. Recent test results from large-scale inlet models indicate that bleed hole size, bleed hole length, and boundary layer velocity profile upstream of the bleed region are important parameters in the design of an effective and efficient bleed system. (Author)

**A73-13446 # Some effects of normal shock boundary layer interaction on the performance of straight walled conical diffusers.** J. L. Livesey and A. O. Odukwe (Salford University, Salford, Lancs., England). *American Institute of Aeronautics and Astronautics and*

*Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1140. 8 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.*

**A73-13447 #** Effects of transverse ribs on pressure recovery in two-dimensional subsonic diffusers. F. D. Stull (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and H. R. Velkoff (Ohio State University, Columbus, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1141. 12 p. 16 refs. Members, \$1.50; nonmembers, \$2.00. USAF-sponsored research.*

An experimental investigation was conducted to evaluate the performance of two-dimensional ribbed diffusers. Static pressure recovery of a straight wall diffuser and a corresponding ribbed diffuser was obtained over a wide range of diffuser total angles and subsonic Mach numbers for three diffuser length-to-throat width ratios. At selected geometries, total pressure recovery and distortion index were obtained. In addition to an optimum rectangular rib design, obtained from earlier water table flow visualization tests, a chamfered rib and a roughened surface insert were also tested. Test results indicated that for an unstalled two-dimensional diffuser, the use of transverse ribs decreases performance, but increases of around 25% in static pressure recovery were obtained at larger diffuser total angles of from 25 to 40 deg. Under very limited conditions, gains of over 200% were achieved. (Author)

**A73-13448 #** Prediction of inlet duct overpressures resulting from engine surge. F. L. Marshall (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1142. 7 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.*

**A73-13469 #** Geared fan engine systems - Their advantages and potential reliability. T. A. Lyon and R. D. Hillery (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1173. 7 p. Members, \$1.50; nonmembers, \$2.00.*

Studies indicate that a reduction in aircraft noise is attainable through the use of high-bypass-ratio, low-fan-tip-speed turbofan propulsors. The weight and installation penalties associated with high-bypass-ratio, direct-drive engines could be reduced significantly by incorporating a small, high-speed turbine to drive the fan through a reduction gear system that is designed to current criteria as represented by the Allison T56 reduction gear planetary system. Operational experience with the T56 reduction gear indicates that the addition of a geared fan drive system will not compromise engine reliability. (Author)

**A73-13470 #** Recent developments in large area ratio thrust augmentors. B. Quinn (USAF, Energy Conversion Research Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1174. 12 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.*

Ejectors offer interesting means for resolving problems arising from the additional power requirements of V/STOL aircraft. The feasibility of ejector propulsion-lift concepts requires the simultaneous attainment of two conflicting objectives: high performance and compactness. It is shown that performance is degraded by losses occurring in the inlet, the primary nozzle and the duct-diffuser of the ejector. Analytic results identified practical loss trade-offs that led to the design of the ejector's components. Experiments with independently varied duct and diffuser lengths showed, surprisingly, that skewed flows can be diffused effectively. (Author)

**A73-13471 \* #** Installation effects on performance of multiple model V/STOL lift fans. J. H. Diedrich, N. Clough, and S. Lieblein (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1175. 10 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.*

The location and appendages of a lift fan on a V/STOL aircraft are expected to have a measurable effect on fan performance. To study such installation effects, an experimental program was performed in which the individual performance of multiple VTOL model lift fans was measured. The model tested consisted of three 13.97-cm diameter tip-turbine driven model VTOL lift fans mounted chordwise in a two-dimensional wing to simulate a pod-type array. The performance data provided significant insight into possible thrust variations and losses caused by the presence of cover doors, adjacent fuselage panels, and adjacent fans. The effect of a partial loss of drive air supply on fan performance was also investigated. (Author)

**A73-13472 #** Comparison of propulsion system concepts for V/STOL commercial transports. J. M. Zabinsky and R. N. Carter (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1176. 12 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.*

The influence of the propulsion concept on the design of a V/STOL commercial transport for the 1980-1985 time period is presented. On a V/STOL airplane, it provides the force for lift and cruise, is the sole source of energy for control, and is powerful enough to handle emergencies including those within the propulsion system itself. The propulsion system concepts all have moderate pressure ratio fans. Some are remotely driven and can be interconnected for power transfer and others are integral fans. The problems of propulsion integration and the conflicting aspects of the various concepts are shown. The aircraft size, weight, and initial and operating costs are affected by the propulsion system. (Author)

**A73-13487 #** Progress in techniques for measurement of gas turbine engine exhaust emissions. A. W. Nelson, J. C. Davis, and C. H. Medlin (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1199. 8 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.*

Recent measurement of engine exhaust emissions revealed significant data scatter. Investigation into causes of variations was conducted for the JT3D turbofan. This program covered a wide range of inlet temperatures but only a limited humidity range. Emissions were sampled using 3 methods: 12-point rake, exhaust pressure probes, and multipoint traverses. Analysis indicated significant temperature but little humidity effect. Combining data with other programs resulted in a larger humidity spread and emission mathematical models having strong temperature and humidity effects. Analysis also indicates that the major scatter needs explanation. Additional programs are required to minimize measurement errors and to define ambient effects for other engines. (Author)

**A73-13488 \* #** Nacelle design studies for advanced transport aircraft. M. B. Sussman, D. W. Gunnarson, and P. Edwards (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1204. 14 p. 5 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. NAS1-10703.*

Results are given of several analytical studies of nacelles suitable

for advanced subsonic commercial transport aircraft. The impact on the nacelle of reduced aircraft noise and increased cruise Mach number is emphasized and initially developed in terms of the individual nacelle components: inlet, fan cowl, nozzle, etc. This is achieved by relating the noise and cruise speed constraints to which the aircraft system must be designed to specific limitations on the individual nacelle components. Performance assessments are then made (separately for each nacelle component) of competitive design concepts. Overall nacelle designs, synthesized on the basis of the individual component studies, are briefly discussed. (Author)

**A73-13489 #** **Combustion instability in a turbofan mixed-flow augmentor.** G. E. Smith (Northern Research and Engineering Corp., Cambridge, Mass.) and R. E. Henderson (USAF, Aero Propulsion Laboratory, Wright-Patterson, AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1206.* 15 p. 7 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-70-C-1669.

An investigation of instability in a TF-30-P1 engine augmentor provided the first chance to check a previously developed analytical model against test data. The tests disclosed an instability when operating with an abnormal fuel zone combination. Amplitudes ranged as high as 37 per cent on cold days. The analysis predicted the augmentor to be unstable at the same frequency as observed. Results agreed qualitatively with the observed sensitivity to fuel zone combination, inlet temperature, fuel type, and liner and flameholder geometry. The combination of analysis and experiment clearly identified the conditions which must occur for the instability to reach significant amplitudes. (Author)

**A73-13491 #** **Vibrational and chemical nonequilibrium in a stoichiometric turbojet engine using kerosene-type fuel.** W. P. DeCarli and A. E. Fuhs (U.S. Naval Postgraduate School, Monterey, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1208.* 10 p. 21 refs. Members, \$1.50; nonmembers, \$2.00.

**A73-13518 \*** **Optimal horizontal guidance law for aircraft in the terminal area.** T. Pecsvaradi (NASA, Ames Research Center, Flight Systems Research Div., Moffett Field, Calif.; U.S. Army, Corps of Engineers, Washington, D.C.). *IEEE Transactions on Automatic Control*, vol. AC-17, Dec. 1972, p. 763-772. 7 refs.

Study of the horizontal guidance of aircraft in and near the terminal area. The problem of guiding an aircraft in minimum time from an arbitrary point to the outer marker is formulated as a nonlinear optimal control problem, and the control law solution is obtained by the application of the maximum principle. It is found that for some initial states the problem is singular. Furthermore, the extremal controls for this problem are not unique. Consequently, the optimal controls must be obtained on the basis of the value of the performance index. The control law is implemented in the form of a digital computer program which computes the optimal trajectory for arbitrary initial conditions. (Author)

**A73-13521** **Variable stability simulation techniques for nonlinear rate-dependent systems.** P. R. Motyka (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *IEEE Transactions on Automatic Control*, vol. AC-17, Dec. 1972, p. 809-812. 6 refs.

This paper deals with the development of variable stability simulation techniques for nonlinear rate-dependent systems. In particular, the model-following and response-feedback modes of dynamic simulation are considered for these systems. The paper begins with a development of variable stability simulation theory for nonlinear rate-dependent systems. Simple examples are given to

demonstrate the application of the theory. A model-following flight control system, in which the inertial coupling nonlinearities of the plant and model are taken into account, is then developed. Time histories are included to demonstrate the quality of model following that can be achieved. Finally, linear systems are considered as a special case of the general theory. (Author)

**A73-13524 #** **An automated jet-engine-blade inspection system.** R. W. Rothfusz (Bendix Corp.; Westinghouse Corp., Air Brake Div., Elyria, Ohio), D. J. Nadon, M. C. Kurko, and R. S. Kiwak (Bendix Research Laboratories, Southfield, Mich.). *Bendix Technical Journal*, vol. 5, Summer-Autumn 1972, p. 41-47.

This paper describes a prototype automated system for fluorescent-dye-penetrant inspection of jet-engine blades. The fluorescent-dye penetrant is automatically applied to the blade and developed, and the blade is then inspected for defects under ultraviolet illumination using a vidicon scanner. The scanner data are processed and evaluated on-line by a small digital computer to determine blade condition. Blades with defects are automatically separated from those of acceptable quality by blade-handling equipment under computer control. The automated system consistently detects flaws of the minimum specified size at a blade-processing rate of 250 per hour. (Author)

**A73-13561 #** **The interaction between turbulent wakes and boundary layers.** I. S. Gartshore (British Columbia University, Vancouver, Canada). *CASI Transactions*, vol. 5, Sept. 1972, p. 49-55. 7 refs. Defence Research Board of Canada Grant No. 9550-39; National Research Council of Canada Grant No. A-4308.

The mixing between a two-dimensional boundary layer and a wake has been investigated experimentally. Only the zero pressure gradient case has been studied. Measurements of mean velocity and turbulent intensity before and during interaction have been made for various wake and boundary layer combinations. An analysis has been devised to predict the mean velocity in the combined flow, based on the linearization of the equations of motion for small-deficit flows, and using a suitably defined virtual viscosity to account for the turbulent mixing. Addition of wake and boundary layer defects is then possible. The analytical framework predicts the measured mean velocity defect to within about 15% of the original defect, without the use of new empirical constants. (Author)

**A73-13562 #** **Aerodynamics of wing-slipstream interaction.** H. S. Ribner and N. D. Ellis (Toronto University, Toronto, Canada). *CASI Transactions*, vol. 5, Sept. 1972, p. 56-63. 25 refs. National Research Council of Canada Grant No. A-2003; Grant No. AF-AFOSR-70-1885.

A fundamental theory of wing-slipstream interference accounts for slipstreams of arbitrary cross section by means of vortex sheaths. These sheaths together with the wing circulation pattern lead to simultaneous integral equations for their determination. In a stepwise lifting line approximation these are ultimately reduced to simultaneous algebraic equations for machine inversion. Programs for the IBM 360-65 digital computer have been developed for the case of round slipstreams distributed with lateral symmetry on a rectangular wing. The computed span loadings have the shape expected from experiment. A sequence of curves of added lift due to the slipstreams (integrals of the span loadings), show a progression from slender body theory for very narrow slipstreams to strip theory for very broad slipstreams. (Author)

**A73-13571 #** **Experimental investigation of fatigue damage accumulation.** R. W. Baldi (General Dynamics Fatigue Laboratory, San Diego, Calif.). *Aircraft Engineering*, vol. 44, Nov. 1972, p. 4-6. 5 refs.

A test program is described that was conducted to check the validity of the Miner approach (1945) for fatigue damage accumula-

tion of 7075-T6 aluminum alloy. In this approach the expended life of a specimen was defined to be equal to the summation of the number of cycles that are applied at each different stress level when expressed as a percentage of the number of cycles that would cause failure. Results clearly indicate that a relationship exists between cycle ratio and stress ratio. The Miner approach appears to be slightly optimistic. F.R.L.

**A73-13572 #** Reducing the smoke hazard in small transformer failures. J. R. Bell (Ferranti, Ltd., Professional Components Dept., Dundee, Scotland). *Aircraft Engineering*, vol. 44, Nov. 1972, p. 16, 17.

**A73-13574 #** Extension of a portable tactical instrument approach and landing system. *Aircraft Engineering*, vol. 44, Nov. 1972, p. 26-29.

**A73-13575** Improving load factor control. J. Monbeig and A. Sypkens (McKinsey and Co., Inc., Washington, D.C.). *Interavia*, vol. 27, Nov. 1972, p. 1205-1207. 5 refs.

It is suggested that airlines could increase their load factors without impairing their service to the public, by clearly defining the relationship between the quality of that service and the average passenger load factor. The current industry uncertainties on the size of required capacity adjustments are reviewed, followed by description of how better load factor control can be achieved by relating quality of service to average passenger load factor. Some observations are made concerning the need for cooperation and/or coordination between airlines for successful load factor planning. F.R.L.

**A73-13585** New forms of reinforcement for composite materials. (Nouvelles formes de renforts pour matériaux composites). J. Brochier (Société Brochier Technique, Villeurbanne, Rhône, France). In: Composite materials of today and tomorrow: New materials and conventional industries; International Conference, 1st, Lyons, France, September 22-24, 1971, Proceedings. Paris, Editions Eyrolles; Editions Gauthier-Villars, 1972, p. 159-163. In French.

Description of three different types of composite materials in which reinforcement is achieved through the use of special shaping processes. The materials discussed include so-called 'stockings,' designed for use as radomes in aircraft or rocket noses, so-called extensible plane structures, which are honeycomb materials consisting of two tissues connected by partitions woven at the same time as the tissues, and, finally, blocks of tissues woven in three dimensions. A.B.K.

**A73-13586** Advantage of reinforced plastics for helicopter blades and hubs (Avantage des plastiques armés pour les pales et moyeux d'hélicoptères). G. Bourquardez and A. Violleau (Société Nationale Industrielle Aérospatiale, Paris, France). In: Composite materials of today and tomorrow: New materials and conventional industries; International Conference, 1st, Lyons, France, September 22-24, 1971, Proceedings. Paris, Editions Eyrolles; Editions Gauthier-Villars, 1972, p. 164-178. In French.

**A73-13594** Utilization in aeronautics of composite materials for working structures (L'utilisation dans l'aéronautique des matériaux composites pour les structures travaillantes). M. Collard (Société Bertin et Cie., Plaisir, Yvelines, France). In: Composite materials of today and tomorrow: New materials and conventional industries; International Conference, 1st, Lyons, France, September 22-24, 1971, Proceedings. Paris, Editions Eyrolles; Editions Gauthier-Villars, 1972, p. 406-408. In French.

**A73-13623 #** Supersonic flow past a dihedral angle (Conical case) (Obtekanie sverkhzvukovym potokom dvugrannogo ugla (Koni-cheskii Sluchai)). N. F. Vorob'ev and V. P. Fedosov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1972, p. 170-175. 5 refs. In Russian.

The supersonic flow past two plane wings which intersect to form a dihedral angle is analyzed within the framework of linear theory. Formulas for the pressure in the interaction region are derived, and the influence of the nonlinearity of the boundary conditions in the region of diffraction behind the characteristic head surface on the flow parameters at the edge of the dihedral angle is examined. V.P.

**A73-13701 #** Handling characteristics in roll of two light airplanes for steep approach landings. H. Chevalier (Texas A & M University, College Station, Tex.) and J. A. Burke (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *Journal of Aircraft*, vol. 9, Nov. 1972, p. 759-764. 16 refs. Army-supported research.

A flight test program has been conducted to measure experimentally the roll control and spiral stability characteristics of two general aviation airplanes and to relate these characteristics to the increase in pilot's workload associated with preserving a level wing attitude during steep landing approaches. A DeHavilland Beaver DHC-2 airplane and a Beechcraft T-34B airplane were used in the investigation. Values of measured roll control and stability parameters are compared with current handling qualities criteria. Rates of roll are compared with values calculated using lifting-line theory. The experimental results show that the problem of reducing the pilot's workload is not dependent upon improving the roll control characteristics of the airplanes tested, but appears to be mostly dependent upon providing additional spiral stability and reducing cross-coupling. The requirement for additional spiral stability needed during the landing approach conflicts with the need for neutral spiral stability during the turning maneuver. Comparisons of roll control parameters with current handling qualities criteria show that both airplanes are within the range for satisfactory operation. (Author)

**A73-13702 \* #** Wind shear near the ground and aircraft operations. G. H. Fichtl (NASA, Marshall Space Flight Center, Huntsville, Ala.). *Journal of Aircraft*, vol. 9, Nov. 1972, p. 765-770. 7 refs.

The variance of wind shear in the first 150-200 m of the atmosphere is a function of the direction of the mean wind relative to the flight path, the zenith angle of the flight path, the standard deviation of the three components of the turbulence velocity vector, the surface friction velocity, the stability properties of the atmospheric boundary layer, and the heights above natural grade of the beginning and end points of the portion of the flight path over which the shear is to be calculated. The results are applied by calculating wind shear for various risks of occurrence assuming wind shear is a Gaussian process, and it is shown that turbulence produces significantly large dispersions in wind shear about the mean wind shear. The results are interpreted in terms of the ICAO interim shear criteria for reporting wind shear in qualitative terms. (Author)

**A73-13703 #** Application of geometric decoupling theory to synthesis of aircraft lateral control systems. E. M. Cliff and F. H. Lutze (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Journal of Aircraft*, vol. 9, Nov. 1972, p. 770-776. 15 refs.

A vector space formulation is used to develop a computational procedure for decoupling a multivariable system. The concepts fundamental to this geometric approach are defined and their relation to the behavior of the linear system is discussed. Two theorems that provide the basis for the procedure are stated. The vector space statements are translated into algebraic operations suitable for machine calculation. A principal result of these computa-

tions is a set of linear algebraic equations that the elements of a decoupling feedback matrix must satisfy. The set of all solutions defines (in certain cases) the class of feedback matrices that will give the desired decoupling. A penalty function method is used to choose a matrix from this class so that the augmented system has desirable handling qualities. Two examples from the open literature are used to illustrate the method. (Author)

**A73-13704 \* #** Slowly oscillating lifting surfaces at subsonic and supersonic speeds. G. W. Brune and A. R. Dusto (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *Journal of Aircraft*, vol. 9, Nov. 1972, p. 777-783. 21 refs. Contract No. NAS2-5006.

The paper presents an unsteady aerodynamic influence coefficient method based on the low-frequency approximation. The influence coefficients are of a type which have been used to compute steady flow about wing-body combinations; therefore, the new method may be extended readily to low-frequency unsteady flow about wing-body combinations. The validity of the method is demonstrated by comparisons with numerical results from conventional, unsteady lifting surface methods. The method is valid for arbitrary wings in supersonic flow and for wings of finite span in subsonic flow. The method, when extended to include wing-body-tail interactions, will have important applications for predicting stability, control, and gust response characteristics of large airplanes. Dynamic stability derivatives and pressure distributions are given for several planforms. The comparison with either analytical or other well established numerical methods shows good agreement. (Author)

**A73-13705 \* #** Selective reinforcement of wing structure for flutter prevention. P. A. Cooper and W. J. Stroud (NASA, Langley Research Center, Structures Div., Hampton, Va.). *Journal of Aircraft*, vol. 9, Nov. 1972, p. 797-799.

The results of an analytical study are presented on the use of boron polyimide filamentary composite material for the purpose of increasing the flutter speed of a simple titanium full depth sandwich wing structure designed for strength. The results clearly demonstrate that selective reinforcement of wing surfaces, using judiciously placed filamentary composites, promises sizable mass savings in the design of advanced-aircraft structures. M.V.E.

**A73-13721** Numerical solution for a flat plate experiencing a ground effect (Soluzione numerica della lastra piana in effetto suolo). V. Losito (Napoli, Università, Naples, Italy). (*Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 1st, Palermo, Italy, Oct. 27-29, 1971.*) *L'Aerotecnica - Missili e Spazio*, vol. 51, June 1972, p. 183-187. 6 refs. In Italian.

Development of a numerical method of solving the problem of a flat plate undergoing a ground effect in an incompressible fluid which makes it possible to operate directly in the physical plane and to calculate load distributions along the chord. The proposed method is based on the use of vortex distributions on the plate and on its mirror image with respect to the ground, the unknown local circulation being expressed by a suitable trigonometric series expansion which extends the result for a plate in an indefinite stream. The tangential flux condition no longer leads to the calculation of the coefficients of the series in closed form, so that the latter must be evaluated by solving a system of algebraic equations. A.B.K.

**A73-13724** An axial-flow compressor for an air-cushion vehicle (Compressore assiale per veicolo a cuscino d'aria). O. Scrofani (Palermo, Università, Palermo, Italy). (*Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 1st, Palermo, Italy, Oct. 27-29, 1971.*) *L'Aerotecnica - Missili e Spazio*, vol. 51, June 1972, p. 205-215. 15 refs. In Italian.

Description of a recently constructed axial-flow compressor with variable-inlet guide vanes for the levitation of air-cushion vehicles. With the aid of this compressor it is possible to rapidly

modify, while in operation, the slope of the performance curve in order to adapt to various necessities of levitation, and the power absorbed by the compressor can be reduced as the speed of the vehicle increases. The compressor was constructed in two stages for the purpose of using only one for the levitation of amphibious or marine vehicles and two in series for tracked air-cushion vehicles. For the latter use, dividing the pressure rise into two stages results in an appreciable reduction of the airspeed and, consequently, the noise. A.B.K.

**A73-13765 #** Air-space analogies - The velocity limits in aeronautics and astronautics (Analogías aero-espaciales - Las velocidades límites en aeronáutica y en astronáutica). S. S. Arangué (Instituto Nacional de Técnica Aeroespacial, Madrid, Spain). *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée*, vol. 17, no. 4, 1972, p. 733-744. In Spanish.

The equations of motion in the case of the free fall of a body are examined, taking into account altitudes reached in conventional flights of subsonic aircraft. Attention is given to the system of differential equations, the equation of the hodograph, horizontal and vertical velocities, acceleration, and flight times involved. The equations for the relativistic motion of a spacecraft are also discussed. The established relations provide a basis for interstellar flight conducted according to the most suitable physical and mathematical concepts. Practical examples are considered, taking into account accelerations which can be tolerated by the human body. G.R.

**A73-13770 #** Study of the asymptotic behavior of axial perturbation velocities in the vicinity of singularities (L'étude du comportement asymptotique des vitesses axiales de perturbation, au voisinage des singularités). A. Nastase (Bucuresti, Institutul Politehnic Gheorghe Gheorghiu-Dej, Bucharest, Rumania). (*Colloque Euromech 25 sur les Méthodes de Perturbations Singulières en mécanique, Paris, France, July 5-7, 1971.*) *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée*, vol. 17, no. 4, 1972, p. 867-884. 13 refs. In French.

**A73-13801 #** Relative Capacity Estimating Process /RECEP/ - Operational implications for ATC capital investment decision making. J. O. Williams and R. S. Ratner (Stanford Research Institute, Menlo Park, Calif.). *Operations Research Society of America, National Meeting, 42nd, Atlantic City, N.J., Nov. 8-10, 1972, Paper. 19 p.* FAA-supported research.

An analytical process has been developed to estimate the controller's effect on the attainable capacity of a present or postulated air traffic control (ATC) system. The process uses a set of analytical models that relate, quantitatively, statements of sector physical configuration, traffic flow and mix, and the particular ATC system configuration to frequencies of occurrences of various types of ATC events. A second set of models attach a decision time required of the controller and a delay time imposed on the user to each ATC event. The process then aggregates the decision times required and compares this to a threshold value to generate relative capacity estimates for alternative ATC system specifications. (Author)

**A73-13838** An acceptable exposure level for aircraft noise in residential communities. N. S. Yeowart (Salford, University, Salford, Lancs., England). *Journal of Sound and Vibration*, vol. 25, Nov. 22, 1972, p. 245-254. 30 refs.

A review of existing guidelines and noise laws relating to aircraft indicated that they were governed, not by the acceptability of the aircraft noise to an exposed community, but by economic considerations. To examine the impact on aircraft noise requirements of a change in emphasis, from vehicle economy to noise acceptability, existing literature was used to estimate the maximum noise exposure from aircraft that a community would probably find acceptable. The

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suggested limit is 90 (plus or minus 5) PNdB for twenty noise events per day. Ideally, this noise level should fall within the airport boundary or on nonresidential land. (Author)

**A73-13840** Analysis of internally generated sound in continuous materials. II - A critical review of the conceptual adequacy and physical scope of existing theories of aerodynamic noise, with special reference to supersonic jet noise. P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 25, Nov. 22, 1972, p. 263-335. 68 refs. Contract No. F33615-71-C-1663.

**A73-13841** A moving source problem relevant to jet noise. R. Mani (GE Research and Development Center, Schenectady, N.Y.). *Journal of Sound and Vibration*, vol. 25, Nov. 22, 1972, p. 337-347. 8 refs. Research supported by the GE Corporate Research and Development Center.

The total power and power spectrum due to a point source convecting at a uniform subsonic velocity along the axis of a round jet are calculated. The source is a discrete frequency source in its own frame of reference and the jet is assumed to have a slug flow velocity profile with velocity equal to that of the source. The model problem is intended to provide some guidance concerning the issue of convective amplification in jet noise and the solution confirms that the convective amplification is very much frequency dependent. Some implications with regard to Strouhal scaling are pointed out. (Author)

**A73-13842 #** Direct correlation of noise and flow of a jet. H. K. Lee and H. S. Ribner (Toronto, University, Toronto, Canada). *Acoustical Society of America, Journal*, vol. 52, Nov. 1972, pt. 1, p. 1280-1290. 20 refs. National Research Council of Canada Grant No. A-2003; Grant No. AF-AFOSR-70-1885.

A direct correlation between the flow and noise of a jet has been measured. Two kinds of correlations were explored - namely, (1) the broadband turbulence signal (hot-film) with the broadband acoustic signal (microphone), and (2) the narrow-band filtered turbulence signal with the narrow-band filtered acoustic signal; the latter approach was ultimately adopted. The correlations were analyzed in terms of an extension of Proudman's form of Lighthill's integral for aerodynamic noise. This yielded the relative intensity and spectrum of the noise originating from a unit volume of a jet (35 locations) and received at a farfield point, which in turn led to the relative emission of successive 'slices' of a jet versus axial distance X over the measurement range (1D less than or equal to X less than or equal to 7D). Qualitative agreement was found with Ribner's X to the zero power law, and the spectral peaks for each slice were located in frequency essentially as predicted by Powell. (Author)

**A73-13897** The Pentagon enters its era of austerity. C. J. V. Murphy. *Fortune*, vol. 86, Dec. 1972, p. 142-146, 148, 150.

Financial problems in connection with the development and the production of aircraft and ships for the Defense Department are discussed, giving attention to the C-5A, the Cheyenne helicopter, and the DD-963 class of highly automated destroyers. Approaches for solving these problems include a reduction in force levels, a decreased rate in the development of systems based on novel technologies, and a relaxation in the insistence on the utmost in performance. The military procurement mechanism introduced by Packard is discussed, together with the development of the B-1 supersonic bomber, the F-15 fighter program, and the problems experienced in connection with the F-14 fighter. G.R.

**A73-13915** An improvement to an algorithm for computing aircraft reference altitude. R. L. Blanchard (North American Rockwell Corp., Anaheim, Calif.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-8, Sept. 1972, p. 685-687.

A recently developed algorithm which is being used to compute an aircraft reference altitude from air data inputs is accurate in a stationary column of air. However, pressure gradients in the atmosphere can introduce significant errors. An improvement (which corrects for pressure gradient errors) has been developed which is based on the equilibrium equation for the motion of the air mass in the presence of pressure gradients. (Author)

**A73-13920 #** Speed brake in carbon fibre composite construction. H. Boche, E. Henze, and S. Roth. *Dornier Post* (English Edition), no. 3, 1972, p. 12-14.

The use of a carbon fiber composite (CFC) in fabrication of the highly stressed speed brake of the Alpha Jet aircraft is discussed. Various questions had to be answered experimentally in order to support the design. The manufacturing technique selected is suitable for mass production, and each production step can be controlled. In the static test the component proved to be capable of bearing 80% of the calculated ultimate load or 110% of the limit load. The weight saving is 39% as compared to a light limit construction. F.R.L.

**A73-13921 #** Trends in helicopter guidance and control systems with bad weather capability. W. Metzdorff. *Dornier Post* (English Edition), no. 3, 1972, p. 15-19.

As the helicopter displays unfavorable natural flight characteristics in hover flight and the low transition range, and as these characteristics are subject to change over the entire flight envelope, the control performance by the pilot no longer meets the increasing difficulties of the missions. Also, the human control performance available is reduced by bad weather, since data acquisition from instruments places a heavier workload on the pilot than direct visibility. The control performance necessary for an operational military helicopter guidance and control system must be made good by technical control systems. Attention is given to dynamic response to disturbances, handling response, guidance, and technical design of integrated mechanical and electronic control systems. F.R.L.

**A73-13922 #** Air superiority fighter. *Dornier Post* (English Edition), no. 3, 1972, p. 20, 21.

The basic considerations for gaining air superiority over a combat zone are that the performances and characteristics of the aircraft must be comparable to or better than enemy fighters, and that a sufficient number of these aircraft must be able to take part in the operation. To arrive at an optimum design for the air superiority fighter, a comparison was made among several candidate configurations such as the conventional, the delta, and the canard with delta wing or standard wing. The design of the 'short-coupled canard' as basically realized in the SAAB Viggen proved to be very promising. F.R.L.

**A73-13923 #** Light combat aircraft with hover capability. *Dornier Post* (English Edition), no. 3, 1972, p. 22, 23.

The main task of a ground support aircraft is to ensure that suitable weapons are transported in the required number to the desired location. The aircraft in question must be capable of using small, camouflaged, and decentralized bases to avoid the initial threat of the enemy. A single-seater light hovercraft combat aircraft (LHCA) is described which has a radius of action of 200 km with a weapons load of more than 1000 kg, flying at high speeds and very low altitudes. The most important design parameter is the fan pressure ratio. F.R.L.

**A73-13945** An advanced concept in electrical power distribution control and management. J. R. Courter and T. R. Murrow (USAF, Washington, D.C.). In: Power Processing and Electronics Specialists Conference, Atlantic City, N.J., May 22, 23, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 165-167.

A new concept in electrical power distribution systems for aircraft is described and compared with conventional systems. Following a review of the development history of this concept, its practical application and advantages are discussed. Among the latter are: (1) reduced weight, volume, and maintenance time requirements; (2) increased flexibility; (3) improved power quality; and (4) automatic load management. The distinctive character of the proposed distribution system concept lies in the particular manner it utilizes multiplexing and computer control. M.V.E.

**A73-13947 \*** Electric power processing, distribution and control for advanced aerospace vehicles. A. Krausz (TRW Systems Group, Redondo Beach, Calif.) and J. L. Felch (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Power Processing and Electronics Specialists Conference, Atlantic City, N.J., May 22, 23, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 183-193.

The results of a current study program to develop a rational basis for selection of power processing, distribution, and control configurations for future aerospace vehicles including the Space Station, Space Shuttle, and high-performance aircraft are presented. Within the constraints imposed by the characteristics of power generation subsystems, and the load utilization equipment requirements, the power processing, distribution and control subsystem can be optimized by selection of the proper distribution voltage, frequency, and overload/fault protection method. It is shown that, for large space vehicles which rely on static energy conversion to provide electric power, high-voltage dc distribution (above 100 V dc) is preferable to conventional 28 V dc and 115 V ac distribution per MIL-STD-704A. High-voltage dc also has advantages over conventional constant frequency ac systems in many aircraft applications due to the elimination of speed control, wave shaping, and synchronization equipment. (Author)

**A73-13997** Business aircraft use - Yes or no (Geschäftsreiseflugzeug - Ja oder nein). H. G. Wellmann. *Flug Revue/Flugwelt International*, Dec. 1972, p. 31-34, 39-42. In German.

It is pointed out that there are approximately 134,000 general aviation aircraft in the U.S. About one half of these aircraft are employed for business trips of company personnel. The number of similarly employed general aviation aircraft in Europe is much smaller. The reasons for this difference in business aircraft use are not exclusively related to economical factors. A lack of knowledge regarding the possibilities of aircraft use, feelings of distrust and uncertainty, and the attitude of the government are important factors. The economical aspects involved in a decision concerning the employment of business aircraft are examined, giving attention to savings in time, indirect advantages and drawbacks, and costs. G.R.

**A73-14011** Determining the life of a design element on the basis of some concepts of the mechanism of fatigue failure. A. S. Mostovoi, A. A. Kozlov, L. K. Frolova, and A. A. Churakov (Kuibyshevskii Aviatsonnyi Institut, Kuibyshev, Ukrainian SSR). (*Problemy Prochnosti*, vol. 4, Mar. 1972, p. 21-27.) *Strength of Materials*, vol. 4, no. 3, Oct. 1972, p. 273-279. 6 refs. Translation.

A method for calculating the fatigue strength of an aircraft element prepared from 1Kh18N10T (nickel-chromium-titanium) steel is proposed. The mechanism of fatigue failure is described by an integral equation with respect to derivatives inverse to the crack propagation rates along the selected coordinates. Integration of the derivatives obtained yields the crack propagation time. Fatigue strengths calculated for harmonic and programmed loads are verified experimentally. V.P.

**A73-14040** Acoustic power spectrum of a subsonic jet. A. G. Munin and M. A. Shchepochkin. (*Akusticheskii Zhurnal*, vol. 18, Apr.-June 1972, p. 292-298.) *Soviet Physics - Acoustics*, vol. 18, Oct.-Dec. 1972, p. 241-245. 5 refs. Translation.

Analysis of the acoustic spectral power distribution of the radiation of a submerged subsonic jet. Expressions are derived to determine the noise spectra in the initial and principal sections of a submerged jet. The results are interpolated to any section of a jet between two fixed cross sections. V.Z.

**A73-14127 #** Investigations on incipient boundary layer separation on axisymmetric compression surfaces. W. Wyborny and H.-P. Kabelitz (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Gasdynamik, Porz-Wahn, West Germany). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 38 p. 14 refs.*

**A73-14128 #** An aircraft designer's review of some airframe and engine integration concepts. P. R. G. Williams and D. J. Stewart (British Aircraft Corp., Ltd., Weybridge, Surrey, England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 26 p. 6 refs.*

A brief historical review of past trends in engine/airframe integration has been made and future needs are discussed. Particular attention has been given to buried engines in the rear fuselage which ingest fuselage boundary layer air. It is shown that this type of integrated installation potentially offers significant improvements in overall performance, especially if cruise Mach numbers are to be increased into the high subsonic/transonic speed range. It is noted that in the application of boundary layer ingestion the realization of the potential gains and the engineering of the installation would be easier with an aft fan rather than a front fan engine. It has therefore been suggested that the aft fan arrangement warrants a serious reappraisal. STOL aircraft, because of the steep approach angles employed and the low approach thrust levels required, pose problems of thrust modulation and response. The variable-pitch fan engine is seen as an attractive solution to these problems, thus it is suggested that variable-pitch fan technology should be actively pursued. (Author)

**A73-14129 #** Effect of wake-wake interactions on the generation of noise in axial-flow turbomachinery. G. J. Walker (Tasmania, University, Hobart, Tasmania, Australia). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 45 p. 13 refs.* Research supported by the Department of Supply of Australia and Australian Research Grants Committee.

This paper describes the interaction between the viscous wakes of successive blade rows in an axial-flow turbomachine. It is shown that wake-wake interactions produce regular spatial variations in the unsteady velocity field, and therefore have a significant influence on the generation and propagation of internal noise. The discussion is supported by noise measurements and flow observations at low speed in a single-stage axial-flow compressor. (Author)

**A73-14130 #** A status report on jet noise suppression as seen by an aircraft manufacturer. W. C. Swan and C. D. Simcox (Boeing Co., Seattle, Wash.). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 42 p. 11 refs.*

Summary of the activities of an aircraft company with regard to the reduction of jet efflux noise for three major applications of commercial aircraft. The SST noise problem is discussed first. Activities with regard to the use of chutes, spades, and tubes in combination with C-D and plug nozzles will be outlined. Comparisons of noise suppression and thrust loss are made, and it is shown how these data support the compatibility of an SST with the community. The conventional subsonic jet noise problem is reviewed in the light of current and proposed noise regulations. Recent test experience is reviewed and an estimate is made of the apparent jet

noise floor which can be economically accepted. The jet noise problem for future STOL or short-haul aircraft is discussed and the apparent lack of agreement on noise data in the low-velocity, 300 to 800 ft/sec range is indicated. The amplification of jet noise due to flap impingement on an EFB configuration is noted. (Author)

**A73-14131 #** Development of the Olympus turbojet to meet supersonic civil transport requirements. A. B. Street (Rolls-Royce, Ltd., Bristol, England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 25 p.*

The redesigning of the military initial (1950) Olympus twin-spool turbojet engine to meet the requirements of the Anglo French supersonic transport is discussed. The civil engine is called the Olympus 593, and the versions currently fitted to the prototype aircraft are 593-3B engines. A modified version of these, termed the 593-4, has been used to power the first preproduction aircraft 01. The 593-4 engines will be later replaced with the production standard called 593-602 to power the subsequent aircraft. The principal topics discussed are: the environmental conditions, the flight envelope, development testing, compressors, main shafts, bearing compartments, combustion system, turbine, control system, pollution control, servicing and engine health monitoring, and performance. V.P.

**A73-14134 #** The application of adhesive bonded structures and composite materials on advanced turbofan engines. E. M. Pendlebury (CIBA-GEIGY /UK/, Ltd., Duxford, Cambridge, England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 34 p.*

The historical development of structural adhesive bonding is described, and its application to nonmetallic honeycomb structures and glass fiber and carbon fiber reinforced plastics is discussed. Particular attention is given to the design selection of adhesives and their use in the airframe and aircraft-engine industry. The advantages of metal to metal and sandwich bonding over bolting, riveting, and welding are outlined. Among these are substantial weight savings, the possibility of using thinner gauge materials, increased strength without additional weight or reduced weight without loss of strength, higher fatigue life of bonded panels than of panels joined by other methods, and reduction of production costs. Film adhesives, surface protection solutions, and core splice adhesives are examined. V.P.

**A73-14135 #** Study of the waves configuration in an axial-flow supersonic compressor (Etude de la configuration d'ondes dans un compresseur axial supersonique): J. Paulon (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 8 p. 5 refs. In French.*

Performance and operation stability of a transonic or supersonic compressor are conditioned by the intensity of the shock waves and their position in the blade channels. An experimental facility, which, in a small-height annular channel, simulates a rotating cascade at supersonic speed, provides optimum conditions to study the shock wave pattern and stability. This facility, using Freon 114 as working gas, includes a window for visualization through which instantaneous schlieren shock wave configurations are recorded. Outer wall pressure taps give mean pressure distributions in blade channels and check indications taken from schlieren pictures. Thus, it is possible to show that, as a function of back pressure, several flow patterns are obtained which extend from entirely supersonic operation in blade channels to rotating stall operation. (Author)

**A73-14137 #** High pressure stage efficiency of the turbines of modern turbojets (Rendement de l'étage haute pression des

turbines de turboréacteurs modernes). P. Martinat (SNECMA, Moissy-Cramayel-Villaröche, Seine-et-Marne, France). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 28 p. In French.*

For a high pressure turbine stage, the distribution of different energy reductions leads to an overall efficiency of 84 to 85 per cent. A hypothesis is developed which indicates that all the losses are cumulative, and experiment shows that this hypothesis is close to reality. Losses may be caused by the airfoil section, involving the distributor and the turbine wheel, or the losses may be secondary. Leakages from exterior and interior walls and from the rim are a factor. Energy losses occur due to blade cooling. F.R.L.

**A73-14138 #** Sources of noise in aero-engines. D. A. A. Marshall (Rolls-Royce, Ltd., Derby, England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 25 p.*

A noise source breakdown in level and directivity is presented for low-bypass-ratio engines, such as the Rolls-Royce Spey, and for high-bypass-ratio engines, such as the Rolls-Royce RB.211. It can be seen that the change from low to high bypass ratios has resulted in a marked noise reduction by substitution of discrete tone and broadband noise (characteristic of fan, compressor, and turbine) for the low frequency roar of the jet. The generative mechanisms of jet, compressor, fan, and turbine noise are analyzed. A study of jet mixing noise reveals a new source, termed tailpipe noise, which is an internal source amenable to reduction both by design and with acoustic linings. It is shown that intake airflow quality can be a significant factor for the single-stage fan without inlet guide vanes. Turbine noise investigation also requires careful experimentation to reveal the source. V.P.

**A73-14140 #** The S4-Modane hypersonic wind-tunnel - Its use for air breathing engine tests (La soufflerie hypersonique S4 de Modane - Utilisation pour les essais de moteurs aérobiés). J. Laverré and C. Soulier (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 10 p. In French.*

**A73-14142 #** Directional devices for noise reduction of high speed jets (Dispositifs directionnels de réduction du bruit des jets à grande vitesse). R.-G. Hoch, M. Julliard, and H. Lacombe (SNECMA, Paris, France). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 32 p. In French.*

**A73-14143 #** Study of the influence of the volumetric mass of a jet on acoustic sound emission (Etude de l'influence de la masse volumique d'un jet sur son émission acoustique). R. G. Hoch, J. P. Duponchel (SNECMA, Paris, France), B. J. Cocking, and W. D. Bryce (National Gas Turbine Establishment, Pyestock, Hants., England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 38 p. 20 refs. In French.*

**A73-14145 #** Practical application of boundary layer theory to flow and heat transfer problems in turbomachines. D. K. Hennecke (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper, 24 p. 16 refs.*

**A73-14146 \* #** Stoichiometric gas turbines - Development problems. H. E. Helms (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *Institut de Mécanique des Fluides, Inter-*



*national Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 57 p. 10 refs. Research supported by the General Motors Corp., U.S. Navy, U.S. Air Force, and NASA.*

Detroit Diesel Allison has been active in demonstrating the feasibility of stoichiometric gas turbine engines for many years. Results of this program are presented with emphasis placed on areas requiring additional development work. Cooling air usage, the effect of cooling air on turbine efficiency, fabrication (materials) methods, and control (instrumentation) techniques are the areas discussed and illustrated. Lamilloy, a pseudo-transpiring material developed by Allison, is discussed in detail. (Author)

**A73-14147 # The variable pitch fan - Propulsion for quiet STOL.** D. G. M. Davis (Dowty Rotol, Ltd., Gloucester, England). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 30 p. 6 refs.*

Review of design and development work on the concept of variable pitch fan propulsion for a quiet STOL transport aircraft. The results of the six year span of work are summarized as a demonstration of the basic feasibility of a fully variable pitch fan driven by an Astazou turboshaft engine and the refinement of mechanical design aspects to meet the requirements of various applications. Special attention is given to the aerodynamic and acoustic tests on different blade designs covering the entire pitch range. A compressor test rig with the blade pitch locked and reset between tests and an Astazou-driven variable pitch fan were used in the tests. The advantages of this STOL propulsion design concept are indicated. V.Z.

**A73-14148 # Some experiments on the noise emission of coaxial jets.** H. W. Dahlen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für luftsaugende Antriebe, Braunschweig, West Germany). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 17 p. 5 refs.*

The extent to which reduction of jet noise can be achieved by surrounding a circular primary jet with an annular flow is examined. Acoustic experiments have been performed with a model hot primary jet which had a Mach number very close to one, surrounded by a secondary cold annular flow of variable velocity and area ratios of the coplanar convergent nozzles. The experiments show that the reduction of high frequency noise emission depends on secondary flow velocity. In most cases, this reduction seems to be not compensated by an increase in low frequency noise power. (Author)

**A73-14149 # Viscous interaction in integrated supersonic intakes.** M. Culley (Department of Supply, Aeronautical Research Laboratories, Melbourne, Australia). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 30 p. 10 refs.*

An experimental investigation has been conducted into the nature of the flow interference which occurs between a supersonic intake and an airframe in an integrated design of aircraft. It has been shown that an intake pressure field is of ample strength to cause three dimensional separation of a boundary-layer within its influence. The most energy-deficient portion of the separated boundary layer is diverted by the separation, to be spilled into the airstream as vortices. A shock wave is generated by the three dimensional separation, and through this the boundary layer is able to influence the intake flow. (Author)

**A73-14150 # Survey of some current aerodynamic problems pertaining to supersonic air intakes (Aperçu de quelques problèmes aérodynamiques actuels posés par les prises d'air supersoniques).** P. Carriere (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Institut de Mécanique des Fluides, International Symposium on Air*

*Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 22 p. 48 refs. In French.*

After briefly recalling the general concepts of air intakes and the present state of theoretical knowledge for designing a supersonic intake, two, very important aspects of experimental problems are emphasized - namely, the characterization of the flow distortion at the outlet of the intake and the analysis of its fluctuations with time; and the study of the performance variations attached to the mode of installation of the intake. As an illustration, some interesting problems, which arose during studies leading to the definition of the Concorde external supersonic compression air intake are cited and the difficulties and complications encountered in the studies of internal supersonic compression intakes are reviewed. (Author)

**A73-14152 # Demonstration of supersonic compressor technology.** J. W. Blanton (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *Institut de Mécanique des Fluides, International Symposium on Air Breathing Engines, 1st, Marseille, France, June 19-23, 1972, Paper. 9 p.*

Cascade tests of blade sections, operation of single stage compressor rigs, and evaluation in experimental engines have contributed to improved understanding of supersonic compressors. Several rotor and stator combinations were tested in compressor rigs with performance ranging from disappointing to satisfactory for use in experimental engines. Generally there was good correlation between cascade and rotating rig test results. Simple turbojets were operated with single stage supersonic compressors as the only compression source. Finally, the supersonic compressor was tested along with transonic stages in an experimental turbofan. (Author)

**A73-14179 # Calculation of compressible turbulent boundary layers with roughness and heat transfer.** F. A. Orak (Boeing Co., Seattle, Wash.). *AIAA Journal*, vol. 10, Nov. 1972, p. 1447-1451. 17 refs.

A skin-friction law developed for incompressible turbulent boundary layers on rough surfaces in pressure gradient is extended to compressible flow by employing a procedure used previously by Spalding and Chi for smooth surfaces. The resulting equations coupled with the compressible momentum and entrainment integral equations provide a calculation method for predicting the growth of the compressible turbulent boundary layer over rough surfaces. Comparisons of the calculation method with a limited amount of experimental data indicate satisfactory agreement. (Author)

**A73-14180 \* # Lee-side vortices on delta wings at hypersonic speeds.** D. M. Rao and A. H. Whitehead, Jr. (NASA, Langley Research Center, Hypersonic Vehicles Div., Hampton, Va.). *AIAA Journal*, vol. 10, Nov. 1972, p. 1458-1465. 25 refs.

A fluid-dynamic investigation was carried out to determine the cause of intense heating observed on the lee meridian of hypersonic delta wings and also to derive means for its suppression. Several experimental techniques were combined with analysis of extensive heat-transfer measurements at a freestream Mach number of six in a range of Reynolds number to acquire a general description of the lee-flow structure. With attached leading-edge flow on the delta wings, the dominant feature is a pair of embedded vortices on the lee meridian whose interaction with the boundary-layer is responsible for the observed local heating. On the basis of flow visualization results and heat-transfer correlations, a qualitative vortex flow model is proposed which differs essentially from the conventional inboard separation vortex model. (Author)

**A73-14186 # Thrust coefficient of artificially excited vortex trail behind a jet flap aerofoil.** S. F. A. Kirmani (Hatfield Polytechnic, Hatfield, Herts., England). *AIAA Journal*, vol. 10, Nov. 1972, p. 1523, 1524.

Instantaneous wake photographs were taken with a stationary camera at various jet flap aerofoil velocities, Reynolds and Strouhal numbers, and amplitude settings in an experimental setup described by Wood (1967). The aerofoil model was suspended in a vertical plane below a trolley towed by a cable at constant speed along a glass tank with still water. Lateral oscillatory motion was provided by a subframe swinging without rotation under the trolley. The fluid motion was made visible by a suspension of neutrally-buoyant polystyrene beads illuminated by parallel beams from mercury vapor lamps. The aerofoil nose had an elliptical cross section. The circulation around vortices was measured on photographs. Diagrams of the findings are included. V.Z.

**A73-14188 # Rates of change of flutter Mach number and flutter frequency.** S. S. Rao (Indian Institute of Technology, Kanpur, India). *AIAA Journal*, vol. 10, Nov. 1971, p. 1526-1528.

Derivation of exact expressions for the rates of change of flutter Mach number and flutter frequency with respect to the design parameters of a supersonic aircraft wing. In the proposed method of derivation the piston theory of aerodynamics is used to obtain the air-force matrix. The use of the expressions derived is illustrated in two numerical examples, involving a double wedge airfoil and a delta wing, respectively. A.B.K.

**A73-14191 # Aerodynamic noise and boundary-layer transition measurements in supersonic test facilities.** E. R. Bergstrom (Loughborough University of Technology, Loughborough, Leics., England) and S. Raghunathan. *AIAA Journal*, vol. 10; Nov. 1972, p. 1531, 1532. 7 refs. Science Research Council Contract No. B/SR/8362.

Comments on the boundary-layer transition on models tested in supersonic test facilities. A comparison is made of all the noise measurements in supersonic flow known to the authors, leading to the suggestion of a more physically meaningful correlation of the data. On the basis of this comparison it is shown that the relationship between sound pressure level and transition Reynolds number holds for a considerable volume of earlier transition data obtained in a wide variety of wind tunnels. A.B.K.

**A73-14194 # Lift of wing-body combination.** H. T. Yang (Southern California, University, Los Angeles, Calif.). *AIAA Journal*, vol. 10, Nov. 1972, p. 1535, 1536.

Correction of a formula given by Miles (1952) for the lift of a wing-body combination. The corrected formula is obtained by using the conformal transformation given by Miles' Eqs. (1) and (2) to represent the complex potential in the base plane of the combination and then, using the notation employed by Ashley and Landahl (1965), expanding Miles' Eq. (1) in inverse powers of the complex cross flow plane. A.B.K.

**A73-14328 # Fatigue failure distributions for ball bearings.** C. F. Smith (Rolls-Royce, Ltd., Derby, England). *American Society of Mechanical Engineers and American Society of Lubrication Engineers, International Lubrication Conference, New York, N.Y., Oct. 9-12, 1972, ASME Paper 72-Lub-10*. 8 p. 16 refs. Members, \$1.00; nonmembers, \$3.00.

Description of test bearing assemblies with two different types of rigs (contrarotating and unisteeel rigs) for surface fatigue life estimation in the early failure region of aircraft gas turbine mainshaft ball bearings. Statistical analysis of test data suggests that ball bearing fatigue lives for low failure probabilities can be estimated more reliably from lognormal distributions than from extrapolation of Weibull distributions. This conclusion is particularly important when the Weibull shape parameter is below a value of about 1.3. Lognormal distributions are found to be a more reliable and economical means for comparing the fatigue lives of ball bearing track materials in the early failure region as compared with a Weibull distribution with empirical corrections. V.Z.

**A73-14370 Development of solid lubricant compact bearings for the supersonic transport.** L. C. Lipp (Hughes Aircraft Co., Culver City, Calif.), J. W. Van Wyk (Boeing Co., Seattle, Wash.), and F. J. Williams (North American, Rockwell Corp., Torrance, Calif.). *American Society of Mechanical Engineers and American Society of Lubrication Engineers, International Lubrication Conference, New York, N.Y., Oct. 9-12, 1972, ASLE Preprint 72LC-7C-1*. 7 p. Members, \$1.50; nonmembers, \$2.00.

This paper presents the bearing requirements and a bearing development program conducted for the supersonic transport. Five different solid lubricant compact materials were evaluated in a slider bearing material screening program using button specimens reciprocating at 20,000 psi. A test program was conducted using one-inch-bore sleeve bearings at loads of 5,000, 10,000 and 20,000 psi at temperatures of 70 F, 350 F at pressures simulating sea level and 70,000 ft altitude. Wear rates were determined for all combinations of temperature and atmospheric pressure at the 20,000 psi unit stress level. Wear rates increased as the temperature increased from 70 F to 500 F. The wear rate decreased when operation was changed from a sea-level condition to a simulated 73,000 ft altitude. (Author)

**A73-14376 # Side-slipping wings in the transonic range (Schiebende Tragflächen im Transsonik-Bereich).** B. Wagner (Darmstadt, Technische Hochschule, Darmstadt, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-127*. 31 p. 20 refs. In German.

The procedure reported takes into account the free vortices which at side slipping of the aircraft move away from a lateral edge. An integral equation for the vortex strength in the wake is derived with the aid of the theory of singular integral equations. The method of solution presented makes it possible to take into consideration an arbitrary degree of wing camber and wing warping. Singularities of vortex distribution in the wing tip and the wake are discussed. Solutions are shown for a conic wing and for wings with general form characteristics. G.R.

**A73-14377 Transonic profile theory - Critical comparison of various procedures (Transsonische Profiltheorie - Kritische Gegenüberstellung verschiedener Verfahren).** A. Eberle and P. Sacher (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 37* p. 20 refs. In German.

The use of theoretical methods for the design of profiles in the supercritical flow range and the employment of computation procedures for the determination of profile characteristics is discussed. The results obtained with the aid of various methods are compared on the basis of an investigation covering six selected profiles. Suggestions regarding the merits of the individual methods for the selection and definition of supercritical profiles are presented, and a new formulation is provided concerning the design approach for profiles with shockless compressing. G.R.

**A73-14378 # The prediction of airfoil pressure distributions for subcritical viscous flow and for supercritical inviscid flow.** S. Anders and L. Gustavsson (Forsvarsdepartementet, Flygtekniska Forsöksanstalten, Bromma, Sweden). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 18* p. 15 refs.

This paper first describes an approximate method originally presented by Powell, for calculating the pressure distribution on a thick cambered airfoil in subcritical viscous flow. The results obtained by the method are then compared with recent experimental results for subcritical flow conditions. This work is described in a FFA report (1972). For supercritical inviscid flow conditions pressure distributions have been calculated with two finite difference methods, the method of Krupp and Murman (1971) and the method of Garabedian and Korn (1972). A comparison is made between the two methods and with recent experimental results. (Author)

**A73-14379 #** Theoretical investigation of transition phenomena in the boundary layer on an infinite swept wing (Theoretische Untersuchung von Transitionsphänomenen in der Grenzschicht eines unendlich gestreckten gepfeilten Flügels). E. H. Hirschel (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Gasdynamik, Porz-Wahn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-124.* 24 p. 21 refs. In German.

**A73-14380 #** The transonic wind-tunnel section of the Institute of Aerodynamics in Braunschweig (Die transsonische Profilmessstrecke des Instituts für Aerodynamik in Braunschweig). G. Kausche (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-133.* 20 p. In German.

Description of a proposed transonic wind tunnel for profile measurements at fairly high Reynolds numbers. A detailed account is given of the present state of development of this tunnel, which is a reconstruction of a formerly existing supersonic wind tunnel. The concept underlying the design of this tunnel is reviewed, criteria for the design of the tunnel are outlined, and the range of operation of the tunnel is discussed. A.B.K.

**A73-14381 #** Comparative measurements involving three geometrically similar calibration models of a transport aircraft type in the transonic wind tunnel of the AVA Göttingen (Proposal: ONERA/ (Vergleichsmessungen an drei geometrisch ähnlichen Eichmodellen eines Transportflugzeugtyps im transsonischen Windkanal der AVA Göttingen /Vorschlag: ONERA/). W. Lorenz-Meyer (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-122.* 33 p. 7 refs. In German.

**A73-14382 #** The calculation of buffeting limits for swept wings (Die Berechnung der Schüttelgrenzen von Pfeilflügeln). G. Redeker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-123.* 63 p. 45 refs. In German.

Description of a method of determining the buffeting limits for swept wings in the transonic flow regime. In this case Thomas' method for determining buffeting limits of unswept and moderately swept wings is extended to the case of more highly swept wings. This is achieved by considering an infinite yawed wing, using Sinnott's method to calculate the transonic pressure distribution and an integral method to calculate the three-dimensional turbulent compressible boundary layer. A.B.K.

**A73-14383** Results regarding the use of collisionless transonic profiles in the case of transport aircraft (Ergebnisse zur Anwendung stossfreier transsonischer Profile bei Transportflugzeugen). J. Scheerer and B. Kiekebusch (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-130.* 37 p. 27 refs. In German.

Results concerning the design and calculation of supercritical profiles in order to ascertain the applicability of collisionless transonic profiles for wings of large and medium aspect ratio. In

order to determine whether the aerodynamic properties of these profiles can be applied to wings, test results concerning the design of straight and yawing quasi-two-dimensional wings are presented and discussed. In spite of the fact that the test results are not satisfactory in every respect, the limited use of sweepback theory in the case of supercritical wings is regarded as useful for design purposes. In a comparison with comparable conventional profiles an estimate is made of the separation behavior of supercritical profiles in the low-velocity range ( $Re$  equals 10,000,000). In connection with the results and experiences discussed for supercritical profiles a possibility of transonic wing design is indicated and discussed. A.B.K.

**A73-14384 #** Analog-analytic construction of supercritical flows past profiles (Analog-analytische Konstruktion überkritischer Profilströmungen). H. Sobieczky (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für theoretische Gasdynamik, Aachen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-129.* 19 p. In German.

Derivation of a principle for solving mixed elliptic-hyperbolic differential equations on the basis of the special boundary value problem of supercritical flows past profiles. For this purpose an electrical potential flow similar to a plane inviscid gas flow is employed through the construction of which both the subsonic region of the profile and the starting point for the analytical calculation of the supersonic region are given. With the aid of this method both collisionless flows and flows with weak compression shocks can be calculated. A.B.K.

**A73-14385 #** The influence of a strake on the flow field of a delta wing ( $\lambda = 2$ ) at near-sonic velocities (Zum Einfluss eines Strakes auf das Strömungsfeld eines Deltaflügels ( $\lambda = 2$ ) bei schallnahen Geschwindigkeiten). W. Stahl (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-125.* 23 p. In German.

**A73-14386** Improvement of maneuverability at high subsonic speeds (Verbesserung der Manöverleistungen im hohen Unterschall). W. Staudacher (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-126.* 24 p. 7 refs. In German.

Results of a series of experimental studies regarding the improvement of the maneuverability of fighter aircraft. The applicability of slotted and unslotted leading-edge and trailing-edge flaps was tested up to the transonic region on a wind-tunnel model as a geometrically variable configuration variant. As a geometrically fixed configuration variant, strakes, or high-sweepback leading-edge modifications, were attached to the basic delta wing at the wing root and were tested in the entire Mach number range of a fighter aircraft. Through a combination of the maneuver aids improvements of more than 100% over the basic wing could be achieved in certain flight ranges. The efficiency of the strake in the range of high angles of attack considerably exceeds that of the flap system. A.B.K.

**A73-14387 #** Calculation of supercritical flow past airfoils by the Murman-Krupp difference method (Berechnung überkritischer Profilströmung mit dem Differenzenverfahren von Murman-Krupp). R. Vanino (Dornier AG, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Tragflügel-Aerodynamik bei schallnahen Strömungen, Göttingen, West Germany, Oct. 26, 27, 1972, Paper 72-128.* 29 p. 7 refs. In German.

Results of an evaluation of the effectiveness of the Murman-Krupp difference method as a means of calculating steady supercritical flow past lifting airfoils. It is shown that this method is a good means for practical airfoil design. With a simple computational scheme useful solutions within a practicable computation time can

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be obtained even with the unperturbed flow as the initial solution. Examples are presented which demonstrate the wide range of applicability of the method, which yields good results even for relatively thick airfoils with strong suction points at large angles of attack. A.B.K.

**A73-14447 # Investigation of air stream from air-entry holes of the high-intensity combustor-liner.** T. Aiba (National Aerospace Laboratory, Chofu, Japan) and M. Inoue (Mitsubishi Heavy Industries, Ltd., Nagasaki, Japan). *JSME, Bulletin*, vol. 15, Oct. 1972, p. 1290-1297; Discussion, p. 1297, 1298; Authors' Closure, p. 1298. 12 refs.

An investigation of the jets flowing from the air entry holes of the liner of a gas turbine combustor was carried out using simplified models. Cold air was supplied through the air entry holes normally into the primary hot gas flows. The mass flows of the primary hot gas and issuing jets were measured, and the behavior of the air jets was studied by measuring the temperature distribution of the gas mixture. The maximum penetration of the jets, the jet flow path, the mixing of the jets, and the discharge coefficient of the holes were investigated. Some empirical expressions were obtained for the case of a single air entry hole. The results showed that the penetration rate and the path of the jets flowing from paired holes parallel to the primary flow can be estimated from the modified empirical expressions obtained for the single air entry hole. (Author)

**A73-14467 Concept and conduct of proof test of F-111 production aircraft.** W. D. Buntin (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.). *Aeronautical Journal*, vol. 76, Oct. 1972, p. 587-598. 5 refs.

The broad spectrum of service requirements for the F-111 includes short-field takeoff and landing capability, all-weather and deep interdiction, close air support with large payloads, high altitude, high speed air defence, and worldwide deployment with minimum tanker support. The development of the F-111 structural system included numerous element and component fatigue tests. Particular emphasis was given to full-scale component testing, using spectrum loadings representative of the design requirements. A basic objective of the proof test program is to screen the structural system for gross defects, including material flaws and any other defect not amenable to standard inspection practices. F.R.L.

**A73-14468 The aeroplane as a threat to the environment.** P. Lloyd. *Aeronautical Journal*, vol. 76, Oct. 1972, p. 599-606. 16 refs.

An attempt is made to assess the effects of noise, smoke, and odors produced by aircraft on the environment. The engineering and administrative measures which are being taken to control these effects are also considered. It is suggested that, in addition to causing noise and odors, aircraft add to pollution indirectly by enabling people to visit remote places of the earth which would normally be free from pollution. Atmospheric pollution, engine-generated noise, the sonic boom, and pollution of the stratosphere are discussed in detail. It is considered that noise in the vicinity of airports is the core of the problem. F.R.L.

**A73-14469 Scar tissue and aircraft propulsion development.** E. C. Simpson (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Aeronautical Journal*, vol. 76, Oct. 1972, p. 607-612.

An attempt is made to provide guidance in creating an environment to encourage success in aircraft propulsion development, with a view to alleviation of mental stress, among the personnel involved. The basic resources for aircraft engine development are money, manpower, facilities, and knowledge. The general size and importance of the problem, and the resources to be applied are defined. The problems of organization are outlined, followed by

a definition of the rules of procedure. The problems line people must overcome are discussed, followed by what to expect and where to inspect for problems. An approach to the technical portion of the problem is suggested. F.R.L.

**A73-14472 The induced drag on a rolling wing.** G. J. Hancock (Queen Mary College, London, England). *Aeronautical Journal*, vol. 76, Oct. 1972, p. 617-620.

Garner's (1970) discussion of the induced (inviscid) drag on lift-dependent drag on finite wings which have effective antisymmetric incidence distributions is examined. One of Garner's examples, which considered a symmetric finite wing at zero angle of attack, rolling at a constant rate of roll due to an externally applied moment, is extensively studied in terms of the Trefftz plane consideration of a rolling wing and a self-rolling wing. The mean wing incidence has been taken to be zero, and there has been no resultant lift. If the mean wing incidence is nonzero then, following through the analysis, the induced drag due to mean incidence is merely additive to all the drag results derived here because, due to the symmetry of the mean incidence loading and the antisymmetry of the loadings from the antisymmetric and rolling incidences, all cross terms vanish. F.R.L.

**A73-14489 \* # The optimal control of merging aircraft-derivation of the hybrid air traffic controller.** J. G. Schatz (Bell Aerospace Co., Buffalo, N.Y.) and T. E. Stern (Columbia University, New York, N.Y.). In: Annual Allerton Conference on Circuit and System Theory, 9th, Monticello, Ill., October 6-8, 1971, Proceedings. Urbana, University of Illinois, 1972, p. 1130-1139. 13 refs. NSF Grant No. GK-2283; Grant No. NGL-33-008-090.

The Federal Aviation Administration has initiated a program to automate its existing manual air traffic handling procedures. One procedure, whose automation is expected to increase controller efficiency by 2.6 to 2.9 times, is known as aircraft merging. This procedure is concerned with the merging of N aircraft, which are distributed among K feeder routes, into one or more final routes. The question of obtaining an exactly realizable and easily implementable automatic controller for merging is discussed. The optimal control of a linear system with state and control constraints is considered. G.R.

**A73-14501 A system for the precise calibration of air navigational receivers.** G. U. Sorger (Singer Co., Palo Alto, Calif.). (Institute of Electrical and Electronics Engineers and International Union of Radio Science, Conference on Precision Electromagnetic Measurements, 13th, Boulder, Colo., June 26-29, 1972.) *IEEE Transactions on Instrumentation and Measurement*, vol. IM-21, Nov. 1972, p. 519-527. 7 refs. FAA-supported research.

A new RF signal generator for the calibration of very high frequency omnidirectional radio (VOR) and instrument landing system (ILS) navigational receivers is presented. This new instrument improves the calibration accuracy of VOR angle and glide slope and localizer angle deviation by an order of magnitude over the calibration systems used up to now. The same order of magnitude improvement applies to the precision of AM level, phase angle settings, RF level, etc., and the stability of the simulated RF carrier in order to make the improved accuracy realizable. A new frequency lock technique allows to cover the RF frequency ranges continuously and still obtain a stability close to frequency synthesizer performance. (Author)

**A73-14542 \* # Intensive probing of clear air convective fields by radar and instrumented drone aircraft.** J. R. Rowland (Johns Hopkins University, Silver Spring, Md.). In: Radar Meteorology Conference, 15th, Urbana, Ill., October 10-12, 1972, Preprints. Boston, American Meteorological Society, 1972, p. 321-326. 11 refs. USAF-NASA-supported research.

Clear air convective fields were probed in three summer experiments (1969, 1970, and 1971) on an S-band monopulse tracking radar at Wallops Island, Virginia, and a drone aircraft with a takeoff weight of 5.2 kg, wingspan of 2.5 m, and cruising glide speed of 10.3 m/sec. The drone was flown 23.2 km north of the radar and carried temperature, pressure/altitude, humidity, and vertical and airspeed velocity sensors. Extensive time-space convective field data were obtained by taking a large number of RHI and PPI pictures at short intervals of time. The rapidly changing overall convective field data obtained from the radar could be related to the meteorological information telemetered from the drone at a reasonably low cost by this combined technique. V.Z.

**A73-14615 #** Modeling of nonlinear systems for the example of a single-shaft jet turbine engine (Modelowanie układów nieliniowych na przykładzie jednowalowego turbinowego silnika odrzutowego). S. Bramski and M. Rybak. *Instytut Lotnictwa, Prace*, no. 50, 1972, p. 3-14. 5 refs. In Polish.

**A73-14645** Wall boundary layers in turbomachines. H. Marsh (Durham, University, Durham, England) and J. H. Horlock (Cambridge University, Cambridge, England). *Journal of Mechanical Engineering Science*, vol. 14, Dec. 1972, p. 411-423. 15 refs.

Equations for the passage-averaged flow in a cascade are used to derive the momentum integral equations governing the development of the wall boundary layer in turbomachines. Several existing methods of analysis are discussed and an alternative approach is given which is based on the passage-averaged momentum integral equations. The analysis leads to an anomaly in the prediction of the cross flow and to avoid this it is suggested that for the many-bladed cascade there should be a variation of the blade force through the boundary layer. This variation of the blade force can be included in the analysis as a force deficit integral. The growth of the wall boundary layer has been calculated by four methods and the predictions are compared with two sets of published experimental results for flow through inlet guide vanes. (Author)

**A73-14658** Computer-mediated human communications in an air traffic control environment - A preliminary design. M. L. Constant and P. L. Seeley (Waterloo, University, Waterloo, Ontario, Canada). In: *Computer communications: Impacts and implications; Proceedings of the First International Conference*, Washington, D.C., October 24-26, 1972. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 172-177.

Description of some communication requirements characteristic of current manually operated air traffic control systems, and development of an improved computer-mediated alternative. The present air traffic control situation with respect to the flight progress strip, the ATC sector, and the handling of information and information categories is reviewed, and some general design considerations regarding possible alternatives are presented. Design criteria are proposed for hardware, software, and the man/machine interface. On the basis of a hardware/software simulation a design solution is presented which takes the form of a terminal consisting of a console containing a planning display area, a control display, and a touchwire overlay unit and a local processing unit consisting of a minicomputer and an input/output interface. A.B.K.

**A73-14672 #** Climatic impact assessment for high-flying aircraft fleets. A. Goldberg (Boeing Co., Seattle, Wash.). *Aeronautics and Aeronautics*, vol. 10, Dec. 1972, p. 56-64. 30 refs.

Historical and technological developments leading to the creation of the Climatic Impact Assessment Program (CIAP) are reviewed. CIAP results up to the summer of 1972 are discussed, covering predictions for chemical constituent concentrations in SST exhaust emissions, in the ambient stratosphere, and in the troposphere up to circa 1990; possible new solar radiation transmissions to

the troposphere and the earth's surface resulting from SST-related stratospheric perturbations, and expected social and economic costs of such perturbations. It is pointed out that the assessment of SST pollution and stratospheric-damage effects tends to become more favorable as the studies of these effects make progress. V.Z.

**A73-14673 \* #** New design goals and a new shape for the SST. R. T. Jones (NASA, Ames Research Center, Moffett Field, Calif.). *Aeronautics and Aeronautics*, vol. 10, Dec. 1972, p. 66-70. 10 refs.

Considerations are given to demonstrate that a wing which pivots as a whole would permit supersonic aircraft which avoid sonic boom and reduce noise around airports. Several such wing designs are discussed. Wind-tunnel tests results are given to support the soundness of this wing design. V.Z.

**A73-14706 #** Colloquium on Structural Reliability notes on 'Fatigue Lecture.' P. C. Paris (Del Research Corp., Hellertown, Pa.). In: *Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design*, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 20-34. 8 refs.

The approach and characteristics of modern analysis of structural flaw growth rates for particular structural configurations, loading conditions, materials, and environments are outlined. The possibility of correlating cyclic-load fatigue crack growth rates for different structural configurations in terms of the crack tip stress intensity factor (the K parameter in fracture mechanics) is noted, and methods based on the use of the K parameter are discussed. On the other hand, it is shown that flight by flight spectrum loading crack growth rates cannot always be correlated on a K basis alone. V.P.

**A73-14712 #** The design and development of fracture resistant structures. C. F. Tiffany (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: *Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design*, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 210-216.

Damage tolerant design concepts are discussed as they pertain to two general categories: those where unstable crack propagation is locally contained through the use of multiple load paths and/or tear stoppers, and those where flaws or defects are not allowed to attain the critical size required for unstable rapid crack propagation. Both design approaches assume the presence of undetected flaws or defects, and have a specified minimum residual strength level both during and at the end of a specified period of unrepaired service usage. V.P.

**A73-14714 #** Reliability analysis methods for metallic structures. D. M. Forney, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: *Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design*, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 237-243. 13 refs.

The development of structural reliability analysis methods is reviewed, starting with Freudenthal's analysis based on time to the first failures in a fleet, the establishment of a relation between the mean first failure and the mean (or characteristic) value of the parent population by introduction of the modern theory of order and extreme-value statistics, and the further development of this concept by noting that the expected time to first failure has its own distribution which is extremal regardless of the type of the parent distribution. It is shown that the single challenging technical problem facing the effective application of such analysis methods to the performance characterization of operating aircraft fleets is the task of correctly accounting for the changes from initial design reliability estimates brought about by fleet operational deviations from engineering design assumptions. V.P.

**A73-14715 # Evaluation of a reliability analysis method for fatigue life of aircraft structures.** C. S. Sarphe, Jr. (Lockheed-Georgia Co., Roswell, Ga.). In: Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 246-264. 11 refs.

**A73-14716 # The additivity of cumulative damage in the test or use environment.** C. S. Davis (Lockheed-California Co., Burbank, Calif.) and E. P. Coleman (California, University, Los Angeles, Calif.). In: Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 268-274. 20 refs.

The influence of the properties of additive processes on the analysis of the damage which accumulates in a structure subjected to sequences of variable-amplitude loadings is examined. The results apply not only to cumulative fatigue damage but to other forms such as wear, stress corrosion, and creep as well. It is shown that addition provides a valid basis for prediction of service life under progressive damage of any form if such damage defines failure and is measurable, and is allocated among events as disjoint damage effects. V.P.

**A73-14722 # Ballistic-damage-tolerant flight control systems.** L. A. Fry (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). In: Colloquium on Structural Reliability: The Impact of Advanced Materials on Engineering Design, Pittsburgh, Pa., October 9-12, 1972, Proceedings. Pittsburgh, Carnegie-Mellon University, 1972, p. 396-411. 7 refs.

Helicopter flight control systems are extensive and critical to flight, yet highly vulnerable to ballistics. Experience has shown that when forged or cast metallic components of these systems are hit by small-arms fire, they are subject to failure in a catastrophic manner. A solution has been found in the development of lightweight ballistic-damage-tolerant flight control components made from fiberglass-reinforced composite material. These components incorporate a multipath load capability, are designed to function in spite of ballistic hits from small arms, and are intended to replace metal components so as to improve aircraft survivability. Methods of manufacturing these components are presently being investigated, with emphasis on verification and environmental testing as well as repeatability in production. (Author)

**A73-14735 A universal digital autopilot and integrated avionics system.** W. E. Rouse (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). In: Western Electronic Show and Convention, Los Angeles, Calif., September 19-22, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 27/1-1 to 27/1-13.

The paper describes a system that was developed to perform navigation, guidance, control, and pilot-interface flight experiments in a variety of flight research vehicles. Emphasis placed on versatility and growth potential induced selection of an integrated digital system using modern avionics components. The system performs all computation for time-constrained navigation, guidance, control, and display in a general-purpose computer. Methods for conserving computation time while maintaining easy performance modification are described. Cockpit display flexibility was achieved by using cathode-ray-tube units; one is used to present a complex moving map. (Author)

**A73-14741 New metallic materials in the 70's - Opportunities and challenges.** M. E. Shank (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Opportunities in materials; Proceedings of the Fourth Buhl International Conference, Pittsburgh, Pa., November 16-18, 1971. Pittsburgh, Carnegie Press, 1971, p. 1-29. 16 refs.

New developments in the field of metallic materials are related to new usages for older materials, combinations of materials, new processing for old compositions, and new compositions. Further work for improving the impact strength of beryllium is required in order to utilize the full potential of this metal. The newer metallic materials include high temperature superalloys, refractory metals, composites, directionally solidified superalloys, and directionally solidified eutectics. Changes in aircraft constructional materials in the past 40 years are considered, giving attention to the use of titanium and superalloys in the new aircraft and their engines. Benefits and problems associated with fiber composites are examined. G.R.

**A73-14825 # Is the heavy-load airship experiencing a revival (Ger tunga lyft luftskeppen renassans).** A. S. Engstrom. *Teknisk Tidskrift*, vol. 102, Nov. 24, 1972, p. 20-22, 25. In Swedish.

Description of a proposed design of an airship which will carry loads of up to 400 tons over short and medium distances. Its total length will be 410 m, its maximum diameter about 80, its volume about 1,000,000 cubic meters, and it will have a displacement of 1100 tons. The airship will employ helium as the gas filler for safety reasons. The skin construction will be of honeycomb type. The airship will be powered by six Rolls Royce 4475-kW gas turbines equipped with standard 5.5-m propellers. Four of the engines are capable of tilting downward from their normal horizontal alignment to bring the ship down during landing and of tilting back up during takeoff. Loading and unloading are accomplished during a hovering maneuver with the aid of winches powered by a 930-kW gas turbine. A.B.K.

**A73-14826 Synoptic conditions of wave formation above convection streets.** H. Jaekisch. *Aero-Revue*, Dec. 1972, p. 651-653.

Two criteria for a favorable synoptic situation for gliders are obtained by analysis of air flow conditions above convection streets at Munich, Stuttgart, Cologne, Hannover and Berlin. The criteria can be derived from meteorological observations or from weather maps generally available at meteorological offices. V.Z.

**A73-14851 Testing for prediction of material performance in structures and components, Proceedings of the Symposium, Anaheim, Calif., April 21-23, 1971 and Atlantic City, N.J., June 29-July 1, 1971.** Symposium sponsored by the American Society for Testing and Materials. Philadelphia, American Society for Testing and Materials (ASTM Special Technical Publication, No. 515), 1972. 317 p. Members, \$22.80; nonmembers, \$28.50.

Fatigue life performance in lap-type solder joints, predictive testing in elevated temperature fatigue and creep, accelerated testing, evaluation of creep damage in a Cr-Mo-V steel, applications of exoelectron emission to nondestructive evaluation, determination of degradation of nylon 66, early detection of fatigue damage, and verification of structural integrity of pressure vessels are discussed. Attention is given to empirical strength theories, prediction of the service life of neoprene launch tube liner pads, fundamentals of radiation effects testing, techniques for smooth specimen simulation of fatigue behavior, Apollo quality through predictive testing, fatigue life prediction for weldments, and predictive testing of aircraft structures. F.R.L.

**A73-14862 Techniques for smooth specimen simulation of the fatigue behavior of notched members.** S. J. Stadnick and J. Morrow (Illinois, University, Urbana, Ill.). In: Testing for prediction of material performance in structures and components; Proceedings of the Symposium, Anaheim, Calif., April 21-23, 1971 and Atlantic City, N.J., June 29-July 1, 1971. Philadelphia, American Society for Testing and Materials, 1972, p. 229-252. 21 refs.

A relationship, proposed by Neuber, is used to relate the notch root stress-strain response to the nominal stress in a notched member. Further, several methods based on Neuber's rule allow a smooth cylindrical specimen to be used to simulate the stress-strain behavior of the notch root metal. The fatigue life of the smooth specimen is shown to furnish a satisfactory estimate of the fatigue life of the notched member, and the stress-strain plot of the smooth specimen is useful in understanding the local effects on the notch root metal of various nominal load histories. Results are reported for notched specimens subjected to variable load histories and for the corresponding smooth specimen simulations for 2024-T4 and 7075-T6 aluminum, aircraft quality 4340 steel, and Ti-8Al-1Mo-1V. (Author)

**A73-14865 Predictive testing of aircraft structures.** M. S. Rosenfeld (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Testing for prediction of material performance in structures and components; Proceedings of the Symposium, Anaheim, Calif., April 21-23, 1971 and Atlantic City, N.J., June 29-July 1, 1971. Philadelphia, American Society for Testing and Materials, 1972, p. 285-313. 8 refs.

The historic development of airframe structural testing is reviewed, and the role played by structural testing in the development of reliable airframe structures is discussed. The threefold safety-factor, safe-line, and fail-safe design approach provides reliable airframe structures when complemented by an effective laboratory test program that includes static, dynamic, and fatigue tests. Using an iterative analytical and test approach, the operational strength limits of an airframe can be predicted fairly accurately from the static test results. However, predictions of the safe service life from fatigue test data alone leave much to be desired because of the large variations in service usage. The ability to predict the lives of individual aircraft depends upon the development of an instrument that would measure the fatigue damage actually incurred. Until that time, frequent and rigidly controlled periodic inspections must be performed on all aircraft, and an elaborate scheme of progressive preventive maintenance is mandatory. (Author)

**A73-14889 International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1.** Conference sponsored by the Society of Automotive Engineers, U.S. Environmental Protection Agency, and U.S. Department of Transportation. New York, Society of Automotive Engineers, Inc., 1972. 435 p. Members, \$30.; nonmembers, \$40.

Planned development of transportation systems is examined with emphasis on the reduction of adverse effects on the environment. Topics examined include theories of transportation economics, transport demand forecasts and simulation, characteristic emissions of various surface and air transport vehicles, prospects for new powerplants, future automotive fuels, measurement of air pollution at airports, noise pollution from aircraft and trucks, and expected national regulations restricting emissions and noise. T.M.

**A73-14890 The impact of aircraft emissions upon air quality.** M. Platt and E. K. Bastress (Northern Research and Engineering Corp., Cambridge, Mass.). In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1972, p. 42-55. 8 refs.

Aircraft emissions and their impact upon air quality have been studied at four major air carrier airports and two general aviation airports. Predicted concentrations of nonmethane hydrocarbons and carbon monoxide due to aircraft emissions alone have been found to exceed their respective national ambient air quality standards. In the case of nitrogen dioxide, aircraft emissions contribute significantly to excessive concentrations. On the other hand, aircraft contributions to excessive concentrations of particulates and sulfur dioxide are small in areas to which the public has 'reasonable access.' (Author)

**A73-14891 Monitoring and modeling of airport air pollution.** D. M. Rote, I. T. Wang, L. Wangen, J. Pratapas, L. Leffler (Argonne National Laboratory, Argonne, Ill.), and G. Cato. In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1972, p. 56-85. 15 refs. FAA-sponsored research.

The airport air quality monitoring program conducted at both O'Hare and Orange County Airports is discussed and preliminary results are presented. Aircraft and related ground vehicular data are presented along with a summary of engine emissions. These data are discussed and their use in the activity simulation models is described. The models used for activity simulation and calculation of air quality are described briefly. (Author)

**A73-14892 Estimation of engine emissions at altitude through ground testing.** W. T. Westfield (FAA, Washington, D.C.). In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1972, p. 86-93.

An afterburning turbofan engine was operated over a range of simulated altitudes and Mach numbers to determine if correlation existed between static sea level emissions and those at altitudes and flight speeds. Data were taken at a point about 27 feet downstream of the exhaust nozzle exit and on the centerline of flow. No apparent effect of altitude or flight speed on emissions, either gaseous or particle, was observed. (Author)

**A73-14893 Aircraft noise and the airlines.** W. B. Becker (Air Transport Association of America, Washington, D.C.). In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1972, p. 128-133.

New developments concerning aircraft noise are discussed, giving attention to the equipment of aircraft with noise suppressors, the introduction of the fan-jet engine, the appearance of the wide-body aircraft with its high bypass fan engines, special approach and takeoff patterns, and runway realignments. Problems of aircraft modifications in connection with an alleviation of aircraft noise are related to economic questions and the necessity to maintain the required safety standards. G.R.

**A73-14894 Aircraft noise as a continuing national problem.** L. Hinton (Metropolitan Aircraft Sound Abatement Council, Minneapolis, Minn.). In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive Engineers, Inc., 1972, p. 134-147. 23 refs.

The problem of aircraft noise was already recognized at the time of the appointment of the President's Airport Commission by President Truman in February 1952. Aspects of early congressional interest in aircraft noise questions are considered together with views expressed by the Environmental Protection Agency (EPA) and by NASA. Effects of aircraft operation on community noise and possible noise abatement takeoff procedures were studied by individual airlines. The enactment of legislation by Congress is proposed to accomplish immediate alleviation in noise problems on a short term basis and to authorize the EPA to develop national guidelines for the establishment of noise exposure contours at all airports on a long term basis. G.R.

**A73-14895 Air transportation system planning - Progress in noise reduction.** A. L. McPike (Douglas Aircraft Co., Long Beach, Calif.). In: International Conference on Transportation and the Environment, Washington, D.C., May 31-June 2, 1972, Proceedings. Part 1. New York, Society of Automotive

Engineers, Inc., 1972, p. 402-407.

Brief examination of how community noise considerations affect the development of new commercial transport aircraft. The general noise level goals of the manufacturer are discussed, and information is provided to show that, contrary to popular opinion, the noise levels of succeeding generations of jet transports have generally been lower than those of their predecessors. Some of the evaluation procedures available for minimizing community noise are examined, along with some of the constraints the aircraft manufacturer faces in the design process. A brief assessment of what the future trends in community noise levels will be is presented. (Author)

**A73-14902 #** Instrumentation and measurement for determination of emissions from jet engines in altitude test cells. J. L. Grissom (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1068*. 11 p. 6 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F40600-73-C-0004.

**A73-14908 #** A procedure for estimating maximum time-variant distortion levels with limited instrumentation. S. H. Ellis (United Aircraft Corp., Pratt and Whitney Aircraft Div., West Palm Beach, Fla.) and B. J. Brownstein (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Fla.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1099*. 12 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

**A73-14921 \* #** Pollution measurements of a swirl-can combustor. R. W. Niedzwiecki and R. E. Jones (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1201*. 16 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

Pollutant levels of oxides of nitrogen, unburned hydrocarbons, and carbon monoxide were measured for an experimental, annular, swirl-can combustor. The combustor was 42 inches in diameter, incorporated 120 modules, and was specifically designed for elevated exit temperature performance. Test conditions included combustor inlet temperatures of 600, 900 and 1050 F, inlet pressures of 5 to 6 atmospheres, reference velocities of 69 to 120 feet per second, and fuel-air ratios of 0.014 to 0.0695. Tests were also conducted at a simulated engine idle condition. Results demonstrated that swirl-can combustors produce oxides of nitrogen levels substantially lower than conventional combustor designs. (Author)

**A73-14922 \* #** Flap noise measurements for STOL configurations using external upper surface blowing. R. G. Dorsch, M. Reshotko, and W. A. Olsen (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1203*. 39 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

**A73-15004** On the remarkable accuracy of the vortex lattice method. R. M. James (Douglas Aircraft Co., Long Beach, Calif.). *Computer Methods in Applied Mechanics and Engineering*, vol. 1, June 1972, p. 59-79. 21 refs. Research supported by the Douglas Independent Research and Development Program.

Integral equations with Cauchy type singular kernels are of frequent occurrence in aerospace engineering and usually require

solution by complicated numerical techniques because of singularities in the solution itself. The cases of steady or unsteady planar subsonic wing theory are typical, and recently a simple, but remarkably accurate, method known as vortex lattice has been found very satisfactory. In this paper a simplified analog (the finite Hilbert transform) or the equation of two-dimensional incompressible thin wing flow, is studied and several important points concerning this discretization are proved. For instance, it is unique and does not require external imposition of trailing-edge conditions; the singularities in the solution are automatically generated without the use of special loading functions; provided a specific and unique spacing for the collocation points is adhered to. (Author)

**A73-15064** Design of digital force function generator for aircraft tire load testing. C. F. Chen (Akron, University, Akron, Ohio) and R. D. Flower (Goodyear Aerospace Corp., Akron, Ohio). In: *National Electronics Conference, 28th, Chicago, Ill., October 9-11, 1972, Proceedings, Volume 27*. Oak Brook, Ill., National Electronics Conference, Inc., 1972, p. 291-295.

The problem of replacing an analog force function generator for testing aircraft tires under load was investigated and solved by first defining the analog system and then producing the same results with digital techniques. The design of the digital system is discussed, taking into account force generator inputs and generator calculations. Attention is given to questions of initialization, the maximum limit for the rate of force change, aspects of time counting, output, and the control logic. G.R.

**A73-15065** An airborne associative array processor. R. A. Urban (Control Data Corp., Minneapolis, Minn.). In: *National Electronics Conference, 28th, Chicago, Ill., October 9-11, 1972, Proceedings, Volume 27*. Oak Brook, Ill., National Electronics Conference, Inc., 1972, p. 318-321.

The digital computer described is a parallel array processor. It consists of many arithmetic units performing identical operations simultaneously, directed by a single control unit. The airborne associative array processor (AAAP) can be airborne because the use of MOS large scale integrated circuit technology results in small size and light weight. Applications for AAAP include radar data processing, air traffic control, electronic warfare, command and control systems, and the solution of large systems of differential equations. G.R.

**A73-15093 #** Calculation methods of three-dimensional boundary layers with and without rotation of the walls. C. Quemard and J. Cousteix (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*EUROMECH, Colloque sur les Couches Limites Turbulentes Tridimensionnelles, Berlin, West Germany, Sept. 25-27, 1972*.) ONERA, TP no. 1135, 1972. 13 p. 6 refs.

An integral method and a finite difference method based on a mixing length turbulence model are used to perform three-dimensional calculations of boundary layer flows. First, comparisons are made in various experimental cases. Next, calculations of idealized flows, for the infinite swept wing and rotating discs of a diffuser, are presented. (Author)

**A73-15098 #** Combustion in a swirling flow. A. Mestre and A. Benoit (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*International Symposium on Combustion, 14th, Pennsylvania State University, University Park, Pa., Aug. 20-25, 1972*.) ONERA, TP no. 1076, 1972. 13 p. Research sponsored by the Délégation Générale à la Recherche Scientifique et Technique.

Combustion chamber tests were carried out to investigate the effectiveness of combustion in a high-speed whirling flow as an alternative to usual combustion in gas turbine combustion chambers. Upstream flame velocities on the order of 110 to 180 m/sec were achieved when a kerosene-air mixture was injected tangentially in an annular channel with 4 and 3.4 in. outer and inner diameters. Combustion was complete at a distance of 5 in. downstream of a



wedge-shaped flame holder used for flame stabilization. A temperature of 2300 K was recorded by a pneumatic pyrometer during the tests. V.Z.

**A73-15119 # H2-air fuel cells as electric supply on stratospheric airship.** P. Balaskovic and A. Rouscilles (CNRS, Laboratoire Physique Developpement, Verrières-le-Buisson, Essonne, France). In: International Symposium on Fuel Cells, 4th, Antwerp, Belgium, October 2, 3, 1972, Proceedings, Volume 1. Mol, Belgium, Commissariat de l'Energie Atomique, 1972. 17 p.

The fuel cells considered can provide a stratospheric airship with propulsive energy. The airship is generally moving at an altitude of 22 km. It serves mainly as a relay for EM-beams. The power system selected for the airship consists of the electric engine and fuel cells based on air and cryogenic hydrogen. It is pointed out that this system is the only power system of the systems considered which meets the stringent requirements regarding a low weight for the airship power system. G.R.

**A73-15167 # The aerodynamic characteristics of the thin delta wing fitted with a conical body in supersonic flow.** A. Nastase and I. Paraschivoiu (Bucuresti, Institutul Politehnic Gheorghe Gheorghiu-Dej, Bucharest, Rumania). *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée*, vol. 17, no. 5, 1972, p. 963-989. 7 refs.

**A73-15252 Air Force and non-linear estimation.** M. M. Bonner (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: Symposium on Nonlinear Estimation Theory and its Applications, 3rd, San Diego, Calif., September 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 18-22.

The needs of the Air Force are discussed in the light of the current technological capabilities of the industry, with particular reference to areas of interest to the Air Force which cannot be treated by linear approaches but require nonlinear solutions. Causes of nonlinearities which preclude linearization are examined, and some Air Force applications containing significant nonlinearities are discussed. A capability oriented 'shopping list' is presented to indicate the areas where improvements could be used by the Air Force. V.P.

**A73-15393 Forward scatter chaff system for air-ground long haul communications.** L. Katz (Mitre Corp., Bedford, Mass.). In: NTC '72; National Telecommunications Conference, Houston, Tex., December 4-6, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 10C-1 to 10C-7. 18 refs.

This paper presents the results of a preliminary study of the application of a forward-scatter technique to military air-ground long haul communications, using rocket-dispersed chaff as a scattering medium. The first part of the study is concerned with the validity and feasibility of the concept. Calculations are made to show that the signal-to-noise ratio is satisfactory over a typical path; and it is shown that chaff persistence is sufficient to maintain communications over an acceptable time period. In the latter part of the study, a typical rocket vehicle is selected for chaff deployment, and several anticipated technical problems, such as multipath and excessive cloud dispersion are discussed. Finally, existing equipment adaptable to chaff forward-scatter is discussed, and system costs are estimated. (Author)

**A73-15439 Ground reflection multipath effects on air-borne communications.** H. Berger, J. E. Evans, and I. G. Stiglitz (MIT, Lexington, Mass.). In: NTC '72; National Telecommunications

Conference, Houston, Tex., December 4-6, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 33A-1, 33A-2. USAF-sponsored research.

**A73-15441 A model of signal detection for the instrument landing system.** L. M. Jordan (Transportation Systems Center, Cambridge, Mass.). In: NTC '72; National Telecommunications Conference, Houston, Tex., December 4-6, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 33E-1 to 33E-6. 5 refs.

A unified model of ILS signal detection is presented that attempts to reach a higher level of completeness and correctness for actual receivers than previously used models. This model may be applied to all currently existing ILS transmitting systems and has been incorporated into a computer multipath interference simulation program which is currently under development. So far, all results have been consistent with expectations. M.V.E.

**A73-15462 \* On the technology of aerospace communication in multipath.** J. H. Painter (NASA, Langley Research Center, Hampton, Va.), S. C. Gupta (Southern Methodist University, Dallas, Tex.), and L. R. Wilson (LTVAC Hampton Technical Center, Hampton, Va.). In: NTC '72; National Telecommunications Conference, Houston, Tex., December 4-6, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 38G-1 to 38G-10. 45 refs. Contract No. NAS1-10900; Grant No. NGR-44-007-049.

The mechanism, effects, and modelling of multipath propagation, caused by rough earth reflection, are examined for aerospace communication. Emphasis is on binary digital signalling for aircraft and hybrid vehicles, such as Shuttle. The cases of direct Air-Ground and satellite relay (Aerosat) are treated. The recursive, adaptive, coherent Bayes detector for binary phase-shift-keying in nonselective multipath is presented. The derivation for the frequency-shift-keying detector is indicated. (Author)

**A73-15512 \* # The steady-state flow quality of an open return wind tunnel model.** K. W. Mort, M. W. Kelly (NASA, Ames Research Center, Moffett Field, Calif.), and W. T. Eckert (NASA, Ames Research Center, Moffett Field, Calif.; U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). (*Canadian Aeronautics and Space Institute, Annual General Meeting, Toronto, Canada, May 18, 1972.*) *Canadian Aeronautics and Space Journal*, vol. 18, Nov. 1972, p. 285-289. 13 refs.

The structural cost of open return wind tunnels is significantly less than that of the more conventional closed return wind tunnels. However, because of the effects of external winds, the flow quality of open return wind tunnels is an area of concern at the low speeds required for V/STOL testing. The development of a configuration which has good flow quality at low as well as at high test speeds is described. The flow quality required at the low test speeds of interest for V/STOL aircraft is discussed and alternatives to the traditional manner of specifying the flow quality requirements in terms of dynamic pressure and angle of attack are suggested. (Author)

**A73-15513 # Lifting characteristics and spanwise aerodynamic load distribution of an external flow jet flap.** R. H. Wickens (National Aeronautical Establishment, Ottawa, Canada). *Canadian Aeronautics and Space Journal*, vol. 18, Nov. 1972, p. 291-293.

The results obtained in an experimental investigation of the characteristics of a quasi-two-dimensional external flow jet flap are discussed. It is found that the aerodynamic loading, particularly on the flap elements, extends well beyond the original dimensions of the jet. The relatively high values of the normal force coefficient for the flap elements are due to the fact that they are normalized with respect to their own chord and tunnel dynamic pressure. G.R.

**A73-15587** A note on the quantity /effective/ perceived noisiness and units of perceived noise level. K. D. Kryter (Stanford Research Institute, Menlo Park, Calif.). *Journal of Sound and Vibration*, vol. 25, Dec. 8, 1972, p. 383-393. 9 refs. Grant No. NIH-MH-18161-02.

Terminology distinctions to be made between the subjective quantity of perceived noisiness and physical units of sound measurement are briefly discussed. Some recommendations concerning standardization of terminology and units of sound measurement are given. A new analysis of the results of two major experiments involving judgments of aircraft noise made in the field and in the laboratory suggests that the perceived noisiness of the occurrence of sounds of different spectral and temporal characteristics are best and reasonably well predicted from units of physical measurement based on 1/3-octave band spectra and weighted overall sound pressure levels. (Author)

**A73-15591** Attenuation of spiral modes in a circular and annular lined duct. D. J. Snow (Rolls-Royce, Ltd., Hucknall, Notts., England) and M. V. Lowson (Loughborough University of Technology, Loughborough, Leics., England). *Journal of Sound and Vibration*, vol. 25, Dec. 8, 1972, p. 465-477. 16 refs. Research sponsored by Rolls-Royce.

An experimental and theoretical program was undertaken to measure and predict the attenuation of plane and spiral modes within a cylindrical and annular lined duct. A standard duct modal theory was used for the cylindrical duct, whereas a thin annulus model was evolved for the annular configuration. The experimental results show a considerable increase in attenuation rate for the higher-order modes, especially in the cylindrical duct case. Excellent agreement was obtained between theory and experiment for the open cylindrical duct, and moderate agreement was found in the case of annular duct. The results indicate that the theory can be used with reasonable confidence for the design of silencing devices for jet engine noise which is dominated by higher-order mode effects. (Author)

**A73-15651 #** Study of a series of variable-geometry wings derived from delta wings of different aspect ratios. I - Aerodynamic characteristics of delta wings (Studiu asupra unei serii de aripi cu geometrie variabila derivate din aripile delta de diferite lungiri. I - Caracteristicile aerodinamice ale aripiilor delta). E. Carafoli (Institutul de Mecanica a Fluidelor și Constructii Aerospațiale, Bucharest, Rumania) and I. Paraschivoiu (Bucuresti, Institutul Politehnic Gheorghe Gheorghiu-Dej, Bucharest, Rumania). *Studii și Cercetări de Mecanica Aplicata*, vol. 31, no. 5, 1972, p. 1025-1039. 9 refs. In Rumanian.

**A73-15699** A note on the use of airborne 30-millimetre radar at long ranges. S. G. Cornford. *Meteorological Magazine*, vol. 101, Oct. 1972, p. 302-305.

The radar beam of a cruising supersonic transport aircraft will sometimes be attenuated by showers at lower levels. Storms at the flight level may lie in the radar shadow of lower-level showers and may not be detected when they first come into radar range. The effect, due to the curvature of the earth, is alleviated somewhat by refraction. (Author)

**A73-15703 #** Technology for adhesive bonding of elements in aircraft construction (Tekhnologiya skleivaniia detalei v samoletostroenii). I. I. Kapeliushnik, I. I. Mikhalev, and B. D. Eidel'man. Moscow, Izdatel'stvo Mashinostroenie, 1972. 224 p. 44 refs. In Russian.

Description of procedures, materials, and equipment used to join metallic and nonmetallic structural elements by adhesive bonds that provide high mechanical strength, prolonged lifetime, hermetic sealing, and enhanced resistance to corrosion. Attention is given to the physicomaterial and processing characteristics of adhesives, methods of surface preparation, adhesive deposition techniques,

durations of exposure, and pressing conditions. Types of bonds employed in aircraft structures are characterized, including combined adhesive-welded, adhesive-riveted, and adhesive-bolted joints. Quality control measures are also described along with test and inspection methods. T.M.

**A73-15706 #** VTOL aircraft power plants (Silovye ustanovki letatel'nykh apparatov vertikal'nogo vzleta i posadki). V. F. Pavlenko. Moscow, Izdatel'stvo Mashinostroenie, 1972. 284 p. 59 refs. In Russian.

A description is given of the various types of VTOL aircraft power plants, their mode of operation, their characteristics, and their structural peculiarities. The operation of gas-turbine engines of both rotating-wing and jet-powered VTOL aircraft is considered, particular attention being paid to the effect of the power plant exhaust jets on the takeoff and landing runways, on the aircraft itself, and on the engine. Measures which reduce the unfavorable consequences of exhaust-jet action are indicated. Problems connected with the installation of power plants on VTOL aircraft are also considered. A.B.K.

**A73-15708 #** Testing of jet engines (Ispytaniia vozdukhno-reaktivnykh dvigatelei). L. S. Skubachevskii. Moscow, Izdatel'stvo Mashinostroenie, 1972. 228 p. 31 refs. In Russian.

Procedures and equipment for testing both complete jet engines and individual engine components are described within the context of applications arising throughout the overall cycle of initial research, design, production, operational maintenance, and overhaul. Topics covered include methods of measuring engine parameters, experimental data processing procedures, test beds and instrumentation, safety regulations and requirements, and measures to be taken for automation of the testing process. T.M.

**A73-15709 #** Aerodynamic design of axial-flow turbine blades (Aerodinamicheskii raschet lopatok osevykh turbomashin). Ia. A. Sirotkin. Moscow, Izdatel'stvo Mashinostroenie, 1972. 449 p. 187 refs. In Russian.

The direct (calculation of flow about a given solid) and inverse (computation of the shape of the solid) hydrodynamics problems involved in the design of axial-flow turbine stages are examined within the framework of a theory for cylindrical and conical stages with allowance for flow obstruction by blades and for the slope and curvature of streamlines. A strict mathematical formulation of these problems is followed by various methods of solution by digital computer and by manual operations. The effects of the real properties of the flow and turbine elements on the axisymmetric velocity field are examined, and appendices list ALGOL-60 computer programs for solution of selected problems. T.M.

**A73-15746** Improved M50 aircraft bearing steel through advanced vacuum melting processes. R. Schlatter and J. P. Stroup (Latrobe Steel Co., Latrobe, Pa.). (American Vacuum Society and American Society for Metals, Vacuum Metallurgy Conference, Pittsburgh, Pa., June 19-22, 1972.) *Journal of Vacuum Science and Technology*, vol. 9, Nov.-Dec. 1972, p. 1326-1333. 13 refs.

**A73-15828 #** The influence of fuel preparation and operating conditions on flame radiation in a gas turbine combustor. E. R. Norster and A. H. Lefebvre (Cranfield Institute of Technology, Cranfield, Beds., England). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/HT-26*. 8 p. 14 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15830 #** A proposed method for calculating film-cooled wall temperatures in gas turbine combustion chambers. D. R. Ballal and A. H. Lefebvre (Cranfield Institute of Technology, Cranfield,

Beds., England). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/HT-24.* 12 p. 21 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15842 #** The oscillatory boundary layer growth over the top and bottom plates of a rotating channel. M. Kurosaka (GE Research and Development Center, Schenectady, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/FE-5.* 7 p. 8 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15852 #** Theoretical low-speed particles collision with symmetrical and cambered aerofoils. S. A. Morsi (Surrey, University, Guildford, Surrey, England) and A. J. Alexander (Loughborough University of Technology, Loughborough, Leics., England). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/FE-35.* 13 p. 6 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15858 #** Some recent work on aspect ratio effects in compressor cascades. M. R. A. Shaalan (Ain Shams University, Cairo, Egypt). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/FE-41.* 11 p. 22 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15865 #** Modelling of gas turbine combustors - Considerations of combustion efficiency and stability. J. Odgers (Laval University, Quebec, Canada) and C. Carrier. *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-1.* 9 p. 6 refs. Members, \$1.00; nonmembers, \$3.00. Research supported by the National Research Council of Canada.

**A73-15866 #** Gas velocity measurements within a compressor rotor passage using the laser Doppler velocimeter. D. C. Wisler and P. W. Mossey (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-2.* 6 p. 11 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15867 #** Pollutants from methane fueled gas turbine combustion. P. G. Parikh, R. F. Sawyer (California, University, Berkeley, Calif.), and A. L. London (Stanford University, Stanford, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-3.* 8 p. 14 refs. Members, \$1.00; nonmembers, \$3.00. U.S. Environmental Protection Agency Grant No. AP-385.

In view of the greater flexibility of a gas turbine combustion system design as compared to that for a piston engine, control of nitric oxide emissions even while keeping the CO and hydrocarbon emissions at very low levels appears feasible. Factors influencing the production of these pollutants in a methane fueled gas turbine type combustor are studied in this investigation by analyzing the gas samples taken at various locations within the combustor. Increasing the homogeneity of the primary zone gas composition by using gaseous or prevaporized liquid fuels is found to be an effective way to reduced nitric oxide emissions. (Author)

**A73-15868 #** Aircraft turbine engine emissions and the possibilities for control. C. Gray, Jr. (U.S. Environmental Protection Agency, Div. of Emission Control Technology, Ann Arbor, Mich.) and G. D. Kittredge (U.S. Environmental Protection Agency,

Rockville, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-4.* 5 p. 11 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15869 #** A combined theoretical and empirical method of axial compressor cascade prediction. G. L. Mellor (Princeton University, Princeton, N.J.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-5.* 17 p. 11 refs. Members, \$1.00; nonmembers, \$3.00. Contract No. N00019-69-C-0520.

**A73-15872 #** Assessment of emission control technology for turbine-engine aircraft. E. K. Bastress, C. F. Robertson, G. E. Smith, and R. C. Baker (Northern Research and Engineering Corp., Cambridge, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-8.* 14 p. 8 refs. Members, \$1.00; nonmembers, \$3.00. U.S. Environmental Protection Agency Contract No. 68-04-0011.

Specific methods have been identified for controlling emissions of air pollutants by turbine-engine aircraft during operations at airports. These control methods consist of modifications of engines and ground operational procedures. Quantitative estimates have been made of the effectiveness of each control method in reducing aircraft emissions and the cost and time requirements for applying the method to existing and future aircraft. The conclusion is that control methods involving engine modifications can be employed to reduce emissions of all pollutants and that these methods can be incorporated into future engines with a small increase in engine cost. However, retrofitting these control methods into existing engines would be very costly. (Author)

**A73-15883 #** Nonlinear modeling and dynamic simulation of vehicle air cushion suspensions. D. P. Garg (Duke University, Durham, N.C.) and R. Aleman (Creole Petroleum Corp., Cabimas, Venezuela). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Aut-5.* 12 p. 18 refs. Members, \$1.00; nonmembers, \$3.00.

**A73-15906 #** Potential operating advantages of a variable area turbine turbojet. J. W. Ramsay (Boeing Co., Seattle, Wash.) and G. C. Oates (Washington, University, Seattle, Wash.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Aero-4.* 12 p. Members, \$1.00; nonmembers, \$3.00.

The concept of utilizing a variable area turbine (VAT) to better match the operating requirements of an aero-engine installed in an aircraft with wide operating range, is investigated. The study shows that because of the high turbine inlet temperatures expected to be available in future aircraft, the VAT concept deserves serious consideration for future development. The study shows, also, that the improvements in performance due to installation effects are at least comparable to the improvements in the uninstalled engine performance. (Author)

**A73-15907 \* #** Thermodynamic considerations for the design of a sonic-boom reducing powerplant. N. Galanis (Sherbrooke University, Sherbrooke, Quebec, Canada). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Aero-3.* 9 p. 6 refs. Members, \$1.00; nonmembers, \$3.00. NASA-sponsored research.

Third-order analytical expressions are obtained for the lift and wave-drag coefficients of a two-dimensional wing. The expressions are used to demonstrate the possibility of boomless lifting configuration designs when the cross-section area of the stream tube is reduced. The reduction is obtained by processing the captured airstream in such a manner that the stream tube area is smaller at the exit than at the entrance. Calculations by these expressions are shown to be in good agreement with exact results obtained from

## A73-15964

compressive flow tables. It is also shown that three-dimensional wing configurations of this design give the maximum thermodynamic effect when a propulsive power plant is employed for the reduction of the captured-stream area. Thermodynamic guidelines are given for power plant designs to be used for this purpose. V.Z.

**A73-15964 # Control equipment of aircraft (Sredstva upravleniia letatel'nykh apparatami).** Iu. I. Dukhon and N. N. Il'inskii. Moscow, Voenizdat, 1972. 431 p. 22 refs. In Russian.

This book is based on Soviet and western published work on aircraft control systems. Radio communication and navigation systems, automatic guidance and landing systems, homing and radar tracking of aircraft are discussed in detail. The topics include data transmission through radio channels, atmospheric interferences in radio communications, equipment for target detection and identification, radio and light signal systems for near-airport flight control, radio beacon aircraft locating and tracking techniques, and automatic homing on air and ground targets. V.Z.

**A73-15966 # Aircraft landing control automation (Avtomatizatsiia upravleniia posadkoi samoleta).** S. L. Belogorodskii. Moscow, Izdatel'stvo Transport, 1972. 352 p. 38 refs. In Russian.

Operational principles of radio beacons and associated communications equipment used to generate instrument landing trajectories are examined along with problems involving the dynamics of automatic and semiautomatic flight control systems. Functional diagrams are given for Soviet and western systems providing automatic control of landing-phase operations, and emphasis is placed on methods and hardware used to assure safety in the autopilot flight mode. Particular topics considered include minimum landing requirements, aspects of flight control in the presence of characteristic disturbances, and flight status display systems. T.M.

**A73-15968 # Practical aerodynamics of the Il-18 aircraft (Prakticheskaia aerodinamika samoleta Il-18).** P. T. Bekhtir and V. P. Bekhtir. Moscow, Izdatel'stvo Transport, 1972. 200 p. In Russian.

The aerodynamic characteristics of the Il-18 four-engine turboprop aircraft and the operational features of its power plant are reviewed. The technique of piloting the aircraft during level flight, takeoff, climbing, descent, turning, and landing is considered, as well as the stability and controllability of the aircraft and the question of flight safety during these different flight regimes. The problem of flight during failure of one or two engines on one side of the aircraft is discussed, as well as measures to be taken by the crew to restore equilibrium. Finally, the special features of flight in turbulent air and in the presence of icing conditions are summarized. A.B.K.

**A73-15988 # The Joukowski condition in three-dimensional flow (La condition de Joukowski en écoulement tridimensionnel).** R. Legendre. (*International Union of Theoretical and Applied Mechanics, Congress on Theoretical and Applied Mechanics, 13th, Moscow, USSR, Aug. 21-26, 1972.*) *La Recherche Aéronautique*, Sept.-Oct. 1972, p. 241-248. 18 refs. In French.

An attempt is made to determine exactly the extent of the lifting line of a wing, from which the vortex sheet originates. Because the blades of marine propellers for fast ships are lifting surfaces of short length, they are studied in some detail, and the way in which they form a vortex sheet is discussed. Attention is given to the characteristics of delta wings, thin wings, angular edges, wing tips, and leading edges. It is shown that the Joukowski condition of finite velocity on a lifting line which extends to the interior of the fluid by a vortex sheet at the ideal limit for the fluid of zero velocity, does not apply solely to the traditional trailing edge defined geometrically. It can also apply to wing tips and even to more or less extended fractions of the leading edge. F.R.L.

**A73-15989 # Pyrolysis of kerosene and mechanism of formation of carbon deposits (Pyrolyse du kérosène et mécanisme de formation des dépôts de carbone).** G. Lengellé and J. Duterque (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aéronautique*, Sept.-Oct. 1972, p. 249-259. 21 refs. In French.

The study of mechanisms of carbon deposit formation is linked to the problem of coking of kerosene in the supply system of the afterburners of turbojets. Results of experiments relating to surface deposits of carbon in conditions where the formation of soot is not abundant are given. A theoretical analysis is developed which applies to the case of reactors consisting of silicon or protected refractory steel in various temperature and pressure ranges, mass flow rates, and tube diameters. F.R.L.

**A73-16031 Airbus hydraulic power always available.** C. D. Galy (Société Nationale Industrielle Aéronautique, Paris, France). *Hydraulics and Pneumatics*, vol. 25, Dec. 1972, p. 57-60.

Three independent hydraulic systems on the A300B Airbus provide maximum safety and reliability for the powered flight controls, for both normal flying and auto-land operations. The three separate systems operate simultaneously with no fluid interconnection and, therefore, have fundamental failure survival. In addition to the flight controls, the hydraulic systems operate the landing gear, wheel brakes, nosewheel steering, and cargo doors. Aspects of power generation are discussed together with power distribution, system operation, fluid power components, safety valving, maintenance, controls, and instruments. G.R.

## STAR ENTRIES

**N73-12003#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

**A COMPARISON OF THE SURFACE-SOURCE SOLUTION WITH AN EXACT SOLUTION FOR THE TWO-DIMENSIONAL INVISCID FLOW ABOUT A SLOTTED-FLAP AEROFOIL**

B. R. Williams London Aeron. Res. Council 1972 35 p refs  
Supersedes RAE-TR-72008; ARC-33611  
(ARC-CP-1214; RAE-TR-72008; ARC-33611) Avail: NTIS HC \$3.75; HMSO 65p; PHI \$2.75

An exact analytic test case for the two dimensional inviscid flow about a slotted-flap aerofoil is compared with a numerical solution by a surface-source method. Some of the main causes of error in the surface-source method are identified and a general scheme for producing consistent solutions is proposed.

Author (ESRO)

**N73-12004#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

**A COMPUTER PROGRAM TO CALCULATE THE PRESSURE DISTRIBUTION ON AN ANNULAR AEROFOIL**

C. Young London Aeron. Res. Council 1972 56 p refs  
Supersedes RAE-TR-71199; ARC-33665  
(ARC-CP-1217; RAE-TR-71199; ARC-33665) Avail: NTIS HC \$5.00; HMSO 90p; PHI \$3.65

A computer program has been written in FORTRAN to calculate the pressure distribution on an annular airfoil at zero angle of incidence at subsonic speed. The method of surface singularities and the extensions that have been made for the annular airfoil to calculate the pressure distribution at any mass flow ratio are described as well as the computer program. The predicted and experimental results are compared. Close agreement between theory and experiment is obtained. Author (ESRO)

**N73-12005#** National Physical Lab., Teddington (England). Aerodynamics Div.

**PRESSURE MEASUREMENTS ON A MODEL DELTA WING UNDERGOING OSCILLATORY DEFORMATION**

N. C. Lambourne, D. W. Bryer, and J. F. M. Maybrey London Aeron. Res. Council 1972 69 p refs  
Supersedes NPL-Aero-1314; ARC-31979

(ARC-R/M-3693; NPL-Aero-1314; ARC-31979) Avail: NTIS HC \$5.50; HMSO £ 2.40; PHI \$9.40

Effects of leading-edge vortices on the surface pressures over a delta wing were investigated in a wind tunnel. The model, a sharp-edged delta plate, was deformed in chordwise bending over its forward portion only. Surface pressures across the span were measured over the stationary part of the wing. Fourier analysis shows the magnitude of the harmonics that are present in the pressure variations, and which are attributed to the presence of the vortices. An empirical relationship involving a convective time-delay is established between the pressures for oscillatory deformation and those for static deformations. Author (ESRO)

**N73-12006#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

**A TECHNIQUE FOR THE AUTOMATIC, DIGITAL ANALYSIS OF FLIGHT DYNAMIC RESPONSE DATA**

A. P. Waterfall London Aeron. Res. Council 1972 47 p refs  
Supersedes RAE-TR-70228; ARC-32949  
(ARC-R/M-3699; RAE-TR-70228; ARC-32949) Avail: NTIS HC \$4.50; HMSO £ 1.70; PHI \$6.75

A technique is described for using a digital computer for the extraction of aerodynamic force and moment derivatives from measurement of the motion of aircraft or aircraft models, following a disturbance from the trimmed state. The analysis method is based on model matching by least squares using an automatic iterative method and has been found capable of handling coupled three-dimensional motions of much greater complexity than it has been possible to analyze previously. The particular problem of solution divergence which limits the usefulness of iterative method has been overcome, giving a virtually fully-automatic system for response analysis that can be applied to a wide range of aircraft-like problems. A full description is given of the use of the techniques for the analysis of dynamic response data

**N73-11999\*#** Nielsen Engineering and Research, Inc., Mountain View, Calif.

**CALCULATIVE TECHNIQUES FOR TRANSONIC FLOWS ABOUT CERTAIN CLASSES OF WING-BODY COMBINATIONS, PHASE 2**

Stephen S. Stahara and John R. Spreiter (Stanford Univ., Calif.)  
Washington NASA Dec. 1972 115 p  
(Contract NAS2-6259)

(NASA-CR-2157) Avail: NTIS HC \$3.00 CSCL 01A

Theoretical analysis and associated computer programs were developed for predicting properties of transonic flows about certain classes of wing-body combinations. The procedures used are based on the transonic equivalence rule and employ either an arbitrarily-specified solution or the local linearization method for determining the nonlifting transonic flow about the equivalent body. The class of wind planform shapes include wings having sweptback trailing edges and finite tip chord. Theoretical results are presented for surface and flow-field pressure distributions for both nonlifting and lifting situations at Mach number one.

Author

**N73-12000\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**EFFECTS OF WING-PIVOT LOCATION AND FOREWING CONFIGURATION ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A VARIABLE-SWEEP AIRPLANE MODEL**

Jarrett K. Huffman Washington Dec. 1972 58 p refs  
(NASA-TM-X-2674; L-8026) Avail: NTIS HC \$3.00 CSCL 01B

An investigation has been made to determine the effects of the location of the wing pivot and geometry of the forewing on the static longitudinal aerodynamic characteristics at subsonic speeds of a model representing a variable-sweep supersonic fighter airplane. Results indicate that as the wing-pivot location moves aft and outboard, the change in static margin due to wing sweep is reduced. Increasing the forewing area resulted in a forward shift of the aerodynamic center as well as a slight reduction in the aerodynamic-center variation due to wing sweep. Author

**N73-12002#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

**SOME MODIFICATIONS TO THE CALCULATION METHOD FOR WINGS WITH PART-SPAN EXTENDING-CHORD FLAPS GIVEN IN RAE TECHNICAL REPORT 69034**

J. McKie London Aeron. Res. Council 1972 38 p refs  
supersedes RAE-TR-71201; ARC-33547  
(ARC-CP-1213; RAE-TR-71201; ARC-33547) Avail: NTIS HC \$4.00; HMSO 60p; PHI \$2.55

A method is given for the approximate solution of a version of Prandtl's aerofoil equation for wings with an arbitrary number of discontinuities in chord or geometric angle of incidence. The method is an attempt to improve on an earlier one given in RAE Technical Report 69034. For the example of a swept wing of large aspect ratio with part-span, extending-chord flaps, the results for lift, drag and vortex-drag factor by the improved method show no significant differences from those calculated by the earlier method. Comments are made on other factors affecting the accuracy of the solution. Author (ESRO)

from free flight models. However, few modifications would be necessary to the computer programs for application to full-scale aircraft tests and even dynamic stability tests in windtunnels.

Author (ESRO)

**N73-12007#** National Physical Lab., Teddington (England). Aerodynamics Div.  
**EFFECTS OF REYNOLDS NUMBER AND FREQUENCY PARAMETER ON CONTROL-SURFACE BUZZ AT HIGH SUBSONIC SPEEDS**

Y. Nakamura and L. Woodgate London Aeron. Res. Council 1972 24 p refs Supersedes ARC-31897 (ARC-R/M-3702; ARC-31897) Avail: NTIS HC \$3.25; HMSO 70p; PHI \$2.95

Stiffness and damping hinge-moment derivatives have been measured on a two-dimensional aerofoilflap combination model by a free-oscillation technique. The experiments were conducted in the N.P.L. 18 in x 14 in tunnel where it is possible to vary the stagnation pressure and hence the Reynolds number and frequency parameter. To separate the effects of Reynolds number and frequency, flaps of different inertias were used. Measurements were made only in the range of Mach number where control surface buzz oscillations started spontaneously. A method of controlling the flap oscillation was developed which depended on the use of fine air jets issuing from the model surface just forward of the flap. Although changes in Reynolds number produced only small changes in the derivatives, these changes were larger for low values of frequency parameter; the magnitude of the derivatives tended to increase with Reynolds number. The effect of frequency parameters was larger; the values of the limit cycle amplitude and both derivatives decreased numerically with increasing frequency.

Author (ESRO)

**N73-12008#** Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.  
**GLIDE-PATH STABILITY OF AN AIRCRAFT UNDER SPEED CONSTRAINT**

W. J. G. Pinsker London Aeron. Res. Council 1972 17 p ref Supersedes RAE-TR-71021; ARC-33027 (ARC-R/M-3705; RAE-TR-71021; ARC-33027) Avail: NTIS HC \$3.00; HMSO 55p; PHI \$2.35

The motion of an aircraft operating under perfect speed constraint (e.g. by an appropriate autothrottle) is examined theoretically and it is shown that, if engine thrust acts through the aircraft center of gravity, the aircraft will have weak flight path stability in descending flight but be unstable in climb. These effects are readily overshadowed by thrust effects in the sense that with low-slung engines the aircraft motion is destabilized and vice versa. Manual flight with autothrottle engaged is, therefore, shown to be potentially dangerous as the strong flight-path stability possessed by the natural aircraft is suppressed and inadvertent glide-path errors are not self-correcting.

Author (ESRO)

**N73-12010#** California Univ., Los Angeles. School of Engineering and Applied Science.  
**COMPARISON OF RECENT MEASUREMENTS OF JET AIRCRAFT LANDING NOISE TO SAE COMMUNITY NOISE EXPOSURE RATING CRITERIA**

S. R. Lane Jun. 1972 24 p refs (Grant NGR-05-007-323)

(UCLA-Paper-Eng-0872) Avail: NTIS HC \$3.25

Procedures for determining aircraft noise exposure contours around airports are presented. An examination of the effective perceived noise level (EPNL) is made. The EPNL concept is compared with actual noise levels measured during regular operations at airports. Noise levels during landing approach are used.

Author

**N73-12012\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**AIRCRAFT ENGINE NOISE REDUCTION**

Washington 1972 321 p Conf. held at Cleveland, 16-17 May 1972

(NASA-SP-311) Avail: NTIS HC \$6.00 CSDL 20A

This progress report projects work on the reduction of aircraft noise and considers mainly the application of quiet engine technology to reduce and suppress fan and jet noises in current and future aircraft configurations.

**N73-12013\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**INTRODUCTION**

Newell D. Sanders *In its Aircraft Engine Noise Reduction* 1972 p 1-5

CSDL 20A

Progress reported on principle NASA programs for the reduction of aircraft engine noise emphasizes the Quiet Engine Program. Considered are fan noise and performance, fan noise suppression, and jet noise reduction for a broad spectrum of airplanes including new subsonic airplanes, the older subsonic airplanes in service today, STOL airplanes of the future, and future supersonic transports. Noise reductions achieved in the framework of the Quiet Engine Program are demonstrated and future possible applications of low noise technology to airplanes are discussed.

G.G.

**N73-12014\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**FAN NOISE AND PERFORMANCE**

James J. Kramer, Melvin J. Hartmann, Bruce R. Leonard, Jack F. Klapproth (GE), and Thomas G. Sofrin (Pratt and Whitney Aircraft Co.) *In its Aircraft Engine Noise Reduction* 1972 p 7-61

CSDL 20A

Tradeoffs between aerodynamic and acoustic properties of various fan configurations led to the selection of a variety of fans that produce noise levels in the range of 100 to 120 PNdB. Fan configuration and design pressure ratio required for specific mission operations depend in part on the type of mission to be performed. Noise data obtained for single-stage low speed fans, single-stage high speed fans, and two-stage fan engines are presented in table form.

G.G.

**N73-12015\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**FAN NOISE SUPPRESSION**

Charles E. Feiler, John F. Groeneweg, Edward J. Rice, Edward B. Smith (GE), and Roger H. Tucker (Boeing Co.) *In its Aircraft Engine Noise Reduction* 1972 p 63-102

CSDL 20A

The principal suppressor parameters and their relationships have been used to formulate a suppressor design methodology which has been applied to the design of several full-scale suppressors. Tests of these suppressors on several full-scale fans have demonstrated noise reductions of the order of 10 PNdB. The amount of suppression in several instances seems to have been limited by reaching noise floors that are not clearly at the estimated jet noise level but are not far above it. In addition to identifying noise floors, two other areas are considered. The first is attenuation by the fan exhaust suppressors, which seems in most cases to be less than that of the inlet. The second is the effectiveness of outer cowl treatment alone on multiple pure tones. This question relates to whether a high-speed fan can become as quiet as a low-speed fan without a substantial increase in the amount of treatment.

Author

**N73-12016\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**JET NOISE**

Uwe H. VonGlahn, Vernon H. Gray, Eugene A. Krejsa, Robert E. Lee, Jr. (GE), and Gene L. Minner *In its Aircraft Engine Noise Reduction* 1972 p 103-137

CSDL 20A

The main conclusions reached are: (1) At low subsonic jet exhaust velocities, jet noise varies as the velocity to the eighth

power; (2) at high subsonic exhaust velocities, jet noise approaches a variation with velocity to the third power; (3) use of the jet density squared overcorrects density effects on jet noise; (4) subsonic and supersonic jet noise levels can be predicted; and (6) use of multielement nozzles and acoustically lined ejectors significantly suppress jet noise at intermediate jet exhaust velocities. Author

**N73-12017\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**THE QUIET ENGINE PROGRAM**

Newell D. Sanders *In its Aircraft Engine Noise Reduction* 1972 p 139-142

CSCL 20A

Estimates of noise reductions for high bypass ratio engines show that bypass ratio fan noise increases with increasing bypass ratio and dominates above a bypass ratio of about 1.0. Fan noise reduction to the level of jet noise is achieved by elimination of inlet guide vanes, elimination of second fan stage, and increased spacing between rotor and stator. Quiet engine design studies show that, at bypass ratios near 5 or 6 and with low noise fans, noise reductions in the order of 15 to 20 decibels relative to DC-8 and 707 airplanes engines are possible. G.G.

**N73-12018\*** General Electric Co., Philadelphia, Pa.

**QUIET ENGINE DESIGN HIGHLIGHTS**

Bernard L. Koff *In NASA. Lewis Res. Center Aircraft Engine Noise Reduction* 1972 p 143-162

CSCL 20A

Three high performance fans were designed, built, and tested, accumulating 444 hours. All three fans are both aerodynamically and mechanically suitable for direct incorporation into engine applications. Two turbofan demonstrators to evaluate both low- and high-speed fan systems were also designed, built, and tested. All components and engine systems are demonstrating high reliability. These components have demonstrated advanced state-of-the-art in acoustics, aerodynamics, and mechanical design. Author

**N73-12019\*** Boeing Co., Seattle, Wash.

**QUIET ENGINE NACELLE DESIGN**

M. Dean Nelsen *In NASA. Lewis Res. Center Aircraft Engine Noise Reduction* 1972 p 163-181.

CSCL 20A

Reduction of fan noise emanating from turbofan engines by using acoustically treated nacelles is considered. Test performance prediction for an acoustically lined nacelle having a three ring inlet, a single ring fan duct, and external cowling expect a 15 PNdb fan noise reduction with 5 percent takeoff thrust loss and a 5.4 percent cruise specific fuel consumption increase. G.G.

**N73-12020\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**QUIET ENGINE TEST RESULTS**

Carl C. Ciepluch, Frank J. Montegani, Mike J. Benzakein (GE), and Steven B. Kazin (GE) *In its Aircraft Engine Noise Reduction* 1972 p 183-214

CSCL 20A

The acoustic and aerodynamic test results obtained with the two quiet engines are given in this presentation. Some of the test results reviewed include the performance of the untreated or baseline quiet engines. In addition, test results are shown for various degrees and areas of engine acoustic treatment. Finally, the results obtained on a flight-type, acoustically treated nacelle added to one of the quiet engines is examined. Author

**N73-12021\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**QUIET ENGINE DEMONSTRATION**

Harry E. Bloomer *In its Aircraft Engine Noise Reduction* 1972 p 215-218

CSCL 20A

A description of the performance test to compare noise output from a quiet engine with acoustic nacelle to the noise output of the JT3D turbofan engine is presented. Tabulations depict comparative thrusts, bypass ratios, core jet velocities, and fan jet velocities for both engines during simulated takeoff and approach performances. G.G.

**N73-12022\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**APPLICATIONS TO AIRCRAFT PROPULSION SYSTEMS**

Newell D. Sanders, W. Harry Close (DOT), Arthur A. Medeiros, and Richard J. Weber *In its Aircraft Engine Noise Reduction* 1972 p 219-246

CSCL 20A

Estimates of the prospects for quiet airplanes in the future are summarized. The SST using afterburning turbojets and no sound suppression is estimated to produce 129 EPNdb on the sideline. Suppression devices and operating techniques can reduce this noise markedly. The present fleet of 707's and DC-8's produces noises nearly as high as 120 decibels on approach. Combinations of sound absorbing devices and engine modifications are expected to give a noise near 100 decibels. The new advanced technology transports (ATT) are being studied with two noise goals in mind: one is 10 decibels and the other is 20 decibels below the FAR level of 106 on takeoff. New trijets using new quiet engines are expected to meet 90 EPNdb. Future advances in technology are expected to yield another 5 decibels to give noise levels of 80 EPNdb. The STOL airplane has a noise goal of 95 EPNdb along a sideline 500 feet from the runway. Author

**N73-12023\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**STOL NOISE SOURCES AND FAN NOISE TREATMENT**

Raymond J. Rulis *In its Aircraft Engine Noise Reduction* 1972 p 247-258

CSCL 20A

STOL noise goals, noise sources, and their effects on engine and propulsion systems design are considered. It is shown that major noise sources constitute the blown-flap system with its turbofan engine and the augmentor wing propulsion system. Most of the problem areas associated with STOL propulsion systems are defined and the development of a multistage fan engine with proper rotor-stator spacings and low noise core exhaust jet is illustrated. A variable-area acoustic inlet provides near sonic flow conditions during takeoff and landing. G.G.

**N73-12024\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**FLAP NOISE**

Robert G. Dorsch, Paul L. Lasagna, Domenic J. Maglieri, and William A. Olsen *In its Aircraft Engine Noise Reduction* 1972 p 259-290

CSCL 20A

Externally-blown-flap noise research can be summarized by the following remarks: With lower-surface blowing, the sources of the flap noise are beginning to be understood and the noise scaling laws have been established. Further, progress has been made on suppressing the flap interaction noise at the large flap deflections used during landing. Recent small-scale noise tests of configurations using external upper-surface blowing indicate that engine-over-the-wing configurations may be promising. Author

**N73-12025\*** Boeing Co., Seattle, Wash.

**DESIGN INTEGRATION AND NOISE STUDY FOR A LARGE STOL AUGMENTOR WING TRANSPORT**

Jack V. O'Keefe *In NASA. Lewis Res. Center Aircraft Engine Noise Reduction* 1972 p 291-304

CSCL 20A

Analysis, design, experimental static testing, wind-tunnel testing, and design integration studies are used to develop an augmentor wing jet flap configuration for a jet STOL transport aircraft having maximum propulsion and aerodynamic performance

N73-12026

with minimum noise generation. The program has three basic elements: (1) static testing of a scale wing section to demonstrate augmentor performance and noise characteristics; (2) two-dimensional wind-tunnel testing to determine flight-speed effects on performance, and (3) system design and evaluation that optimizes the complete system and ensures that the design is compatible with the requirements for a large STOL transport having a 500-foot sideline noise of 95 perceived noise decibels (PNdb) or less. Author

**N73-12026\*** Boeing Co., Seattle, Wash.  
**SONIC INLET DEVELOPMENT FOR TURBOFAN ENGINES**  
Frank Klujber In NASA, Lewis Res. Center Aircraft Engine  
Noise Reduction 1972 p 305-317

CSCL 20A

The static program has shown to date that very large noise reductions can be achieved by the sonic inlet concept with realistic inlet length and good aerodynamic performance. It is also shown that different inlet concepts produce substantially different results. Author

**N73-12027\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**FLOYVER AND STATIC TESTS TO INVESTIGATE EXTERNAL FLOW EFFECT ON JET NOISE FROM NONSUPPRESSOR AND SUPPRESSOR EXHAUST NOZZLES**  
Richard R. Burley and Raymond J. Karabinus 1972 17 p refs Proposed for presentation at 11th Aerospace Sci. Meeting and Tech. Display, Washington, D. C., 10-12 Jan. 1973; sponsored by AIAA  
(NASA-TM-X-6816; E-7220) Avail: NTIS HC \$3.00 CSCL 01B

The effect of external air flowing across exhaust nozzles on the jet noise characteristics of supersonic transport aircraft at high takeoff speeds was investigated. A series of flyover and static tests were conducted using an F-106B aircraft modified with two underwing nacelles each containing a calibrated J85-GE-13 turbojet engine. Comparison of flyover and static data indicated that external flow reduces the noise of an auxiliary inlet ejector nozzle. An unsuppressed plug nozzle was not affected while the plug suppressor configurations were not as effective in flight. Author

**N73-12029#** New York Univ., N.Y. Research Div.  
**NUMERAL PREDICTION OF INTERIOR AND STRUCTURAL RESPONSE OF BUILDINGS TO SONIC BOOM OVER-FLIGHTS** Final Report  
Simon Slutsky and Lee Arnold Sep. 1972 57 p  
(Contract DOT-FA71WA-2559)  
(FAA-RD-72-116; NYU-AA-72-23) Avail: NTIS HC \$5.00

A procedure for predicting the structural and acoustic response of full scale architectural structures to sonic booms using laboratory techniques is described. It is shown that the essential acoustic properties of a full scale structure located in Istres, France could be accurately simulated on a small scale (1:20) model located at N.Y.U. and that this model could be used to determine acoustic impulse response functions of various rooms under varying window and door configurations and under varying supersonic flight Mach numbers. The calculated impulse response functions were used in conjunction with measured sonic boom signatures from Mirage aircraft overflights at speeds of Mach 1 and Mach 2 to calculate building responses. These responses were then compared with measured building responses. Calculated pressures agreed very well with measured pressures for a large number of cases tested and thereby confirmed the validity of the general procedure. Author

**N73-12030#** Blume (John A.) and Associates Research Div., San Francisco, Calif.  
**ADDITIONAL SONIC BOOM DATA RELATED TO TESTS CONDUCTED AT WHITE SANDS, NEW MEXICO, AND EDWARDS AIR FORCE BASE** Final Report

Lloyd A. Lee Sep. 1972 23 p refs  
(Contract DOT-FA72W1-3631-1)  
(FAA-RD-72-114) Avail: NTIS HC \$3.00

Data in the form of notes and recording which were compiled during the White Sands and Edwards Air Force Base Sonic Boom Test Programs and which are presently available in files at the Blume offices were reviewed to present window mounted strain gage readings with related overpressures during the 1965 White Sands tests and window sizes of the Edwards AFB 1966 test structures. These data are to be used by FAA in current studies. Author

**N73-12031\*#** Arde, Inc., Mahwah, N.J.  
**FEASIBILITY STUDY OF APPLYING AN ADVANCED COMPOSITE STRUCTURE TECHNIQUE TO THE FABRICATION OF HELICOPTER ROTOR BLADES** Final Report  
D. Gleich 1 Dec. 1972 130 p refs  
(Contract NAS1-10028)  
(NASA-CR-112191; ARDE-J/N-41003) Avail: NTIS HC \$8.50 CSCL 01A

The fabrication of helicopter rotary wings from composite materials is discussed. Two composite spar specimens consisting of compressively prestressed stainless steel liner over-wrapped with pretensioned fiberglass were constructed. High liner strength and toughness together with the prescribed prestresses and final sizing of the part are achieved by means of cryogenic stretch forming of the fiber wrapped composite spar at minus 320 F, followed by release of the forming pressure and warm up to room temperature. The prestresses are chosen to provide residual compression in the metal liner under operating loads. Author

**N73-12032\*#** Lockheed-California Co., Burbank.  
**EXPERIMENTAL HINGELESS ROTOR CHARACTERISTICS AT FULL SCALE FIRST FLAP MODE FREQUENCIES (INCLUDING ROTOR FREQUENCY RESPONSE TO SHAFT OSCILLATIONS), PHASE 3** Final Report, Oct. 1971 - Aug. 1972  
W. A. Kuczynski Oct. 1972 252 p refs  
(Contract NAS2-5419)  
(NASA-CR-114519; LR-25491) Avail: NTIS HC \$14.75 CSCL 01B

The completion of the High Advance Ratio Research Program is reported. The primary objectives of the program were to experimentally determine the rotor frequency response to shaft pitching and rolling oscillations and to acquire steady response and frequency response data at high advance ratios for hingeless rotors with typical, full-scale, first flap mode natural frequencies. Secondary objectives of the program included the further evaluation of both the hub moment feedback control system and the simplified rigid blade flapping theory with respect to shaft oscillations. The bulk of the text is devoted to the presentation and examination of representative experimental results. All the analyzed test data are documented in tabular and/or graphical formats. Author

**N73-12033\*#** National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.  
**A FLIGHT EVALUATION OF METHODS FOR PREDICTING VORTEX WAKE EFFECTS ON TRAILING AIRCRAFT**  
Glenn H. Robinson and Richard R. Larson Washington Nov. 1972 59 p refs  
(NASA-TN-D-6904; H-712) Avail: NTIS HC \$3.00 CSCL 01B

The results of four current analytical methods for predicting wing vortex strength and decay rate are compared with the results of a flight investigation of the wake characteristics of several large jet transport aircraft. An empirical expression defining the strength and decay rate of wake vortices is developed that best represents most of the flight-test data. However, the expression is not applicable to small aircraft that would be immersed in the vortex wake of large aircraft. Author

**N73-12034#** National Transportation Safety Board, Washington, D.C.



**AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT; US CIVIL AVIATION. ISSUE NO. 1: 1971 ACCIDENTS**

25 Jul. 1972 505 p

(NTSB-BA-72-3) Avail: NTIS HC \$27.25

This publication contains selected aircraft accident reports, in brief format, occurring in U.S. Civil Aviation operations during calendar year 1971. The 896 General Aviation accidents contained in this publication, represent a random selection. This publication is issued irregularly, normally six times each year. 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 light, pilot certificate, injuries, and causal factors. Author

**N73-12035#** National Transportation Safety Board, Washington, D.C.

**AIRCRAFT INCIDENT REPORT: CONTINENTAL AIRLINES, INCORPORATED, MCDONNELL DOUGLAS DC-10, N68041, TUCSON, ARIZONA, 2 MAY 1972**

18 Oct. 1972 13 p refs

(NTSB-AAR-72-29) Avail: NTIS HC \$3.00

An inflight incident involving a DC-10 aircraft is reported. The incident occurred near Tucson, Arizona about one hour after takeoff when the number two engine low-pressure turbine assembly, turbine rear frame, and reverser assembly separated from the aircraft. An emergency landing was made successfully at the Tucson International Airport. The cause of the accident was failure of a stiffener ring on the pressure tube located in the high pressure turbine shaft which created a sequence of engine component failures. Author

**N73-12036\*#** Tufts Univ., Medford, Mass. Dept. of Mechanical Engineering.

**THE INFLUENCE OF A CROSSFLOW ON JET NOISE**

John E. Cole, III Washington NASA Nov. 1972 43 p refs

(Grant NGR-22-012-028)

(NASA-CR-2169) Avail: NTIS HC \$3.00 CSCL 20D

The acoustic field generated by a circular jet in the presence of a low speed crossflow is calculated. The solution is obtained for a quadrupole source located in a uniformly moving acoustic medium. Ribner's work on straight jets is used to model the flow in the turbulent crossflow jet. The movement of the acoustic medium results in the acoustic intensity being greater upstream of the jet flow than at an equal distance downstream. A summary is also presented of the analysis for the acoustic intensity of a crossflow jet which is in motion through a stationary acoustic medium. The analysis is applicable to the noise generated by the lift jet of a V/STOL aircraft under take-off or landing conditions. The results of these two configurations provide a comparison of the directional distribution of acoustic intensity measured in a wind tunnel test of a crossflow jet and in a corresponding flight test. Author

**N73-12037#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

**AIRCRAFT ACCIDENT REPORT: HUGHES AIR WEST DC-9, N9345, AND US MARINE CORPS F-4B, 151458 NEAR DUARTE, CALIFORNIA, 6 JUNE 1971**

30 Aug. 1972 45 p refs

(NTSB-AAR-72-26; SA-426) Avail: NTIS HC \$4.25

The midair collision of a DC-9 aircraft and a Marine Corps F-4B aircraft near Duarte, California on 6 June 1971 is reported. It was determined that the accident was the failure of both crews to see and avoid the collision. Other factors involved were a very high closure rate, mingling of instrument flight rule and visual flight rule traffic in a congested area, and failure of the Marine Corps crew to request radar advisory service when their transponder was not operating. Author

**N73-12038#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

**AIRCRAFT ACCIDENT REPORT: NORTHWEST AIRLINES, INCORPORATED, BOEING 747-151 N606US OVER THE****NORTH PACIFIC OCEAN, 105 NAUTICAL MILES WEST OF 150 DEG EAST LONGITUDE AT 36 DEG NORTH LATITUDE**

4 Oct. 1972 25 p

(NTSB-AAR-72-27) Avail: NTIS HC \$3.25

A Boeing 747 aircraft, encountered unforecast light-to-severe, clear air turbulence for a period of 55 seconds while cruising at right at 33,000 feet en route to Honolulu, Hawaii, from Tokyo, Japan. There were 146 passengers and a crew of 14 aboard. Seven of the passengers received minor injuries, and two received serious injuries. Five cabin attendants received minor injuries. The aircraft was undamaged. The probable cause of this accident was the entry of the aircraft into an area of unforecast and unexpected severe clear air turbulence when numerous occupants did not have their seatbelts fastened. Author

**N73-12039\*#** Systems Technology, Inc., Hawthorne, Calif.

**AIRCRAFT HANDLING QUALITIES DATA**

Robert K. Heffley and Wayne F. Jewell Washington NASA

Dec. 1972 344 p ref

(Contract NAS4-1729)

(NASA-CR-2144) Avail: NTIS HC \$3.00 CSCL 01B

Available information on weight and inertia, aerodynamic derivatives, control characteristics, and stability augmentation systems is documented for 10 representative contemporary airplanes. Data sources are given for each airplane. Flight envelopes are presented and dimensional derivatives, transfer functions for control inputs, and several selected handling qualities parameters have been computed and are tabulated for 10 different flight conditions including the power approach configuration. The airplanes documented are the NT-33A, F-104A, F-4C, X-15, HL-10, Jetstar, CV-880M, B-747, C-5A, and XB-70A. Author

**N73-12040#** National Transportation Safety Board, Washington, D.C.

**AIRCRAFT INCIDENT REPORT: NEAR MIDAIR COLLISION VICINITY OF FRONT ROYAL, VIRGINIA, NORTHWEST AIRLINES, BOEING 720B, N736US, LOCKHEED AIRCRAFT CORPORATION, CONVAIR 240, N7372, 26 APRIL 1972**

26 Oct. 1972 16 p

(NTSB-AAR-72-30) Avail: NTIS HC \$3.00

An aircraft incident involving a near miss of a Boeing 720 and a Convair 240 near Front Royal, Virginia on 26 April 1972 is reported. It was determined that the probable cause of the accident was lack of visual scanning vigilance on the part of both flight crews to provide safe in-flight separation in visual flight rules conditions. Author

**N73-12041\*#** General Electric Co., Schenectady, N.Y. Specialty Fluidics Operation.

**FLUIDIC EMERGENCY THRUSTER FOR AIRCRAFT**

T. S. Honda Nov. 1972 44 p

(Contract NAS2-5467)

(NASA-CR-114490) Avail: NTIS HC \$4.25 CSCL 01B

The design, development, fabrication and test evaluation of two prototype fluidic emergency thrusters (FET) for aircraft stabilization are discussed. The fluidic control units were designed to provide, between two diametrically opposed nozzles, a thrust differential proportional to an input voltage signal. The emergency roll control requirements of the X-14 VTOL research aircraft were defined as typical design goals. Two control units, one on each wing tip, are intended to provide a maximum thrust of 224 pounds per unit. The units are designed to operate with 2500 psig, 2000 F gas from a solid propellant gas generator. The emergency system including the gas generator was designed to add less than 11 pounds per wing tip. The operating time under emergency conditions was specified as five seconds. The fluidic emergency thruster is similar in concept to a JATO system but has the added feature of controllable thrust. Author

**N73-12042\*#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft.

**ROTOR BLADE BOUNDARY LAYER MEASUREMENT HARDWARE FEASIBILITY DEMONSTRATION**

David R. Clark and Thomas D. Lawton [1972] 38 p refs

Sponsored in part by USAAMRDL  
(Contract NAS1-11213)

(NASA-CR-112194) Avail: NTIS HC \$4.00 CSCL 01B

A traverse mechanism which allows the measurement of the three dimensional boundary layers on a helicopter rotor blade has been built and tested on a full scale rotor to full scale conditions producing centrifugal accelerations in excess of 400 g and Mach numbers of 0.6 and above. Boundary layer velocity profiles have been measured over a range of rotor speeds and blade collective pitch angles. A pressure scanning switch and transducer were also tested on the full scale rotor and found to be insensitive to centrifugal effects within the normal main rotor operating range. The demonstration of the capability to measure boundary layer behavior on helicopter rotor blades represents the first step toward obtaining, in the rotating system, data of a quality comparable to that already existing for flows in the fixed system. Author

N73-12043\*# Massachusetts Inst. of Tech., Cambridge.  
Aeroelastic and Structures Research Lab.

**DYNAMIC NONLINEAR ELASTIC STABILITY OF HELICOPTER ROTOR BLADES IN HOVER AND IN FORWARD FLIGHT**  
Peretz Friedmann and Pin Tong 30 May 1972 298 p refs  
(Contract NAS2-8175)

(NASA-CR-114485; ASRL-TR-166-3) Avail: NTIS HC \$17.00 CSCL 01B

Equations for large coupled flap-lag motion of hingeless elastic helicopter blades are consistently derived. Only torsionally-rigid blades excited by quasi-steady aerodynamic loads are considered. The nonlinear equations of motion in the time and space variables are reduced to a system of coupled nonlinear ordinary differential equations with periodic coefficients, using Galerkin's method for the space variables. The nonlinearities present in the equations are those arising from the inclusion of moderately large deflections in the inertia and aerodynamic loading terms. The resulting system of nonlinear equations has been solved, using an asymptotic expansion procedure in multiple time scales. The stability boundaries, amplitudes of nonlinear response, and conditions for existence of limit cycles are obtained analytically. Thus, the different roles played by the forcing function, parametric excitation, and nonlinear coupling in affecting the solution can be easily identified, and the basic physical mechanism of coupled flap-lag response becomes clear. The effect of forward flight is obtained with the requirement of trimmed flight at fixed values of the thrust coefficient. Author

N73-12044# Sandia Labs., Albuquerque, N.Mex.  
**COMPUTING METEOROLOGICAL EFFECTS ON AIRCRAFT NOISE**

Robert J. Thompson [1972] 14 p refs Presented at the Intern. Conf. on Aerospace and Aeron. Meteorology, Washington, D. C. Sponsored by AEC  
(SC-DC-721007; CONF-720535-1) Avail: NTIS

The sound heard on the ground when a subsonic aircraft flies in the vicinity is affected by a number of things. In particular, winds and sound speed variations are known to have an important effect on sound propagation. A method for estimating these effects is presented, which can be implemented on a digital computer. The method is based on ray acoustics. Author

N73-12045# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

**MATHEMATICAL MODELS OF AIRCRAFT LATERAL MOTION IN THE PRESENCE OF LOW-FREQUENCY GUSTS**  
R. G. Harrison Mar. 1972 29 p refs

(Contract Min-Def/PE-AT/2040/076/NAV)  
(AASU-311) Avail: NTIS HC \$3.50

Results of aircraft lateral motion in the presence of gusts are presented in order to investigate the effects of low altitude gusts upon performance during a fully automatic aircraft landing approach. A brief description is given of the approximations and properties of the random, three-dimensional gust velocity fields in terms of stationarity, homogeneity, and isotropy. Particularly a set of linear differential equations are derived which describe approximately aircraft lateral motion and control in the presence

of low-frequency gusts, the aircraft being a large passenger-transport type with a roll control. Author (ESRO)

N73-12046# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

**OPTIMAL-ADAPTIVE CONTROL THEORY FOR AUTOMATIC CONTROL OF AIRCRAFT**

R. G. Harrison Mar. 1972 44 p refs  
(Contract Min-Def/PE-AT/2040/076/NAV)  
(AASU-314) Avail: NTIS HC \$4.25

The theory and design of optimal adaptive control laws for automatic control of aircraft in the azimuth radio guidance system (instrument landing system) are presented. The control laws are developed using Pontryagin maximum principle with state dynamics and cost function. Author (ESRO)

N73-12047# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

**F-102A EIGHT CHANNEL FLIGHT LOADS DATA RECORDING PROGRAM Final Report, Apr. 1968 - Apr. 1972**

Eugene D. Durkee May 1972 91 p refs  
(AF Proj. 1367)

(AD-747016; AFFDL-TR-72-47) Avail: NTIS CSCL 01/3

The report describes the composite F-102A maneuver loads program comprising instrumentation, data acquisition, processing and analysis of the maneuver loads data as experienced by F-102A airplane S/N 57-70835 from April 1968 to April 1970. The primary objective of this program was to collect typical interceptor type maneuver loads data for the refinement of structural design criteria for interceptor type aircraft. The maneuver loads data were processed and analyzed on the IBM 7094 computer in accordance with six computer programs which were previously prepared and designed to apply maneuver loads data to the development of structural design criteria. Results of the analyses are presented herein in the form of curves, graphs, and envelopes to provide a basis for extending the state-of-the-art in structural design criteria for current and future flight vehicles. Author (GRA)

N73-12048# Army Agency for Aviation Safety, Fort Rucker, Ala.

**PREPARATION OF A SYSTEM SAFETY PROGRAM PLAN FOR AVIATION SYSTEMS DEVELOPMENT Final Report**

Jul. 1972 42 p refs Revised

(AD-746995; USAAVS-TR-72-8-Rev) Avail: NTIS CSCL 01/2

As an essential part of the Army Aviation Accident Prevention Program, System Safety is dedicated to before the fact elimination of hazards from aircraft systems by the application of management, science, and technology principles. MIL-STD-882 gives the general requirements for System Safety Programs. Army experience in attempting to apply the provisions of MIL-STD-882 directly in aircraft development programs has indicated that there is a significant gap between the requirements as stated in the standard and practical, realistic System Safety Program. The statements of philosophy and theory of the System Safety concept in the standard and other System Safety literature alone are insufficient to produce adequate System Safety Programs for aircraft development. The purpose of the report is to identify specific areas of concern which lie between the philosophical and the practical applications of System Safety. Author (GRA)

N73-12049# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

**AIRFRAME INTEGRITY INVESTIGATIONS IN SUPPORT OF THE ANALYTICAL REWORK PROGRAM Progress Report**

Louis Berman 15 Jun. 1972 17 p

(AD-746881; NADC-72098-VT) Avail: NTIS CSCL 01/3

Airframe structural integrity investigations are performed by the Naval Air Development Center, under the cognizance of the Naval Analytical Rework Program, to provide technical support to the Naval Air Rework Facilities. The goal of this support is to assist in defining structural incongruities, necessity and depth of rework required, and to prove the adequacy, integrity, and

service life of aircraft components. The investigations completed and/or initiated during fiscal year 1972 are reported.

Author (GRA)

**N73-12050#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

**AIRCRAFT ACCIDENT REPORT: SUN VALLEY AIRLINES, INCORPORATED, BEECH 85B-80, N1027C, FAIRFIELD, IDAHO, 20 FEBRUARY 1972**

30 Aug. 1972 19 p

(NTSB-AAR-72-25) Avail: NTIS HC \$3.00

The crash of a Beech aircraft while performing air taxi service to Boise, Idaho on 20 February 1972 is reported. The probable cause of the crash was determined to be an uncontrolled fire in the left wheel well which resulted in loss of structural integrity of the left wing spars. The fire was possibly caused by engine malfunction due to improper engine maintenance procedures.

Author

**N73-12051#** Little (Arthur D.), Inc., Cambridge, Mass.

**ADVANCE FIRE EXTINGUISHERS FOR AIRCRAFT HABITABLE COMPARTMENTS** Final Technical Report, 1 Jun. 1971 - 1 Jun. 1972

Sami Atallah, John H. Hagopian, and Ashok S. Kalelkar Jun. 1972 151 p refs

(Contract F33615-71-C-1756; AF Proj. 3048)

(AD-747496; ADL-73863-F; AFAPL-TR-72-62) Avail: NTIS CSCL 13/12

The report describes the results of a program aimed at developing and optimizing portable one-quart and two-gallon size extinguishers for use with a new foamed halon agent (Halon Foam). The program involved several tasks including the study of material compatibility of common materials of construction with Halon Foam; comparative effects of Halon Foam and CB on electronic circuits; optimization of extinguisher system and subsequent testing on several fire configurations; and appropriate specification development.

Author (GRA)

**N73-12052#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE EFFECT OF DYNAMIC GROUND LOADS ON AN AIRCRAFT WING**

V. S. Mukho 5 Jun. 1972 14 p refs Transl. into ENGLISH from Vopr. Ekspuatatsionnoi Prochnosti i Nadezhnosti Aviatcionnykh Konstruktsii (Riga), no. 104, 1967 p 140-148

(AD-747381; FTD-HC-23-0626-72) Avail: NTIS CSCL 01/3

The author investigates the reaction of an aircraft wing in its bending by impact and periodic loads of landing gears in relationship to weight parameters of the wing; damping, and frequency of periodic load. The investigation was conducted on an electric aircraft wing simulator.

Author (GRA)

**N73-12053#** Defense Documentation Center, Alexandria, Va. **FATIGUE AND FRACTURE OF AIRCRAFT STRUCTURES AND MATERIALS** Report Bibliography, Dec. 1956 - Feb. 1972

Sep. 1972 291 p refs

(AD-748100; DDC-TAS-72-51) Avail: NTIS CSCL 01/3

The bibliography is a selection of unclassified references on fatigue and fracture of aircraft structures and materials. References are sequenced numerically within each of the following categories: general and miscellaneous reports, instrumentation, sonic fatigue, materials, airplane panels, wings, fuselages, landing gear and mechanical fasteners. Corporate author-monitoring agency, subject, title, report number and AD number indexes are included.

Author (GRA)

**N73-12054#** Kaman Aerospace Corp., Bloomfield, Conn.

**AN ANALYTICAL EVALUATION OF THE CONTROLLABLE TWIST ROTOR PERFORMANCE AND DYNAMIC BEHAVIOR** Final Report, Jul. 1967 - Mar. 1971

A. Z. Lemnios and A. F. Smith May 1972 400 p refs

(Contract DAAJ02-67-C-0068; DA Proj. 1F1-62203-A-143) (AD-747808; R-794; USAAMRDL-TR-72-16) Avail: NTIS CSCL 01/3

A detailed analytical evaluation is made of a new rotor system with torsionally elastic blades and dual controls-the controllable twist rotor (CTR). The controls consist of conventional pitch horn linkages at the inboard end and an aerodynamic control flap at the outboard end. The analysis involves an aeroelastic loads digital computer program which was developed to account for the blade response modes and blade control modes on either single or dual control rotors. Six response modes are included: blade flapping, blade feathering, blade lagging, blade flapwise bending, blade torsion, and control flap feathering. The two control modes are included separately and incorporate control system stiffness so that control loads are calculated. The aeroelastic analysis includes nonlinear inertia distributions, nonlinear airfoil characteristics, and inertial and mechanical coupling among the modes. The analysis outputs transient responses for stability evaluation and steady-state blade load and angle-of-attack distributions, blade dynamics, and rotor performance for each trimmed flight condition.

Author (GRA)

**N73-12055#** Vought Helicopter, Inc., Dallas, Tex.

**FAN-IN-FIN ANTITORQUE CONCEPT STUDY** Final Report, Jun. 1971 - Mar. 1972

J. K. Davidson, C. T. Havey, and H. E. Sherrieb Jul. 1972 112 p refs

(Contract DAAJ02-71-C-0060; DA Proj. 1F1-62204-AA-42)

(AD-747806; VHI/72R-E-6; USAAMRDL-TR-72-44) Avail: NTIS CSCL 01/3

A study of the development of the Fenestron fan-in-fin helicopter antitorque device and a survey of applicable data from the literature provided the means to analyze the fan-in-fin concept. The objective was to design and evaluate a ducted fan-in-fin system for a helicopter in the 14,000- to 15,000-lb gross weight and 150-kt to 160-kt speed class. A review and study of fan-in-wing literature and shrouded propeller and fan technology provided the foundation to analyze the Fenestron and to determine the basic fan and fin characteristics. A direct performance comparison of an SA 341 helicopter with Fenestron and conventional antitorque systems was conducted to assess the advantages and penalties of the Fenestron. From the knowledge gained, a ducted fan-in-fin antitorque device was designed for the utility transport helicopter in the specified weight and speed class of the SA 330. A parametric analysis of the fan design parameters showed the performance gains achievable with larger diameter fans. The MIL-H-8501A requirements were considered. A fin design was accomplished taking into account area, lift coefficient, lift curve slope, and effective aspect ratio. A trim flap was found to be desirable to optimize performance at off-design conditions.

Author (GRA)

**N73-12056#** Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.

**DEVELOPMENT OF A FLUIDIC CONTROL SYSTEM FOR AN AIRCRAFT EJECTION SEAT** Interim Report

William G. Beduhn 20 Dec. 1971 71 p refs

(Contract N00156-71-C-0418)

(AD-747630; NADC-CS-7127) Avail: NTIS CSCL 13/7

The objective of this program was to develop a fluidic control system capable of stabilizing an ejection seat in the pitch plane during the rocket motor burn portion of an ejection. This document describes the design, fabrication, and laboratory testing phase of the fluidic control system development. The control system consists of a fluidic vortex rate sensor and five fluid amplifiers. During laboratory test the system has demonstrated the capability to sense input rotation and provide as an output a high-pressure, high-flow corrective signal. This corrective signal is designed to produce a control moment by being injected into a rocket motor nozzle through secondary injection ports. The next phase of this program is to install the control system on an injection seat and demonstrate the performance of an actual seat ejection.

Author (GRA)

**N73-12173#** Naval Electronics Lab. Center, San Diego, Calif.

**SPEECH INTELLIGIBILITY IN NAVAL AIRCRAFT RADIOS**

J. C. Webster and C. R. Allen 2 Aug. 1972 66 p refs

(AD-748202; NELC-TR-1930) Avail: NTIS CSCL 17/2

N73-12224

A study was made to determine how speech intelligibility in naval aircraft radio communications is affected by cockpit noise, by the microphone, helmet, and microphone used by the pilot, and by the vocabulary employed. Using six standard word lists, speech-intelligibility tests were administered to 20 Navy enlisted men for 38 hours of listening. Cockpit noise in which the lists were recorded was both in-flight and simulated. The talker and the speech-processing equipment are largely responsible for the quality of the transmissions. Cockpit noise, microphone, and man-worn gear have negligibly degrading effect upon intelligibility of the aircraft radio communications. Speech-processing is recommended to achieve improved intelligibility. Recommendations are made for choosing optimum intelligibility tests for assessing military speech communication systems and for revising the Brevity Code words. Author (GRA)

**N73-12224# National Aerospace Lab., Amsterdam (Netherlands).  
COMPUTER APPLICATION OF SUBSONIC LIFTING  
SURFACE THEORY**

T. E. Labrujere and J. G. Wouters Sep. 1970 38 p refs  
Submitted for publication Sponsored by Direc. of Materiel Air  
RNLAf

(NLR-TR-70088-U) Avail: NTIS HC \$4.00

An ALGOL program is described, based on an elaborate method for lift distribution determination on thin wings in subsonic flow. This method is briefly described. Author (ESRO)

**N73-12267\*# National Aeronautics and Space Administration,  
Marshall Space Flight Center, Huntsville, Ala.  
SYSTEMS SIMULATION FOR AN AIRPORT TRAILING  
VORTEX WARNING SYSTEM**

Harold B. Jeffreys 13 Oct. 1972 92 p refs

(NASA-TM-X-64704) Avail: NTIS HC \$6.75 CSCL 01E

The approach, development, and limited system studies associated with a system simulation for an Airport Trailing Vortex Warning System are documented. The usefulness is shown of a systems engineering approach to the problem of developing a system, as dictated by aircraft vortices, which will increase air-traffic flow in the takeoff/landing corridors of busy airports while maintaining the required safety factor for each operation. The simulation program has been developed in a modular form which permits new, more sophisticated component models, when they become available and are required, to be incorporated into the program with a minimum of program modifications. This report documents a limited system study that has been performed using this Total System Simulation Model. The resulting preliminary system requirements, conclusions, and recommendations are given. Author

**N73-12283\*# Lockheed-Georgia Co., Marietta.  
GROUND EFFECT FOR V/STOL AIRCRAFT CONFIGURATIONS  
AND ITS SIMULATION IN THE WIND TUNNEL.  
PART 1: INTRODUCTION AND THEORETICAL STUDIES**

J. E. Hackett and E. B. Praytor [1972] 50 p refs  
(Contract NAS2-6690)

(NASA-CR-114495) Avail: NTIS HC \$4.50 CSCL 20D

Theoretical studies are made of three dimensional turbulent boundary layer behavior on fixed grounds and on moving grounds of the type used in wind tunnel tests. It is shown that, for several widely-varying STOL configurations, the ground static pressure distributions possess a remarkable degree of fore-aft symmetry about the center of lift. At low Reynolds number, corresponding to small-tunnel testing, the boundary layer displacement surface reflects to a large degree the symmetry of the pressure distribution. For this reason, induced incidence at the model is small for unseparated ground flow. At high Reynolds number, the displacement thickness decrease aft of the static pressure maximum is noticeably more rapid than the corresponding rise. This is attributed to trailing-vortex-induced spanwise pumping within the boundary layer. Author

**N73-12284\*# Lockheed-Georgia Co., Marietta.  
GROUND EFFECT FOR V/STOL AIRCRAFT CONFIGURATIONS  
AND ITS SIMULATION IN THE WIND TUNNEL.  
PART 2: EXPERIMENTAL STUDIES**

J. E. Hackett, R. A. Boles, and E. B. Praytor [1972] 76 p  
(Contract NAS2-6690)

(NASA-CR-114496) Avail: NTIS HC \$6.00 CSCL 20D

Wind tunnel tests on a finite, knee-blowing-flapped wing and on a direct jet lift configuration were performed in a 30 x 42 inch wind tunnel. The objectives of these tests were, in experimental order: (1) to obtain definitive fixed-versus-moving ground comparisons on a powered, high-lift finite wing and on a lifting jet configuration as a function of model height and lift, (2) to understand the flow mechanism which lead to observed differences between moving and fixed-ground results, (3) to discover whether the above effects of a moving ground plane can be simulated by tangential-blowing boundary layer control at the wind tunnel floor, and (4) to check the form and the numerical constants for the wall jet blowing equation derived theoretically in Part I of this report. This relates wall jet blowing quantities to model lift coefficient. Author

**N73-12306# Newcastle-upon-Tyne Univ. (England). Dept. of  
Mechanical Engineering.**

**ANALYSIS OF MIXED FLOW-ROTOR CASCADES**

R. I. Lewis, E. H. Fisher, and A. Saviolakis London Aeron. Res. Council 1972 37 p refs Supersedes ARC-33333  
(ARC-R/M-3703; ARC-33333) Avail: NTIS HC \$4.00; HMSO  
£ 1.25; PHI \$4.90

Mixed-flow rotor cascades present a formidable design problem since rotational effects such as coriolis forces exclude the use of stationary cascade experimental data. The general influence of these effects upon the energy transfer process and the parameters which govern the efficiency of a mixed-flow fan is discussed. Two cascade theories for predicting aerodynamic rotor cascade characteristics are outlined. One deals with a restricted family of Joukowski type airfoils providing a broad range of exact solutions by conformal transformation. The second theory involves the extension of Martensen's method to include relative eddy effects and also to allow for changes in meridional streamline thickness. This method, which is applicable to any profile on any stream-surface of revolution, is shown to produce accurate predictions compared with the exact solutions. Author (ESRO)

**N73-12317# Air Force Systems Command, Wright-Patterson  
AFB, Ohio. Foreign Technology Div.**

**INVESTIGATING THE PROCESS OF VAPORIZATION OF A  
LIQUID INJECTED INTO A HIGH-TEMPERATURE SUPER-  
SONIC FLOW**

A. M. Rusak, V. M. Klevanskii, and A. Ya. Nadyrshin 16 Jun. 1972 12 p refs Transl. into ENGLISH from Tr. Aviats. Inst. (UFA), no. 10, 1968 p 9-13  
(AD-747456; FTD-MT-24-2037-71) Avail: NTIS CSCL 21/4

The report describes a theoretical and experimental study of the vaporization rates of a liquid injected into a high temperature supersonic gas flow. The single valued relation between the static pressure and the distillation and vaporization process is used as a basis of this study conducted in an adiabatic cylindrical tube. Calculations of the parameters of the entire process of distillation and vaporization are carried out, taking into account the changes in the flow parameters. Theoretical calculations are supported by experiments in which aviation gasoline was injected through a laval nozzle into an air flow at M equals 2.5 at a static temperature from 600 to 800 K. Author (GRA)

**N73-12328# Naval Ordnance Lab., White Oak, Md.  
FLOW VISUALIZATION WORKSHOP REPORT**

William C. Ragsdale 8 May 1972 54 p refs  
(AD-747613; NOLTR-72-94) Avail: NTIS CSCL 20/4

A workshop on flow visualization and flow measurement techniques was held at Silver Spring, Maryland. The objective

of this meeting was to provide a forum for technical discussions on new and improved flow visualization and flow measurement techniques. Discussion of the application of new techniques to flow problems associated with turbo-machinery, aircraft and missiles was included. Author (GRA)

**N73-12442#** Army Foreign Science and Technology Center, Charlottesville, Va.

**SOIL STABILIZATION DURING ROAD AND AIRPORT CONSTRUCTION**

V. M. Vezruk 10 Aug. 1972 246 p refs Transl. into ENGLISH of the book "Ukreplenie Gruntov v Dorozhnom i Aerodromnom Stroiti." Moscow, 1971 246 p (AD-748153; FSTC-HT-23-1380-72) Avail: NTIS CSCL 08/13

One peculiarity of motor vehicle roads and airfields is that they depend greatly on the climatic, soil and hydrogeological conditions of the terrain. Therefore, all natural factors must be considered and used to the maximum in the construction and operation of roads and airfields. Another peculiarity is that their construction utilizes tremendous volumes of various types of rock materials. In construction regions where rock materials are not available, rock must be transported over many hundreds of kilometers by railroad, and dozens of kilometers by truck, increasing the costs of these materials by 4 to 5 times or more. The book discusses various methods of stabilization of various types of soils which are widely used and new methods developed for the future. Author (GRA)

**N73-12449\*#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**ACS AVIONICS SYSTEMS REVIEW**

[1971] 174 p

(Contract NAS8-26362)

(NASA-CR-123962; ACS-253-1) Avail: NTIS HC \$10.75 CSCL 01D

Items covered in this study include: (1) refining the baseline avionics system design; (2) clarification of key issues for RFP; and (3) refining the baseline avionics system costs. A. L.

**N73-12451\*#** Hoffmann-La Roche, Inc., Nutley, N.J.  
**APPLICATION OF ROCHROME LIQUID CRYSTAL TAPES FOR THERMOGRAPHIC TESTING OF BONDED STRUCTURES** Final Report

Jun. 1972 21 p refs

(Contract NAS8-26848)

(NASA-CR-123932) Avail: NTIS HC \$3.25 CSCL 14B

The use of ROCHROME liquid crystal tape for thermographic testing of bonded structures for aircraft is described. The techniques for applying the tape, heating, the test panels, and photographing the resulting thermal patterns are described and discussed. The results obtained are compared with those reported previously for the same test panels coated directly with liquid crystals applied by spraying. Other panels previously examined by various nondestructive techniques, both by thermography, were also tested. Results for these latter panels are presented and discussed. For both sets of panels good correlation with previous work was obtained. Deficiencies associated with present ROCHROME tape are described. In general, these stem from the lack of optimization for materials testing of the ROCHROME tape, particularly with respect to the adhesive system and supporting film. Author

**N73-12460#** National Aviation Facilities Experimental Center, Atlantic City, N.J.

**DEVELOP ACCELERATION AND BRAKE MONITOR SYSTEM** Final Interim Report, Oct. 1971 - Feb. 1972

Samuel V. Zinn, Jr. Nov. 1972 25 p refs

(FAA Proj. 183-724-01X)

(FAA-RD-72-112; FAA-NA-72-57) Avail: NTIS HC \$3.25

A literature search was conducted to summarize the results of previous work performed in establishing criteria for continuing the development of an instrument system which will aid pilots in making critical decisions during takeoff and landing rolls. The search revealed that many national and international studies had been made during the past 15 years, but interest diminished after 1963. It appears that much talent and work were applied for creating a monitor but no acceptable units were produced. Additional research and evaluation is considered necessary. Author

**N73-12463\*#** Transportation Systems Center, Cambridge, Mass.  
**FLIGHT TEST EVALUATION AND ANALYSIS OF AN OPTICAL IR PWI SYSTEM** Final Report, Jul. 1970 - Jun. 1972

C. O. Phillips, P. A. Concannon, D. Brandel, and E. Meyer Jun. 1972 46 p refs Sponsored by NASA

(NASA-CR-129525; DOT-TSC-NASA-72-1) Avail: NTIS HC \$4.50 CSCL 01D

The flight test results of the optical infrared (IR) Pilot Warning Instrument (PWI) system are presented. The test program is described and the flight test data presented. The data is analyzed and used to calibrate a model that is developed to characterize the system performance. The cumulative probability of detection versus range from a given system threshold is calculated and compared with the PWI performance specification. The comparison indicates that the Optical IR PWI system tested met the specifications for a detection likelihood of 95 percent for a 1 nmi range for an appreciable fraction of the testing time. Author

**N73-12485#** Instrument Flight Center, Randolph AFB, Tex.  
**OPERATIONAL TEST AND EVALUATION, AUTOMATED SPECIALTIES NORMALIZED ANGLE OF ATTACK SYSTEM**

Roger K. Taylor May 1972 34 p refs

(AD-748844; IFC-TR-72-1) Avail: NTIS CSCL 01/4

The Research and Development Division of the United States Air Force Instrument Flight Center conducted an operational test and evaluation of the Teledyne Avionics (formerly Automated Specialties) Normalized Angle of Attack System. The conclusions of the evaluation are: the Teledyne Avionics angle of attack system accurately displayed the percentage of lift the wing was producing for all flap configurations, the system components were highly reliable throughout the program, the angle of attack information is easily interpreted and flown, and the normalized concept of presenting angle of attack information is a far superior method than displaying it in units or some other meaningful quantity or term. Author (GRA)

**N73-12508#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

**DESIGN GUIDE FOR LOAD SUSPENSION POINTS, SLINGS, AND AIRCRAFT HARD POINTS** Final Report

Walter E. Huebner Jul. 1972 105 p refs

(Contract DAAJ02-71-C-0016; DA Proj. 1F1-62203-AA-33)

(AD-747814; SER-50769; USAAMRD-L-TR-72-36) Avail: NTIS CSCL 13/9

The design guide provides criteria and procedures to be used for the design of lift points on a piece of Army equipment, the sling system used to suspend material as an external helicopter load, and the aircraft hard points to which the sling is attached. Hardware components designed in accordance with the criteria and procedures in this text in the three design areas listed above will be compatible with each other and with existing and future helicopters. Author (GRA)

**N73-12512#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE USE OF METAL POLYFLUOROETHYLENE BEARINGS IN HEAVILY LOADED FRICTION COMPONENTS**

Yu. E. Savinskii 9 Jun. 1972 17 p refs Transl. into ENGLISH from Mashinovedenie (USSR), no. 1, 1971 p 95-100

(AD-747428; FTD-HT-23-468-72) Avail: NTIS CSCL 13/9

N73-12514

The possibilities of constructing helicopter rotor hinges using dry friction bearings capable of operating either with or without lubrication, to achieve sufficient wear resistance and to create by their natural friction the necessary damping in the hinges is studied. One satisfactory material which has been developed consists of a steel base, bronze poly fluoroethylene and fluoroethylene layers. The steel base gives the material high structural strength, the bronze framework, consisting of small bronze particles mixed in the resin, carries the load, transfers heat away from the friction surface and acts as a reservoir for solid lubricant, which flows from the pores of the bronze during operation and thus is delivered to the area of contact between the bronze and the other part of the friction couple, reducing the coefficient of friction. Author (GRA)

**N73-12514#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.  
**INFLUENCE OF THE SHAPE OF A ROLLING BODY ON THE HYDRO-DYNAMIC POWER LOSSES IN HIGH-SPEED ANTI-FRICTION BEARINGS**

V. M. Demidovich and A. P. Klyushkin 3 May 1972 14 p refs Transl. into ENGLISH from Tr. Aviats. Inst. (Kazan), no. 110, 1969 p 115-121

(AF Proj. 7343)  
(AD-747600; FTD-MT-24-1592-71) Avail: NTIS CSCL 13/9

An experimental study was made of the power losses incurred in driving the rolling elements of gas turbine ball bearings. An attempt was made to ascertain whether results obtained regarding the estimation of power losses due to overcoming hydrodynamic resistance forces in roller bearings can be used in calculations of the energy losses incurred in driving gas turbine ball bearings. It is shown that in the absence of an axial load an estimate of the power required to drive turbine ball bearings can be made by a method proposed by one of the authors for high speed roller bearings. Author (GRA)

**N73-12518#** Avco Lycoming Div., Stratford, Conn.  
**SPRAG OVERRIDING AIRCRAFT CLUTCH** Final Report, 15 Mar. - 15 Dec. 1971

P. Lynwander, A. G. Meyer, and S. Chachakis Jul. 1972 168 p refs

(Contract DAAJ02-71-C-0028; DA Proj. 1G1-62207-AA-72)  
(AD-747807; TR-105.7.11; USAAMRDL-TR-72-49) Avail: NTIS CSCL 13/9

The purpose of this program was to investigate the performance of high-speed overrunning clutch assemblies for use in a multiengine helicopter. The design operating conditions were 3,570 inch-pounds torque transmitted at 26,500 rpm. Two clutch configurations with differing design philosophies were evaluated. One design utilizes inner and outer sprag retainers with a central energizing ribbon spring. The other design positions the sprags with one retainer and incorporates garter springs at the sprag edges. An analysis of high-speed sprag clutch operation was performed, and a computer program was developed as an initial step to provide a mathematical model of clutch operation reflecting modern, high-speed mechanical component technology. Author (GRA)

**N73-12521#** Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

**THE NONDESTRUCTIVE INSPECTION OF AIRCRAFT TIRES BY USE OF PULSE ECHO ULTRASONICS**

Gwynn McConnell and Richard Klinman 17 May 1972. 27 p refs

(AD-747633; NADC-72035-VT) Avail: NTIS CSCL 14/2

Due to recent technological advances in ultrasonic flaw detecting apparatus (broad band characteristic), it is shown that ultrasonic pulse-echo inspection of aircraft tires is now possible. The critical acoustic properties of rubber and rubber composites have been studied so that optimum system requirements may be determined. Using off-the-shelf inspection components, a prototype inspection system has been constructed to demonstrate the ability of pulse-echo, ultrasonic inspection of tires to locate critical internal flaws and structural elements. Mechanical refine-

ments necessary to complete semi-automated and fully automated inspection systems are presented. Importance and applications of defect standards for aircraft tires is also considered in connection with inspection evaluation. Author(GRA)

**N73-12522#** TRW Equipment Labs., Cleveland, Ohio. Materials Technology Dept.

**SPIRAL BEVEL GEAR AND PINION FORGING DEVELOPMENT PROGRAM** Final Report, 20 May 1970 - 29 Feb. 1972

John L. Lazar 29 Feb. 1972 159 p refs  
(Contract DAAJ01-69-C-0614)

(AD-747857; ER-7389-F) Avail: NTIS CSCL 13/9

Spiral bevel gear sets used in the main power transmission train of the CH-47 helicopter were produced from forgings with the gear teeth precision preformed into the forging cone face. The total manufacturing process, including forging, die design and die fabrication was studied, and developments made as required to demonstrate a new approach to making these gears. A number of development cycles were required to produce the desired results and an original metrology system had to be organized to direct the development of the proper geometry in the forged teeth. After the planned process development was completed, gears were finished from the precision forgings so that the preformed teeth were finish ground using the same operations as the equivalent cut gear. Metallurgical analysis confirmed that favorable grain flow in the tooth sections was achieved and case and core properties were to specification. Limited single tooth fatigue testing demonstrated that the forged teeth were at least equivalent to cut teeth. Author (GRA)

**N73-12603#** Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

**SELF-LUBRICATING COMPOSITE MATERIALS FOR NAVAL AIRCRAFT** Final Report

Alfeo A. Conte, Jr. 28 Jul. 1972 16 p refs  
(ZRO110101)

(AD-748175; NADC-72142-VT) Avail: NTIS CSCL 11/6

Basic principles are established that related to the self-lubricating performance characteristics of sintered iron-V-bushings impregnated with elemental sulfur. The resultant sulfur-iron composite was investigated as a replenishable lubricant source for various journal materials in sliding contact. The alloying of this system with molybdenum and tungsten is also discussed. Author

**N73-12617#** Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

**DEVELOPMENT OF A NONFLAMMABLE, LOW LEVEL ODOR, ANTI-FOGGING AGENT** Progress Report

P. N. Bellavin and W. C. MacKenzie 8 Jun. 1972 9 p refs  
(AD-746844; NADC-72109-VT) Avail: NTIS CSCL 11/7

A nonflammable anti-fogging agent having a relatively low level, nonobjectionable odor is described. A composition capable of being dispensed from an aerosol container is included. Author (GRA)

**N73-12618#** Midwest Research Inst., Kansas City, Mo.  
**DYNAMIC FOAM AND AERATION TEST APPARATUS** Technical Report, Dec. 1968 - Apr. 1971

Webster D. Wood and William C. Lindsay, Jun. 1972 131 p  
(Contract F33615-69-C-1265; AF Proj. 3048)

(AD-747804; AFAPL-TR-71-83) Avail: NTIS CSCL 11/4

The report describes a technique for the experimental determination of foaming and aeration characteristics of aircraft engine lubricants. A dynamic method is presented which has the following capabilities: oil temperature to 350 F, oil pressure to 200 psig, oil flow rate to 2 gpm, air flow rate to 2,000 ml/min and system pressure from ground level to 3.5 in. Hg (simulated 50,000 ft altitude). Repeatability of the method is plus or minus 25 ml of foam for low-foaming oils, plus or minus 35 ml for medium-foaming oils, and plus or minus 50 ml for high-foaming oils. Results of repeatability tests are shown graphically and data are tabulated for 111 tests on 37 oils. Author (GRA)

**N73-12673#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.  
**CORE RELIABILITY IN THE AUTOMATIC EQUIPMENT OF THE CENTRAL DEVICE OF AN AIRPORT WEATHER STATION**

S. D. Ivakhnenko 6 May 1972 12 p refs. Transl. into ENGLISH from Tr. Gl. Geofiz. Obs. (Leningrad), no. 240, 1969 p 32-35 (AD-747558; FTD-MT-24-1657-71) Avail: NTIS CSCL 04/2

Using a special test stand at the Odessa Hydrometeorological Institute, reliability tests were performed on 1084 computer elements used in the automatic airport weather station developed by the main geophysical observatory Imeni A. I. Voyeykov. The tests were conducted over a period of three years and the total test stand operating time was 19,140 hours. A table is given listing various test parameters and results for ferrite logic cells, germanium diodes, silicon diodes, germanium triodes, and amplifier cell ferrite elements. Author (GRA)

**N73-12675#** Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.

**INVESTIGATION INTO UTILIZATION OF LORAN AND OMEGA WIND-FINDING SYSTEMS FOR MEASURING WINDS BELOW AN AIRCRAFT**

Bernard D. Weiss and James F. Morrissey 23 Jun. 1972 26 p refs

(AF Proj. 6670) (AD-748275; AFCRL-72-0399; AFCRL-IP-177) Avail: NTIS CSCL 04/2

Field tests were made to evaluate the accuracy/resolution relationship of the NAVAID systems (Loran/Omega) for measuring the vertical profile of the wind. Specifically, these tests involve a series of flight comparisons between the AN/FPS-16 radar and the Omega and Loran equipments. These comparisons were performed using balloon-borne radiosondes with the receiving and processing equipment located on the ground. The specific Air Force requirements are for an accuracy of 3 knots with a 2000 ft sensing interval and a fall rate of 1000 ft/min or greater. The Loran equipments were found to be capable of a 1.4 knot accuracy for these conditions, while the Omega equipments provided an accuracy of 4.3 knots. Author (GRA)

**N73-12682#** Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

**MATHEMATICAL INVESTIGATION OF NON-STATIONARY RF INTERFERENCE AT THE OUTPUT OF AN ILS LOCALISER RADIO RECEIVER**

R. G. Harrison Apr. 1972 26 p refs (Contract Min-Def/PE-AT/2040/076/NAV) (AASU-317) Avail: NTIS HC \$3.50

Mathematical models of the time history of R.F. interference at the output of an ILS localizer radio receiver are derived. The analysis was motivated by the requirements for suitable mathematical models of R.F. interference for computer simulation studies. Where experimental results have been obtained, good agreement between theoretical and experimental data exists. Author (ESRO)

**N73-12685#** Air Force Academy, Colo. Frank J. Seiler Research Lab.

**AN ADAPTIVE FILTERING TECHNIQUE FOR GYROCOMPASS AZIMUTH DATA** Interim Report

Ronald E. Janosko Jul. 1972 22 p refs (AF Proj. 7904)

(AD-747478; SRL-TR-72-0010) Avail: NTIS CSCL 17/7

The report presents the results of an initial investigation into the problem of obtaining a true azimuth from noisy gyrocompass data. The main areas in the report present a precise problem statement and a possible mathematical method for the problem solution. The method presented is basically an adaptive filter which in addition to minimizing the effect of measurement noise is also able to account for errors in modeling the gyrocompass problem. Final numerical results of this system will be presented in a forthcoming report. Author (GRA)

**N73-12686#** Princeton Univ., N.J.

**THE PRINCETON PENNSYLVANIA ARMY AVIONICS RESEARCH PROGRAM** Final Report, 1 Sep. 1966 - 30 Jun. 1968

Dunstan Graham Mar. 1972 42 p refs (Contract DA-28-043-AMC-02412(E); DA Proj. 1Y1-62202-A-219)

(AD-747732; ECOM-02412-8) Avail: NTIS CSCL 17/7

Using the tools of feedback system analysis and simulation a study has been made of the limitations on helicopter approach and landing under conditions of low visibility. It is shown that relatively steep approaches to low decision heights can be made on instruments. Successful loop topologies were identified and considerable improvement over the standard GCA approaches was shown to be possible with a scanning beam system especially if beam rate signals were employed. Errors introduced by turbulence and wind shear were the dominant ones. An automatic approach system could be mechanized using the same signals as the manual approaches which were considered. Author (GRA)

**N73-12687#** Instrument Pilot Instructor School, Randolph AFB, Tex.

**LANDING WEATHER MINIMUMS INVESTIGATION** Technical Report, 1964 - 1969

Donald L. Carmack Jan. 1972 279 p

(AD-747654; IPIS-TR-70-3) Avail: NTIS CSCL 01/2

The low visibility environment presents a formidable challenge not only to pilots, but to the engineers, designers and planners who will develop hardware and establish procedures. The pilot, however, is in a unique position, since, in the final analysis, he is the ultimate decision maker whether or not he desires this role. Pilots must know and understand what they are being tasked to do. The report has been written to describe and explain from a pilot's point of view, the requirements and procedures for operating in the low visibility environment. The report represents the experiences acquired from over 250 low visibility approaches and landings in visibilities as low as zero-zero. These have been documented to describe what will be seen from the approach and landing environment and how what is seen may be used. Author (GRA)

**N73-12688#** Instrument Flight Center, Randolph AFB, Tex.

**DULLES CATEGORY IIIA ILS EVALUATION**

Donald L. Carmack May 1972 19 p refs

(AD-747656; IFC-TR-72-2) Avail: NTIS CSCL 17/7

The Category IIIA ILS guidance system is designed to provide a VHF/UHF localizer and glide slope with increased performance and a backup capability. The overall flyability of the systems must be superior to a Category I or II system due to the lower minimums (700 feet RVR) authorized for the approach. Since the radiated signal is in the UHF/VHF frequency band, it is subject to the same errors and limitations caused by ground or airborne vehicles. The success, then, of a Category IIIA approach depends on the control of interference factors and capability of the aircraft and pilot to maintain the localizer and glide path. Author (GRA)

**N73-12689#** Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

**THREE DIMENSIONAL MINIMUM TIME FLIGHT PATHS TO A POINT AND ONTO A LINE FOR A SUPERSONIC AIRCRAFT WITH A MAXIMUM MACH NUMBER CONSTRAINT** Final Report

Michael G. Parsons and Arthur E. Bryson, Jr. Aug. 1972 47 p refs

(Contract N00014-67-A-0112-0063; NR Proj. 213-085) (AD-748219; SUDAAR-444) Avail: NTIS CSCL 01/2

Optimal control theory and the energy-state approximation are used to determine the thrust, altitude, and bank angle programs for minimum-time flight paths of a supersonic aircraft from an initial energy, heading, and horizontal position to a specified final energy, heading, and point or line in a horizontal plane. Constraints on maximum and minimum thrust, stall angle-of-attack, maximum Mach number, maximum dynamic pressure,

and maximum normal load factor are considered. The problem is restricted to those cases in which the flight path is long enough that the maximum Mach number is reached during the flight. Numerical results are presented for a typical supersonic aircraft capable of Mach 2.0 flight. Author (GRA)

**N73-12690#** Radio Corp. of America, Burlington, Mass. Advanced Technology Labs.  
**HOLOGRAPHIC MULTICOLOR MOVING MAP DISPLAY (GROUND SUPPORT EQUIPMENT) Final Report, 30 Jun. - 31 Dec. 1971**

Aug. 1972 44 p. refs  
(Contract N62269-71-C-0652)  
(AD-748648) Avail: NTIS CSCL 17/7

The feasibility of holographically storing and retrieving aerial chart information for display in a cockpit environment has been demonstrated during two sequential exploratory development programs, leading to the development of a laboratory model for a full color holographic moving map display system. The work done on this contract had as its primary goal the definition and consideration of the holographic recording process, and in particular the methods of generating the color separations required for full color recording, methods of registering the separations during recording, definition of the exposure levels and latitudes allowable during exposure, and methods of refining the duplication process for use in a non-laboratory environment.

Author (GRA)

**N73-12748#** Naval Research Lab., Washington, D.C.  
**DEVELOPMENT OF OPTICAL INFORMATION TRANSFER TECHNOLOGY FOR MILITARY APPLICATIONS**  
A. F. Milton, R. A. Andrews, and T. G. Giallorenzi Jul. 1972 32 p. refs

(NRL Proj. N01-31; RR0141104)  
(AD-747946; NRL-MR-2475) Avail: NTIS CSCL 20/6

Military avionics systems can be expected to benefit from the development of optical data communication systems which use fiber optics. Advantages involving size, weight and freedom from electromagnetic interference can be realized in the near future. Integrated optical circuits can increase the flexibility of such systems as well as perform independent functions in other useful optical devices. The state of the art of optical fibers and integrated optical circuits is reviewed. A strategy for the development of these technologies is recommended. The optical technology requirements for four advanced military systems involving multiterminal data bases, heterodyne detection, tethers, and optical phase front control are described in detail.

Author (GRA)

**N73-12752#** General Electric Co., Cincinnati, Ohio.  
**SUPERSONIC JET EXHAUST NOISE Final Report, May 1971 - May 1972**

Meyer J. Benzakein and Paul R. Knott Aug. 1972 795 p. refs  
(Contract F33615-71-C-1662; AF Proj. 3066)  
(AD-747774; AFAPL-TR-72-52) Avail: NTIS CSCL 20/1

The report summarizes the results obtained at General Electric during the first phase of the Air Force Supersonic Exhaust Noise - Velocity Model Program. The overall objective of the program is to develop the technology to significantly reduce supersonic aircraft propulsion system noise with minimum associated performance and weight penalties. To fulfill that objective, research is being carried out to develop the experimental techniques and the necessary theory to reveal the basic mechanisms of jet generated noise through the range of velocities and temperatures typical of present and future military and commercial supersonic aircraft propulsion systems. A comprehensive aerodynamic analytical model describing the flow mechanisms in supersonic jets is presented and compared with experimental data. A large number of theoretical models describing supersonic far field jet noise are evaluated. Author (GRA)

**N73-12852#** Naval Research Lab., Washington, D.C. Chemical Dynamics Branch.  
**THE EFFECT OF ICING INHIBITOR AND COPPER PASSIVA-**

**TOR ADDITIVES ON THE FLAMMABILITY PROPERTIES OF HYDROCARBON FUELS** Interim Report

W. A. Affens and G. W. McLaren Aug. 1972 21 p. refs  
(AD-747945; NRL-MR-2477) Avail: NTIS CSCL 21/4

Since the Navy has decided to use benzotriazole (BT) copper passivator and ethylene glycol monomethyl ether (EGME) icing inhibitor as additives in JP-5 jet fuel, a study has been made to determine the effect of these additives at intended use concentrations of 5-7 ppm BT, and 0.1-0.15% v/v EGME, on the flammability properties of hydrocarbon fuels. By measurements of flash point and flammability index it was observed that although BT did not appear to affect the flammability of hydrocarbon fuels at intended use concentrations, the EGME increased the flammability. At a concentration of 0.15% EGME, the flash point of JP-5 jet fuel, for example was reduced by 7F, and the flammability index was increased by 11%. Author (GRA)

**N73-12865#** Bendix Corp., South Bend, Ind. Energy Controls Div.

**TURBINE ENGINE COMPRESSOR FLOW LIMITING** Final Report

Samuel E. Arnett Aug. 1972 144 p. refs  
(Contract F33615-72-C-1710; AF Proj. 3066)  
(AD-747805; ECD-863-18241-R; AFAPL-TR-72-72) Avail: NTIS CSCL 21/5

Current trend in turbo-gas generator control systems is toward greater use of electronic computer techniques in the control computations. With the increased use of electronics, some greater degree of flexibility in computation can be incorporated, and more signals and greater complexity of control modes appear possible with less weight and size penalty than appears feasible with the more convenient hydromechanical control. Most current controls rely on an open-loop schedule of fuel to avoid compressor stall during acceleration and deceleration of the rotor or rotors. This program which is an extension of an investigation reported by Technical Report AFAPL-TR-71-78 is directed toward closed loop fuel control by sensing pressure relationships at the engine compressor discharge. The control signal was obtained by a special fluidic pressure ratio sensor utilizing the burner wall static pressure and a pressure obtained by a static probe in the last stator vane row. Author (GRA)

**N73-12866#** ARO, Inc., Arnold Air Force Station, Tenn.  
**MEASUREMENT OF POLLUTANT EMISSIONS FROM AN AFTERBURNING TURBOJET ENGINE AT GROUND LEVEL. 2: GASEOUS EMISSIONS** Final Report, 22 Jun. - 21 Sep. 1971

G. R. Lazalier and J. W. Gearhart AEDC Aug. 1972 65 p. refs  
(Contract F40600-73-C-0004)  
(AD-747773; ARO-ETF-TR-72-30; AEDC-TR-72-20) Avail: NTIS CSCL 13/2

The performance of a sampling and measurement system for the gaseous species of carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), total hydrocarbons (C(x)H(y)), nitrogen dioxide (NO<sub>2</sub>), and total oxides of nitrogen (NO(x)) was demonstrated for an afterburning turbojet engine power condition from idle to maximum afterburning at ground level. Data were obtained, using a portable emissions measurement system, at positions ranging from immediately at the nozzle exit to 96 ft aft of the nozzle exit plane. A J85-GE-5 engine was used to generate the gaseous emissions. Nondispersive infrared detectors were used for CO and CO<sub>2</sub> measurements; a flame ionization detector was used for C(x)H(y) measurements; and electrochemical devices operating on the fuel cell principle were used for NO<sub>2</sub> and NO(x) measurements. The effects of inlet humidity and crosswind velocity on the quantity and distribution of gaseous species in the exhaust plume were determined. Author (GRA)

**N73-12867#** Naval Postgraduate School, Monterey, Calif.  
**QUASI AREA RULE FOR HEAT ADDITION IN TRANSONIC AND SUPERSONIC FLIGHT REGIMES** Final Technical Report, 1 Oct. 1970 - 31 Aug. 1971  
Allen E. Ruhs Aug. 1972 155 p. refs  
(AF Proj. 3066)  
(AD-747772; AFAPL-TR-72-10) Avail: NTIS CSCL 21/5



Body shapes, including axisymmetric and three dimensional, have been developed to minimize wave drag. The von Karman ogive and the area rule are examples. Similar work has not been accomplished for optimum shapes with propulsion. Propulsion can be divided into two categories--those devices with internal heat addition and those with external burning. For internal heat addition an analytical model is formulated which introduces the propulsive disc. Attention is shifted to external burning, which is examined for one dimensional and two dimensional linearized flow. Heat fronts and combustion fans are discussed as examples. Forces on a heat source in a uniform stream and adjacent to bodies are derived. Author (GRA)

**N73-12868#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE HEART OF AN AIRCRAFT**

M. Naumov 9 Jun. 1972 21 p Transl. into ENGLISH from Tekh. Molodezhi (Moscow), no. 10, 1970 p 30-34 (AF Proj. 668A)

(AD-747406; FTD-MT-24-1871-71) Avail: NTIS CSCL 21/5

The report deals in some detail with the theory and operation of jet aircraft engines. The various types of jet engines are differentiated; a turbojet engine is discussed in some detail.

Author (GRA)

**N73-12945#** National Aerospace Lab., Amsterdam (Netherlands). **ELECTRON FRACTOGRAPHY OF STRESS-CORROSION FRACTURE SURFACES**

W. J. VanDerVet Mar. 1971 16 p refs Sponsored by the Res. Branch of the Directorate of Materiel Air, RNLAF (NLR-TR-71038-U) Avail: NTIS HC \$3.00

Stress corrosion is the cause of a large number of service failures in high strength materials. Consequently, it became necessary to make an inventory of the features of stress corrosion fracture surfaces for investigating service failures, especially such conspicuous features as intergranular cracking. The results of such an inventory involving a number of aircraft materials, such as low alloy high strength steel, Al-Zn-Mg alloys, Al-Cu alloys, and Ti alloys are presented. It is shown that aluminum alloys generally give easily recognizable stress corrosion failures. In high strength steel, one fracture mechanism results in an intergranular mode of failure. It is concluded that the electron microscope should be used wherever possible in combination with light microscopy, to look for finer details before making a decision as to the failure cause. Author (ESRO)

**N73-12964\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**EFFECT OF WING SWEEP, ANGLE OF ATTACK, REYNOLDS NUMBER, AND WING ROOT FILLET ON THE INTERFERENCE HEATING TO THE WING WINDWARD SURFACE OF AN ENTRY VEHICLE CONFIGURATION**

Louis E. Clark Washington Dec. 1972 53 p refs (NASA-TN-D-7060; L-8486) Avail: NTIS HC \$3.00 CSCL 20M

The phase-change-coating technique was used to study the interference heating to the windward surface of 14 deg, 25 deg, and 50 deg swept wings of an entry vehicle configuration. One wing root of each model was faired to the fuselage with a fillet. Tests were made at Mach 8 at angles of attack of 0 deg, 20 deg, 40 deg, and 60 deg and at free-stream Reynolds numbers based on model length of 0.47 and 1.7 million. Bow shock impingement heating was found to increase in magnitude and affected area with increasing angle of attack until at a higher angle of attack it decreases; this angle of attack is lower for a 50 deg swept wing. Wing root interference heating was found to increase with angle of attack up to 40 deg and then to remain approximately constant. Consequently, wing root interference heating becomes the major type of interference heating at large angles of attack, and this occurs at a lower angle of attack for the highest sweep angle. A wing leading-edge root fillet reduces the peak in wing root interference heating near the leading edge, and increasing Reynolds number increases the level of interference heating. Author

**N73-12982\*#** RAND Corp., Santa Monica, Calif.

**EXTERNAL IMPACTS OF AN INTRAURBAN AIR TRANSPORTATION SYSTEM IN THE SAN FRANCISCO BAY AREA**  
J. Y. Lu, J. R. Gebman, T. F. Kirkwood, P. T. McClure, and J. P. Stucker Oct. 1972 71 p refs

(Contract NAS2-6480)  
(NASA-CR-114492) Avail: NTIS HC \$5.75 CSCL 05C

The effects are studied of an intraurban V/STOL commuter system on the economic, social, and physical environment of the San Francisco Bay Area. The Bay Area was chosen mainly for a case study; the real intent of the analysis is to develop methods by which the effects of such a system could be evaluated for any community. Aspects of the community life affected include: income and employment, benefits and costs, noise, air pollution, and road congestion. F.O.S.

**N73-12986#** Joint Publications Research Service, Arlington, Va.

**USSR SCIENTIFIC ABSTRACTS: ENGINEERING AND EQUIPMENT, NO. 115**

20 Oct. 1972 144 p refs Transl. into ENGLISH from Russian reports

(JPRS-57311) Avail: NTIS HC \$9.25

Abstracts are included on aeronautical, marine, mechanical, automotive, civil and industrial engineering, related research and development, and engineering materials and equipment.

Author

**N73-12990\*#** Massachusetts Inst. of Tech., Cambridge. Charles Stark Draper Lab.

**STOL TRAFFIC ENVIRONMENT AND OPERATIONAL PROCEDURES Final Report**

Robert W. Schlundt, Robert W. DeWolf, Raymond A. Ausrotas, Renwick E. Curry, Dorian DeMaio, Donald W. Keene, Jason L. Speyer, Michael Weinreich, and Saydean Zeldin Mar. 1972 242 p refs

(Contract NAS2-6437)  
(NASA-CR-114523; R-717) Avail: NTIS HC \$14.25 CSCL 15E

The expected traffic environment for an intercity STOL transportation system is examined, and operational procedures are discussed in order to identify problem areas which impact STOL avionics requirements. Factors considered include: traffic densities, STOL/CTOL/VTOL traffic mix, the expected ATC environment, aircraft noise models and community noise models and community noise impact, flight paths for noise abatement, wind considerations affecting landing, approach and landing considerations, STOLport site selection, runway capacity, and STOL operations at jetports, suburban airports, and separate STOLports. Author

**N73-12997#** Center for Naval Analyses, Arlington, Va. Naval Warfare Analysis Group.

**THE USE OF SIMULTANEOUS EQUATION MODELS FOR DECISIONS PERTAINING TO THE BEST MIX BETWEEN AIRCRAFT, SPACE PARTS, SUPPORT EQUIPMENT, AND SUPPORT PERSONNEL**

Chantee Lewis May 1972 126 p refs  
(Contract N00014-68-A-0091)  
(AD-747972; NWAG-Res-Contrib-206) Avail: NTIS CSCL 15/5

The report contains a study of the application of production functions to sea-based tactical air resources: aircraft, spare parts, support equipment, and support personnel. The goal is to develop objective criteria for allocating money among these competing demands using sorties or aircraft ready hours as the output. Author (GRA)

**N73-12999\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**EFFECT OF NOZZLE LATERAL SPACING ON AFTERBODY DRAG AND PERFORMANCE OF TWIN-JET AFTERBODY**

**MODELS WITH CONE PLUG NOZZLES AT MACH NUMBERS UP TO 2.20**

Bobby L. Berrier Washington Dec. 1972 132 p refs  
(NASA-TM-X-2632; L-8481) Avail: NTIS HC \$3.00 CSDL  
01A

Twin-jet afterbody models were investigated by using two balances to measure separately the thrust minus total drag and the afterbody drag at Mach numbers of 0.0 and 0.50 to 2.20 for a constant angle of attack of 0. Translating shroud cone plug nozzles were tested at dry and maximum afterburning power settings with a high-pressure air system used to provide jet total-pressure ratios up to 20.0. Two nozzle lateral spacings were studied by using afterbodies with several interfairing shapes. The close- and wide-spaced afterbodies had identical cross-sectional area distributions when similar interfairings were installed on each. Nozzle cant angles of -5, 0, and 5 degrees were investigated. The results show that the highest overall performance was generally obtained with the close-spaced afterbody, basic interfairings (no base), and uncanted nozzles. Author

**N73-13001\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**NUMERICAL METHOD FOR DESIGN OF MINIMUM-DRAG SUPERSONIC WING CAMBER WITH CONSTRAINTS ON PITCHING MOMENT AND SURFACE DEFORMATION**

Russell B. Sorrells and David S. Miller Washington Dec. 1972 47 p refs  
(NASA-TN-D-7097; L-8585) Avail: NTIS HC \$3.00 CSDL  
01B

A numerical method, based on linearized theory, for designing minimum-drag supersonic wing camber surfaces of arbitrary planform for a given lift, with options for constraining the pitching moment and/or the surface deformation at the trailing edge of the root chord and for selecting any desired combination of eight specified wing-loading distributions to be employed in the optimization procedure is presented. Two examples are given to illustrate applications of the method. The results indicate that relatively small drag penalties are incurred in designing wings to be self-trimming and to have a reasonable camber surface. Author

**N73-13002\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**EFFECT OF WING DESIGN ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A WING-BODY MODEL AT SUBSONIC SPEEDS**

William P. Henderson and Jarrett K. Huffman Washington Dec. 1972 58 p refs  
(NASA-TN-D-7099; L-8562) Avail: NTIS HC \$3.00 CSDL  
01A

An investigation has been conducted to determine the effects of wing camber and twist on the longitudinal aerodynamic characteristics of a wingbody configuration. Three wings were used each having the same planform (aspect ratio of 2.5 and leading-edge sweep angle of 44 deg.) but differing in amounts of camber and twist (wing design lift coefficient). The wing design lift coefficients were 0, 0.35, and 0.70. The investigation was conducted over a Mach number range from 0.20 to 0.70 at angles of attack up to about 22 deg. The effect of wing strakes on the aerodynamic characteristics of the cambered wings was also studied. A comparison of the experimentally determined aerodynamic characteristics with theoretical estimates is also included. Author

**N73-13003#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Aerodynamik.

**MACH NUMBER EFFECT ON WAVE DRAG OPTIMIZED FUSELAGES AND PROFILES IN HYPERSONIC FLOW [DER EINFLUSS DER MACHZAHL AUF WELLENWIDERSTANDS-OPTIMIERTE RUEMPFE UND PROFILE BEIUEBERSCHALL-ANSTROMUNG]**

J. B. Wellmann 1972 34 p refs. In GERMAN Presented at the 5th Ann. DGLR Meeting, Berlin, 4-6 Oct. 1972 (DGLR-Paper-72-108) Avail: NTIS HC \$3.75

The contour of wave drag optimized bodies of revolution is investigated as a function of Mach number. The minimum wave drag contours, calculated by the theory of slender bodies, are independent of Mach number, whereas some nonlinear optimizations indicate such an influence. From a consistent linearization of the conservation theorems, a closed linear theory is presented, by which the optimization of bodies of revolution is possible exactly and explicitly. The contours, represented by the flow function, contain the old solutions as asymptotic exceptions, and are valid also for higher Mach numbers. Author (ESRO)

**N73-13004#** Royal Aircraft Establishment, Farnborough (England). Structures Dept.

**LOW SPEED PULL-UP MANOEUVRES FOR A SLENDER WING TRANSPORT AIRCRAFT WITH STABILITY AND CONTROL AUGMENTATION**

Dorothy M. Holford London ARC 1972 48 p refs Supersedes RAE-TR-70194; ARC-33169  
(ARC-CP-1231, RAE-TR-70194; ARC-33169) Avail: NTIS HC \$4.50; HMSO 65p; PHI \$2.95

Low speed pull-up maneuvers for slender wing transport aircraft are calculated considering two extremes of aircraft weights (386,000 lb and 180,000 lb) and two center of gravity positions for each weight. Stability augmentation, in the form of angle of incidence and for rate of pitch feedback, and control augmentation are investigated as a means of improving the response of the aircraft in pull-up maneuvers. Author (ESRO)

**N73-13005#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**AERODYNAMIC INTERFERENCE BETWEEN A WING AND STORE M.S. Thesis**

Charles L. Turner Jun. 1972 72 p refs  
(AD-748348; GA/MC/72-6) Avail: NTIS CSDL 01/3

Simplified wing and store models are used to determine the aerodynamic interference effects between an aircraft and a store carried beneath its wing. Inviscid flow characteristics are calculated and the results compared to an experimental wind tunnel study. The resulting vertical forces are comparable to those from the wind tunnel study when modeling the wing with a single horseshoe vortex. The remaining forces and moments are not predicted accurately. Methods for correcting the differences are suggested. Modeling the wing with multiple horseshoe vortices changes the side force values to values comparable to those from the wind tunnel study. This indicates that the method can be extended to correct the other forces and moments to more realistic values. Author (GRA)

**N73-13006#** Martin Marietta Corp., Baltimore, Md. Research Inst. for Advanced Studies.

**EXACT SOLUTION FOR LIFTING SURFACES**

Peter F. Jordan Aug. 1972 50 p refs  
(Contract F44620-69-C-0096; AF Proj. 9781)  
(AD-748433; AFOSR-72-1737TR) Avail: NTIS CSDL 20/4

The obstacle which prevented the determination of exact lifting surface solutions was the singularity at the wing tip. This problem has now been solved analytically for the circular wing and thereby, to an extent, for wings with parabolic wing tips in general. The paper reports the analytical results. It describes how numerical solutions for the circular wing can conveniently be calculated if only engineering accuracy is required. Four linearly independent solutions have been determined to very high accuracy and are listed in tables; the tables are short since it is possible to split off the singularity. The samples confirm some expected and provide some unexpected insights into the mechanism of lifting flow. Author (GRA)

**N73-13007#** Martin Marietta Corp., Baltimore, Md. Research Inst. for Advanced Studies.

**ON LIFTING WINGS WITH PARABOLIC TIPS**

Peter F. Jordan, Jul. 1972 50 p refs  
(Contract F44620-69-C-0096; AF Proj: 9781)  
(AD-748432; RIAS-TR-72-166; AFOSR-72-1738TR) Avail:  
NTIS CSCL 20/4

The structure of the singularity in the pressure distribution at parabolic wing tips is investigated on the circular wing model; it is determined on the basis of the remark that the given downwash is always regular at the tip. The solution is characterized by the occurrence of logarithmic sets. The major part of the solving set describes the singularity which is common to all solutions; the minor part which describes the special solution can be separated out. The leading components of the singularity can be generalized to apply to more general wing planforms.

Author (GRA)

**N73-13009#** National Research Council of Canada, Ottawa (Ontario).

**A SUGGESTED METHOD FOR ESTIMATING PATCH LENGTH FROM TURBULENCE MEASUREMENTS USING RESULTS FROM LOW ALTITUDE FLIGHTS BY A T-33 AIRCRAFT.**

D. G. Gould and J. I. MacPherson Aug. 1972 26 p refs  
(NRC-12793; LR-562) Avail: NTIS HC \$3.50

When an aircraft encounters a patch of turbulence, the RMS turbulence intensity is usually constant only, over a portion of the total period of exposure. A method is suggested for estimating the patch length as a function of intensity for turbulence encounters that have two or more regions of different turbulence intensities. It makes use of the fact that the amplitude or level crossing distributions that fall between the normal distribution and the exponential distribution may be closely approximated by a superposition of normal distributions of different intensities. Levels crossing distributions of vertical acceleration from a series of T-33 low altitude turbulence research flights are analyzed using this procedure, and results from flatland and hilly lakeland are compared.

Author

**N73-13010#** La Plata Univ. (Argentina). Dept. of Aeronautical Engineering.

**CALCULATING THE AERODYNAMIC DERIVATIVES OF A SUBSONIC AIRCRAFT AT HIGH VELOCITY [SOBRE EL CALCULO DE DERIVATIVAS AERODINAMICAS EN AVIONES SUBSONICOS DE ALTA VELOCIDAD]**

Juan Pedro Weisz Mar. 1972 35 p refs In SPANISH  
Avail: NTIS HC \$3.75

A computer program in FORTRAN is presented for the IBM 360 computer for calculating wing loading on a subsonic wing at high velocity with low frequency oscillations. Subroutines are included for calculating the Multhopp influence, for deriving the functions of the influence for the oscillations, and aerodynamic coefficients. A separate program for calculating pressure distribution, and wing loading in a fixed regime is also included.

Transl. by F.O.S.

**N73-13011\*#** Lockheed-Georgia Co., Marietta.  
**PROGRAM FOR ESTABLISHING LONG-TIME FLIGHT SERVICE PERFORMANCE OF COMPOSITE MATERIALS IN THE CENTER WING STRUCTURE OF C-130 AIRCRAFT. PHASE 1: ADVANCED DEVELOPMENT**

W. E. Harvill, A. O. Kays, E. C. Young, and W. M. McGee [1972] 192 p  
(Contract NAS1-11100)

(NASA-CR-112126) Avail: NTIS HC \$11.75 CSCL 01B

Areas where selective reinforcement of conventional metallic structure can improve static strength/fatigue endurance at lower weight than would be possible if metal reinforcement were used are discussed. These advantages are now being demonstrated by design, fabrication, and tests of three boron-epoxy reinforced C-130E center wing boxes. This structural component was previously redesigned using an aluminum build-up to meet increased severity of fatigue loadings. Direct comparisons of relative structural weights, manufacturing costs, and producibility can therefore be obtained, and the long-time flight service performance of the composite reinforced structure can be evaluated against the wide background of metal reinforced structure.

Author

**N73-13012\*#** Scientific Translation Service, Santa Barbara, Calif.  
**LATEST CIVIL V/STOL AIRCRAFT PROJECTS OF HAWKER SIDDELEY AVIATION**

T. K. Szenkier Washington NASA Nov. 1972 27 p Transl. into ENGLISH from Flug-Rev. Int. (West Germany), no. 6, Jun. 1971 p 59-62 and 71-74

(Contract NASw-2035)

(NASA-TT-F-14619) Avail: NTIS HC \$3.50 CSCL 01B

VTOL, RTOL and STOL projects are reviewed for the 1967-1971 time period. These include configurations with up to 16 fan-lift engines (HS 141-16). Operational characteristics and implications for air transport are discussed.

Author

**N73-13013\*#** Scientific Translation Service, Santa Barbara, Calif.  
**NUMERICAL PREDICTION OF THE DIFFUSION OF EXHAUST PRODUCTS OF SUPERSONIC AIRCRAFT IN THE STRATOSPHERE**

R. Joatton and A. Doury Washington NASA Nov. 1972 17 p refs Transl. into ENGLISH from l'Aeronautique et l'Astronautique (Paris), no. 36, 1972 p 37-44

(Contract NASw-2035)

(NASA-TT-F-14622) Avail: NTIS HC \$3.00 CSCL 01B

The numerical prediction of the diffusion of exhaust products produced by supersonic aircraft during flight in the stratosphere is discussed. The diffusion of gaseous or finely scattered substances (nitrogen oxides, carbon monoxide, water vapor) which can become suspended in the stratosphere is evaluated. Numerical results are presented assuming three hundred supersonic jets, each making a return trip every day on a heavily traveled route.

Author

**N73-13014\*#** Scientific Translation Service, Santa Barbara, Calif.  
**A VORTEX MODEL FOR THE STUDY OF THE FLOW AT THE ROTOR BLADE OF A HELICOPTER**

W. H. Isay Washington NASA Dec. 1972 45 p refs Transl. into ENGLISH from Z. Angew. Math. Mech. (East Germany), v. 52, Jun. 1972 p 283-309

(Contract NASw-2035)

(NASA-TT-F-14637) Avail: NTIS HC \$4.25 CSCL 01B

On the base of unsteady vortex lifting line theory, an approximate method to calculate the loading distribution on rotor blades in forward flight is presented. The theory takes account of the vortex wake geometry for nonuniform flow through the rotor disc as well as the effect of rolling up and contraction of free tip- and root-vortices. Calculating the blade circulation distribution requires careful attention to the case where the blades pass through the rolled-up tip- and root-vortex of the foregoing foil.

Author

**N73-13015#** National Transportation Safety Board, Washington, D.C.

**AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT. SUPPLEMENTAL ISSUE: 1970 ACCIDENTS**

21 Jul. 1972 113 p

(NTSB-BA-72-5) Avail: NTIS HC \$7.75

Reports of aircraft accidents and incidents that occurred in 1970 and have not been included in a prior issue of briefs. Included are 9 U.S. Air Carrier Accidents, 82 U.S. Air Carrier incidents, 108 U.S. General Aviation accidents, and 39 U.S. General Aviation incidents. Five Foreign Air Carrier accidents, and 11 Foreign General Aviation accidents that were investigated by the National Transportation Safety Board are also included. This publication is the final issue of Briefs of Accidents that occurred in calendar year 1970.

Author

**N73-13016\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**A WIND TUNNEL FLIGHT CORRELATION OF APOLLO 15 SONIC BOOM**

Raymond M. Hicks, Joel P. Mendoza, and Frank Garcia, Jr. Jan. 1972 18 p refs

(NASA-TM-X-62111) Avail: NTIS HC \$3.00 CSCL 20A

A correlation of sonic boom pressure signatures recorded during reentry of the Apollo 15 command module with wind-tunnel signatures extrapolated to flight distances has been made for

## N73-13017

Mach numbers of 1.16 and 4.57. The flight pressure signatures were recorded by pressure sensors located onboard ships positioned near the ground track while the wind-tunnel signatures were measured during tests of a 0.016-scale model of the command module. The agreement between estimates based on wind-tunnel data and flight measurements was better at Mach 4.57 than at Mach 1.16. Author

**N73-13017#** National Transportation Safety Board, Washington, D.C.

**AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT US CIVIL AVIATION. ISSUE NUMBER 2: 1971 ACCIDENTS**  
8 Sep. 1972 481 p

(NTSB-BA-72-4) Avail: NTIS HC \$26.25

Selected aircraft accident reports, in U.S. Civil Aviation operations during calendar year 1971. The 900 General Aviation accidents contained in this publication represent a random selection. 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 light, pilot certificate, injuries, and causal factors. Author

**N73-13018#** Advisory Group for Aerospace Research and Development, Paris (France).

**AGARD FLIGHT MECHANICS PANEL SYMPOSIUM ON STABILITY AND CONTROL Technical Evaluation Report**  
William T. Hamilton (Boeing Co., Seattle) Oct. 1972 10 p refs Conf. held at Brunswick, 10-13 Apr. 1972

(AGARD-AR-48) Avail: NTIS HC \$3.00

With the passing of time and better understanding of the aerodynamic and structural characteristics of aircraft configurations the opportunities to improve aircraft performance, reliability, or cost through the use of more sophisticated control systems was recognized. These advanced control systems involved additional disciplines such as complicated mechanisms, hydraulics, electronics, and new visual systems. Author

**N73-13019#** Advisory Group for Aerospace Research and Development, Paris (France).

**A RELATION BETWEEN MEASURED CENTER OF GRAVITY VERTICAL ACCELERATIONS AND THE LOADS AT THE T-TAIL OF A MILITARY AIRPLANE**

O. Buxbaum (Lab. fuer Betriebsfestigkeit, Darmstadt-Eberstadt, West, Germany) Sep. 1972 20 p refs

(AGARD-597) Avail: NTIS HC \$3.00

A method for the establishment of a statistical basis for the relations between center of gravity vertical accelerations and structural loads on a tailplane is described. The development and application of a fatigue meter for this purpose are discussed. Bending moments and load factors are plotted as graphs to show reliability of test procedures. Author

**N73-13020\*#** North American Rockwell Corp., Columbus, Ohio. Aircraft Div.

**FLIGHT TESTS OF A ROTATING CYLINDER FLAP ON A NORTH AMERICAN ROCKWELL YOY-10 AIRCRAFT**

D. R. Cichy, J. W. Harris, and J. K. MacKay Washington NASA Nov. 1972 164 p refs

(Contract NAS2-5326)

(NASA-CR-2135) Avail: NTIS HC \$3.00 CSDL 04B

Flight tests were conducted of a twin engine airplane modified to a STOL configuration with rotating cylinder flaps and interconnected propellers. The flight tests included verification of the functional operation of the rotating cylinder flap system and the determination of the low speed flying qualities and performance characteristics with emphasis on approach and landing. Author

**N73-13022\*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

**A STUDY OF THE VARIABLE IMPEDANCE SURFACE CONCEPT AS A MEANS FOR REDUCING NOISE FROM**

**JET INTERACTION WITH DEPLOYED LIFT-AUGMENTING FLAPS**

Richard E. Hayden, Yoram Kadman, and Robert C. Chanaud  
15 Jul. 1972 107 p refs

(Contract NAS1-9559)

(NASA-CR-112166; Rept-2399) Avail: NTIS HC \$7.50 CSDL 01B

The feasibility of quieting the externally-blown-flap (EBF) noise sources which are due to interaction of jet exhaust flow with deployed flaps was demonstrated on a 1/15-scale 3-flap EBF model. Sound field characteristics were measured and noise reduction fundamentals were reviewed in terms of source models. Test of the 1/15-scale model showed broadband noise reductions of up to 20 dB resulting from combination of variable impedance flap treatment and mesh grids placed in the jet flow upstream of the flaps. Steady-state lift, drag, and pitching moment were measured with and without noise reduction treatment. Author

**N73-13023\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**ACTIVE AIR CUSHION CONTROL SYSTEM MINIMIZING VERTICAL CUSHION RESPONSE Patent Application**

Jack D. Leatherwood and David G. Stephens, inventors (to NASA)  
Filed 1 Nov. 1972 14 p

(NASA-Case-LAR-10531-1; US-Patent-Appl-SN-302720) Avail: NTIS HC \$3.00 CSDL 01B

An active control system for an air cushion vehicle which reduces or eliminates the effects of excessive vertical vibratory acceleration and/or displacement is described. A typical air cushion vehicle with valves located in air supply ducts to regulate the air supply flow to air cushions under the control of transducers is illustrated. The system itself, including acceleration and position controllers, which process the output signals of transducers and whose outputs are summed by summing amplifier to produce a control signal for servo valve is analyzed. NASA

**N73-13025\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**EXTRACTION OF LONGITUDINAL AERODYNAMIC COEFFICIENTS FROM FORWARD-FLIGHT CONDITIONS OF A TILT-WING V/STOL AIRPLANE**

James L. Williams Washington Dec. 1972 24 p refs  
(NASA-TN-D-7114; L-8301) Avail: NTIS HC \$3.00 CSDL 01B

A parameter-estimation algorithm was used to extract the longitudinal aerodynamic derivatives from flight data for the XC-142A airplane in a cruise condition. The flight data were the response to a tail-plane doublet input. Results of this study showed that a set of derivatives were determined which yielded a calculated aircraft response in close agreement with the measured response. This calculated response was in much closer agreement with the flight data than the response obtained by using derivatives which were calculated from empirical methods. There were large differences between some of the important derivatives extracted from flight data and those calculated from empirical methods. The reasons for these differences were not identified. Author

**N73-13026\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**NOISE GENERATED BY IMPINGEMENT OF A JET UPON A LARGE FLAT BOARD**

William A. Olsen, Jeffrey H. Miles, and Robert G. Dorsch  
Washington Dec. 1972 35 p refs

(NASA-TN-D-7075; E-6983) Avail: NTIS HC \$3.00 CSDL 01B

Data were obtained on the noise generated by an air jet impinging on a large flat board. The board was large enough so that the flow leaving the edges of the board generated no significant noise. The impingement angle, nozzle shape and size, jet velocity, and the distance from the nozzle to the board were varied in the experiment. Far-field noise data are presented. The nozzle-alone noise contribution to the total noise was generally small and was subtracted from the total, leaving the impingement-only noise. The impingement-only noise was adequately correlated by eighth power of the peak impingement velocity and first power

of the impingement area. The spectral data were correlated by a Strouhal number based on the peak impingement velocity and a characteristic impingement diameter. Author

**N73-13027\*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.  
**SOME LOADING CONDITIONS IMPOSED BY GROUND TURNING MANEUVERS WITH THREE JET TRANSPORT AIRPLANES**

Albert W. Hall Washington Dec. 1972 29 p refs (NASA-TN-D-7132; L-8597) Avail: NTIS HC \$3.00 CSCL 01B

Some loading conditions imposed during ground turning maneuvers are presented for arrival and departure operations at several airports with C-141A, 727, and DC-9 airplanes. The data presented for a total of 809 turns include: ground speed, lateral acceleration, the number of turns required during arrival and departure, and the magnitude of the turns. Author

**N73-13028\*#** Boeing Co., Philadelphia, Pa. Vertol Div.  
**THEORY/TEST CORRELATION OF HELICOPTER ROTOR BLADE ELEMENT AIRLOADS IN THE BLADE STALL REGIME**

Christopher J. Bobo Aug. 1972 50 p refs (Contract NAS2-5473) (NASA-CR-114489; D210-10508-1) Avail: NTIS HC \$4.50 CSCL 01B

The effects of stall on a rotor blade element in a three-dimensional rotating environment was investigated. The model rotor test provided blade element airloads and local boundary layer flow characteristics at the three-quarter blade radius position for a wide range of rotor operating conditions. A description of the test program and the test results are presented. Author

**N73-13029\*#** Techtran Corp., Glen Burnie, Md.  
**UTILIZATION OF VARIATIONAL METHODS IN THE CALCULATION OF ROTOR BLADES AND PROPELLER VIBRATIONS**

Yu. S. Vorobyev and P. P. Gontarovskiy Washington NASA Dec. 1972 10 p refs Transl. into ENGLISH from Dinamika i Prochnost Mashin (USSR), no. 14 p 37-43 (Contract NASw-2037)

(NASA-TT-F-14627) Avail: NTIS HC \$3.00 CSCL 20K  
 Relations for the torsional-bending and longitudinal vibrations of rotating shafts are applied to the determination (by a variational method) of the free vibrations of individual rotor blades, the in-phase vibrations of blade cascades, and the vibrations of shrouded blades. The critical flutter speed of a propeller is also determined. The influence of various factors on the frequencies, mode shapes, and stresses of rotor blades is studied on the basis of computer calculations. It is shown that, depending on the shaft geometry, Coriolis forces can increase and decrease the critical flutter speed. Author

**N73-13030#** National Aviation Facilities Experimental Center, Atlantic City, N.J.

**DEVELOPMENT OF LOW-COST COCKPIT/OUTSIDE TIME SHARING TRAINING EQUIPMENT Final Report, Sep. 1971 - Jul. 1972**

Warren G. Crook Nov. 1972 20 p refs (FAA-RD-72-95; FAA-NA-72-61) Avail: NTIS HC \$3.00

Time-sharing training using a low-cost visual in-cockpit device is discussed. Training sessions in a ground trainer with subsequent flight checks in an airplane showed marked improvement in cockpit/outside visual scanning and piloting proficiency. Pilots expressed favorable comments regarding use of the concept for student pilot training. Three pilot training schools also evaluated an in-cockpit aural signal device designed to prompt pilots to scan outside for other aircraft. The device received unfavorable comments from student pilots and flight instructors due to excessive amounts of annoyance and distraction, and was not recommended as a training aid. Author

**N73-13031#** Technische Hochschule, Aachen (West Germany). Inst. fuer Luft- und Raumfahrt.

**ACOUSTIC FEEDBACK PHENOMENA OF THE SUBSONIC AND HYPERSONIC FREE JET IMPINGING ON A FOREIGN BODY [AKUSTISCHE RUECKKOPPLUNGSEINHEITEN AM UNTER- UND UEBERSCHALLFREISTRABL, DER AUF EINEN STOERKOERPER TRIFFT]**

G. Neuwerth Sep. 1972 30 p refs In GERMAN; ENGLISH summary Presented at the 5th Ann. DGLR Meeting, Berlin, 4-6 Oct. 1972

(DGLR-Paper-72-84) Avail: NTIS HC \$3.50

The acoustic feedback phenomena associated with the impingement of a free subsonic or supersonic jet on an obstacle, for example blown flaps, or for the ground (VTOL), are investigated. In the noise spectrum of an under-expanded jet there are discrete screech frequencies generated by feedback between the flow and the pressure field generated by it. But when a choked jet impinges on an obstacle it was found that this becomes the dominant sound source when there are less than 5 cells of the jet between the nozzle exit and the obstacle. The feedback mechanism for this case was investigated and the discrete frequencies were determined as a function of distance between nozzle and obstacle, nozzle diameter and the nozzle pressure ratio. The appearance of two different vortex modes is explained. Possibilities to destroy the feedback and to reduce the noise are given. Author (ESRO)

**N73-13032#** Technische Univ., Berlin (West Germany). Inst. fuer Technische Akustik.

**SOUND GENERATION IN A TURBULENT FREE JET WITH AN ELASTIC PLATE AS FOREIGN BODY [SCHALLERZEUGUNG BEI EINER ELASTISCHEN PLATTE ALS STOERKOERPER IN EINEM TURBULENTEN FREISTRABL]**

W. Boehnke 1972 9 p refs In GERMAN Presented at the 5th Ann. DGLR Meeting, Berlin, 4-6 Oct. 1972

(DGLR-Paper-72-85) Avail: NTIS HC \$3.00

Measurements are presented of sound generated by the impingement of a turbulent jet on elastic plates. It is found that for sufficiently large plates the acoustic radiation increases when the distance between plate and jet nozzle is less than 15 nozzle diameters. Sound can be generated by means of easily vibrating plates, which diminished with increasing flow velocity due to deflection and reflection. Author (ESRO)

**N73-13033#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Aeroelastik.

**INVESTIGATION OF UNSTEADY INTERFERENCE EFFECTS ON A HARMONICALLY OSCILLATING WING-TAILPLANE MODEL WITH VARIABLE SWEEPBACK IN THE LOW SUBSONIC RANGE [UNTERSUCHUNG INSTATIONAERER INTERFERENZEFFEKTE AN EINEM HARMONISCH SCHWINGENDEN FLUEGEL-HOEHENLEITWERKS-MODELL MIT VARIABLER FLUEGELPFEILUNG IM NIEDRIGEN UNTERSCHALLBEREICH]**

H. Triebstein and J. Becker (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich) Dec. 1971 49 p refs In GERMAN; ENGLISH summary Presented at the 4th DGLR Ann. Meeting, Baden-Baden, West Ger., 11-13 Oct. 1971

(DLR-FB-71-52; AVA-FB-7130) Avail: NTIS HC \$4.50; DFVLR, Porz, West Ger.: 15 DM

The results of pressure measurements on harmonically oscillating wing-tailplane configurations in the incompressible speed range are presented. The model used consists of a variable sweep wing and a horizontal stabilizer. Special emphasis is given to the unsteady aerodynamic interfering effects on various wing-tailplane configurations. In particular, the effects of the wing sweep-back, the wing angle of attack and the V-position of the tailplane stabilizer are investigated in detail for several reduced frequencies and longitudinal positions of the wing and tailplane. Author (ESRO)

**N73-13034#** Aeroplane and Armament Experimental Establishment, Boscombe Down (England). Engineering Div.  
**ANDOVER C. Mk1 AIRFIELD CRITERIA TRIALS**

**N73-13035**

J. Howell London Aeron. Res. Council 1972 87 p refs  
Supersedes ARC-31190  
(ARC-CP-1220; ARC-31190) Avail: NTIS HC \$6.50; HMSO  
£ 1.35; PHI \$5.30

The Andover C Mk.1 short takeoff transport aircraft was tested on various types and conditions of soils and surfaces used as landing sites. It was concluded that the aircraft can be operated without excessive damage from natural and semiprepared surfaces subject to certain specified limitations. On smooth surfaces of adequate bearing strength, operation can proceed with existing specifications. On rough surfaces, takeoff and landing weights are restricted. Loose surface materials are acceptable subject to performance considerations (6 inches depth when dry, 8 inches depth when wet) provided that the sub-grade bearing strength at these depths is adequate. Author (ESRO)

**N73-13035#** Army Foreign Science and Technology Center, Charlottesville, Va.

**HELICOPTER DESIGN**

V. N. Dalin 1972 316 p refs Transl. into ENGLISH of the book "Konstruktsiya Vertoketiv" Moscow, Mashinostroyeniye, 1971

(AD-748751; FSTC-HT-23-1472-72) Avail: NTIS CSCL 01/3

This book presents diagrams of helicopters, design, kinematic and power diagrams of the basic components of domestic series-produced helicopters, general data on the process of designing a helicopter and necessary information from the history of helicopter construction development. Author (GRA)

**N73-13036#** Army Research Office, Durham, N.C.

**HELICOPTER NOISE SYMPOSIUM**

Sep. 1971 164 p refs Conf. held at Durham, N. C., 28-30 Sep. 1971

(AD-748876; AROD-9164-1-E) Avail: NTIS CSCL 01/3

A symposium in which recognized experts in the helicopter noise field participated was organized. Primary researchers from ten ARO-D-sponsored contracts and five other groups presented papers on the subject of helicopter noise. In addition, helicopter noise research at two U.S. Army Air Mobility R and D Laboratories (AAMRDL), at NASA Langley Research Center, and at the Office of the Chief of Research and Development (OCRD) was discussed. The report includes all formal papers presented at the Helicopter Noise Symposium held in Durham, North Carolina, on September 29-30, 1971. Author (GRA)

**N73-13037#** Applied Behavioral Sciences, Inc., New Castle, Del.

**A SYSTEM OF COMPUTER AIDED TROUBLESHOOTING**  
Walter A. Jablonski, Frank Barclay, and Gerald O'Brien Oct. 1971 22 p refs

(AD-748665; ABS-TR-1-71) Avail: NTIS CSCL 01/3

A study was conducted to determine the feasibility of a computer assisted troubleshooting system. The researchers developed a fully proceduralized computer program which was capable of guiding a maintenance technician to the source of an equipment malfunction. The CATS equipment included a cathode ray input/output device, a Univac 1108 computer, and a microfiche viewer. The computer terminal provided step by step guidance, while at the same time, the microfiche viewer provided visual information concerning location, removal, and replacement of components, lists of special tools and materials, and special test procedures. The results of the study indicated that existing computer technology can be used for a fully proceduralized computer assisted troubleshooting system. Preliminary tests showed that the artwork and program concepts were feasible, workable, and sound. Author (GRA)

**N73-13038#** Army Materials and Mechanics Research Center, Watertown, Mass.

**RESPONSE OF ROTOR BLADES TO RANDOM INPUTS. PART 2: COMBINED BENDING AND TORSION**

Chatta Lakshmikantham and Chintakindi V. Joga Rao May 1972 15 p refs

(DA Proj. 1TO-61102-B-33A)

(AD-746627; AMMRC-TR-72-15-Pt-2) Avail: NTIS CSCL 01/3

The response of a flexible helicopter rotor blade to random loading is investigated, the random input being the vertical velocity component. The model takes into account blade flexibility in bending as well as torsion, and also general rotor-end fixity. The spectral density and the mean square value of the transverse displacement are computed for both hingeless and hinged rotor blades and the results are evaluated. Author (GRA)

**N73-13039#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**THE MINIMUM TIME TO TURN PROBLEM FOR A HIGH THRUST TO WEIGHT RATIO AIRCRAFT** M.S. Thesis

Larry J. Roach Jun. 1972 69 p refs

(AD-748354; GAW/MC/72-14) Avail: NTIS CSCL 01/2

Optimal control theory is used to determine open-loop control laws for thrust, coefficient of lift, and bank angle for minimum time maneuvers for high thrust-to-weight ratio aircraft. In obtaining these control laws, an aircraft mathematical model is used which includes constraints on thrust, coefficient of lift, and on the aircraft load factor. Numerical results are discussed for two maneuver problems which are stated as minimum-time turns from specified initial conditions to the following terminal conditions: only heading angle specified, and heading angle and velocity specified. Author (GRA)

**N73-13040#** Southwest Research Inst., San Antonio, Tex.

**THE RESPONSE OF A MODEL HELICOPTER ROTOR BLADE TO RANDOM EXCITATION DURING FORWARD FLIGHT** Final Report, 18 May 1965 - 17 Aug. 1972

Daniel D. Kana and Wen-Hwa Chu 15 Aug. 1972 55 p refs (Contract DA-31-124-ARO(D)-375)

(AD-748457; AROD-55988-5) Avail: NTIS CSCL 01/3

The response of a model helicopter rotor blade to random excitation while in simulated forward flight is studied analytically and experimentally by means of an electromechanical apparatus. Complex transfer functions are defined which relate steady-state responses in bending, flapping, and torsion modes to a sine input. Responses occur at the input and side-band frequencies. These transfer functions are then used along with excitation power spectra to predict the nonstationary time-averaged power spectrum of the response. Validity of the transfer function analysis is investigated by means of the electromechanical model which includes analog computer simulation of the interaction of blade deflections and aerodynamic load. Author (GRA)

**N73-13041#** Illinois Univ., Savoy, Aviation Research Lab.

**DEVELOPMENT AND EVALUATION OF A FLIGHT DIRECTOR SYSTEM FOR INSTRUMENT LANDINGS**

Joe A. Lamb May 1972 63 p refs

(Contract F44620-70-C-0105)

(AD-748244; ARL-72-11/AFOSR-72-6; AFOSR-72-1661TR) Avail: NTIS CSCL 01/4

The research evaluates comparatively, in a simulated instrument landing system, four different configurations of a flight director display using command heading and command flight path angle. The four configurations include moving horizon display, moving aircraft display, frequency-separated display, and kinalog display. ILS localizer tracking performance with any of the experimental displays was superior to that with the conventional cross-pointer flight-path display. Author (GRA)

**N73-13042#** Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

**EVALUATION OF LATERAL-DIRECTIONAL HANDLING QUALITIES AND ROLL-SIDESLIP COUPLING OF FIGHTER CLASS AIRPLANES** Final Report

Edward M. Boothe and Michael L. Parrag May 1972 151 p refs

(Contract F33615-71-C-1240)

(AD-748435; CAL-BM-3053-F-2-Vol-1;

AFFDL-TR-72-36-Vol-1) Avail: NTIS CSCL 01/3

Lateral-directional handling qualities for Class 4 airplanes in Flight Phase Category A were investigated in the USAF/CAL variable stability NT-33A airplane. The primary purpose was to

extend the data base for roll-sideslip coupling requirements specified by MIL-F-8785B (ASG) for this class of airplanes. Other purposes included evaluation of the minimum Dutch roll frequency and damping requirements of MIL-F-8785B (ASG) for Class 4 airplanes in Flight Phase Category A and an investigation of the applicability of MIL-F-83300 roll-sideslip requirements to airplanes in high speed flight conditions. Author (GRA)

**N73-13043#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**AIRCRAFT CONSTRUCTION TECHNOLOGY**  
A. L. Abibov and N. M. Biryukov 12 May 1972 1038 p refs  
Transl. into ENGLISH of the book "Tekhnologiya Samoletostroeniya" Moscow, Izd-vo Mashinostroyeniye, 1970 p 1-599  
(AD-748712; FTD-MT-24-1515-71) Avail: NTIS CSCL 01/3

The book presents the theoretical bases of the technology of aircraft construction, and describes the various technological processes in the manufacture of components, the assembly from them of units, panels, subassemblies and the entire aircraft (helicopter) as a whole, the application of protective coatings, the installation of systems and equipment, the tests, employed in series production. The principles of structuring technological processes, the methods and means of ensuring high quality, reliability and the required service life of products are presented. Author (GRA)

**N73-13044#** Army Foreign Science and Technology Center, Charlottesville, Va.

**TECHNOLOGY OF AIRCRAFT CONSTRUCTION**  
A. L. Abibov et al 21 Aug. 1972 77 p Transl. into ENGLISH from the publ. "Tekhnologiya Samoletostroeniya" Moscow, Mashinostroyeniye, 1970 Chapters 13, 23, 27  
(AD-749558; FSTC-HT-23-1302-72) Avail: NTIS CSCL 01/3

The document consists of three chapters of a monograph, Chapter 13 discusses the manufacture of parts of plastics, ceramic and metal ceramics used in aircraft construction. Chapter 23 presents details on manufacture and assembly of sections and aggregates of nonmetallic materials. Chapter 27 describes the general assembly and testing of aircraft (helicopters). Author (GRA)

**N73-13046#** Collins Radio Co., Cedar Rapids, Iowa.  
**YAW AXIS CONTROL AS A MEANS OF IMPROVING V/STOL AIRCRAFT PERFORMANCE**

James A. Klein Wright-Patterson AFB, Ohio AFFDL 18 Sep. 1972 44 p  
(Contract F33615-72-C-1793; AF Proj. 643A)  
(AD-749489; AFFDL-TR-72-99) Avail: NTIS CSCL 01/3

Cross coupling between the yaw axis and other control inputs of a V/STOL aircraft limits its performance capabilities. Yaw control augmentation was investigated as a means to reduce the cross coupling effects. Using the CH-3 helicopter as an example of V/STOL aircraft, this report defines yaw damping, turn coordination and heading hold control laws that can be used for yaw control augmentation. Improved vehicle performance is achieved by using the recommended control laws in a yaw control system. Author (GRA)

**N73-13047#** Naval Weapons Lab., Dahlgren, Va.  
**ANGULAR MOMENTUM AND THE AIRCRAFT-STORE SEPARATION PROBLEM**

P. Daniels and T. A. Clare Apr. 1972 16 p refs  
(AD-749027; NWL-TR-2721) Avail: NTIS CSCL 01/3

The stability criterion of a missile containing an internal spinning fly wheel is derived and the effect of this fly wheel on the missile's launch disturbance is explained. Author (GRA)

**N73-13067#** Boeing Co., Philadelphia, Pa. Vertol Div.  
**ADVANCED TECHNOLOGY HIGH-CAPACITY HOIST-DRIVE SYSTEM Final Technical Report**

Dennis Stein, Richard F. Campbell, Newt N. Rothman, and Joseph Sheffrin Apr. 1972 220 p refs  
(Contract DAAJ02-70-C-0042)

(AD-746629; D210-10405-1; USAAMRDL-TR-72-21) Avail: NTIS CSCL 01/3

Studies of current airborne hoist drive systems for handling external loads indicate that use of present technology to design hoist systems with larger capacities will result in excessive weights, incompatible configurations, complex controls, and other undesirable factors. A pneumatic air-turbine motor drive shows the best potential for powering high-capacity systems. For helicopter hoisting applications, there is no practical limit for system capacity. This report documents a program of design and design analysis of an advanced technology hoist-drive subsystem applicable to a family of cargo hoists with capacities ranging from 12.5 to 50 tons. Author (GRA)

**N73-13154#** Transportation Systems Center, Cambridge, Mass.  
**ASDE-2 TRANSMITTER MODIFICATIONS Final Report**

Henry R. Guarino Sep. 1972 30 p refs  
(FA-221)  
(FAA-RD-72-82; DOT-TSC-FAA-72-16) Avail: NTIS HC \$3.50 CSCL 171

The engineering inadequacies that caused ASDE-2 radar failures at various airports are examined. Statistical analysis revealed that the preponderance of these failures originated in the modulator-transmitter section where the mean time between failures was controlled by the following interrelated factors: (1) an undersized hydrogen thyratron driver for the power amplifier, (2) an inadequate trigger pulse amplifier output, and (3) poor operating conditions for the power amplifier tubes. The modifications made to one channel of radar are described and the resulting performance improvements are given. Author

**N73-13257\*** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

**FERRY SYSTEM Patent**  
Thomas A. Blackstock, inventor (to NASA) Issued 17 Oct. 1972 4 p Filed 24 Aug. 1970

(NASA-Case-LAR-10574-1; US-Patent-3,698,659;  
US-Patent-Appl-SN-66206; US-Patent-Class-244-1SS) Avail: US Patent Office CSCL 01E

A method for providing a ferrying capability for an entry vehicle is presented. The device consists of a pair of wings which bolt on to the entry vehicle. One propulsion system is attached to each wing. Fuel tanks are formed within the wings and the body member. P.N.F.

**N73-13259#** CONSAD Research Corp., Pittsburgh, Pa.  
**A COMMUNITY/AIRPORT ECONOMIC DEVELOPMENT MODEL VOLUME 1: GENERAL CONCEPT AND APPLICATION Final Report, Apr. 1971 - May 1972**

Jere J. Hinkle May 1972 90 p refs  
(Contract DOT-FA71WA-2565)  
(FAA-EQ-72-3-Vol-1) Avail: NTIS HC \$6.50

A community/airport economic development model (CAEDM) which was developed to assist in the land use planning process in the vicinity of airports in metropolitan areas is described. The model is a computerized technique which has two objectives. The first is to examine the existing or projected land use activities in the vicinity of an airport to determine their compatibility with aircraft generated noise levels and to estimate the economic and social costs of alternative remedial actions that can be taken to resolve the incompatibilities. The second objective is to determine the kind and amounts of land use activities that can be located in the vicinity of the airport that can utilize the services available (transportation and utilities) and be compatible with the noise levels anticipated there. The results of the application of this technique to Dulles International Airport are described, and the applicability to the CAEDM to fourteen airports is assessed. Author

**N73-13260#** CONSAD Research Corp., Pittsburgh, Pa.  
**A COMMUNITY/AIRPORT ECONOMIC DEVELOPMENT MODEL VOLUME 4: PROGRAMMERS' MANUAL Final**

N73-13261

Report, Apr. 1971 - May 1972

Jere J. Hinkle May 1972 55 p refs  
(Contract DOT-FA71WA-2565)

(FAA-EQ-72-3-Vol-4) Avail: NTIS HC \$4.75

Sample output of the community/airport economic development model is given. Author

N73-13261# National Aviation Facilities Experimental Center, Atlantic City, N.J.

FLIGHT TEST AND EVALUATION OF HELIPORT LIGHTING FOR IFR Final Report, Mar. 1969 - Oct. 1972

Thomas H. Paprocki Dec. 1972 27 p ref

(FAA Proj. 074-390-02X)

(FAA-RD-72-133; FAA-NA-72-89) Avail: NTIS HC \$3.00 CSCL 01E

Various approach lighting system patterns, developed through mockup and VFR flight testing efforts, were evaluated to determine their effectiveness in providing visual guidance for helicopter IFR approach and landing operations. Four basic lighting configurations were flown, under actual IFR weather conditions, by experienced helicopter pilots. As a result of information collected through in-flight recording of objective data and post flight completion of pilot questionnaires, one of the lighting patterns was chosen as most effective for the conditions specified. Author

N73-13264# IIT Research Inst., Chicago, Ill.

STUDY OF NOISE IN AIR ROUTE TRAFFIC CONTROL CENTER, FLIGHT SERVICE STATION, AIR TRAFFIC CONTROL TOWER AND REMOTE FACILITIES Final Report, 18 Nov. 1971 - 18 May 1972

J. M. Clinch and H. G. Wakeley Oct. 1972 28 p refs

(Contract DOT-FA71WA-2587)

(J-6250; FAA-RD-72-104) Avail: NTIS HC \$3.50

Various methods of reducing noise in several FAA air traffic control and navigational facilities that exceed the recommended facility noise criteria are described. Noise control procedures for each facility under consideration are discussed as well as the reasons for selecting specific noise reduction methods. Author

N73-13267# CONSAD Research Corp., Pittsburgh, Pa.

A COMMUNITY/AIRPORT ECONOMIC DEVELOPMENT MODEL VOLUME 2: APPENDICES TO VOLUME 1 Final Report, Apr. 1971 - May 1972

Jere J. Hinkle May 1972 218 p refs

(Contract DOT-FA71WA-2565)

(FAA-EQ-72-3-Vol-2) Avail: NTIS HC \$13.00

Data is presented, which was assembled during the course of the development of the Community/Airport Economic Development Model (CAEDM). Included are land use category recommendations, land use - aircraft noise level compatibility, zoning recommendations as related to aircraft generated noise, suggested unit costs used for relocation of activities in the airport vicinity, suggested employment categories for model operations, sample measures of support service required for different activities, a discussion and presentation of a derivation of unit rates of consumption of support services of alternative land use activities, and a detailed presentation of the survey of the fourteen airports conducted during the course of the development of the CAEDM. Author

N73-13278# ARO, Inc., Arnold Air Force Station, Tenn.

WIND TUNNEL DESIGN FOR TESTING V/STOL AIRCRAFT IN TRANSITION FLIGHT Final Report

Richard A. Kroeger AEDC Sep. 1972 103 p refs

(Contract F40600-71-C-0002; AF Proj. 69BT)

(AD-749154; ARO-OMD-TR-72-102; AEDC-TR-72-119) Avail: NTIS CSCL 14/2

Wind tunnels have afforded the best potential for studying regions of aerodynamic uniqueness of V/STOL aircraft, but they have been of limited value because of the magnitude of the flow interference they introduce. A new wind tunnel concept is described for covering the spectrum of transition testing, from

hover throughout wing sustained flight. The wall interference corrections are physically produced by the structure of the wall. A small scale tunnel was designed, constructed, and tested employing this concept. Data from a small rotor model were obtained in the new tunnel and a large conventional one as a basis for comparative evaluation. Author (GRA)

N73-13290\*# Bell Aerospace Co., Buffalo, N.Y.

DEVELOPMENT AND APPLICATIONS OF SUPERSONIC UNSTEADY CONSISTENT AERODYNAMICS FOR INTERFERING PARALLEL WINGS: USER'S MANUAL

Andrew A. Paine Washington NASA Aug. 1972 54 p refs  
(Contract NAS1-10880)

(NASA-CR-112184; Rept-2471-941001) Avail: NTIS HC \$4.75 CSCL 20D

The input data required to execute the computer program AIC/INT (aerodynamic influence coefficients with interference) are presented. The purpose of the computer program is to generate aerodynamic forces for a pair of plane and interfering nearly parallel, non-coplanar wings at supersonic Mach numbers. A finite element technique has been employed. Planforms are described by triangular elements and diaphragm regions are generated automatically. Author

N73-13291\*# Bell Aerospace Co., Buffalo, N.Y.

DEVELOPMENT AND APPLICATIONS OF SUPERSONIC UNSTEADY CONSISTENT AERODYNAMICS FOR INTERFERING PARALLEL WINGS: PROGRAMMER'S MANUAL

Andrew A. Paine Aug. 1972 123 p

(Contract NAS1-10880)

(NASA-CR-112185) Avail: NTIS HC \$8.25 CSCL 20D

The computer program written in support of the problem to determine aerodynamic influence coefficients on parallel interfering wings is described. The information is geared to the programmer. It is sufficient to describe the program logic and the required peripheral storage. Author

N73-13318# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

AN EXPERIMENTAL STUDY OF ATTENUATION OF SHOCK WAVES IN THREE MIXTURES M.S. Thesis

James W. Clark, Jr. Jun. 1972 84 p refs

(AD-748350; GAW/MC/72-3) Avail: NTIS CSCL 13/4

Two experiments were conducted to determine the effects of adding a gas to a foam-water mixture to increase the attenuation of shock waves caused by hydraulic ram. In each experiment three target materials were impacted: water, water and reticulated polyurethane foam, and water and Pneumacel. Pneumacel is a Du Pont tradenamed product consisting of Dacron fibers inflated 12% by weight Freon gas. In the first experiment, plane (one dimensional) shock waves were generated by impacting the target materials with a flat aluminum disc. In the second experiment, 1/2 inch spheres were fired into the target materials. In each experiment pressures were measured at various depths in each mixture for several impact velocities. Author (GRA)

N73-13397# Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.

HOW DRY IS THE SKY: A DECADE LATER AND THE SST Air Force Surveys in Geophysics

Norman Sissenwine; Arthur J. Kantor, and Donald D. Grantham 27 Apr. 1972 31 p refs

(AF Proj. 8624)

(AD-748797; AFCRL-AFSIG-240; AFCRL-72-0294) Avail: NTIS CSCL 04/1

Water vapor that would be added to the stratosphere by a potential fleet of SSTs is related to the most accepted humidity balance in the stratosphere based on general circulation considerations, and to moisture introduced into the stratosphere by vaporization from convective clouds. A mean residence time of 25 months for water vapor was calculated from general circulation values. On the assumption that other water vapor



reaching the stratosphere was an equal time of residence, a fleet of SSTs would increase humidity by 0.5 ppm or 25 percent of the generally accepted 2 ppm equilibrium value. Vaporization of only 1 percent of the convective cloud mass, calculated herein to enter the stratosphere, would increase its mixing ratio by 1 ppm. Author (GRA)

**N73-13431\*** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.  
**WIND TUNNEL INVESTIGATION OF AN UNSWEPT AIRFOIL WITH A 0.098-CHORD BLOWING FLAP**  
Thomas R. Turner Washington Dec. 1972 32 p refs  
(NASA-TM-X-2675; L-8573) Avail: NTIS HC \$3.00 CSDL 01A

An investigation of the longitudinal aerodynamic characteristics of an aspect ratio 4.735 airfoil having a 9.8 percent chord blowing flap has been made in and out of ground influence over the endless moving belt ground plane in the 5.18 meter test section of the former Langley 300 MPH 7 by 10 foot wind tunnel. For flap deflections of 30 deg or less, at a height of 0.25 span, ground effect was negligible; but at this ground height, at a flap deflection of 60 deg and a lift coefficient of 8.0, the lift loss was 27 percent. The lift loss for this same condition becomes negligible at a height of one span. Author

**N73-13445#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).  
**COMPARISON OF CONTACT ANALOG CHANNEL DISPLAY AND CONVENTIONAL INSTRUMENTATION BY MEANS OF SIMULATOR STUDIES [VERGLEICHENDE SIMULATORSTUDIEN MIT DEM KONTAKTANALOGEN KANAL-DISPLAY UND MIT KONVENTIONELLEN INSTRUMENTIERUNGEN]**  
W. Schattenmann and V. Wilckens 1972 38 p refs  
GERMAN; ENGLISH summary Presented at the 5th Ann. DGLR Meeting, Berlin, 4-6 Oct. 1972  
(DGLR-Paper-72-100) Avail: NTIS HC \$4.00

The precision of flight path guidance and control activity is compared in simulator tests for four different displays: standard ILS, accumulated ILS, flight director, and the contact analog channel display. Displays should offer a confidence-imminent survey, enhance the manual abilities of the pilot, and allow a flexible selection of flight trajectories. Some results on these matters are presented. It is shown that the channel display offers equivalent guidance precision compared to an optimized flight director. With regard to orientation and training quality as well as flexibility of path selection, the channel display is obviously superior. There are indications that it can produce an exceptionally high degree of confidence. Author (ESRO)

**N73-13471\*** Avco Lycoming Div., Stratford, Conn.  
**DESIGN STUDY OF AN AIR PUMP AND INTEGRAL LIFT ENGINE ALF-504 USING THE LYCOMING 502 CORE**  
Dale Rauch Jul. 1972 172 p  
(Contract NAS3-15696)  
(NASA-CR-120992; Lycoming-105.22.21) Avail: NTIS HC \$10.75 CSDL 131

Design studies were conducted for an integral lift fan engine utilizing the Lycoming 502 fan core with the final MQT power turbine. The fan is designed for a 12.5 bypass ratio and 1.25:1 pressure ratio, and provides supercharging for the core. Maximum sea level static thrust is 8370 pounds with a specific fuel consumption of 0.302 lb/hr-lb. The dry engine weight without starter is 1419 pounds including full-length duct and sound-attenuating rings. The engine envelope including duct treatment but not localized accessory protrusion is 53.25 inches in diameter and 59.2 inches long from exhaust nozzle exit to fan inlet flange. Detailed analyses include fan aerodynamics, fan and reduction gear mechanical design, fan dynamic analysis, engine noise analysis, engine performance, and weight analysis. Author

**N73-13481#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

**AIRCRAFT CLUTCH ASSEMBLIES, RAMP ROLLER** Final Report

Jules G. Kish Jul. 1972 97 p refs.  
(Contract DAAJ02-71-C-0026; DA Proj. 1G1-62207-AA-72)  
(AD-747816; SER:50767; USAAMRDL-TR-72-31) Avail: NTIS CSDL 13/9

The results of a 12-month program to evaluate a ramp roller clutch operating at engine input conditions of 26,500 rpm and 1500 hp are contained herein. The purpose of this design, manufacture, and test program was to evaluate clutch operation at the high speeds of advanced technology engines. The ramp roller clutch was designed using the most advanced state-of-the-art technology available. Several new features were added to enhance high-speed operation. The most outstanding results were obtained from hollow rollers, which were used for the first time in a ramp roller clutch. Author (GRA)

**N73-13575#** Sylvania Electric Products, Inc., Hicksville, N.Y. High Temperature Composites Lab.

**DEVELOPMENT OF PROTECTIVE COATINGS FOR COLUMBIUM ALLOYS GAS TURBINE BLADES** Final Technical Report, 1 Jul. 1969 - 30 Jul. 1971

Seymour Priceman and Richard Kubick Wright-Patterson AFB, Ohio AFML Jun. 1972 154 p refs  
(Contract F33615-69-C-1613; AF Proj. 7312)  
(AD-748837; AFML-TR-71-172) Avail: NTIS CSDL 11/3

Four developmental cycles of candidate selection, screening test and evaluation were performed on coatings for columbium turbine blade airfoils and root sections. Candidate coatings included numerous fused silicide compositions, silicided sintered underlays, and fused silicides plus glass, ceramic, soft metal, and flame sprayed overlays. The first three developmental cycles employed thermogravimetric analysis, isothermal furnace tests, slow cyclic tests, thermal fatigue torch tests, ballistic impact plus furnace oxidation tests, and prestrain plus oxidation tests as screening criteria. Extensive coating and coating processing compatibility studies were carried out with the aim of preventing deleterious reactions between root and airfoil coatings and degradation of the substrate alloy mechanical properties. The program was concluded with a series of advanced simulated environmental tests and mechanical property evaluations. GRA

**N73-13622#** Northwest Environmental Technology Labs., Inc., Bellevue, Wash.

**EFFECTIVENESS OF FOG DISPERSAL TECHNIQUES AT SEATTLE-TACOMA AND SPOKANE INTERNATIONAL AIRPORTS** Final Report, 12 Nov. 1971 - 10 Jul. 1972

W. G. Tank, W. T. Kreiss, J. M. Lansinger, D. R. Makela, and N. M. Barr Jul. 1972 181 p refs  
(Contract DOT-FA72WA-2758)  
(NETL-72-005-1; FAA-RD-72-92) Avail: NTIS HC \$11.25

An evaluation of the effectiveness of airborne chemical fog dispersal techniques employed at the Seattle-Tacoma and Spokane International Airports, Washington, was conducted during the 1971-72 winter season. Measurements of meteorological and fog parameters, combined with visual and photographic observations made during a three-month field period; were subjected to interpretive analysis; the analysis resulted in the assignment of 25 percent and 57 percent effectiveness ratings for the Sea-Tac and Spokane fog dispersal programs, respectively. Immediately apparent environmental impact of these operations was judged to be minimal. A substantial body of evidence was acquired which indicates that heat is more effective than chemicals in local dissipation of both warm and cold fogs. Author

**N73-13628#** Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.

**PROBABILITY OF ENCOUNTERING THUNDERSTORMS AT 50,000 AND 60,000 FEET FOR SELECTED ROUTES OVER THE UNITED STATES**

Donald D. Grantham and Arthur J. Kantor 14 Jul. 1972 16 p refs  
(AF Proj. 8624)

**N73-13643**

(AD-748798; AFCRL-72-0415) Avail: NTIS CSCL 04/2

The probability of encountering cumulonimbi has been determined for the worst route, month and time that is, over the southern U.S. during July between 1800 and 1800 LST. Three transcontinental routes are examined: Miami to Los Angeles, Miami to San Francisco, and Washington D. C. to Los Angeles, distances measuring 2000, 2250, and 2030 nmi, respectively. Preliminary results indicated one encounter (within a 10-mile-wide flight path) for every 4 flights along the Miami-West Coast routes at 50,000 ft, and one for every 57 flights along the same routes at 60,000 ft. Clouds are assumed to be dome-shaped with base diameters ranging from 6.7 to 15 nmi at 50,000 ft and 6.7 to 10.5 nmi at 60,000 ft.

Author (GRA)

**N73-13643\*** Massachusetts Inst. of Tech., Cambridge.  
**DISPLAY RESEARCH COLLISION WARNING SYSTEM**  
Patent

Renwick E. Curry, Laurence R. Young, Thomas Basil Smith, III, and John Rawson, inventors (to NASA) Issued 17 Oct. 1972  
6 p Filed 25 Jun. 1971

Sponsored by NASA

(NASA-Case-HQN-10703; US-Patent-3,699,511;  
US-Patent-Appl-SN-156724; US-Patent-Class-340-27NA;  
US-Patent-Class-340-33; US-Patent-Class-340-97;  
US-Patent-Class-343-112CA) Avail: US Patent Office CSCL  
17G

A head-up display for a PWI system is discussed. The display consists of strips of an electroluminescent tape secured above and below the windshield and above side windows of a cockpit. The strips are associated with elevation range and azimuth range sectors which are viewable by the pilot through the windshield or windows, and are located in the directions of these sectors. When a target is detected in any of the sectors by a corresponding detector the strip or strips associated with the particular sector are illuminated. The pilot's peripheral vision is sufficient to notice their illumination thereby enabling him to directly view the particular sector without reference to a display on the instrument panel.

Official Gazette of the U.S. Patent Office

**N73-13648#** North American Systems Corp., Londonderry, N.H.  
**INFRARED INSPECTION OF ARTCC ELECTRICAL EQUIPMENT** Final Report, Apr. - Oct. 1972

Roger L. Hall and Raymond J. Lutze Oct. 1972 64 p refs  
(Contract DOT-FA72WA-2908)  
(C-208; FAA-RD-72-55) Avail: NTIS HC \$5.25

The electrical equipment at two ARTCC's was surveyed and current maintenance procedures reviewed to evaluate the applicability of IR inspection as a preventative maintenance tool.

Author

**N73-13649#** Lincoln Lab., Mass. Inst. of Tech., Lexington.  
**DEVELOPMENT OF A DISCRETE ADDRESS BEACON SYSTEM (DABS)** Quarterly Technical Summary Report,  
1 Jul. - 30 Sep. 1972

1 Oct. 1972 108 p refs  
(Contracts DOT-FA72WAI-261; F19628-70-C-0230; Proj.  
034-241-012)

(FAA-RD-72-117; QTSR-3) Avail: NTIS HC \$7.50

Studies are described which include variations of a discrete address beacon system (DABS) for small terminals, parallel approach monitoring, sensor calibration and synchronization of sensors; improved tracking of aircraft under surveillance; data link transmission rates, message formats and segmentation, message priorities, error protection techniques; and software planning. Link design and experimental hardware development reports summarize modulation and coding studies; mutual interference analyses; propagation studies and planned experiments; ATRCBS transponder bench tests; and DABS experimental facility implementation status.

Author

**N73-13651#** Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.

**ADVANCED CARRIER-BASED AIR TRAFFIC CONTROL**

Final Technical Report, 15 Mar. 1971 - 14 Jul. 1972  
Keith L. Curtner, Raymond J. Kirk, Robert P. Irons, and Nelson R. Zagalsky Aug. 1972 109 p  
(Contract N00014-71-C-0265; NR Proj. 215-188)  
(AD-748302; F2027-FR) Avail: NTIS CSCL 17/7

A carrier-based air traffic control system which features enroute trajectory optimization and a computer-aided marshal reassignment procedure is described. Results of computer simulations of both the airborne and shipboard systems are used to demonstrate system concept feasibility. The system description is followed by system performance estimates and hardware requirements estimates.

Author (GRA)

**N73-13652#** Federal Aviation Administration, Washington, D.C.  
Office of Management Systems.

**AIR TRAFFIC PATTERNS FOR IFR AND VFR AVIATION, CALENDAR YEAR 1971**

Jun. 1972 54 p  
(AD-748901) Avail: NTIS CSCL 17/7

The report presents a detailed record of flight plans filed at flight service stations and combined station/towers as collected in a 2-percent random sample of all Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) flight plans filed in the 50 states and the ARTC area of San Juan, Puerto Rico. These data furnished the various Offices and Services of the Federal Aviation Administration with terminal and enroute air traffic activity for use in planning and management of the air traffic control system.

Author (GRA)

**N73-13653#** Naval Postgraduate School, Monterey, Calif.  
**A METHOD FOR SOLUTION OF AN AIR TRAFFIC CONTROL PROBLEM**

Richard H. Franke 25 Jul. 1972 21 p  
(AD-749326; NPS-53FE72071A) Avail: NTIS CSCL 17/7

A method is given for computing flight plans for aircraft returning to the carrier after a mission. The basic goal is to minimize the total flight time for the landing aircraft, while maintaining various individual and interactive constraints on the aircraft.

Author (GRA)

**N73-13772#** Naval Research Lab., Washington, D.C.  
**REDUCTION OF ELECTROSTATIC CHARGE IN JET FUELS DURING REFUELER LOADING** Final Report

Joseph T. Leonard and W. Carhart 20 Jun. 1972 21 p refs  
(AD-748995; NRL-7415) Avail: NTIS CSCL 21/4

A 30-second relaxation chamber and a static charge reducer (SCR) were evaluated for their effectiveness in dissipating the electrostatic charge during refueler loading of JP-5 fuel at flow rates of 300 to 540 gpm. The electrical conductivity of the JP-5 fuel was in the range of 0.1 to 10 C.U. at 78F(1 C.U. = 1 X 10 to the minus 14 power mhos/cm). A JP-4 fuel with a conductivity of 7.8 C.U. was also tested to a limited extent. The experimental setup consisted of a 600-gpm filter/separator equipped with fuel monitors, a 30-second relaxation chamber, and a static charge reducer located in parallel downstream of the filter/separator, a 13-ft refueling hose (2-1/2in. or 3-in. diameter), and either a 7050- or a 8200-gallon refueler. The charge density in the fuel was measured immediately downstream of the filter/separator, at the outlet of the relaxation device, and at the dry break or loading connection to the refueler.

Author (GRA)

**N73-13777\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**TESTS OF A MIXED COMPRESSION AXISYMMETRIC INLET WITH LARGE TRANSONIC MASS FLOW AT MACH NUMBERS 0.6 TO 2.65**

Donald B. Smeltzer and Norman E. Sorensen Washington Dec. 1972 189 p refs  
(NASA-TN-D-6971; A-4231) Avail: NTIS HC \$3.00 CSCL  
21E

A 38.8-cm (15.28-in.) capture diameter model of a mixed-compression axisymmetric inlet system with a translating cowl

was designed and tested. The internal contours, designed for Mach number 2.65, provided a throat area of 59 percent of the capture area when the cowl was retracted for transonic operation. Other model features included a boundary-layer removal system, vortex generators, an engine airflow bypass system, cowl support struts, and rotating rakes at the engine face. All tunnel testing was conducted at a tunnel total pressure of about 1 atm (a unit Reynolds number of about 8.53 million/m at Mach number 2.65) at angles of attack from 0 deg to 4 deg. Results for the following were obtained: total-pressure recovery and distortion at the engine face as a function of bleed mass-flow ratio, the effect of bleed and vortex generator configurations on pressure recovery and distortion, inlet tolerance to unstart due to changes in angle of attack or Mach number, surface pressure distributions, boundary-layer profiles, and transonic additive drag. At Mach number 2.65 and with the best bleed configurations, maximum total pressure recovery at the engine face ranged from 91 to 94.5 percent with bleed mass-flow ratios from 4 to 9 percent, respectively, and total-pressure distortion was less than 10 percent. At off-design supersonic Mach numbers above 1.70, maximum total-pressure recoveries and corresponding bleed mass flows were about the same as at Mach number 2.65, with about 10 to 15 percent distortion. In the transonic Mach number range, total pressure recovery was high (above 96 percent) and distortion was low (less than 15 percent) only when the inlet mass-flow ratio was reduced 0.02 to 0.06 from the maximum theoretical value (0.590 at Mach number 1.0). Author

**N73-13779\*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.

**SINGLE-STAGE EXPERIMENTAL EVALUATION OF TANDEM-AIRFOIL ROTOR AND STATOR BLADING FOR COMPRESSORS. PART 5: ANALYSIS AND DESIGN OF STAGES D AND E**

J. A. Brent, J. G. Cheatham, and D. R. Clemmons 15 Dec. 1972 157 p refs  
(Contract NAS3-11158)  
(NASA-CR-121008; FR-5212) Avail: NTIS HC \$10.00 CSCL 21E

A conventional and a tandem bladed stage were designed for a comparative experimental evaluation in a 0.8 hub/tip ratio single-stage compressor. Based on a preliminary design study, a radially constant work input distribution was selected for the rotor designs. Velocity diagrams and blade leading and trailing edge angles selected for the conventional rotor and stator were used in the design of the tandem blading. The effects of axial velocity ratio and secondary flow on turning were included in the selection of blade leading and trailing edge angles. Design values of rotor tip velocity and stage pressure ratio were 757 ft/sec and 1.26, respectively. Author

**N73-13789#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ANALYSIS OF THE EFFECTIVENESS OF DIFFERENT METHODS OF THE ADJUSTMENT OF PARAMETERS OF A TWIN-SHAFT TURBOJET ENGINE**

V. P. Alatorsev, A. M. Akhmedzyanov, and A. S. Tikhonov 4 Aug. 1972 11 p refs Transl. into ENGLISH from Aviat. Inst., UFA. Tr. (USSR), no. 10, 1968 p 48-50  
(AD-749058; FTD-MT-24-226-72) Avail: NTIS CSCL 21/5

Analysis of the comparative quality of plotting the parameters of a two shaft turbojet engine by varying the rpm in the low pressure cascade during plotting, or the passage cross section of the jet nozzle, or the areas of the nozzle system passage cross sections in the first and second cascades of the turbine. These plotting techniques are applied in correcting the thrust, specific fuel consumption, gas temperature and compressor steady performance margin of a turbojet engine of this type. Author (GRA)

**N73-13923\*#** North American Rockwell Corp., Downey, Calif. Space Div.

**DEVELOPMENT AND FABRICATION OF A GRAPHITE POLYIMIDE BOX BEAM**

M. A. Nadler and F. J. Darms 29 Sep. 1972 233 p

(Contract NAS8-24511)

(NASA-CR-123959; SD-72-SA-0171) Avail: NTIS HC \$13.75 CSCL 13B

The state-of-the-art of graphite/polyimide structures was evaluated and key design and fabrication issues to be considered in future hardware programs are defined. The fabrication and testing at 500 F of a graphite/polyimide center wing box beam using OV-10A aircraft criteria was accomplished. The baseline design of this box was developed in a series of studies of other advanced composite materials: glass/epoxy, boron/epoxy, and boron/polyimide. The use of this basic design permits ready comparison of the performance of graphite/polyimide with these materials. Modifications to the baseline composite design were made only in those areas affected by the change of materials. Processing studies of graphite fiber polyimide resins systems resulted in the selection of a Modmor II/Gémon L material. Author

**N73-13925#** Aeronautical Research Labs., Melbourne (Australia).

**A PROBABILISTIC APPROACH TO STRUCTURAL DESIGN**

J. M. Grandage and A. O. Payne Feb. 1972 48 p refs  
(ARL/SM-Rept-337) Avail: NTIS HC \$4.50

Reliability theory is used to determine the risk function and probability of failure for structures under ultimate load and under a wear-out process such as fatigue. Representative data are obtained for a high strength steel aircraft structure, and numerical integration methods are developed for evaluating the risk function. The application of the reliability approach to structural design is discussed. Author

**N73-13926#** National Aerospace Lab., Amsterdam (Netherlands). **EFFECTS OF TEST FREQUENCY ON FATIGUE CRACK PROPAGATION UNDER FLIGHT-SIMULATION LOADING**

J. Schijve 31 Mar. 1972 19 p refs Presented at AGARD Symp. on Random Load Fatigue, Lyngby, Denmark, 13 Apr. 1972 (NLR-MP-72010-U; ICAF-Doc-594) Avail: NTIS HC \$3.00

Fatigue crack propagation in 2024-T3 and 7075-T6 sheet material was studied at three test frequencies, 10, 1 and 0.1 cycles per second. The flight-simulation loading was based on a gust spectrum. The design stress level was adopted as a second variable of the investigation. Differences between the crack propagation rates at the three test frequencies were small and unsystematic. The propagation was much slower than predicted from constant-amplitude test data. Moreover, the macro-cracking behaviour appeared to be different. In the discussion attention is paid to interaction with environmental effects and to implications for practical problems of aircraft fatigue. Author

**N73-13929\*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**STRUCTURAL PANEL Patent Application**

Liam Robert Jackson, inventor (to NASA) Filed 29 Nov. 1972 12 p

(NASA-Case-LAR-11052-1; US-Patent-Appl-SN-310611) Avail: NTIS HC \$3.00 CSCL 13H

A panel is fabricated from several pairs of elongate hollow ribs. The ribs of each pair are located on opposite sides of the panel and the ribs on each side of the panel are in parallel side by side adjacency. The ribs of a pair may be superposed directly over one another or they may be offset laterally. Each rib is formed by a sheet member which is part-circular (semi-circular) in section along its entire length. At least one rib of each pair is considered to have three portions which in some embodiments are distinct while in others they are not. In any event, each portion of at least one is part-circular in section and the central portion, which may occupy up to 70 deg of a circle having its center on either side of the rib. The other rib may be symmetrical and, in any event, is part-circular in section. The structure produces a very strong light-weight panel. NASA

**N73-13938#** Pisa Univ. (Italy). Inst. of Aeronautics. **FATIGUE BEHAVIOR OF HAT SECTION STRINGER STIFFENED PANELS COMPRESSED IN THE POST BUCK.**

**N73-13969**

**LING RANGE Final Technical Report, Apr. 1971 - Mar. 1972**

A. Salvetti and C. Casarosa Mar. 1972 59 p refs  
(Contract DAJA37-71-C-1147)  
(AD-748855) Avail: NTIS CSCL 01/3

This report includes the analytical and experimental research results of work conducted during the period of performance of the contract. Panels which were constructed using current aircraft construction techniques were subjected to compressive loads until buckling occurred. Both static and dynamic tests were performed. Strain gauge measurements were made on 29 panels constructed of 2024-T3 or 7075-T6 aluminum to determine the maximum allowable load and then to assess the fatigue damage on each panel. A statistical analysis of the static test results was made to determine the distribution of the maximum tensile stresses measured. Author (GRA)

**N73-13969** University of Southern Calif., Los Angeles.  
**FEASIBILITY CRITERIA FOR THE ESTABLISHMENT OF COMMUNITY COLLEGE CURRICULA FOR AEROSPACE AVIATION TRAINING** Ph.D. Thesis  
Thomas Osborne 1971 422 p  
Avail: Univ. Microfilms Order No. 72-6092

Criteria for the development of air transportation curricula in a public two-year community college, current and future manpower needs of the air transportation industry in the Greater Los Angeles Metropolitan area, an air transportation curricula for community colleges serving large metropolitan areas to meet employment needs of citizens, and knowledge and skills essential to the development of air transportation programs are discussed. A definitive study was made of the literature relating to manpower needs and employment opportunities in major divisions of the air transportation industry. A list of criteria was developed from the literature and findings derived from the study to be used by community colleges as guidelines in evaluating and developing air transportation training programs.

Dissert. Abstr.

**N73-13974#** Aerospace Research Labs., Wright-Patterson AFB, Ohio.

**TECHNICAL PUBLICATIONS AND PRESENTATIONS, 1971**  
1971 35 p refs

(AD-746707; ARL-MR-72-0001) Avail: NTIS HC \$3.75

Technical publications and presentations produced by the Aerospace Research Laboratories of the U.S. Air Force for calendar year 1971 are presented in the form of titles and authors. The subjects covered are: (1) applied mathematics, (2) energy conversion, (3) fluid dynamics, (4) hypersonic research, (5) chemistry research, (6) metallurgy and ceramics, (7) plasma physics, and (8) thermomechanics. P.N.F.

**N73-13975#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany).

**ANNUAL REPORT, 1971 [JAHRESBERICHT 1971]**

1971: 594 p refs In GERMAN

Avail: NTIS HC \$31.75

The annual report covers work on flow mechanics, aerodynamic flight control, materials strengths and construction methods, propulsion and energy, electronics, space physics, space simulation, and aerospace medicine. Briefly discussed are also activities at five data processing centers, air traffic problems, and interdisciplinary aerospace research. Transl. by G.G.

**N73-13982\*#** Air Force Dept., Washington, D.C.

**RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO AVIATION PROGRESS (RADCAP), VOLUME 1**

John G. Paulisick Aug. 1972 123 p refs Sponsored by NASA, DOT, and DOD 2 Vol.

(NASA-CR-129572) Avail: NTIS HC \$8.25 CSCL 05D

**N73-13983\*#** Air Force Dept., Washington, D.C.

**RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO AVIATION PROGRESS (RADCAP), VOLUME 2, AP-**

**PENDICES 1 THRU 9**

Charles R. Hudson, Jr. Aug. 1972 606 p refs Sponsored by NASA, DOT, and DOD 2 Vol.

(NASA-CR-129573) Avail: NTIS HC \$32.50 CSCL 05D

**N73-13984\*#** Air Force Dept., Washington, D.C.

**RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO AVIATION PROGRESS (RADCAP): EXECUTIVE SUMMARY**

Aug. 1972 39 p Sponsored jointly by DOD, NASA, and DOT (NASA-CR-129574) Avail: NTIS HC \$4.00 CSCL 05D

Positive contributions of military aeronautical research and development programs to civil aviation are reviewed and some possible future contributions of those military programs are assessed. A summary is presented of detailed results concerned with: (1) review of the progress that has been made in aviation since 1925 and the significant technological advances that have been made; (2) an examination of current and planned military aeronautical research and technology programs and an assessment of their relevancy to the aeronautical R and D needs of civil aviation; (3) the relationship of the development base generated by military programs to the needs of civil-airliner design, development, and production; (4) information on aeronautical R and D funding; and (5) the findings and observations of the RADCAP study. Author

**N73-13997#** Phillips Scientific Corp., Bartlesville, Okla.

**INVESTIGATION OF NAVY AIRCRAFT FUEL DISPENSING METHODS**

D. P. Keeler and E. E. Kleinmann Apr. 1972 212 p

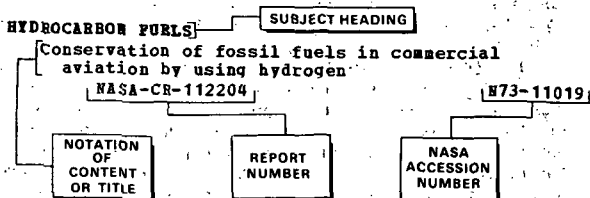
(Contract N00025-71-C-0026)

(AD-748211) Avail: NTIS CSCL 15/5

The report is the result of study to determine the most effective, practical, and economical system for onshore fueling of Navy aircraft, including fighters, patrol, helicopters, and transport aircraft. The Recommended Service Station Fueling System is a pressure system automatically controlled by fuel demand, utilizing groups of pumps, filter-separators, and a pipeline distribution system arranged for extreme flexibility and simplicity in operation. A minimum of hydraulic and electric controls are used, and no radio or telephone is required for coordination of fueling. The Recommended Service Station Fueling System consists of fueling spots to which aircraft come for fueling. Each fueling spot consists of a meter, a primary and secondary pressure control valve, a filter-separator, and a loading hose or arm to transfer fuel from a pipeline to the aircraft. Author (GRA)

# SUBJECT INDEX

## Typical Subject Index Listing



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Reproduction of sound propagation in the standard atmosphere  
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Directional devices for noise reduction of high speed jets.  
A73-14142

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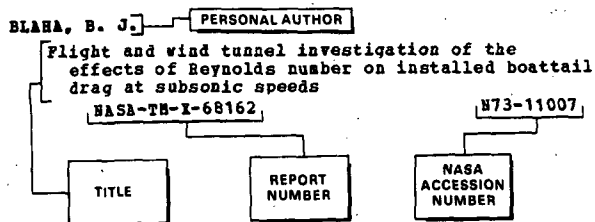
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1. Report No. NASA SP-7037 (29)	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 29)		5. Report Date March 1973	6. Performing Organization Code
		8. Performing Organization Report No.	
7. Author(s)		10. Work Unit No.	
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		11. Contract or Grant No.	
		13. Type of Report and Period Covered	
12. Sponsoring Agency Name and Address		14. Sponsoring Agency Code	
		15. Supplementary Notes	
16. Abstract  This special bibliography lists 410 reports, articles, and other documents introduced into the NASA scientific and technical information system in February 1972.			
17. Key Words (Suggested by Author(s)) Aerodynamics Aeronautical Engineering Aeronautics Bibliographies		18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 121	22. Price* \$3.00

\*For sale by the National Technical Information Service, Springfield, Virginia 22151

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