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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY
WITH INDEXES
Supplement 18

MAY 1972

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7037 (18)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 18

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 April 1972 in

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

Scientific and Technical Information Office
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INTRODUCTION

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 367 reports, journal articles, and other documents originally announced in April 1972 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

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

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

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

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

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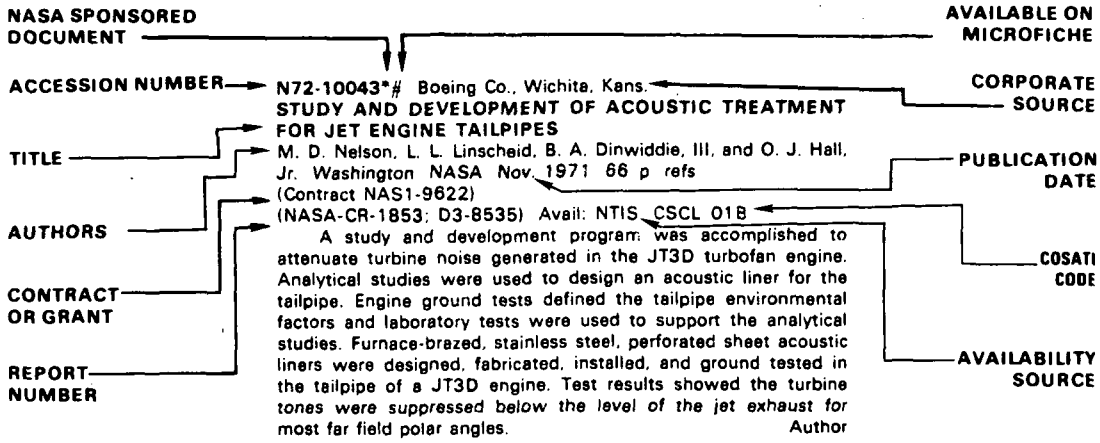

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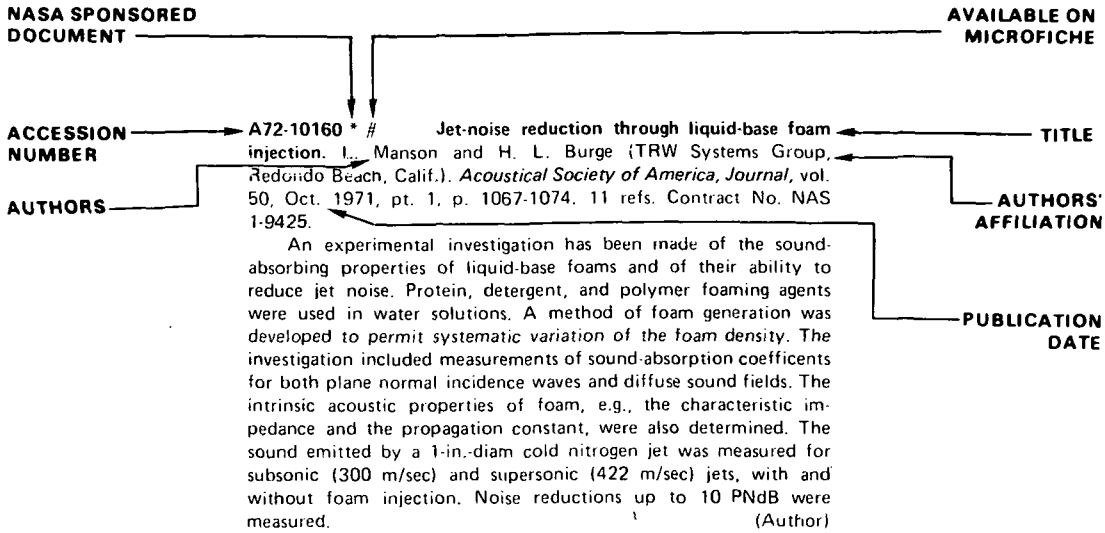

AERONAUTICAL ENGINEERING

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IAA ENTRIES

A72-18751 National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Conference sponsored by the U.S. Naval Air Propulsion Test Center. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971. 445 p. $23.50.

The papers deal with hot corrosion in jet engines; improvement of jet engine lubrication systems; the effects of solid particles and separation of solid particles; acoustic comparison of engines; simulation of the ingestion of missile exhaust; and the effects of condensation. Catapult steam ingestion tests, aircraft inlet and turbofan engine compatibility, steady-state circumferential inlet pressure distortion index, and a forecasting technique for accumulated contamination on spacecraft assemblies are discussed. Effects of hail, icing, and lightning are reviewed, and lightning protection techniques are considered. Attention is given to engine condition monitoring, smoke emission sampling, and reduction of bird hazards. The impact of the national environmental policy act on the advanced technology turbine engine is studied.

F.R.L.

A72-18752 # Effect of very low sulfur in JP-5 fuel on hot corrosion. R. M. Schirmer and H. T. Quigg (Phillips Petroleum Co., Bartlesville, Okla.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 1-1 to 1-32. 21 refs.

Results of an experimental investigation to determine whether the present limit of 0.4% by weight (4,000 ppm) of sulfur in JP-5 fuel is a safe level for the protection of turbine-blade materials from hot corrosion in high-performance engines when operated in a marine environment. It is shown that a hundredfold reduction in the sulfur limit to 40 ppm would not reduce hot corrosion significantly. No change in the sulfur limit for JP-5 to alleviate hot corrosion of turbine-blade materials is recommended at this time. The use of an essentially sulfur-free fuel, containing only 4 ppm sulfur, significantly decreased both the surface scale on specimens and the weight lost by specimens when exposed under conditions which simulate those in an aircraft-turbine engine ingesting air with 1 ppm sea salt. Thus indications are that the sulfur in fuel must be below a 'threshold' concentration to improve the durability of turbine-blade materials, and it is suggested that this 'threshold' varies with the sodium concentration in the environment. (Author)

A72-18754 # A methodology for improving the condition of jet engine lube systems and extending the mean time to failure of rubbing and rolling element engine components. J. J. Sherlock (Midwest Aero Industries Corp., Royal Oak, Mich.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 3-1 to 3-23. 16 refs.

Turbine engine builders and turbine operators spend great amounts of effort and money working to extend the useful life of gas turbine engines. TBOs started at 200 + hours for early turbine engines - and in twenty years climbed to well over 12,000 hours. This paper highlights the importance of lube system filtration to achieving even longer rolling element bearing life - to achieve extended MTTF (Mean Time to Failure) of advanced gas turbine engines. (Author)

A72-18755 # Investigation of feasibility of integral gas turbine engine solid particle inlet separators. W. J. McAnally, III (United Aircraft Florida Research and Development Center, West Palm Beach, Fla.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 4-1 to 4-23.

Consideration of an engine inlet particle separator that is designed as an integral part of the engine, thus offering advantages of reduced penalties in engine performance, weight, maintainability, and reliability. Semireverse-flow and powered mixed-flow separators were evaluated with respect to other separator concepts; both were considered to be potentially superior to current separator designs. The semireverse-flow separator concept is feasible as an integral part of an engine inlet, and the full-size separator as tested is superior to current engine air particle separators. Although the powered mixed-flow separator is feasible, its performance was inferior to current engine air particle separators. Separator designs that incorporate swirl vanes are vulnerable to foliage accumulation, which can produce a significant increase in pressure drop. F.R.L.

A72-18756 # Simulation of environmental solid-particles trajectories and velocities through an axial flow compressor stage and the pressure distribution on blades. W. Tabakoff, A. Hamed, and F. Hussein (Cincinnati, University, Cincinnati, Ohio). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 5-1 to 5-31. 12 refs. Grant No. DAHC04-69-C-0016. Project THEMIS.

An experimental investigation of the trajectories and velocities of solid particles suspended in a fluid passing through an axial flow compressor stage was performed. Such an investigation is of importance to the study of erosion damage sustained by the blade. Two test facilities were used for this study: a subsonic cascade wind tunnel for compressible flow and a water table for incompressible flow. From the test technique it may be concluded that the present existing theoretical analysis for particle trajectories through a

compressor stage is not valid. The wind tunnel test simulation is much better than the water table and may be used for predicting particle trajectories. (Author)

A72-18757 # **Acoustic comparisons of J52-P-8A and J52-P-408 engines installed in an A-6A aircraft.** N. Arcas and R. A. Cea (Grumman Aerospace Corp., Bethpage, N.Y.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 7-1 to 7-23.

Description of a test program conducted to evaluate the increase in sound pressure level caused by the substitution of an 11,200-lb thrust (J52-P-408) engine for the 9300-lb thrust (J52-P-8A) engine on the airframe of the A-6A aircraft. The program also includes an evaluation of the acoustic fatigue effects of thrust change and of single vs two engine operation on the aircraft structure. M.V.E.

A72-18758 # **The simulation of the ingestion of missile exhaust by turbojets.** W. A. Rich (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 8-1 to 8-7.

Attempt to provide engine missile exhaust tolerance data necessary for proper aircraft inlet and missile hard point design. Missile exhaust simulators intended for use in a specially instrumented altitude test chamber were necessary, and two types of simulators were developed. One simulator is basically a design tool that features a great amount of flexibility. The second simulator is a simpler device intended for use as a specification tool. The intent of the schemes discussed was to reduce the intensity of the characteristic compressor stall following the ingestion of missile exhaust. F.R.L.

A72-18759 # **The effect of condensation within an aircraft inlet duct on installed turbofan engine performance.** J. H. Spencer and D. C. Archer (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 9-1 to 9-10.

Investigation of the reasons for significant variations in military trim level in TF30-P-6 and P-8 engines installed in A-7 aircraft with changes in the relative humidity levels of the ambient atmosphere. The development of condensation effects on engine performance is discussed, as well as the results of engine tests conducted to substantiate the theories presented, and the military trim corrections required to eliminate the need for repetitive engine trimming are derived. The maximum predicted overtrim condition possible under high humidity conditions, also confirmed by test data, is 3% excessive turbine inlet temperature. Use of trim corrections applicable to operation in high humidity environments not only virtually eliminates excessive time required for engine trimming, but also has the potential for improving engine life as they eliminate engine operation at unnecessarily high levels of turbine inlet temperature. (Author)

A72-18760 # **Catapult steam ingestion test of three turbofan engines in the A-7 aircraft.** W. E. Mallett and R. F. Parcells (Vought Aeronautics Co., Dallas, Tex.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 10-1 to 10-17.

The TF30-P-6 turbofan engine in the A-7A aircraft stalled and lost power during the first launch from a land based steam catapult. Subsequent test results indicated that leakage steam entered the inlet and produced local areas of higher-than-ambient temperature at the engine face. Compressor stall occurrences were correlated with the rate of temperature increase in the distorted region. Steam catapult tests are discussed, giving attention to a review of the steam flow path to the engine, the characteristic conditions produced at the engine face, and the test results for the three turbofan engines. G.R.

A72-18761 # **Aircraft inlet and turbofan engine compatibility assessment techniques.** H. D. Hardy (United Aircraft Florida Research and Development Center, West Palm Beach, Fla.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 11-1 to 11-12.

Study of flow phenomena in aircraft inlets which can precipitate blade stalling, leading to engine surge, and their influence upon engine and aircraft inlet design. Early in the aircraft development program the manufacturer identifies from model data the probable inlet flow patterns. The engine designer incorporates this information in his basic design considerations and his analytic models of the proposed system. Later, an extensive test program utilizing engine components and prototype engines is conducted to acquire additional data on critical areas of the design concept or at critical flight conditions. These data are then correlated with earlier predictions to refine the inlet and engine designs at the earliest possible date in the development program. F.R.L.

A72-18762 # **A steady-state circumferential inlet pressure distortion index for axial-flow compressors.** D. F. Brunda and J. F. Boytos (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 12-1 to 12-10.

A circumferential inlet pressure distortion index is derived using the one-dimensional isentropic flow expressions for total pressure, total temperature and axial velocity upstream of a high hub-tip ratio multistage compressor. These expressions are combined with two conditions required for inlet flow similarity at compressor stall: namely, constant rotor angle of attack and constant ratio of dwell time to air residence time in the blade passage. The theory was tested and proven on a twin-spool turbofan engine with a three-stage fan at sea level static conditions. (Author)

A72-18764 **Impact of hail at high speed on light alloy plate and D-nosed specimens.** I. I. McNaughtan and S. W. Chisman (Royal Aircraft Establishment, Farnborough, Hants., England). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 15-1 to 15-27.

Evaluation of test results on the indentation and penetration of L72 (25 tons/sq in., 15% elongation) and L73 (27 tons/sq in., 8% elongation) aluminum alloy flat plate specimens by the impact of 1/2 in. and 3/4 in. diam hail at speeds up to 2500 ft/sec. The data cover a range of plate thicknesses and impact (sweep) angle. Test results are also presented on indentation and penetration by 1 in. diam hail of L72 and L73 D-nosed specimens over a range of skin thicknesses, sweep angle, and nose radius. The data, together with test results from 3/4 in. and 1 in. hail impacts on aircraft leading edge structure, are used to obtain empirical estimates of the resistance to hail penetration of aircraft forward-facing structures. (Author)

A72-18765 # **Icing tests on the JT15D turbofan engine.** W. Grabe (National Research Council, Ottawa, Canada) and G. K. Vanslyke (United Aircraft of Canada, Ltd., Montreal, Canada). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceed-

ings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 16-1 to 16-17. 5 refs.

Extensive icing tests were carried out on the United Aircraft JT15D turbofan engine. As a result, an anti-icing system evolved which is believed to provide full protection to the engine under all expected icing conditions. Certain highlights of the icing program are discussed in some detail, particularly such features as are believed common to modern turbofan engines. Early tests on a series of unheated nose cones showed that centrifugal and aerodynamic forces were inadequate for de-icing this area. Heating the entire cone surface and bleeding some air through the central bolt prevented ice build-ups with the exception of rime ice accretions at low temperatures and fan speeds. In early testing, excessive jet pipe temperature increases at relatively high engine speeds were traced to large glaze ice accretions on the primary flow stators. Heating these stators eliminated this problem. (Author)

A72-18766 # **Engine condition monitoring through sonic and vibration analysis.** R. E. Oberndorfer (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 18-1 to 18-5.

The progress of a program is described for the evaluation of two maintenance-aid systems designed to determine the physical condition of aircraft gas turbine engines and to provide indications of malfunction and overhaul need prior to failure. One system is based on a sonic analysis technique, the other on vibration analysis. M.V.E.

A72-18767 # **Advanced structure fuel system lightning protection.** S. D. Schneider and L. L. Oh (Boeing Co., Seattle, Wash.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 19-1 to 19-12. 23 refs.

Assessment of previously unsuspected hydrocarbon fuel ignition hazards in newer types of airframe construction. Hydrocarbon fuel vapor ignition sources include puncture and backside heating of fuel tank skins, high current and induced arcing and sparking, and open arc attachment. Unless precautions are taken, an adhesively bonded airframe results in electrically isolated metallic structural sections. Lightning strike energies can electromagnetically couple into such isolated sections and create ignition hazards, hence electrical bonds may be required. The use of high strength materials such as titanium and stainless steel has created a need to determine the exact mechanism by which lightning can move back over an airfoil surface once the initial stroke contact is made at a forward projection point. Problems of high-modulus fiber structures such as boron- and graphite-reinforced plastics are considered. F.R.L.

A72-18768 # **A laboratory test technique for evaluating swept lightning stroke effects on aircraft.** J. A. Plumer and A. F. Rohlfs (GE High Voltage Laboratory, Pittsfield, Mass.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 20-1 to 20-13.

Development of a test technique which has several unique characteristics, among which is the application of a multiple-stroke flash instead of a single stroke or single continuing-current flash. The technique involves moving the test object through a stationary lightning flash. It permits the use of long high-voltage arcs, as well as simulation of multiple-stroke flashes, both continuous and restriking. It is a high voltage test, and the breakdown current levels are low enough to avoid catastrophic destruction of the test piece, while permitting establishment of lightning stroke attachment points and, to some extent, the subsequent breakdown paths. F.R.L.

A72-18769 # **Design, manufacture, and testing of the CH-54A/B engine air particle separator anti-ice system.** C. D. Stephenson (U.S. Army, Material Command, St. Louis, Mo.), H. N. Shohet, and K. M. Rosen (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 22-1 to 22-39. 10 refs.

Description of an engine air particle separator (EAPS) anti-ice system which consists of a front frame inlet lip protected by a tapered gap heat exchanger, through which engine bleed air passes, and a number of surfaces which are thermoelectrically heated. The principal design objective was to create a system which met the anti-ice requirements and minimized the compressor air bleed and electrical power load. The analysis, design procedures, and manufacturing techniques are outlined. A prototype EAPS anti-ice system was tested over an appropriate range of icing and engine conditions in the NASA Lewis Icing Research Tunnel. F.R.L.

A72-18770 # **Gas turbine smoke emission sampling using Navy specification test method.** W. H. Birk (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings.
Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 23-1 to 23-3.

A review of the apparatus and procedures prescribed by the Navy 'Specification for Gas Turbine Engines' Smoke Emission Test' is presented. The method is compared with ARP 1179 established by the SAE. Smoke limits are discussed. A program to evaluate the test method and verify the established limits is described. (Author)

A72-18771 # **How we reduce bird hazards to aircraft.** V. E. F. Solman (National Research Council, Wildlife Service, Ottawa, Canada). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 24-1 to 24-11. 10 refs.

Habitat management including reduction of food, cover, and water, can reduce the attractiveness of airfields to birds. Proper design can make airfield structures unusable by birds. Casual bird visitors can be driven from airfields by well-motivated energetic people with equipment ranging from pyrotechnic devices to trained falcons. Birds aloft can be observed by radar, their movements can be forecast and safer courses for aircraft can be described and used. Air traffic control personnel can be trained to use bird movement forecasts and realtime radar data on bird activity to guide aircraft to safer passage through the feather curtain. Aircraft structures less vulnerable to damage by bird strikes can be developed. Further improvements are possible and desirable. (Author)

A72-18772 # **A plan to measure pollution potential of Army aircraft especially turbine engines.** D. P. Altholz and R. Mantler (U.S. Army, Aviation Systems Command, St. Louis, Mo.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 25-1 to 25-4.

A proposed U.S. Army aircraft pollution evaluation program is outlined that is designed to assess the relative pollution potential of the most numerous types of turbine engines in inventory over a certain range of operating conditions. The execution of this program would enable the Army either to prove compliance with any pollution limits set in the future or to know what improvements are needed for complying. M.V.E.

A72-18773 # **Impact of National Environmental Policy Act of 1969 /PL91-190/ on the advanced technology turbine engine.** J.

N. Bujac, Jr. and R. Mantler (U.S. Army, Aviation Systems Command, St. Louis, Mo.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 26-1 to 26-19.

A study was conducted to determine the impact of this Public Law upon the development of advanced Army aircraft turbine engines in terms of performance, additional cost, and added development time. Turbine engine contributions to noise, smoke, and invisible chemical pollution are evaluated, and approaches taken to minimize these effects are outlined. Graphs illustrate previous and anticipated contents of hydrocarbons, carbon monoxide, nitrogen oxides, and particulates in turbine engine emissions. T.M.

A72-18774 # A lightning simulation laboratory for aerospace testing. D. W. Clifford and E. H. Schulte (McDonnell Aircraft Co., St. Louis, Mo.). In: National Conference on Environmental Effects on Aircraft and Propulsion Systems, 10th, Trenton, N.J., May 18-20, 1971, Proceedings. Trenton, N.J., U.S. Naval Air Propulsion Test Center, 1971, p. 1-7. 21 refs.

A lightning simulation laboratory, designed for the needs of the aerospace industry, is being developed at the McDonnell Aircraft Company (MCAIR). Several high energy generators for simulating various lightning components and strike conditions are already in operation. Model attach point studies and other high voltage tests have been conducted using the 1.6-million-volt generator built at MCAIR. The high current generators used for development studies and qualification testing incorporate unique design features to produce more realistic simulations than were previously possible. A 7-megajoule capacitor bank provides adequate discharge energy for any foreseeable high current test requirement, including MIL-spec qualification testing of full-size aircraft. Both high voltage and high current systems are located in facilities adjacent to Lambert Field at St. Louis and are accessible to flight aircraft. (Author)

A72-18778 A hybrid computer analysis of a non-stationary process. K. G. Beauchamp, P. G. Thomasson, and M. E. Williamson (Cranfield Institute of Technology, Cranfield, Beds., England). In: Computer aided engineering; Proceedings of the Symposium, University of Waterloo, Waterloo, Ontario, Canada, May 11-13, 1971. Waterloo, Canada, University of Waterloo, 1971, p. 19-30.

Attempt to describe a spectral analysis method by which the engineer can be given a quantitative description of detected noise values so as to enable an assessment to be made of his practical measures in aircraft noise abatement. Hybrid methods of analysis were chosen because the signal itself is analog, and nonstationary analysis can be effectively carried out only if it is assumed that the data have short-term stationary characteristics. A description of the analysis method for aircraft flyover noise is given, the object being to derive precise information concerning noise radiated by jet aircraft under operational conditions. The procedures for detailed implementation are outlined. F.R.L.

A72-18787 Numerical analysis of cascade computations by the method of singularities. F. J. Legerer (Waterloo, University, Waterloo, Ontario, Canada). In: Computer aided engineering; Proceedings of the Symposium, University of Waterloo, Waterloo, Ontario, Canada, May 11-13, 1971. Waterloo, Canada, University of Waterloo, 1971, p. 299-313. 12 refs.

Numerical analysis of Imbach's (1965) method of computing the velocity distribution in a cascade of profiles, which modified Prager's (1928) singularities method in which vortices were distributed along the contour of a body which was assumed to be an ellipse. It is shown that the algorithm can fail for particular types of data. In engineering terms the accuracy of the results decreases with decreasing thickness. An example of a straightforward algorithm which does not always ensure good results is provided. F.R.L.

A72-18788 Recent trends in Galerkin's method. H. H. E. Leipholz (Waterloo, University, Waterloo, Ontario, Canada). In: Computer aided engineering; Proceedings of the Symposium, University of Waterloo, Waterloo, Ontario, Canada, May 11-13, 1971. Waterloo, Canada, University of Waterloo, 1971, p. 315-331. 27 refs.

Galerkin's method is shown to be independent of Ritz's method and applicable to nonconservative, nonself-adjoint problems. The problems of convergence and choice of coordinate functions are discussed and certain generalized Galerkin's equations are introduced for coordinate functions which violate some of the dynamic boundary conditions. The relations between the method and other approximate methods are discussed and it is shown that it may be based on a variational principle by using the concept of adjoint systems. (Author)

A72-18827 Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Seminar sponsored by the Flight Safety Foundation. Arlington, Va., Flight Safety Foundation, Inc., 1971. 190 p. $6.75.

The general situation of aviation safety today is examined, with particular attention to air traffic services in Latin America. Approaches to achieve safety are considered, taking into account safety enhancement with the astrolog program, incipient failure detection, the achievement of safety attitudes, and steps taken to ensure safety of the Concorde aircraft. Safety in training and operations is discussed, together with unusual problems presented by disturbed passengers, hijacking, and drug abuse. G.R.

A72-18828 # Concorde and the sources of safety. D. Meadowcroft (Société Nationale Industrielle Aérospatiale, Paris, France). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 18-25.

The safety of an aircraft results from three main groups of factors including factors especially related to the airworthiness of the aircraft type, factors related to the production and preparation for operation of a given aircraft, and factors related to the operation itself. The primary condition for ensuring safety is that the aircraft, in its entirety and in each of its components, shall be used only for the purpose for which it was designed, produced, and tested. The Concorde is designed to accommodate a Navigational and Flight System which has the most advanced state-of-the-art equipment. Steps are being taken to ensure that the crews of the aircraft will make optimal use of the equipment. G.R.

A72-18830 # Safely introducing a new aircraft into airline service as seen by the engine manufacturer. G. E. Woodger (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 41-47.

The design of the JT9D engine for the 747 aircraft illustrates the extremely wide range of problems that must be overcome in safely introducing a new engine into airline service. Numerous innovations were introduced into the JT9D providing a compact and simple basic configuration. A typical outgrowth of suggestions by the airlines is the incorporation of numerous borescope provisions which improve flight safety by making the early detection of potential fatigue failures in critical areas of the engine possible. A major concern during the design of the JT9D engine was that it should have the capability of withstanding major component failure without subsequent aircraft structural damage. G.R.

A72-18831 # **Safely introducing new aircraft into airline service as seen by government.** J. E. Dougherty (FAA, Washington, D.C.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 48-62. 13 refs.

The government's role in the introduction of widebody aircraft to air-carrier service is considered. The Federal Aviation Act empowers the Administrator to prescribe minimum standards governing, in the interest of safety, the design, materials, workmanship, construction, performance and inspection and overhaul of aircraft and related components. The Federal Aviation Act also empowers the Administrator to find that a particular aircraft design and related components meet the applicable minimum airworthiness standards. Factors of modern maintenance program development are discussed together with in-service aspects, the relationship of maintainability to design, and fail-safe structural configurations. Also considered are questions of accessibility, inspectability, serviceability, replaceability, redundancy of systems, and environmental quality. G.R.

A72-18832 # **What the pilot sees during instrument approach in low-visibility conditions.** J. J. Carroll (National Transportation Safety Board, Bureau of Aviation Safety, Washington, D.C.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 63-65.

As the available cues for the pilot during approach and landing are reduced by fog, haze, rain, glare, snow, sleet, or smog, the need for cue enhancement and automated control and guidance increase. In all cases, stabilization of the approach is desirable, but in the low visibility condition, the need can become very critical. During any transition from actual instrument conditions to visual guidance, the pilot subconsciously, as well as consciously, analyzes dynamic but subtle cues that cause him to accept or reject the situation. G.R.

A72-18833 # **Crosswind landings under adverse conditions - A professional challenge.** J. B. Clark (American Airlines, Inc., New York, N.Y.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 66-80. 5 refs.

The conventional crosswind approach procedure considered works satisfactorily in light to medium crosswinds as long as the main gear flight path is over the runway centerline. When a long fuselage aircraft is approaching in a crab, the cockpit has to be some distance upwind of the runway centerline for the main gear to track over the centerline. An approach procedure which provides more safety reserve toward the downwind is also described. A third technique is very effective in difficult crosswinds, but requires a high level of pilot competency. G.R.

A72-18834 # **The case against engine-out flight training.** T. G. Foxworth and H. F. Marthinsen (Air Line Pilots Association, Washington, D.C.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 81-112. 31 refs.

It is pointed out that almost all fatal training accidents of air carrier jets involved engine-out operations. The factors which led to these accidents are examined taking into consideration minimum control speed certification requirements and training procedures. Certification and operational requirements of military and foreign authorities are compared with those of the FAA. It is concluded that the introduction of changes into either the certification requirements or the training procedures is urgently needed if accidents are to be eliminated in engine-out flight training. G.R.

A72-18835 # **Operation evaluation of Collision Avoidance System.** W. O. Tadlock (Piedmont Aviation, Inc., Piedmont Airlines, Winston-Salem, N.C.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 113-116.

The combined efforts of many members of the Aviation Community has resulted in the development of a workable Collision Avoidance System (CAS). Every three seconds in a given time slot the CAS unit transmits a signal to all equipped aircraft or ground stations within a ninety-mile radius. On the basis of accurate time measurements the altitude, range, and range rate of the CAS unit become known to the other units. The signals are synchronized to one mil of a second with the aid of a cesium clock. A safe CAS performance was proven in every encounter of a number of evaluation tests. It was found that the protected airspace volume required is generally less than IFR minimum separation. G.R.

A72-18837 **Non-misting fuels as an aid to aircraft safety.** R. E. Miller and S. P. Wilford (Royal Aircraft Establishment, Farnborough, Hants., England). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 135-150. 14 refs.

Study of the possibility of modifying fuel properties as a means of reducing the incidence of crash fires, with emphasis on the potential advantage of antimisting kerosene fuels. The standard rocket sled test provides a convenient method of evaluating aircraft safety fuels under a wide variety of conditions. Using one rocket, the test conditions are comparable with those encountered by the fuel in relatively mild crashes. With two rockets the conditions are severe enough to include 95% of crashes occurring at 80 mph. Mist inhibiting additives of the high molecular weight polymeric type give a considerable increase in the fire resistance of fuels under severe crash conditions. Although there are difficulties regarding water separation and filtration, two of the antimisting additives, FM 4 and FM 6, appear to give rise to no insurmountable handling problems. F.R.L.

A72-18838 # **Improvements in aviation weather forecasting as a result of new technology.** N. A. Lieurance (NOAA, Washington, D.C.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 160-166.

Discussion of the improvements in forecasting which have come about through the use of weather radar, computer applications, weather satellites, and high speed communications. Weather radar makes it possible to perceive the location, thickness, height, and rate of movement of storm cells and to make quite accurate short-range predictions. Expansion of computer techniques to almost every area of forecasting provides excellent guidance information. For forecast offices which have to deal with large data-scale areas such as oceans, deserts, and sparsely settled mountainous areas satellite pictures are a source of information never before available. Without high speed communications computerization would not function, fewer charts would be produced, forecasters would have less data to work with, and the timely exchange of data on a worldwide basis would not be possible. F.R.L.

A72-18839 # **Simulation - The only safe way.** W. P. Moran (American Airlines, Inc., New York, N.Y.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary. Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 167-170.

Review of the contributions made to aircraft safety by recent innovations in training methods and equipment. An attempt is made to explain how material and technique improvements have produced

better trained crew members while drastically reducing the accident rate of the most accident-prone flying - i.e., aircraft flight training. The use of modern digital computer simulators with visual and motions systems is discussed, and the B-747 training program is described. The improved fidelity of simulator and visual systems is pointed out, evidence of learning transfer from the simulator to the actual aircraft is presented, and training on the simulator for emergency procedures is discussed. The flight simulator is now believed to be an appropriate device for total training of experienced flight crew members. F.R.L.

A72-18840 # **Non-destructive testing in the Boeing commercial fleet.** D. K. Cochrane (Boeing Co., Seattle, Wash.). In: Annual International Air Safety Seminar, 24th, Mexico City, Mexico, October 18-21, 1971, Technical Summary.
Arlington, Va., Flight Safety Foundation, Inc., 1971, p. 171-175.

Discussion of nondestructive testing (NDT) of aircraft structure, which involves the use of various electronic devices and techniques to inspect for hidden or inaccessible defects. The types of NDT equipment in common use in the airline industry are X-ray, ultrasonic, and eddy current; they are briefly described. NDT makes its greatest contribution by keeping aircraft in the air as much as possible, no matter what type of operation is conducted by the airline concerned. The procedure is used both for routine maintenance and to investigate special problems. Some typical examples of NDT usage are cited. F.R.L.

A72-18951 * # **Rotor design of high tip speed low loading transonic fan.** J. R. Erwin and N. G. Vitale (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-83.* 10 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS3-13498.

This paper describes the design concepts, principles and details of a high tip speed transonic rotor having low aerodynamic loading. The purpose of the NASA sponsored investigation was to determine whether good efficiency and large stall margin could be obtained by designing a rotor to avoid flow separation associated with strong normal shocks. Fully supersonic flow through the outboard region of the rotor with compression accomplished by weak oblique shocks were major design concepts employed. Computer programs were written and used to derive blade sections consistent from the all-supersonic tip region to the all-subsonic hub region. Preliminary test results indicate attainment of design pressure ratio and design flow at design speed with about a 1.6 point decrement in efficiency and large stall margin. (Author)

A72-18957 * # **The structure of jet turbulence producing jet noise.** C. E. Wooldridge, D. C. Wooten (Ultrasystems, Inc., Newport Beach, Calif.), and A. J. Amaro (Stanford Research Institute, Menlo Park, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-158.* 29 p. 15 refs. Members, $1.50; nonmembers, $2.00. Contract No. NASw-1938.

Measurements are presented that characterize the structure of the jet in both the core and the surrounding annular mixing region. Experiments were carried out in a 1.5-inch diameter subsonic jet at Mach numbers of 0.3, 0.5, and 0.7. The growth of pressure fluctuations within the core from the jet outlet to the end of the jet core was traced through the examination of spectral results. The spectra in the jet core exhibited a peak whose frequency scaled with the jet velocity and the jet diameter which is related to a characteristic dimension of the mixing process. A digital data reduction program was used to calculate the auto- and cross-correlations of axial velocity fluctuations. In the core the cross-correlations were nearly constant in the space-time plane indicating a traveling pressure wave, while in the annular mixing region the cross-correlations exhibited the usual decay in the space-time plane characteristic of convected turbulence. (Author)

A72-18958 # **Review and evaluation of a three-dimensional lifting potential flow computational method for arbitrary configurations.** P. E. Rubbert and G. R. Saaris (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-188.* 16 p. 13 refs. Members, $1.50; nonmembers, $2.00.

Applications of a general subsonic potential flow computational method to complex aerodynamic analysis and design problems are reviewed. The method is a general boundary value problem solver that uses source and doublet panels distributed on the configuration boundary surfaces and internally. Examples are given to demonstrate the accuracy of the method and to illustrate the broad variety of aerodynamic problems that have been treated. The method is shown to be a useful tool for many different aerodynamic analysis and design applications. (Author)

A72-18962 * # **Externally-blown-flap noise.** R. G. Dorsch, W. J. Kreim, and W. A. Olsen (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-129.* 20 p. 11 refs. Members, $1.50; nonmembers, $2.00.

Noise data were obtained with a large externally blown flap model. A fan-jet engine exhaust was simulated by a 1/2-scale bypass nozzle supplied by pressurized air. The nozzle was pylon mounted on a wing section having a double-slotted flap for lift augmentation. Noise radiation patterns and spectra were obtained for nozzle exhaust velocities between 400 and 1150 ft/sec. The blown flap noise data are in good agreement with previous small model results extrapolated to test conditions by Strouhal scaling. The results indicate that blown flap noise must be suppressed to meet STOL aircraft noise goals. (Author)

A72-18976 # **Plane flow of an ideal incompressible fluid past solid profiles of arbitrary configuration with a large camber of the center line (Obtekanie ploskim potokom ideal'noi neszhimaemoi zhidkosti telesnykh profilei proizvol'noi formy s bol'shim vygibom srednei linii).** V. B. Avdeev. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 5-14. 6 refs. In Russian.

A computer solution is obtained to the direct stationary problem in a layer of constant thickness for large-camber profiles of arbitrary shape and thickness. The complex singularity-distribution function is defined on a quadratic parabola (or any other curve of parametric shape) in the form of a trigonometric series, whose coefficients are determined from two coupled singular integral equations. These equations are reduced to an infinite system of linear equations with coefficients expressed through Fourier-series coefficients, and are solved by the method of successive approximations. The determination of relative velocities at the profile is reduced to quadratures, using an expansion of the integrals into Fourier cosine-series. V.P.

A72-18977 # **Determination of modified sensitivity functions of a system of differential equations describing the perturbed motion of an aircraft (Opredelenie modifitsirovannykh funktsii chuvstvitel'nosti sistemy differentsial'nykh uravnenii, opisyvaiushchei vozmushchennoe dvizhenie letatel'nogo apparata).** A. F. Bochkarev and I. A. Mostovoi. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 15-20. In Russian.

A method is proposed for obtaining modified sensitivity functions that depend on the time derivatives and on the system parameters and coordinates. The method of modified sensitivity functions is based on converting the initial system of differential equations to a new argument, and calculating the sensitivity functions from the converted system. The solution is then reconverted to the initial argument (if this should prove necessary). It is

shown that the conversion of the argument can be performed on the basis of the natural frequency of angular motion. By using modified sensitivity functions, the accuracy of the approximate solution can be substantially improved. V.P.

A72-18978 # **Processing of test results (K voprosu ob obrabotke rezul'tatov ispytanii).** Iu. V. Kozhevnikov, M. Kh. Bikchantaev, V. P. Cheprasov, and V. D. Shershukov. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 21-25. In Russian.

The problem is examined of obtaining estimates of a process described by a polynomial relation, from available test data, studying the statistical properties of the process, and determining the reliability of the estimate obtained. The problem is solved with the aid of the principle of maximum likelihood, under the assumption that the measurement errors are normally distributed. V.P.

A72-18979 # **Flight control in the case of continuous data flow (Upravlenie poletom pri nepreryvnom pritoke informatsii).** G. I. Kostychev. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 26-30. In Russian.

Certain optimal control problems are examined for the case of continuous data flow on the time-variable conditions of the flight. It is assumed that the behavior of the plant is defined solely by the data acquired at the given moment. A method of determining the control law for every moment of time and the actual flight path of the aircraft is proposed. The method is also suitable for solving problems encountered in differential games. V.P.

A72-18990 # **Study of the motion dynamics of an aircraft with an automatic pilot in the presence of noise (Issledovanie dinamiki dvizheniia samoleta s avtopilotom pri vozdeistvii pomekh).** E. A. Kuklev and A. S. Shalygin. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 96-98. 7 refs. In Russian.

Analysis of the effectiveness of a closed aircraft-automatic pilot control system in the case of various types of random disturbances and noise, such as atmospheric turbulence, thermal noise in electric circuitry, noise in radar communications systems, and superpositions of aircraft information channel signals and ground radar signals. The effects of these interferences on the motion of an airliner are discussed specifically. V.Z.

A72-18991 # **Determination of basic flight-vehicle parameters for a constant-altitude flight at a given speed (Opredelenie osnovnykh parametrov letatel'nykh apparatov dlia poleta na postoiannoi vysote s zadannoi skorost'iu).** L. P. Fedorov. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 99-102. In Russian.

Procedures are given for determining the optimal design parameters of air-jet propelled flight vehicles to obtain the minimum takeoff weight for a prescribed flying range at a prescribed constant altitude at an optimal mode of engine operation. The minimum takeoff fuel weight, the optimal wing load and area and the optimal characteristic engine dimension are considered among the parameters to be optimized. V.Z.

A72-18995 # **Effect of the variations of efficiency on the positions of working lines in the cascade characteristics of a turbojet engine compressor (Vliianie izmeneniia k.p.d. na polozhenie rabochikh linii na kharakteristikakh kaskadov kompressora TRD).** E. D. Sten'kin. *Aviatsionnaia Tekhnika,* vol. 14, no. 3, 1971, p. 119-122. In Russian.

Analysis of the relation between the efficiency of turbojet engine compressors and the positions of working lines in diagrams of their cascade characteristics. It is shown how the correct plotting of a displaced working line can be controlled by using influence coefficients. V.Z.

A72-19057 **A new shape in the sky /60th Wilbur and Orville Wright Memorial Lecture/.** M. Morgan (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Journal,* vol. 76, Jan. 1972, p. 1-18. 19 refs.

Early research leading to the final aerodynamic configuration of the Concorde aircraft is reviewed, and the aerodynamic performance of this aircraft is described together with the stability and control characteristics. Several initial wing-layout proposals are discussed to illustrate factors influencing the decision in favor of a long slender shape. Controlled separation is shown to be a distinctive feature of the Concorde-like wing, and attention is given to the drag, lift, vortex breakdown, lateral stability, longitudinal stability, and weight distribution characteristics. T.M.

A72-19062 **The development of a composite propeller blade with a carbon fibre reinforced plastics spar.** W. J. Colclough and J. G. Russell (Dowty Rotol, Ltd., Gloucester, England). *Aeronautical Journal,* vol. 76, Jan. 1972, p. 53-57.

Review of the development of a reinforced propeller blade incorporating carbon fiber reinforced plastics. Carbon fibers of superior tensile, flexural, and interlaminar-shear strengths were selected and converted into sheets of prepreg using as matrix an epoxy novalac resin with a boron trifluoride complex curing agent. Boards of carbon fiber reinforced plastics containing 55 vol % of carbon fiber in various alignments were moulded and used in the determination of mechanical properties to provide the initial design data. While component testing was under way, construction of blades for use in actual propellers was started. The first complete propeller was subjected to overpower and overspeed testing on a test tower in November 1970 and to stress measurements on tethered hovercraft in December 1970 and January 1971. The promising test results obtained are discussed. M.V.E.

A72-19064 **Airport simulation - A new approach.** J. A. Moreland. *Journal of Air Traffic Control,* vol. 14, Jan. 1972, p. 21-24.

Use of fast-time simulation through the use of digital computers to analyze air traffic control problems. A computer program was prepared that would simulate the arrival and departure operations at a single-runway airport. Three aircraft approach speeds were used, ranging from 70 to 140 kt. The length of the final approach course was arbitrarily set at eight miles. A demand pattern was set up which, although containing random elements, was structured so that the rate of aircraft desiring service would be zero at both the start and end of the simulation period, and a maximum at the midpoint. The (simulated) controllers were required to maintain a minimum of three miles separation between arriving aircraft, a two-mile separation between a departing and an arriving aircraft, operate on a first-come, first-served basis, and allow no more than one aircraft to occupy the runway at any time. F.R.L.

A72-19070 # **Low light television and its application to navigation.** R. J. Corps (Royal Aircraft Establishment, Farnborough, Hants., England) and A. G. Hicks (RAF, College of Air Warfare, Manby, Lincs., England). *Journal of Navigation,* vol. 25, Jan. 1972, p. 73-86; Discussion, p. 86-90.

Survey of some of the techniques, components, and applications of low-light television (LLTV) systems, and discussion of their potential in the field of navigation. LLTV tubes are shown to be variants of vidicon and orthicon TV camera tubes. Image intensification techniques using fiber optics, carrier-motion-compensation, and some other LLTV techniques are briefly introduced. Data on achievable static and dynamic resolution are presented as a function of illumination, along with identification range values for various field-of-view and resolution magnitudes. Applications are shown to include reconnaissance, navigation safety in congested areas, and

other watchkeeping systems. Future LLTV system component developments are reviewed. (Author)

A72-19091 # **Aircraft performance optimization.** R. L. Schultz and N. R. Zagalsky (Honeywell, Inc., Systems and Research Div., Minneapolis, Minn.). *Journal of Aircraft,* vol. 9, Feb. 1972, p. 108-114. 14 refs. Contracts No. N00014-69-C-0339; No. N00014-69-C-0101.

Using the calculus of variations, the solutions to various fixed end point flight-path optimization problems are developed. These include the minimum fuel-fixed range problem, the minimum time-fixed range problem, and the minimum fuel-fixed range-fixed time problem. Altitude profiles and throttle control laws are presented. A variety of aircraft mathematical models is initially examined, and the existence of a classically optimal controller is verified for a simple model. For this model, the first integral condition is used to eliminate the requirement of integrating the Euler Lagrange adjoint differential equations. The resulting computational algorithms are attractive for both laboratory investigations and airborne implementations. (Author)

A72-19092 # **Application of airfoil theory for nonuniform streams to wing propeller interaction.** G. Kleinstein and C. H. Liu (New York University, Bronx, N.Y.). *Journal of Aircraft,* vol. 9, Feb. 1972, p. 137-142. 12 refs. Contract No. DA-31-124-ARO/D/-464.

The effect of a single propeller on the aerodynamic characteristics of a high aspect ratio wing has been studied. The basic assumptions of classical analysis have been retained except the one for the two-dimensional sectional analysis. For the section inside the propeller stream, classical analysis assumes that the sectional height of the propeller stream is infinitely large. When the oncoming propeller stream is uniform and with a distinct boundary with the outer stream the modification is now made to take into consideration the finite height of the higher velocity propeller stream in the calculation of the sectional lift. When the oncoming propeller stream is not uniform, and without distinct boundary, the sectional two-dimensional analysis is computed numerically by a finite-difference scheme, while in the three-dimensional analysis of downwash, the propeller stream is replaced by an equivalent circular cylindrical jet of uniform velocity. The numerical examples show that the modifications due to the use of more realistic two-dimensional analysis are significant. (Author)

A72-19093 # **Incipient stall detection through unsteady-pressure monitoring on aircraft wings.** H. H. Heller (Bolt Beranek and Newman, Inc., Cambridge, Mass.), D. B. Bliss, and S. E. Widnall. *Journal of Aircraft,* vol. 9, Feb. 1972, p. 186-188. USAF-sponsored research.

The system considered utilizes the detection of increased levels of fluctuating pressure associated with flow disturbances at the wing. The approach arises from the expectation that at or near stall there occur, at certain locations, amplitude changes in the fluctuating pressure which are orders of magnitude larger than corresponding changes in the static pressure on the wing surface. Since unsteady pressures can be measured precisely by flush-mounted microphones, a potential stall-warning system could use appropriately processed information to indicate critical flight conditions with a high degree of accuracy. An experimental program was undertaken to study the various typical flow patterns on a variety of model wings. G.R.

A72-19110 # **Linearized theory of the lifting surface in an ideal, incompressible gas (Linearizovaná teorie nosné plochy v ideálním nestlačitelném plynu).** Z. Škoda. *Zpravodaj VZLÚ,* no. 4, 1971, p. 7-12. 5 refs. In Czech.

By linearizing the equations of motion, a relation has been derived between the downwash behind the lifting surface and its loading in the absolute system of coordinates. This relation can be interpreted as a general integral equation, which can be employed for determining the corresponding loading for a given motion of the lifting surface. By transforming the system of coordinates to a system moving along with the lifting surface, all known integral equations of linear motion can be obtained from this equation, and new integral equations for special cases of curvilinear nonstationary motion can be formulated. O.H.

A72-19111 # **Basic aircraft parameters for the calculation of its fatigue life (Základní parametry letounu při výpočtu životnosti).** V. Kahánek. *Zpravodaj VZLÚ,* no. 4, 1971, p. 13-26. 5 refs. In Czech.

An analysis is given of the principal parameters that have the decisive effect on the fatigue life of an aircraft. The parameters include the stress of the critical section during horizontal flight, the aircraft weight, the flight speed, and the number of takeoffs during one hour of flight. The points of view which have to be taken into account when determining these parameters are also given. O.H.

A72-19112 # **Problems inherent in climatic tests of electrical equipment for the aircraft industry (Problematika klimatických zkoušek elektrických zařízení pro letecký průmysl).** V. Nikodém. *Zpravodaj VZLÚ,* no. 4, 1971, p. 27-29. In Czech.

Problems associated with testing of the JT607 igniter for a small turboprop engine are identified and discussed. Preparations of the manufacturing process, design alterations, and climatic tests necessary for assessing the igniter quality are described. O.H.

A72-19137 # **NCLT - A complete approach.** J. R. McDaniel (U.S. Navy, Lemoore, Calif.). *Approach,* vol. 17, Feb. 1972, p. 16-22.

Modern technology has produced a new tool, the Night Carrier Landing Trainer (NCLT), which promises to eliminate many of the unknowns from night carrier landing practice for pilots of at least one series of aircraft - the A-7. The NCLT is expected to provide a precise simulation of the night carrier landing environment and a means whereby supervisors can more thoroughly evaluate pilot abilities, tendencies and habit patterns. G.R.

A72-19178 # **Regional air transportation study: The demand for scheduled air carrier service 1971-1990. Volume 1. Volume 2 - Appendix.** Manhasset, N.Y., R. Dixon Speas Associates, Inc., 1971. Vol. 1, 101 p.; vol. 2, 177 p.

The study background is examined, giving attention to the background of the region, transportation, and airline route development. Institutional factors considered comprise general regulatory conditions, the Civil Aeronautics Board, and federal aviation regulations. Technical factors are discussed, and a summary of discussions and surveys is given. Forecasts of demand provided include an estimation of traffic potential at nonhub points, system changes through 1990, passenger traffic at the hub points, the distribution of traffic by route sector, and aircraft routing methods. City summary sheets, socio-economic data sheets, and surveys of chambers of commerce and travel agents are presented in an appendix. G.R.

A72-19249 **VAK 191 B flight testing (Flugerprobung VAK 191 B).** R. Riccius (Vereinigte Flugtechnische Werke-Fokker GmbH, Düsseldorf, West Germany). *Flug Revue/Flugwelt International,* Feb. 1972, p. 23-25. In German.

Prototypes V1 and V2 of VFM-Fokker's single-seat V/STOL experimental reconnaissance fighter have carried out successful first flights on September 10 and October 2, 1971, respectively. The

different phases of the test program are discussed, giving attention to test benches, simulations, the SG 1262 hovering vehicle, static tests, ground and flight tests. It is pointed out that VFW-Fokker has proposed a joint VAK 191 B test program to the Luftwaffe and to the US Air Force. G.R.

A72-19250 V/STOL-weapon system VJ-101. II - VJ-101A+B (V/STOL-Waffensystem VJ-101. II - VJ-101A+B). H. Redemann. *Flug Revue/Flugwelt International,* Feb. 1972, p. 35-39. In German.

The models VJ-101A and VJ-101B were independently developed by the two German aerospace companies, Heinkel and Messerschmitt. The VJ-101A was the last version of the He231. The VJ-101A6 was equipped with six propulsive units of the type Rolls-Royce RB.153. The propulsion units were aligned in a vertical direction for the takeoff, and subsequently brought into normal position. The P1227 project of the Messerschmitt company involved a design with a delta wing. An evaluation of the designs for the VJ-101A and the VJ-101B models led to plans for the development of the VJ-101C model. G.R.

A72-19251 V/STOL weapon system VJ-101. I - Heinkel He231 (V/STOL-Waffensystem VJ-101. I - He231). H. Redemann. *Flug Revue/Flugwelt International,* Nov. 1971, p. 18-22. In German.

The history of the Heinkel He231 began in December 1957 when the German Ministry of Defense sent out requests of proposals to the industry for an all-weather fighter with V/STOL capabilities. A number of different designs were worked out by the Heinkel design team. The designs are discussed and a number of design sketches are presented. In February 1959 an organization for the further development of the fighter was founded by the aerospace companies Heinkel, Messerschmitt, and Bölkow. G.R.

A72-19268 # The reduction of aircraft engine fan-compressor noise using acoustic linings. R. A. Mangiarotty (Department of Trade and Industry, London, England). *(British Acoustical Society, Spring Meeting on Transport Noise and Vibration, University of Birmingham, Birmingham, England, Apr. 5-7, 1971.) British Acoustical Society,* vol. 1, Autumn 1971. 4 p. 6 refs.

The maximum potential reduction of engine noise that could be achieved with a given aircraft configuration was investigated by determining the relative amplitudes of the spectral components of the various sources of engine noise from flyover tests. Potential methods for attenuating the various noise sources were evaluated theoretically and by limited laboratory model tests. The use of acoustical linings on the walls of the engine nacelle inlet and exhaust was found to be the most practical concept for an existing engine. Theoretical lining concepts were evaluated by laboratory tests, in a full scale engine nacelle, and finally by means of flight tests. G.R.

A72-19269 # Design for acceptable aircraft vibration. A. G. Woods. *(British Acoustical Society, Spring Meeting on Transport Noise and Vibration, University of Birmingham, Birmingham, England, Apr. 5-7, 1971.) British Acoustical Society,* vol. 1, Autumn 1971. 4 p.

A number of vibration problems with various types of aircraft are discussed, taking into account flight vibrations and runway response. A literature survey and experimental investigations showed that the levels of vibration experienced during taxiing could be caused by running over quite small discontinuities. The forcing was proportional to the effective tire stiffness. Only from 10 to 25% of the structural vibration was produced by forcing through the nosewheel. The need for the measurement and analysis of acceptable vibration levels on aircraft in service is pointed out. G.R.

A72-19277 Some human factors considerations in the design of instructor's stations for automated flight training systems. J. N. Fox (Texas, University, Arlington, Tex.) and A. S. Blaiwes (U.S. Navy, Naval Training Devices Center, Orlando, Fla.). In: Hawaii International Conference on System Sciences, 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 73-75. 5 refs.

Attempt to ascertain the informational requirements of the instructor's station in automated flight training systems. The functions of the instructor in such a system are reviewed, noting the effect of automated and adaptive training in increasing flexibility of the instructor functions. The informational requirements of the instructor are discussed from the standpoint of procedural information and flight path information. The application of computer generated displays to training device instructor stations is considered. A.B.K.

A72-19279 Singular surfaces in aircraft/aircraft differential games assuming a spherical acceleration vectogram for each aircraft. S. M. D. Williamson-Noble (RAF, Cranwell, Lincs., England). In: Hawaii International Conference on System Sciences, 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 94-97.

A two player perfect information zero-sum differential game between two aircraft each having a spherical acceleration vectogram is investigated. Both players are permitted to move freely in three-dimensional space, allowing the model to serve as a basis for formulating pseudo-optimal controls in a realistic dogfight situation. Open-loop and equivalent closed-loop minimax controls are evaluated for the minimum time to capture problem, and a preliminary investigation is made of the singular surfaces that make up the solution 'in the large.' (Author)

A72-19282 Optimal thrust reversing in pursuit evasion games between two aircraft. A. L. Leatham and G. M. Anderson (USAF, Wright-Patterson AFB, Ohio). In: Hawaii International Conference on System Sciences, 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 142-144.

This paper presents some initial results of a study of the optimality of thrust-reversing in a pursuit-evasion situation between two aircraft in a horizontal plane. Various cost functions and termination criteria are considered. It is shown that for these cost functions and termination criteria, thrust reversing for either aircraft can be optimal only when the final angle between the pursuer's velocity vector and the line of sight to the evader appears in either the cost function or the terminal condition. Some typical saddle point solutions are presented to illustrate the differences between optimal trajectories with thrust reversing and those without. (Author)

A72-19286 An innovations approach to maximum likelihood identification of linear and nonlinear dynamic systems. R. K. Mehra (Systems Control, Inc., Palo Alto, Calif.). In: Hawaii International Conference on System Sciences, 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 252-254. 8 refs.

This paper presents a new approach to maximum likelihood identification of multi-input multi-output linear and nonlinear dynamic systems with arbitrary inputs. The approach is based on state vector formulation and uses the innovation properties of optimal filters for these systems. Applications to the identification of the transfer function of a chemical reactor and to the estimation of the stability and control derivatives of a VTOL aircraft are considered. (Author)

A72-19287 * Optimal horizontal guidance law for aircraft in the terminal area. T. Pecsvaradi (NASA, Ames Research Center, Moffett Field, Calif.). In: Hawaii International Conference on

System Sciences; 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 264-266.

A complete nonlinear control law is derived for guiding an aircraft in minimum time from an arbitrary initial position and heading to a prescribed terminal position and heading in the horizontal plane. The solution is obtained with the aid of the maximum principle, and is implemented by constructing a digital-computer program for the resulting switching logic. V.P.

A72-19301 Digital simulation of the air traffic control radar beacon system. L. A. Kleiman (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: Hawaii International Conference on System Sciences, 5th, University of Hawaii, Honolulu, Hawaii, January 11-13, 1972, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1972, p. 558-560.

This paper describes a FORTRAN simulation of the Air Traffic Control Radar Beacon System, which aids air traffic controllers in the location and identification of cooperative aircraft. Operating on real air traffic data and actual characteristics of the relevant ground interrogators, the simulation program reenacts system operation in a realistic 'pulse-by-pulse' manner. The realism employed in the program structure makes possible the production of computer-generated movies that depict an air traffic controller's display. Typical frames from such a movie are presented and discussed. (Author)

A72-19331 # Exhaust noise field generated in the JT8D core engine-noise floor presented by the internal noise sources. E. Grande (Wyle Laboratories, Inc., El Segundo, Calif.). *Acoustical Society of America, Fall Meeting, 82nd, Denver, Colo., Oct. 19-22, 1971, Paper.* 15 p. 8 refs.

It is shown experimentally that internally generated core-engine noise may be determined from sound pressure measurements in the primary exhaust duct. The observed agreement between the measured and theoretical cross-power spectral densities indicates that substantial simplifications in the measurement technique should be possible. The far field noise levels due to internally generated core-engine noise lie well below the total noise levels of the JT8D engine, except at very low engine power settings. The contribution is, however, sufficient to impose a constraint on the noise-suppression potential of the engine. This constraint should be even more significant in high-bypass-ratio turbofan engines, owing to their relatively greater work extraction in the turbine stages and corresponding lower core-engine jet velocities. V.P.

A72-19484 Statistical evaluation cuts testing costs for jet engine parts. J. Chander (United Aircraft of Canada, Ltd., Longueil, Quebec, Canada), J. T. Lamberti (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.), and A. Kumar. *Metals Engineering Quarterly,* vol. 12, Feb. 1972, p. 36-38.

A system is described for testing forgings that eliminates the need of integral material on the forging and replaces 100% integral testing, reducing material and testing cost. Tests taken from five locations in each of three parts predict tensile properties as well as does 100% testing of integral material. The quality of any batch can be quantitatively defined. The system allows faster laboratory release of parts for machining. M.V.E.

A72-19490 # Instrumentation for the California airport noise standards. G. R. Partridge (General Radio Co., Concord, Mass.). *Acoustical Society of America, Fall Meeting, 82nd, Denver, Colo., Oct. 19-22, 1971, Paper.* 13 p.

A simple and efficient battery-operated instrument has been developed to measure both the hourly noise level (HNL) and the community noise equivalent level (CNEL) values and to record them automatically. Features of the instrument and its operation are presented. Results of experimental airport noise measurements obtained by using this instrument are given. O.H.

A72-19573 LDC-2, a new coating for nickel alloys (LDC-2, eine neue Schutzschicht für Nickellegierungen). G. Lehnert and H. W. Meinhardt (Deutsche Edelstahlwerke AG, Forschungsinstitut, Krefeld, West Germany). *DEW-Technische Berichte,* vol. 11, Nov. 1971, p. 236-240. In German.

Summary of experience gained with a new coating for nickel alloys used in aircraft engine components subjected to high temperatures and corrosion. The new coating, LDC-2, is shown to be a remarkable improvement over the relevant contemporary technology by citing the results of cyclic sulfidation with additions of sulfur and synthetic sea salt, and the results of high-temperature oxidation, hot corrosion, and thermal shock testing. The coating is produced by an aluminum diffusion treatment following galvanic platinum deposition. LDC-2 is recommended as a coating for the walls of the cooling passages of water-cooled turbine blades. A.B.K.

A72-19597 Airline meteorology today. W. B. Beckwith (United Air Lines, Inc., Chicago, Ill.). *Technology Review,* vol. 74, Feb. 1972, p. 11-19.

Five types of weather problems which were once responsible for airline operating delays have ceased to exist as causes of interruptions, and six others have been reduced in effect by technological developments of the last 35 years. But new technology has also resulted in a new set of five problems to which earlier aircraft and airline operations were not susceptible. Problems due to the occurrence of fog are discussed together with difficulties caused by snow and freezing rain, thunderstorms, strong crosswind, headwinds, tail winds, clear air turbulence, low-level wind shear, high surface temperatures, and wet runways. Solutions to the overall problem of delays caused by weather are complex and involve efforts by both government and industry. G.R.

A72-19645 The location of the ground focus line produced by a transonically accelerating aircraft. J. M. Nicholls and B. F. James (Meteorological Office, Bracknell, Berks., England). *Journal of Sound and Vibration,* vol. 20, Jan. 22, 1972, p. 145-167. 19 refs.

This paper describes the theory of propagation of a sonic bang in a horizontally stratified atmosphere with wind, and the way in which this theory has been utilized to derive a computer program for finding, for an aircraft climbing and accelerating (normally along a straight line ground track), the location of the intersection of the bang wavefront with the ground. The locations of the ground focus line, along which there is a marked enhancement of the bang 'overpressure' on the ground, are found for a large range of atmospheric structures. The feasibility of forecasting these locations, and the possibility of defining an area on the ground which would encompass all focus lines for a given flight plan, are also examined. (Author)

A72-19648 Hovercraft noise and vibration. E. J. Lovesey (Royal Aircraft Establishment, Engineering Physics Dept., Farnborough, Hants., England). *(British Acoustical Society, Spring Meeting, Birmingham, England, Apr. 5-7, 1971.) Journal of Sound and Vibration,* vol. 20, Jan. 22, 1972, p. 241-245.

Hovercraft are a relatively new and unique form of transport, capable of traversing terrains which hitherto have been almost impassable at speed by surface transport. This high-speed capability was gained partially at the cost of ride comfort, but unlike some vehicle developments, as power and speed have increased, the noise and vibration within the hovercraft have steadily decreased with each new craft. The sources of noise and vibration are discussed, together with their possible methods of reduction in order to improve crew and passenger comfort. (Author)

A72-19708 **A new approach to a model-following control for nonlinear multivariable systems.** E. Kienzle and G. Schmidt (Dornier AG, Friedrichshafen, West Germany). In: Multivariable technical control systems; Proceedings of the Second Symposium, Düsseldorf, West Germany, October 11-13, 1971. Volume 2. Amsterdam, North-Holland Publishing Co., 1971, p. 2.1.2 1-2.1.2 13. 6 refs.

Discussion of some aspects of a new approach to model following for nonlinear multivariable plants. It is assumed that model and plant are described by a known set of nonlinear state equations. The model-following control system discussed is designed with respect to the requirement that the plant be controlled so that it perfectly matches the dynamics of the model. It is shown that an explicit solution to the nonlinear model-following control problem cannot be given. However, by means of a Newton-type iteration procedure an implicit control algorithm can be solved for the control vector. This process is performed in real time and repeated during every sampling interval. Some computational and realization aspects of this method of control are discussed. The method is demonstrated by the well-known problem of synthesis of a control for a variable-stability aircraft. (Author)

A72-19709 **Predictive control of multivariable systems.** N. C. Megson and C. R. Guy (Cambridge University, Cambridge, England). In: Multivariable technical control systems; Proceedings of the Second Symposium, Düsseldorf, West Germany, October 11-13, 1971. Volume 2. Amsterdam, North-Holland Publishing Co., 1971, p. 2.1.3 1-2.1.3 13. 8 refs.

Some methods are described for the application of predictive control to multivariable systems. A two variable second order system is treated in detail, and various control strategies are postulated. It is difficult to derive a strategy which gives good control in the general case, and the best method depends on the properties of the system under consideration, i.e., the amount of cross-coupling and the drive power available. In addition to two variable second order systems, the m variable n-th order case is considered. A scheme for controlling this configuration is outlined, and, although no claims are made for its optimality, the strategy has the advantage of simplicity. The control which results should be adequate in most practical cases, and, as an example, the case of an automatic landing of a VTOL aircraft is used. M.V.E.

A72-19725 **Against fatigue.** W. E. Goff. *Flight International,* vol. 101, Jan. 27, 1972, p. 145-148.

It is pointed out that to a much greater degree than with fabricated structures integral construction makes possible the avoidance of stress concentrations, which can be the cause of fatigue problems. Aircraft plate is made from ingots produced by the continuous-casting process. Details of the casting process are discussed together with the procedures for stress relieving and ultrasonic flaw-testing. G.R.

A72-19758 # **Contribution to the theory of a gyrohorizon compass with azimuthal correction of the sensitive-element housing (K teorii girogorizontkompasa s korrektiruemoi v azimute obolochkoi chuvstvitel'nogo elementa).** G. F. Zolotenko and S. M. Onishchenko (Akademiia Nauk Ukrainskoi SSR, Institut Matematiki, Kiev, Ukrainian SSR). *Prikladnaia Mekhanika,* vol. 7, Dec. 1971, p. 65-70. In Russian.

The small motions of the sensitive element of a Geckeler-Anschütz two-rotor gyrohorizon compass are analyzed in a precession formulation of the problem. The presence of initial nonzero deflections in the compass coordinates and the absence of a coupling between the gyrocompasses are taken into account. By a special transformation of the coordinates, the initial equations are reduced to four Il'iushin type equations and one second-order inhomogeneous equation. For a linear azimuthal correction of the sensitive-element housing, quadrature solutions are obtained for an arbitrary motion of the suspension center-point over the earth's surface. V.P.

A72-19768 # **Structural changes in the surface layers of the C-137 sealing material during dry friction at high speeds (Strukturnye izmeneniia v poverkhnostnykh sloiakh uplotnitel'nogo materiala C-137 pri vysokoskorostnom sukhom trenii).** N. L. Golego, M. E. Belitskii, A. D. Gaidarenko, and V. A. Liashko (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Fiziko-Khimicheskaia Mekhanika Materialov,* vol. 7, no. 6, 1971, p. 20-24. 6 refs. In Russian.

The friction coefficient, standard wear, and surface-layer temperature of a seal intended for friction pairs in jet engines are determined experimentally. Particular attention is given to changes in the crystal lattice parameters in the surface layers as a function of the external conditions. It is found that changes in the slip velocity and pressure lead to the formation of a surface layer whose properties differ from the matrix material. V.P.

A72-19873 # **A preliminary investigation of the aeroacoustics of jets perturbed by screens.** R. E. A. Arndt (Pennsylvania State University, University Park, Pa.). *Acoustical Society of America, Fall Meeting, 82nd, Denver, Colo., Oct. 19-22, 1971, Paper.* 48 p. 18 refs. Contract No. N00017-70-C-1407.

It is observed that the placement of a screen across the exit plane of a jet nozzle results in a substantial reduction in noise intensity compared to conditions with an equivalent unperturbed jet. The general features of this phenomenon are analyzed experimentally, utilizing both acoustic and velocity (hot wire) measurements. Acoustic radiation data from a jet operating in the Mach number range from 0.2 to 0.8 indicate that the insertion of a screen into the flow can reduce the maximum intensity by as much as 14 dB. Associated with this noise reduction are a loss of directivity and a substantial flattening of the power spectrum. G.R.

A72-20062 **Flows with heat addition and associated pressure fields.** E. G. Broadbent (Royal Aircraft Establishment, Farnborough, Hants., England). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 10th, Rynia, Poland, September 6-11, 1971, Proceedings. Part 1. Warsaw, Państwowe Wydawnictwo Naukowe, 1972, p. 79-113. 42 refs.

It is shown that inverse methods are particularly valuable in exploring flows with heat addition. The numerical method makes it possible to calculate the pressure gradients in a combustion chamber. The isothermal expansion offers the possibility of approaching Carnot-cycle efficiency. It is found that heat addition is usually accompanied by a geometric expansion of the flow. Examples are given of internal and external combustion on a hypersonic aircraft, of base-burning, and of isothermal heat addition. G.R.

A72-20068 # **Well-posed problems and transonic flow.** C. S. Morawetz (New York University, New York, N.Y.). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 10th, Rynia, Poland, September 6-11, 1971, Proceedings. Part 1. Warsaw, Państwowe Wydawnictwo Naukowe, 1972, p. 325-333. 5 refs.

The present existence and uniqueness theorems for mixed equations are reviewed. Statements about transonic flow are derived on the basis of model problems which are mathematically valid. Some boundary value problems for the two-dimensional transonic profile flow are outlined, and a set of mathematically simpler models is described. The boundary value problems considered include the flow past a symmetric profile without shock, a perturbed shockless flow, the flow past a symmetric profile with a single shock, and the perturbation problem with shock. G.R.

A72-20079 # **A numerical method for computing flows past wing airfoils at Mach number one.** D. Euvrard, J. Hubert, and G. Tournemine (Rennes, Université, Rennes; Paris, Université, Paris, France). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 10th, Rynia, Poland, September 6-11, 1971, Proceedings. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1972, p. 155-159. 6 refs.

A method of computing the transonic range (including the subsonic region upstream and two narrow supersonic strips extending to infinity and bounded downstream by the limiting characteristics) is proposed. Using this method, a solution is obtained by fitting mixed initial-boundary conditions. The mathematical difficulties arising from the fact that the domain of integration tends to infinity, making it necessary to deal with essentially nonlinear equations of mixed type, are overcome with the aid of the ideas underlying Chushkin's (1957) method. V.P.

A72-20100 # **New aspects of sound generation by circular jets.** A. Michalke (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Turbulenzforschung, Berlin, West Germany). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 10th, Rynia, Poland, September 6-11, 1971, Proceedings. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1972, p. 439-448. 12 refs.

An approach to jet noise is developed which is based on the use of cylindrical coordinates in the source term of Lighthill's equation for a circular jet and on a spectral method proposed by Michalke (1970) for the noise radiated by a circular jet. The sound intensity of spectral components far from a circular jet is analyzed, and some essential features of the mechanism of sound generation are revealed. V.P.

A72-20101 # **Unsteady air forces on tandem airfoils in subsonic flow.** M. Nowak (Polska Akademia Nauk, Instytut Podstawowych Problemów Techniki, Warsaw, Poland). In: Symposium on Advanced Problems and Methods in Fluid Mechanics, 10th, Rynia, Poland, September 6-11, 1971, Proceedings. Part 2. Warsaw, Państwowe Wydawnictwo Naukowe, 1972, p. 459-463.

Discussion of some calculation results pertaining to the characteristics of the unsteady aerodynamic interference between two lifting surfaces in tandem at subsonic velocities. The calculations are based on a simple two-dimensional model. The mathematical treatment uses Possio's (1938) integral equation. M.V.E.

A72-20163 **Aircraft noise and sonic boom.** J. B. Large (Boeing Co., Renton, Wash.). In: Transportation noises; Symposium on Acceptability Criteria, University of Washington, Seattle, Wash., March 26-28, 1969, Proceedings. Seattle, University of Washington Press, 1970, p. 3-14. 6 refs.

The noise signatures of turbojet and turbofan engines are first described at the source and then at a distant receiver after being affected by atmospheric propagation. Directional characteristics of compressor, jet, fan, and turbine noise components are explained, together with the frequency dependence of atmospheric attenuation and the time histories of takeoff and approach noise levels. Effectiveness of engine noise suppression systems is evaluated, and the theory of sonic boom effects is analyzed in detail. Sonic boom track width, signatures, frequency spectra, and effects of turbulence are treated. T.M.

A72-20201 # **Aircraft ac generating systems - Recent development history and future trends.** W. Hart (Lucas-Rotax, Ltd., Montreal, Canada). *(Canadian Aeronautics and Space Institute, Annual General Meeting, Montreal, Canada, May 6, 1971.) Canadian Aeronautics and Space Journal,* vol. 18, Jan. 1972, p. 9-16.

This paper briefly reviews the history of electric power generation in aircraft. The growth of installed electrical power capacity is traced and the way in which aircraft performance has influenced electrical system design, culminating in the modern Constant Frequency AC Generating System, is examined. This system, because of its wide utilization, is dealt with in some detail, considering the associated specification requirements of such a system and indicating the major design parameters involved in achieving compliance. Typical examples of modern equipment are described briefly, indicating the major components and showing the improvement in power/weight ratio over the years in all types of equipment and the manner in which these improvements have been achieved. In conclusion, some modern trends are noted and briefly discussed. (Author)

A72-20204 **Practical solution of linear equations with periodic coefficients.** M. A. Gockel (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Journal,* vol. 17, Jan. 1972, p. 2-10. 11 refs.

Several helicopter components governed by linear systems of equations with periodic coefficients are listed. A sample problem is investigated by the conventional method of simulation, which is shown to have several shortcomings. Two methods of obtaining closed-form solutions are discussed. Characteristic exponents and characteristic functions are found for the sample problem. The manner in which the closed-form solution offers insight into the behavior of the system is described. (Author)

A72-20205 **Articulated rotor blade flapping motion at low advance ratio.** F. D. Harris (Boeing Co., Vertol Div., Philadelphia, Pa.). *American Helicopter Society, Journal,* vol. 17, Jan. 1972, p. 41-48. 26 refs.

At low advance ratio, articulated rotors exhibit an excessive amount of lateral flapping due primarily to major nonuniformities in induced velocity along the longitudinal axis of the rotor. An experimental study of this blade motion characteristic was conducted with a 5.5 foot diameter, CH-47C model rotor in a wind tunnel. Data taken over an advance ratio sweep from 0 to 0.24 at constant lift showed maximum lateral flapping of 3.4 deg at 0.08 advance ratio. Classical rotor aerodynamic theory assuming uniform downwash accounts for only 0.4 deg of this lateral flapping. Experimental data for longitudinal flapping illustrate that lateral nonuniformity in induced velocity is considerably less significant. Variations in both shaft tilt and collective pitch at an advance ratio of 0.08 produced experimental blade motion trends that were nearly linear with both variables. (Author)

A72-20268 **Examples of technological trend forecasting for research and development planning.** J. Martino (USAF, Office of Research Analyses, Holloman AFB, N. Mex.). *Technological Forecasting and Social Change,* vol. 2, no. 3-4, 1971, p. 247-260.

The research reported here was directed at evaluating existing means of technological forecasting and obtaining improved methods. This report presents the results of fitting appropriate trend curves to several sets of data on technologies of interest to the Air Force. These trends, when projected, represent technological forecasts. The likelihood of continuation or change of the trend is discussed in each case, with implications of R & D (research and development) planning. These forecasts are considered of possible interests as examples of applied forecasting techniques. (Author)

A72-20269 **The rate of innovation in the commercial aircraft jet engine market.** A. W. Blackman, Jr. (United Aircraft Research Laboratories, East Hartford, Conn.). *Technological Forecasting and Social Change,* vol. 2, no. 3-4, 1971, p. 269-276. 5 refs.

The applicability of a deterministic model which was developed

by Mansfield (1961) and which describes the rate at which new product innovations are adopted was applied to the commercial aircraft jet engine market. The model was found to agree well with (1) historical market share data related to the displacement of the turbojet engine by the first generation turbofan, and with (2) forecasts of future market shares related to the displacement of the first generation turbofan by the second generation turbofan. The rate at which a new product innovation displaces an existing product in a given market appears to be an increasing function of: (1) the proportion of firms already using the new product, and (2) the profitability of the new product relative to the old product and a decreasing function of the size of the investment required to adopt the new product. (Author)

A72-20306 **The Mitsubishi T-2 Japanese two-place supersonic trainer (Le biplace japonais d'entrainement supersonique Mitsubishi T-2).** F. Riga (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique,* no. 33, 1972, p. 29-34. In French.

Historical review of the evolution of the Japanese pilot training program, followed by description of the prototype Mitsubishi T-2, which is intended to supersede the T-33 and F-86F. The aircraft has a double-delta high wing, a large vertical fin, and a tricycle landing gear. It is powered by two Rolls-Royce/Turbomeca 'Adour' jet engines, the air inlets of which are incorporated in the fuselage. F.R.L.

A72-20308 **Brief survey of French and foreign military aircraft (Aperçus sur les avions militaires français et étrangers).** G. Bruner (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique,* no. 33, 1972, p. 41-52. In French.

Summary of the particulars of a number of military aircraft, the French aircraft described being the Marcel Dassault Mirage types III, 5, Milan, F 1, and G 8. French and German cooperation developed the Dassault-Breguet/Dornier Alpha-Jet. The BAC-Breguet Jaguar is a Franco-British project. The Italian G 222 and the Anglo-German-Italian Panavia 200 receive attention. U.S. aircraft described are the B-1, F-15, A-4M. CL-1200, and C-5A. Brief comment is made on the Israeli light cargo aircraft Arava, and the British Britten-Norman Defender. F.R.L.

A72-20309 **Reliability and testing of the equipments of the Concorde aircraft (Fiabilité et essais des équipements de l'avion Concorde).** M. Bossard (Société Nationale Industrielle Aérospatiale, Toulouse, France). *L'Aéronautique et l'Astronautique,* no. 33, 1972, p. 53-59. In French.

Discussion of the procedures adopted to achieve a high safety level in the various Concorde systems. The procedures determine the general structure of the systems, analyze the safety of each of them, and study certain particular risks. Operating and environmental conditions are discussed. Studies of the possible consequences of breakdown have been made both in flight and by means of simulators. Predictions of the rates of breakdown in service have been made, and appropriate maintenance methods have been devised. F.R.L.

A72-20310 **The Mercure, its program and its utilization (Le Mercure, son programme et son utilisation).** J. Gelos (Avions Marcel Dassault, Vaucresson, Hauts-de-Seine, France). *(Salon Aéronautique et Spatial, 8th, Toulouse, France, June 24, 1971.) L'Aéronautique et l'Astronautique,* no. 33, 1972, p. 61-68. In French.

Analysis of the main features of the Mercure transport aircraft, which is well adapted to short routes, and has capability for further development. From the inception of the Mercure concept, major attention was given to theoretical calculations to eliminate, as far as possible, long delays in the construction of wind tunnel models. Because of the short flight stages, a speed of Mach 0.83 was considered adequate. Features previously developed for the Falcon series of business jets have been adapted for use in the Mercure. The structure is integral and is shaped by machining, thus lightening it and reducing possibilities of fatigue damage. F.R.L.

A72-20311 **On high turbine entry temperatures in turbojets and gas turbines (Des hautes températures devant turbine sur turboréacteurs et turbines à gaz).** P. Alesi (SNECMA, Villaroche, France). *L'Aéronautique et l'Astronautique,* no. 33, 1972, p. 69-78. In French.

Turbine engine performance investigations show the advantage of high turbine entry temperatures. In gas turbines, high temperatures will provide considerably increased specific power, lower specific fuel consumption and, in particular, a less significant increase in SFC at partial rating to such an extent that gas turbines can compete with Diesel engines. A review of turbojets shows that higher turbine entry temperatures always result in a weight reduction: by increasing the thrust-weight ratio with straight flow turbojets and moderate by-pass ratio turbofans, and by increasing the by-pass ratio of the third generation turbofans. In high by-pass ratio turbofans, the reduction of the SFC implies necessarily an increased pressure ratio and increased turbine and compressor component efficiencies, in addition to higher turbine entry temperatures. (Author)

A72-20336 **A cockpit simulator for air traffic control research.** M. E. Connelly, R. Rausch, T. Imrich, and R. Anderson (MIT, Cambridge, Mass.). In: Summer Computer Simulation Conference, Boston, Mass., July 17-21, 1971, Proceedings. Volume 1. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 216-225.

A cockpit simulator for the Boeing 707 jet transport is described that uses computer-generated displays to provide the pilot with a set of basic flight instruments, a moving map for area navigation, and selected air traffic control information. The simulation test program for this facility is discussed. The principal research objective of the program was to specify the air traffic control functions that could beneficially be delegated to the pilot and to determine how best to utilize airborne displays in implementing these functions. (Author)

A72-20341 **A model of the airfield surface system.** D. Maddison (Peat, Marwick, Mitchell and Co., Burlingame, Calif.). In: Summer Computer Simulation Conference, Boston, Mass., July 19-21, 1971, Proceedings. Volume 1. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 522-527.

The fast-time computer simulation model of the airfield surface system described in this paper was developed as a tool for use in airport planning. Details of the model's structure and its application in comparing two terminal configurations in terms of aircraft delay are presented. (Author)

A72-20342 **Air/ground interface simulation.** N. E. South (Ford Motor Co., Dearborn, Mich.). In: Summer Computer Simulation Conference. Boston, Mass., July 19-21, 1971, Proceedings. Volume 1. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 528-537.

A novel air/ground interface system concept is described along with three versions of a simulation model that was written in GPSS/360 to analyze the system. Some implications and selected results are presented and discussed. (Author)

A72-20343 **Simulation of nonlinear air cushion vehicle dynamics using bond graph techniques.** C. J. Radcliffe and D.

Karnopp (California, University, Davis, Calif.). In: Summer Computer Simulation Conference, Boston, Mass., July 19-21, 1971, Proceedings. Volume 1. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 550-558.

The nonlinear heave dynamics of air cushion vehicles with two different lift fan types are simulated through the use of bond graph techniques. The construction of bond graph models of the vehicle and the derivation of system equations are explained, followed by presentation of typical results for axial fan and centrifugal fan versions of the model. Finally, the modification of the model for shorter computation time and additional degrees of freedom is discussed. (Author)

A72-20353 Aircraft performance simulation for preliminary design, and in education. M. Saarlas (U.S. Naval Academy, Annapolis, Md.). In: Summer Computer Simulation Conference, Boston, Mass., July 19-21, 1971, Proceedings. Volume 1. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 724-732.

Aircraft preliminary design is approached from the point of view of attempting to strike a balance between the laborious, repetitive, and approximate manual design routine and the precise and detailed but somewhat inflexible computer aided design programs. The mission requirements or a need for a vehicle form the basis to this approach with the following four requirements: (1) minimum number of inputs; (2) performance synthesis within the design; (3) educational use in design classrooms; (4) quick turnaround time. These conditions combine to yield a highly flexible system suitable for interactive time sharing computer facility. Use of the program in a classroom situation is discussed with an illustrative example. (Author)

A72-20362 Transportation systems simulation requirements. B. Wong and A. M. Colella (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: Summer Computer Simulation Conference, Boston, Mass., July 19-21, 1971, Proceedings. Volume 2. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 1075-1083. 26 refs.

Discussion of simulation requirements for air and ground transportation systems, with particular attention to mathematical models capable of relating meaningful system performance characteristics to design parameters and variables. The key requirements of simulation are given as the abilities of handling rapidly great volumes of input data, executing efficiently the relevant mathematical models and providing a visual interpretation of critical system design parameters. Block diagrams are included for some representative traffic control systems. V.Z.

A72-20363 Multi-modal transportation system simulation. R. C. Ricci and J. R. Roy (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: Summer Computer Simulation Conference, Boston, Mass., July 19-21, 1971, Proceedings. Volume 2. Denver, Colo., Board of Simulation Conferences; Montvale, N.J., American Federation of Information Processing Societies, 1971, p. 1084-1095. 8 refs.

Discussion of the present status of a laboratory being developed for real-time simulation of command and control functions in transportation systems. Details are given on the simulation models and structure and on programming techniques used in defining and evaluating the maximum effectiveness of controllers in future air traffic control systems. The topics include simulation philosophy, program language, processing time, macro approach to air traffic simulation, Fortran approach, display software, multi-modal transportation systems, bus routing simulation and rapid transit and highway system simulation. The equipment of the laboratory is described. V.Z.

A72-20365 Probabilities of aircraft encounters with heavy rain. J. Briggs. *Meteorological Magazine,* vol. 101, Jan. 1972, p. 8-13.

Estimates of probabilities of aircraft encounters with heavy rain have been obtained for three localities. The estimates are necessarily based on somewhat arbitrary assumptions, especially as regards the variation in rainfall probabilities with variation of height. However, the assumptions are reasonably supported by observational evidence and the method used has the merit that estimates can be made fairly readily for any area where the available rainfall data are adequate. (Author)

A72-20371 # State of development and possibilities of employment of the air cushion vehicle. I (Entwicklungsstand und Einsatzmöglichkeiten des Luftkissenschiffes. I). S. Knöfel. *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 7, no. 12, 1971, p. 538-550. In German.

The first crossing of the channel from Dover to Calais by an air cushion vehicle was undertaken in July 1959. In 1968 the presently largest air cushion vehicle with a weight of 177 t and a capacity for 800 passengers was introduced into service. Air cushion vehicles for transportation over water at velocities of 300 km/hr are a possibility. The physical principles upon which the operation of the air cushion vehicles is based are discussed. The efficiency of an air cushion vehicle depends on the approach used for the generation of the air cushion. Various types of air cushion vehicles are considered, together with questions of equipment and design. G.R.

A72-20372 # Aeromechanical analysis of various flight conditions for conventional aircraft. I - Mechanical foundations /kinematics/ (Flugmechanische Analyse verschiedener Flugzustände konventioneller Flugzeuge. I - Mechanische Grundlagen /Kinematik/). F. Seidler (Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 7, no. 12, 1971, p. 551-567. 5 refs. In German.

A basic introduction into aeromechanics is provided, giving attention to scalars and vectors, velocity and angular velocity, degrees of freedom of an aircraft, acceleration, and angular acceleration. A classification of translational motion is presented, taking into account accelerated and not accelerated motions. A special case discussed concerns curvilinear motions with constant speed. G.R.

A72-20373 # Purity requirements concerning aircraft turbine fuels (Reinheitsforderungen an Flugturbinenkraftstoffe). R. Herrmann. *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 7, no. 12, 1971, p. 568-577, 584. 10 refs. In German.

It is pointed out that the introduction of gas turbine propulsion into aviation had a decisive effect upon the development and the production of new aviation fuels. The use of kerosene increased considerably, and the requirements concerning the quality and purity of the fuels became more exacting. The nature of fuel impurities in aviation fuel and the significance of these impurities is discussed. Mechanical impurities, water in liquid and solid phase, microorganisms, surface-active substances, corrosive fuel components, resinlike substances, and paraffins with a high boiling point are considered. G.R.

A72-20459 French geared variable-pitch turbofan. K. T. Fulton (Bristol Siddeley Engines, Ltd., Bristol, England). *Chartered Mechanical Engineer,* vol. 19, Feb. 1972, p. 54, 55, 58.

A new turbofan, the Astafan, in which engine rotational speed is automatically held constant under all operating conditions is discussed. The inlet guide vanes have been eliminated, and the single-stage fan rotor has been equipped with variable-pitch blades. Thrust variation is obtained by altering the pitch of the fan blades.

The Astafan consists of three basic sections including the fan with its light alloy cowl, the reduction gearbox with integral core engine air inlet, and the Astazou power section. G.R.

A72-20542 Application of theoretical acoustics to the reduction of jet engine noise. J. D. Kester and G. F. Pickett (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Journal of Physics, Part D - Applied Physics,* vol. 5, Jan. 1972, p. 12-27. 10 refs. FAA-sponsored research.

Two examples of the application of acoustical theory to specific noise generating mechanisms are presented. The first example discusses discrete-tone interaction noise from fans and compressors. Some of the problems arising from predicting noise levels of this type of noise are considered, and a recent test is described that illuminates certain features of these problems. The second example describes some current work on combination-tone noise from supersonic tip speed fans, which has become prominent with the advent of high bypass ratio turbofan engines. Results of large-scale fan tests are used to illustrate the physical characteristics of this noise. A mathematical model is introduced that determines the importance of blade shock-wave spacing in the noise generation process. Finally, a method of estimating the standard deviation of shock-wave spacing is presented and compared with full-scale data. O.H.

A72-20592 Linear sensitivity analysis applied to a two-loop system with feedback variations. J. F. Klafin, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.) and V. Krishnan (Brooklyn, Polytechnic Institute, Brooklyn, N.Y.). *International Journal of Control, First Series,* vol. 15, Feb. 1972, p. 305-317. 12 refs.

The objective of this investigation is to determine correlation between engineering observations of system sensitivity compared to analytically computed sensitivity parameters. A two-loop system representative of an aircraft altitude control system, designed by the compensation parameter variation technique is presented as an example. Sensitivity observations are made of the behavior of the system poles in the complex plane. For the inner loop reasonable correlation was found between the observed pole sensitivities and the computed Bode pole sensitivities. For the outerloop system also the computed Bode pole sensitivities showed good correlation with the observed outer-loop pole sensitivities, but not with the observed output sensitivities. (Author)

A72-20593 A new approach to system transient response sensitivity. D. R. Towill and Z. Mehdi (Institute of Science and Technology, Cardiff, Wales). *International Journal of Control, First Series,* vol. 15, Feb. 1972, p. 319-331. 15 refs.

An intuitive approach to the convolution problem allows the transient response sensitivity of zero velocity lag servomechanisms to be readily sketched. This procedure leads to a considerable insight into the advantages of feedback compensation in sensitivity reduction; this is much greater than any advantage obtained in choosing between alternative unity feedback designs, and is confirmed by Monte Carlo simulation. Prediction of transient response sensitivity to parameters other than system gain is readily achieved and illustrated by the prediction of the relative importance of elemental blocks of a sixth-order aircraft blind landing system. Maximum percentage overshoot is seen as a critical part of the deterministic performance specification. Not only does the maximum value of the basic sensitivity function increase with maximum percentage overshoot, but the sensitivity function is more oscillatory, with the first turning point no longer giving the peak value. (Author)

A72-20597 Use of a sailplane in measuring acoustic attenuation in the atmosphere. D. W. Beran and J. T. Gething (Melbourne, University, Melbourne, Australia). *Aero-Revue,* Feb. 1972, p. 93-95. 5 refs.

An experiment is described in which the atmospheric attenuation of acoustic waves was determined with the aim of quantitatively assessing the backscattering cross section of atmospheric turbulence. A Slingsby Dart 17R was used as a silent platform to carry an acoustic source whose output was measured at the ground. The distance to the glider was calculated, and from a comparison of the successive sound levels received at the ground (as the glider descended from heights up to 3000 m), a profile of the atmospheric attenuation was derived. An example of the raw CW data shows the decrease in variance of the signal at lower altitudes, as a result of reduced scintillation over shorter path lengths. V.P.

A72-20625 Fans without formulae. E. Eves. *Flight International,* vol. 101, Feb. 10, 1972, p. 217-220.

General consideration of fan-jet engines, which have the advantage of quietness. A high-bypass fan engine makes approximately a quarter of the noise of a suppressed pure jet, and half as much as a low-bypass jet. Primary and secondary costs are discussed, and various makes and types of fan-jet engines are briefly described, with outline of their principles of operation, their structural configurations, and their advantages and disadvantages. F.R.L.

A72-20671 Initial and continuing responsibilities of general aviation manufacturers. L. S. Carsey. *(Symposium on General Aviation Law, Southern Methodist University, Dallas, Tex., Mar. 17-19, 1971.) Journal of Air Law and Commerce,* vol. 37, Summer 1971, p. 295-307. 97 refs.

The relevant regulations and statutes which delineate the initial and continuing responsibilities of aviation manufacturers are examined together with the common-law sources of liability and the role of regulations in establishing limits of liability. Topics examined include the implementation of safety regulations, airworthiness directives, maintenance manuals, reporting obligations, component assembly, modifications and improvements, inspection requirements, and evidence of negligence. T.M.

A72-20783 # A simplified approach to parachute mortar design. V. W. Drexelius and M. L. Schimmel (McDonnell Aircraft Co., St. Louis, Mo.). In: Symposium on Explosives and Pyrotechnics, 7th, Philadelphia, Pa., September 8, 9, 1971, Proceedings. Philadelphia, Franklin Institute Research Laboratories, 1971, p. IV-6-1 to IV-6-4.

The use of boron/potassium nitrate as an energy source in parachute mortars for aircraft and spacecraft applications has been found to have significant advantages over the high-low propellant mortars used so far for this purpose. The impetus delivered by boron/potassium nitrate is a function of system geometry. For the F-111 and F-4 applications, the values were 70,000 and 120,000 ft lb/lb respectively. O.H.

A72-20929 Minimum frequency separation determination for avionics receivers and transmitters. F. D. Parsons and J. M. Stafford (IBM Corp., Huntsville, Ala.). In: Instrument Society of America, Annual Conference, 26th, Chicago, Ill., October 4-7, 1971, Proceedings. Part 4. Pittsburgh, Instrument Society of America, 1971, p. 847.1-847.5.

This paper describes a method of determining the minimum frequency separation required between a transmitter and receiver in order that the interference be kept to an acceptable level. This method requires knowing the receiver sensitivity and bandwidth, the transmitter amplitude spectrum, and the power arriving at the receiving antenna. This paper also contains the analytical mathematics used in the development of the method. (Author)

A72-21001 **1971 Report to the aerospace profession; Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., September 16-18, 1971, Proceedings.** Society of Experimental Test Pilots, Technical Review, vol. 10, no. 4, 1972. 232 p.

An outlook into the future of the aeronautical and astronautical field is presented, taking into consideration the industry, the space shuttle, the Air Force, the Navy, and developments in space. Subjects considered in the area of military and commercial aircraft include a performance and failure assessment monitor for the DC-10 autoland maneuver, the role of operational test and evaluation procedures in the future military Navy procurement decision process, and F-14 'Tomcat' flight test progress. Topics in the realm of manned space flight are discussed together with new developments regarding V/STOL.

G.R.

A72-21003 **Performance and failure assessment monitor for the DC-10 autoland maneuver.** A. J. Bailey, Jr., B. Boskovich, and W. Glasser (Honeywell, Inc., Minneapolis, Minn.). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 30, no. 4, 1972, p. 47-70.

A satisfactory inferface between the pilot and the automatic landing system is presently lacking in current operational systems. The DC-10 Performance and Failure Assessment Monitor is designed to bridge this gap. This concept differs from previous automatic landing monitor systems primarily with respect to the scope of the monitor's view of the monitored process and the depth of the resulting assessment. The design concept is discussed together with a performance assessment, failure assessment, and aspects of information display. G.R.

A72-21004 **Basic about scale one to one head-up display.** U. Frieberg (Saab-Scania A.B., Linköping, Sweden). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 4, 1972, p. 77-85.

In pitch the horizon lines must be scaled one to one and be wide enough to eliminate all tendencies for vertigo during IMC flying. As command symbol a pole track is selected consisting of imaginary poles standing on the ground at altitudes below 1500 feet with the bottom on the ground. The HUD navigation-mode is considered together with the response to stick input, the gust step response, the speed error, the HUD landing-mode, and the HUD takeoff mode.

G.R.

A72-21005 **F-14 'Tomcat' flight test progress.** R. K. Smyth (Grumman Aerospace Corp., Bethpage, N.Y.). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 4, 1972, p. 87-95.

Flight test progress on the F-14 program suffered a setback with the loss of the Number 1 aircraft on December 30, 1970. The second aircraft, scheduled to fly last February, was to explore the low speed regime. The first flight of this aircraft was delayed until changes were incorporated to replace certain small diameter titanium lines with stainless steel. After extensive ground testing of the revised hydraulic system the first flight was made on May 24 of this year. The results of this flight and the following test flights are discussed together with aspects of the flight test system. G.R.

A72-21010 **FAA activity in V/STOL development.** G. E. Lundquist (FAA, Washington, D.C.). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 4, 1972, p. 165-171.

One way of alleviating short haul transportation problems is connected with the introduction of V/STOL operation into the system. An important factor for the acceptability of the aircraft to the public is the requirement for quiet smokeless operation. The introduction of a V/STOL system requires in addition to a suitable aircraft also the development of the air traffic control system, navigation, and special landing aids. A short haul special projects office is to provide leadership within the FAA concerning the development work required. G.R.

A72-21011 **Sudden engine failure problems of high performance attack helicopters.** M. W. Buss (U.S. Army, Edwards AFB, Calif.). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 4, 1972, p. 173-188.

It is pointed out that no rotary-wing aircraft has an effective crew escape system. All maximum performance operations are generally conducted at very low altitudes. At these altitudes there is no time for a second effort if an emergency occurs. The results of simulated sudden engine failure tests performed with the HueyCobra are discussed. In all cases, the response following the throttle chop was similar, varying only in severity. Pilot reaction cues were identified. Pilot delay times are shown together with data regarding roll response, yaw response, sideslip, rotor speed decay, and engine torque. G.R.

A72-21012 **Avionics integration - The pilot's part.** N. Driscoll (Vought Aeronautics Co., Dallas, Tex.). *(Society of Experimental Test Pilots, Symposium, 15th, Beverly Hills, Calif., Sept. 16-18, 1971.) Society of Experimental Test Pilots, Technical Review,* vol. 10, no. 4, 1972, p. 189-197.

A modern and relatively complete weapons system, the A7, is considered as a basis for discussion of a possible function of pilots in the development area. The heart of the system is a general purpose digital computer. Other standard building blocks include the head-up display, a projected map, an inertial platform, radar, and Doppler. Next year's model is being offered with forward looking IR and illuminated low light television for those who might like to fly after dark. G.R.

A72-21019 **Supersonic boom theory.** M. J. Lighthill (Cambridge University, Cambridge, England). In: Shock tube research; Proceedings of the Eighth International Shock Tube Symposium, Imperial College of Science and Technology, London, England, July 5-8, 1971. London, Chapman and Hall, Ltd., 1971, p. 7/1-7/15, 7/17-7/20; Discussion, p. 7/15, 7/16. 6 refs.

Booms generated on the ground by supersonic aircraft flying at high altitude through a stratified atmosphere are considered. The key concept is that of acoustic impedance. First this is used to make self-evident for constant-area tubes the concept of the Riemann invariant, after which the rules for development in such tubes of acoustic pulses containing one or more weak shocks are simply interpreted in terms of mass conservation. The theory is extended to tubes of nonuniform, but gradually varying, impedance. In this case the second Riemann invariant remains practically constant within the pulse. The theory is extended to three-dimensional propagation within stratified atmospheres of pulses whose length is small compared with the atmospheric scale-height. Several aspects of the practical application of the theory to supersonic booms are discussed. G.R.

A72-21024 **Double-duty valve helps land and stop plane.** A. Horstin (Bendix Corp., Electrodynamics Div., North Hollywood, Calif.). *Hydraulics and Pneumatics,* vol. 25, Feb. 1972, p. 67-69.

Combination of the controls of the landing gear and speedbrake

hydraulic system on the F-111 aircraft into one valve. This has reduced the required number of hydraulic valves and helped minimize aircraft weight. The combination valve controls hydraulic fluid flow to the speedbrake door, landing gear, and landing gear door actuators of the aircraft. Aircraft configuration selection is accomplished by means of pilot-actuated electrical signals, mechanical inputs, or combination of these methods. Performance details of the valve components in the operational sequences are tabulated.
F.R.L.

A72-21090 Aircraft collision prevention in highly dense environments. J. A. Maynard (Honeywell, Inc., Minneapolis, Minn.). *(Institute of Navigation, Annual Meeting, 27th, Pasadena, Calif., June 29-July 1, 1971.) Navigation,* vol. 18, Winter 1971-1972, p. 409-416. 5 refs.

Some of the statistics are reviewed that describe the problem of the rapidly increasing probability of midair collisions taking place at present in the aviation environment. Present efforts directed at a solution of this problem are discussed, and an example is presented of a solution reached in the case of a special situation. A plan is suggested for the development of a total solution. M.V.E.

A72-21091 * Optimal and suboptimal methods of satellite surveillance for traffic control of transoceanic flights. H. Winter (Bell Aerospace Co., Buffalo, N.Y.). *(Institute of Navigation, Annual Meeting, 27th, Pasadena, Calif., June 29-July 1, 1971.) Navigation,* vol. 18, Winter 1971-1972, p. 417-424. 6 refs. Contract No. NAS5-21101.

Description of a system which uses two synchronous equatorial satellites. Aircraft location is determined by measuring the range of the aircraft to each satellite as well as aircraft altitude, and transmitting this information periodically to a ground station. There, the aircraft's geographic position at the time of transmission is computed. This information is then combined with past position measurements in a suboptimal filter to determine aircraft position and velocity (the velocity being used to estimate aircraft position between transmissions). The suboptimal filter is a simplification of the optimal Kalman filter. Except for altitude information, the system is independent of the aircraft navigation system. (Author)

A72-21092 # Influence of the parameters and position of the balance weight on the critical flutter rate (Vliianie parametrov i polozheniia balansiruiushchego gruza na kriticheskuiu skorost' flattera). P. S. Landa, M. V. Pentegova, and S. P. Strelkov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Moskovskii Universitet, Vestnik, Seriia III - Fizika, Astronomiia,* vol. 12, Sept.-Oct. 1971, p. 499-505. In Russian.

Investigation of the effect of the natural inertia moment of the balance weight situated at the wing tip on the magnitude of the critical flutter rate. It is shown that the dependence of the critical flutter rate on the natural inertia radius of the weight under constant mass is not a monotonic function when the weight increases; at first, the critical rate rises, then it starts falling. M.V.E.

A72-21174 # On the dynamical equivalence between two types of vehicles with rotors. M. R. M. Crespo da Silva (Cincinnati, University, Cincinnati, Ohio). *British Interplanetary Society, Journal,* vol. 25, Mar. 1972, p. 177-181.

The equations of motion of a vehicle, connected by bearings to a rotor driven by a motor, are analyzed and the equivalence between its motions and those of a similar vehicle whose rotor is not driven by any device, nor subject to any torque about its symmetry axis, is established. For the types of constraints imposed to the spin rate of the rotor, a 'limiting approach' method to obtain the equations of motion and a Hamiltonian for the driven rotor case is presented.
(Author)

A72-21203 The 'Aérosat' program (Le programme 'Aérosat'). B. Manuali (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France). *L'Onde Electrique,* vol. 52, Jan. 1972, p. 13-15. In French.

Discussion of the provisions of the impending international agreement among the U.S., Europe, Canada, Australia, and Japan about four geostationary satellites to be placed over the Atlantic and Pacific Oceans. French contributions to this project are reviewed.
M.V.E.

A72-21274 Another thoroughbred from Dassault - Falcon 10 flight report. D. H. Chopping. *Interavia,* vol. 27, Feb. 1972, p. 147-149.

Discussion of the flight characteristics of the Dassault Falcon 10 executive jet, powered by the Garrett TFE731-2 turbofan engine. Probably the most striking demonstration of the aircraft's excellent safety characteristics was the stalling practice at 20,000 ft. With power off, clean, stick fully back, there was no wing drop. Stall speed was 105 kt, angle of incidence 23 deg, and at the stall there was still full aileron control. Circuit flying is precise and comfortable. The advanced aerodynamic design of the wing is the secret of the Falcon 10 performance. The profile has been optimized beyond that of the Falcon 20 by using design formulas worked out for the Mercure. F.R.L.

A72-21275 Soviet civil gas turbine engines. *Interavia,* vol. 27, Feb. 1972, p. 158-161.

Review of Soviet gas turbine engine construction and performance on the basis of available published information and external characteristics. According to Soviet reports, turbojet, turboprop, and turboshaft engines installed in Aeroflot aircraft have proved extremely reliable. They are designed specifically for domestic air transport requirements and for the climatic conditions encountered in the country. Recent developments indicate that there is a tendency to replace turboprops by turbojets for medium and short range routes. Compared with Western engines, it appears that Soviet engines have relatively high rates of fuel consumption. Technical data for Soviet engines are tabulated. F.R.L.

A72-21450 Fuel lubricity. W. G. Dukek (Esso Research and Engineering Co., Linden, N.J.) and R. A. Vere (Esso Petroleum Co., Ltd., Abingdon, Berks., England). *(International Air Transport Association, Aviation Fuel Symposium, Geneva, Switzerland, May 4-6, 1971.) Esso Air World,* vol. 24, no. 3, 1971, p. 63-67. 7 refs.

Discussion of fuel lubricity, a property influencing the friction and wear behavior of rubbing surfaces under boundary lubrication conditions. Many aircraft engine pump failures have been ascribed to lack of this property. Fundamental studies have revealed that wear is due to corrosion and can be eliminated by excluding oxygen and water from the fuel. A more practical solution is to alter the pump metallurgy to noncorroding materials. It has been found that corrosion inhibitor added to fuel will replace the natural lubricity agents removed in refining, but this method has caused difficult quality control problems of electrical conductivity and water separation. F.R.L.

A72-21468 # An application of linear programming to contingency planning - A tactical airlift system analysis. D. C. Dellinger (Duke University, Durham, N.C.). *Naval Research Logistics Quarterly,* vol. 18, Sept. 1971, p. 357-378.

Application of linear programming to the selection of aircraft for a tactical airlift fleet which provides mobility within a contingency area. The elements in the system are the different types of candidate aircraft, and the problem is to decide on the number of

each type to include in the tactical airlift fleet. The desired capability and flexibility of the entire system is specified, and an entire system which meets the specification is sought as a solution to the problem. The model is a standard linear program, consisting of an objective function to be minimized and a set of constraint equations (or inequalities). The unusual feature of the model is that it permits an explicit specification of the flexibility to be possessed by the fleet. This is accomplished by specifying a number of mission sets, each of which must be within the capability of any fleet in the set of feasible fleets. T.M.

A72-21469 # **Allocation of carrier-based attack aircraft using non-linear programming.** E. W. Rice, A. W. Pennington (U.S. Navy, Washington, D.C.), and J. Bracken (Institute for Defense Analyses, Arlington, Va.). *Naval Research Logistics Quarterly,* vol. 18, Sept. 1971, p. 379-393.

The paper presents the formulation and several solutions of a model for allocating a fixed number of aircraft to carriers and to missions. The amount of damage that can be inflicted is maximized. A nonseparable concave nonlinear objective function expresses diminishing marginal damage. Linear constraints on aircraft, carrier space, and aircraft availability for missions are included. The model is solved using the sequential unconstrained minimization technique (SUMT). The model is presented in terms of a scenario. Several different exponential damage functions are treated, and S-shaped damage functions are discussed. (Author)

A72-21470 # **Dynamic programming approach to the optimization of Naval aircraft rework and replacement policies.** A. N. Schwartz, J. A. Sheler (Rochester, University, Rochester, N.Y.), and C. R. Cooper (U.S. Naval Air Systems Command, Washington, D.C.). *Naval Research Logistics Quarterly,* vol. 18, Sept. 1971, p. 395-414. 9 refs. Contract No. N0014-14-68-A-0091.

This paper describes a method for determining optimal repair and replacement policies for aircraft, with specific reference to the F-4. The objective of the analysis is to choose the set of policies from all possible alternatives over a finite planning horizon which minimizes the cost of operations. A dynamic program is presented which seeks an optimal path through a series of decision periods, when each period begins with the choice of keeping an aircraft, reworking it before further operation, or buying a new one. We do not consider changes in technology. Therefore, when a replacement does occur, it is made with a similar aircraft. Multivariable statistical techniques are used to estimate the relevant costs as a function of age, and time since last rework. (Author)

A72-21479 **Handbook of aviation meteorology /2nd edition/.** London, Her Majesty's Stationery Office, 1971. 454 p. 40 refs. $5.95.

Physical principles involved in aviation meteorology are discussed, giving attention to the atmosphere, pressure, temperature, density, motion of the atmosphere, formation of cloud and precipitation, thunderstorms, ice accretion on aircraft, visibility, and characteristics of high-altitude flight. Meteorological observations are considered, taking into account surface observations, upper air observations, and the collection and charting of observations. Subjects of synoptic meteorology examined include air masses and fronts, frontal and other depressions, anticyclones, and elements of forecasting. Meteorological services for aviation are considered together with aspects of general circulation and world climate, and aviation climatology of air routes. G.R.

A72-21484 # **Hydraulic starter systems for aircraft turbine engines. I - Design, construction, and operation (Hydrauliczne układy rozruchu lotniczych silników turbinowych. I - Konstrukcja obliczenia eksploatacja).** B. Boliński. *Technika Lotnicza i Astronautyczna,* vol. 27, Jan. 1972, p. 10-14. 6 refs. In Polish.

Methods of calculating fundamental operational parameters of hydraulic starter systems for aircraft turbine engines are explained, and several structural design alternatives of such systems are compared. On-board and ground-based systems are described in terms of hydraulic pump, motor, duct, valve, and storage tank arrangements. Fluid pressure, pump output, and motor flow capacity are calculated as functions of torque and rotational speed required in cranking the compressor. T.M.

A72-21485 # **Aircraft wheel mechanics. I (Mechanika koła samolotu. I).** M. Mielniczak. *Technika Lotnicza i Astronautyczna,* vol. 27, Jan. 1972, p. 15-17, 27. In Polish.

The kinematics and mechanics of a rotating wheel are analyzed to define mechanisms leading to landing-gear wheel damage under various operational conditions. Forces acting on a freely turning wheel are described, together with antiskid mechanisms, lateral drift of a wheel, and forces acting on the landing gear and fuselage during landing. T.M.

A72-21486 # **Fluctuating forces on rotating airfoils and their relationship to radiated sound.** H. H. Heller, R. E. Hayden (Bolt Beranek and Newman, Inc., Cambridge, Mass.), and S. E. Widnall (MIT, Cambridge, Mass.). *Acoustical Society of America, Fall Meeting, 82nd, Denver, Colo., Oct. 19-22, 1971, Paper H 6.* 13 p.

It is pointed out that aerodynamically induced forces on blades are directly responsible for the radiation of sound. An attempt is made to relate, both experimentally and analytically, fluctuating forces to radiated sound, without considering the particular force-generating mechanism. In order to conduct such a program it was necessary to develop the technology of measuring fluctuating characteristics directly on rotating blades. Small size differential-pressure sensors are described, and a broadband differential-pressure spectrum transmitted from the rotating blade is shown. To relate fluctuating blade forces on multibladed rotors, interacting with multibladed stators, a theoretical model was developed. G.R.

A72-21491 **Dynamics of atmospheric flight.** B. Etkin (Toronto, University, Toronto, Canada). Research supported by the U.S. Air Force, Grant No. AF-AFOSR-68-1490A. New York, John Wiley and Sons, Inc., 1972. 589 p. 197 refs. $19.95.

The motion of vehicles that fly in the atmosphere is dealt with, with special reference to the stability and control of airplanes. After a summary of the principal analytical tools that are used in the formulation and solution of problems of flight mechanics, the system theory, reference frames used in vehicle dynamics, and transformations are discussed. An extensive set of numerical examples covers STOL airplane, subsonic jet transport, hypersonic airplane, stability augmentation, and wind and density gradients. Equations of motion are completely covered. Detailed attention is also given to human pilots, aircraft handling qualities, and flight in turbulence, with numerical examples for a jet transport. Small-perturbation equations for longitudinal and lateral motion are presented in convenient matrix forms, both in time domain and Laplace transforms, dimensional and nondimensional. O.H.

A72-21521 **Weather effects on airport capacity.** E. Bromley, Jr. (FAA, Communications Development Div., Washington, D.C.) and A. P. Stoliar (Sperry Rand Corp., Sperry Div., Great Neck, N.Y.). *Sperry Rand Engineering Review,* vol. 24, no. 3, 1971, p. 2-10.

Discussion of the key role weather plays in airport capacity, and review of the impact of individual weather factors such as wind, wind shear, turbulence, precipitation, temperature, visibility and ceiling. It is shown that reductions in airport capacity due to weather factors can be minimized by integrating tailored weather information into an upgraded air traffic control system and making this information available to pilots. M.V.E.

A72-21522 **Weather instrumentation.** R. T. Brown, Jr. (Sperry Rand Research Center, Sudbury, Mass.). *Sperry Rand Engineering Review*, vol. 24, no. 3, 1971, p. 11-17. 5 refs.

Weather - its certainties and uncertainties - is a vital link in the air transportation system. While meteorological measuring devices have existed for many years and become highly refined and accurate, the needs of modern aircraft and airports dictate even greater precision and further development of specialized equipment. Some of these new instruments take advantage of the accuracy and flexibility afforded by laser technology and digital presentations. All-weather landing and take-off will especially hasten the refinement and installation of new meteorological instruments to arm a pilot with the information he needs - at the instant he has to make a critical judgment. (Author)

A72-21523 **Area navigation.** D. H. Baker (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). *Sperry Rand Engineering Review*, vol. 24, no. 3, 1971, p. 18-24.

Discussion of the development and present status of area navigation systems. Defined originally as 'a method of navigation which permits aircraft operation on any desired course within the coverage of station-referenced navigation signals, or within the limits of self-contained capability,' area navigation systems have been later divided into three characteristic categories, called Mark 1, 2, and 3, whose peculiarities are outlined. Sperry Rand initiated the development of a Mark 1 system in January 1970, and is flying it. The system has shown a 2-sigma accuracy of one-half mile and the capability of reducing the workload for pilots and, eventually, for air traffic controllers. Systems of Mark 2 complexity are being developed for the new commercial aircraft of the seventies. The future development of area navigation systems, coupled with cathode-ray-tube displays and data links, promises the solution to many serious problems in aviation today. M.V.E.

A72-21524 **Cockpit equipment.** R. E. Schaffer (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). *Sperry Rand Engineering Review*, vol. 24, no. 3, 1971, p. 29-35.

In this, the era of wide-bodied jet aircraft, each carrying several hundred passengers at near-sonic speed, effective flight path management is more important than ever. More accurate, more versatile, and more sophisticated sensing, computing, and control devices have been developed over the past decade. These tools extend the capabilities of the aircraft to new levels of operational dependability, safety, and economy. But the assimilation of this expanded capability in the cockpit confronts the designer with a dual challenge: not only must he provide all the information necessary to control an immensely complex vehicle, but he must also achieve this with a degree of integrity never before realized and at reduced crew stress levels. These objectives demand the consolidation of all flight data and control functions into as simple and intelligible a display arrangement as possible. (Author)

A72-21525 **Radar performance monitoring.** G. W. Pate (Sperry Rand Corp., Sperry Microwave Electronics Div., Gainesville, Fla.). *Sperry Rand Engineering Review*, vol. 24, no. 3, 1971, p. 36-41.

Increasing the complexity of radar systems for the sole purpose of performance monitoring has long been debated by system designers and users. The human operator, particularly in air traffic control, continuously monitors the radar system by observing the display. As such, he becomes familiar with returns from landmarks and known aircraft flying established air traffic routes. At the very least, he can immediately report a total failure of the system when all targets disappear. However, the ability of the operator to judge performance has been limited by advances in radar signal processing and displays. For example, the use of moving target indicator (MTI) techniques removes from the display fixed targets that could be used as performance landmarks. Also, with digital display techniques, all target levels above a specified detection threshold are presented at a uniform intensity, so that the observer cannot detect any gradual degradation in system performance. The advent of multisystem processors, in which the display system can select several radar outputs to be displayed, further requires knowledge of the relative performance of the system for selection and control. This paper analyzes the necessity for performance monitoring, what radar parameters should be monitored, and the techniques of performance monitoring. (Author)

A72-21560 **Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings.** Van Nuys, Calif., Survival and Flight Equipment Association, 1972. 148 p. $12.50.

The papers deal with detection of hazards; ejection, takeoff, landing, and survival accidents; Martin-Baker ejection seats; and hypoxia incidents. Oxygen masks, protective helmets, and a vibrotactile warning device are described. Behavioral inaction under stress conditions, physiological evaluation of a passenger oxygen mask, a business jet planned for safety, and a simulator study of an altimeter display are considered. Disorientation, decompression sickness, minimization of dynamic response index, seat cushion evaluation, personnel restraint systems, fire and explosion protection, improvement of helicopter personnel survivability, colors for markers and signals, an emergency instant exit system, rescue signaling devices, testing of fire-protective clothing, and fire-resistant fibrous materials are discussed.

F.R.L.

A72-21561 **Detection of hazards associated with aerospace operations.** J. P. Meade (USAF, Directorate of Aerospace Safety, Norton AFB, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 5-7.

Discussion of detection system selection criteria and other factors involved. Basically, a detection system must detect a hazard in its initial stages. Some potentially hazardous situations that would warrant detection and warning systems are overheat and fire, the presence of combustible vapors, the possibility of explosion, and toxic vapor concentrations. Comment is made on visual vs auditory detection systems. F.R.L.

A72-21562 **SR-71 ejection escape experience.** R. H. Shannon and A. N. Till, Jr. (USAF, Directorate of Aerospace Safety, Norton AFB, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 8-10.

Description of the SR-1 ejection seat used in the SR-71 aircraft. It is activated by a seat-mounted D-ring. It includes a high impulse rocket catapult that results in an impulse of approximately 2000 lb-sec, and a separation velocity of 49 ft/sec. The system is designed to provide safe recovery of the crew from a static condition on the runway up to speeds of Mach 3 plus at extremely high altitudes. Case histories of six ejections from four accidents are examined individually. These histories demonstrate that the ejection survival rate of the SR-71 is extremely high. F.R.L.

A72-21563 **A review of high performance aircraft takeoff and landing accidents.** E. V. Rice and E. H. Ninow (U.S. Navy, Naval Safety Center, Norfolk, Va.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif.,

Survival and Flight Equipment Association, 1972, p. 10-14.

Analysis of takeoff and landing emergencies which are categorized as occurring on the deck with or without ejection, and occurring over the runway on liftoff or landing with or without ejection. Survival rates for on-the-deck emergencies not resulting in ejections are significantly higher than any of the other condition rates, and are similar for both takeoff and landing emergencies. The information is intended to serve as a guideline so that pilots may prepare themselves for emergencies by planning in advance a course of action which will enhance their survival chances in their particular aircraft. F.R.L.

A72-21564 A study of USAF survival accidents 1 Jan 1965 - 31 Dec 1969. H. G. Munson (USAF, Directorate of Aerospace Safety, Norton AFB, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 14-19.

Evaluation of survival incidents for the 5-yr period 1965 through 1969, and comparisons with a previous analysis of the 1958 through 1963 time period. Survival times have decreased significantly, with 91% of the personnel involved being rescued in less than 2 hr vs 50% in five hours in 1958 through 1963. Also, prolonged survival, i.e., over 24 hr. has markedly decreased. The primary rescue factor continued to be some type of visual sighting. F.R.L.

A72-21565 21 years of ejection experience - 1949-1970: Martin-Baker ejection seats. J. Jewell. In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 19-26.

Examination of the results of over 6000 ejections, both emergency and test, using Martin-Baker seats. These ejections have resulted in the development and evolution of an escape system of superior performance and reliability. For an ejection to stand a reasonable chance of success, the flight conditions at the time of ejection must combine to enable the seat and occupant to spend sufficient time in the air for the complete sequence to take place. *Command ejection, ejection through the canopy, causes of fatality,* ejection injuries, and seat reliability are discussed. F.R.L.

A72-21570 Behavioral inaction under stress conditions similar to the survivable aircraft accident. D. A. Johnson (Douglas Aircraft Co., Long Beach, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 42-47. 11 refs. Research sponsored by the McDonnell Douglas Independent Research and Development Program.

Simulation of conditions similar to those found in some aircraft accidents so that inaction, as a maladaptive behavior, could be displayed and factors relevant to the occurrence of inaction could be determined. The requirements to be met were simulation of confusion, the need for novel responses, and a threat for incorrect or no response. In a situation requiring that novel responses be quickly made, inaction will occur independently of whether the individual is or is not physically threatened for failure. F.R.L.

A72-21571 Physiological evaluation of a modified jet transport passenger oxygen mask. E. B. McFadden (FAA, Civil Aeromedical Institute, Oklahoma City, Okla.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 53-61. 14 refs.

Description of altitude chamber experiments conducted with human subjects using new disposable passenger oxygen masks. These masks, applicable for emergency use to 40,000-ft altitudes, differ in configuration from the previous mask. The inner face flap or seal has been eliminated and the cylindrical shape has been reduced to a modified cone. The tests showed that the average inspired tracheal oxygen partial pressure remained above 83.3 mm Hg under all conditions of rest and exercise at all altitudes except for the third minute of exercise at 40,000 ft. G.R.

A72-21572 A business jet that planned ahead - for safety. C. L. Lair (Cessna Aircraft Co., Wichita, Kan.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 62-70.

The development of an aircraft from preliminary design to a final production configuration is discussed. The aircraft considered is the aircraft Cessna Citation, an eight-place, turbofanpowered, business jet. The Citation has a maximum operational altitude of 35,000 ft and a cruising speed of over 400 mph. The structure of the aircraft is considered together with the fuel system, the engines, engine controls, and the crew station design. G.R.

A72-21573 Altimetry display for commercial aircraft - A simulator study. D. M. Zamarin and D. I. Blom (Douglas Aircraft Co., Long Beach, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 71-78. 5 refs.

Five different altimeter configurations were selected for evaluation. Five-digit instruments selected include a device using snap action counter turnover, a device utilizing analog counter turnover, and a third device using a hybrid counter turnover with a hold feature. Two three-digit instruments using snap action turnover were also investigated. Test pilots and airline pilots were used as subjects in the study. Statistical analysis of the results obtained in the tests indicated that no true differences existed among altimeters. G.R.

A72-21576 Dynamic response index /DRI/ minimization for personnel escape systems. L. A. DeStefano (U.S. Army, Propellant Actuated Devices Laboratory, Frankford Arsenal, Philadelphia, Pa.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 87-93.

Outline of a technique which may be employed with minimum catapult component modification to reduce the injury probability for users of aircraft emergency escape systems. A booster charge of 4 gm of solid propellant is used. Experimental tests have demonstrated a 5.3% reduction in dynamic response index and a corresponding 40% decrease in probability of injury. This technique may also be used to upgrade the performance of existing and future aircraft escape systems by permitting maximization of the ejection velocity with respect to the allowable catapult stroke and DRI specification limit. F.R.L.

A72-21577 Dynamic principles for seat cushion evaluation. J. T. Shaffer (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 93-97. 9 refs.

Until the development of dynamically similar models of the seated human body, seat cushion design for +Gz impact environments was conducted with little regard for the cushions effect on human body tolerance. Evaluation of seat cushion behavior in the

environments associated with helicopter crash or aircraft ejection is discussed using recently developed dynamic models of the cushion and the seated human body. An analytical technique is presented for determining the effects of a particular cushion on the probability of the occurrence of a spinal injury. Models of cushions are discussed from the viewpoint of the applicability of statically determined properties of the materials used. The conclusions indicate that the method presented is consistent with responses observed during impact tests using either rigid masses or human subjects. (Author)

A72-21578 Crashworthy personnel restraint systems for general aviation. R. A. Hughes (Pacific Scientific Co., City of Commerce, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 98-103. 5 refs.

Study of occupant safety in general aviation aircraft, with emphasis on effective personnel restraint systems incorporating upper torso restraint. It is proposed that effective cooperation between the restraint system designers and aircraft installation engineers will insure that the aircraft equipped with these systems will also meet the qualitative requirements of comfort and easy fit, ease of donning and removing, and user confidence. F.R.L.

A72-21579 Aircraft fuel system fire and explosion protection concepts. R. G. Clodfelter (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 104-111.

The present understanding of aircraft fuel system vulnerability to gunfire is reviewed. Techniques that are available or under development to counteract the fire and explosion threat are described, and implications concerning future requirements are considered. O.H.

A72-21581 Method for improving helicopter crew and passenger survivability. F. B. Pollard (Aircraft and Missile Consultants, Manhattan Beach, Calif.) and G. D. Klotz (Teledyne, Inc., McCormick Selph Div., Hollister, Calif.). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 114-123. 8 refs.

Description of a number of emergency systems for improving helicopter survivability. These involve the use of shaped explosive charges to sever blades and the use of ejection seats, extraction systems, or parachute bail-out. If individual in-flight escape systems cannot be used, a controlled modular descent by parachute after blade severance is possible. A post-crash egress mode involves explosively severing the airframe at a predetermined location. F.R.L.

A72-21583 'ELSIE' - A progress report. F. B. Burkdoll, D. E. Nicholson (Explosive Technology, Fairfield, Calif.), and B. Chesterfield (USAF, Wright-Patterson AFB, Ohio). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 128, 129.

Description of the characteristics and the results of the design and ground testing of the Emergency Life Saving Instant Exit System (ELSIE) - i.e., a system that will open emergency exits instantaneously in an aircraft fuselage after a crash landing. The system has been proved by ground testing and has been installed in operational Air Force gunships. O.H.

A72-21585 Systems approach testing for new aircraft fire-fighters protective clothing. N. L. Arnold (U.S. Department of Defense, Aircraft Ground Fire Suppression and Rescue Systems Program Office, Wright-Patterson AFB, Ohio). In: Survival and Flight Equipment Association, Annual Symposium, 9th, Las Vegas, Nev., September 27-30, 1971, Proceedings. Van Nuys, Calif., Survival and Flight Equipment Association, 1972, p. 136, 137.

An extensive study, including flame resistant materials tests and fire fighters' exposure tests, has been conducted to obtain the necessary data for the development of a new aircraft fire fighters' protective clothing. Results indicate that new lighter weight protective clothing can be developed for large quantity production, and that it will meet or exceed the requirements desired by users and, at the same time, will be competitive in total cost with existing standard issue clothing. O.H.

A72-21603 # Lateral dynamics of flight on a great circle. A. M. Drummond (Auburn University, Auburn, Ala.). *AIAA Journal*, vol. 10, Mar. 1972, p. 247-251. 9 refs.

The lateral stability of a hypersonic vehicle representative of a space shuttle or hypersonic transport is calculated at two lift coefficients at speeds up to parabolic. Linearized equations of motion are used and Newtonian Impact Theory is utilized for stability derivative estimation. The damping in the natural modes is very small or negative, the dominant motion being an extension of the conventional Dutch Roll mode. The mode is unstable for high subcircular speeds. Coupling of the roll-convergence and spiral modes occurs at about 40% of circular speed and after decoupling, some instability exists at supercircular speeds. A new undamped mode describing lateral position variation is found exactly. The results are not very sensitive to the lift coefficient, and approximations to the modes are discussed and compared with the numerical solutions. (Author)

A72-21604 # Towed vehicle system in a coordinated turn. T. C. Cannon (Bell Telephone Laboratories, Inc., Whippany, N.J.) and J. Genin (Purdue University, Lafayette, Ind.). *AIAA Journal*, vol. 10, Mar. 1972, p. 252-257.

Analytical methods are developed to study the equilibrium configurations assumed by a towed cable (with towed body attached) moving in a uniform flowfield, when the towing vehicle executes a coordinated turn. With appropriate assumptions closed form solutions for the governing nonlinear differential equations are obtained for the coordinates of the towed body with respect to the towing vehicle. The exact two point boundary problem is then solved numerically, and good agreement is shown to exist between both solutions. (Author)

A72-21608 # Aerodynamic analysis of tube vehicle systems. A. G. Hammitt (TRW Systems Group, Redondo Beach, Calif.). *AIAA Journal*, vol. 10, Mar. 1972, p. 282-290. 17 refs.

A general description of the aerodynamics of tube vehicles is presented. The advantages of dividing the flowfield into a far flowfield away from the vehicle and a near flowfield close to the vehicle are discussed. Solutions for the near flowfields and asymptotic short- and long-time solutions for the far flow are presented. Combined flowfield solutions are then presented along with predictions of thrust and power requirements. The effects of the vehicle propulsion system and of flow velocities reaching M = 1 about the vehicle are shown to be of fundamental importance. (Author)

A72-21614 # Laminar boundary layer on a rotating round-nosed blade. M. Takematsu. *AIAA Journal*, vol. 10, Mar. 1972, p. 333, 334. 6 refs. Army-supported research.

Consideration of the laminar boundary layer on an infinite cylindrical blade rotating with constant angular velocity about an

axis normal to its generators. The utility of a conformal coordinate system in the (X, Z)-plane for solution of the boundary layer problem as an alternative to the customary boundary-layer coordinates is demonstrated. F.R.L.

A72-21616 # **A simple formula for flat plate boundary-layer transition in supersonic wind tunnels.** R. Ross (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *AIAA Journal,* vol. 10, Mar. 1972, p. 336, 337.

Development of a simple formula which takes account of freestream turbulence. An equation which defines the correlation between the important parameters for flat plates with zero leading edge thickness is further developed to obtain values of the Reynolds number based on distance from the leading edge to the end of the transition region which, at Mach 6 and lower, are in general within 10% agreement. F.R.L.

A72-21631 # **Comment on 'Vortices induced in a jet by a subsonic cross flow.'** A. M. Thompson (Imperial College of Science and Technology, London, England). *AIAA Journal,* vol. 10, Mar. 1972, p. 364, 365; Author's Reply, p. 365-367. 10 refs.

The vortex model proposed recently by Durando (1971) is critically examined and it is suggested that it does not appear to be a satisfactory representation of the vortex-dominated region of a deflected jet. A reply of Durando is presented which emphasizes the general validity of this model which, despite some corrections that had to be done, still overpredicts the vortex strength by a factor of more than two. O.H.

A72-21632 # **Static and dynamic characteristics of a glider with an all-moving tailplane (Charakterystyki statyczne i dynamiczne szybowca z płytowym usterzeniem wysokości).** J. Sandauer. *Instytut Lotnictwa, Prace,* no. 47, 1971, p. 3-34. 6 refs. In Polish.

Analysis of the influence of the parameters of various all-moving tailplanes on the static and dynamic characteristics of a glider. Attention is given to (1) smooth and trimmer-equipped tailplanes without a geared tab, and (2) a tailplane provided with a geared tab that also serves as the trimmer. Static characteristics examined include lateral stability and maneuverability margins of a glider with a released stick and also gradients of stick forces with respect to air speed and acceleration. The dynamic characteristics involve short-period longitudinal oscillations of a glider with a released stick. Conditions accompanying the onset of pilot induced oscillations are defined on the basis of results obtained for the effects of (1) the position of the axis of rotation of the tailplane, and (2) the nonlinearity of the tailplane aerodynamic response within the range of small deflections. T.M.

A72-21634 # **Investigation of the service life of the PZL-104 Wilga-3 aircraft structure (Badanie żywotności konstrukcji samolotu PZL-104 Wilga-3).** J. Borzyszkowski. *Instytut Lotnictwa, Prace,* no. 47, 1971, p. 65-81. 8 refs. In Polish.

Description of theoretical analyses and final test procedures employed in a structural-fatigue evaluation program for the PZL-104 Wilga-3 aircraft. The main problem considered is the proper distribution of measurement points for determining loads acting on the entire structure under operational conditions. The determination of operational load spectra is described, together with methods employed for reproducing these load conditions on the test stand. The results obtained are discussed in terms of service-life estimates for the aircraft, and some structural design modifications and improvements incorporated on the basis of test data are outlined. T.M.

A72-21686 **Feasibility evaluation of carbon/epoxy composite materials to aircraft wheel applications.** V. A. Chase, A. L. Price, and K. R. Berg (Whittaker Corp., Research and Development Div., San Diego, Calif.). In: Society of the Plastics Industry, Annual Conference, 27th, Washington, D.C., February 8-11, 1972, Proceedings. New York, Society of the Plastics Industry, Inc., 1972, p. 13-A,1 to 13-A,10. 6 refs. Contract No. F33615-71-C-1089.

The feasibility of applying carbon composite reinforced plastic materials to the fabrication of aircraft wheels was investigated. The main landing gear wheel for the T-37B aircraft was selected as the demonstration article. Analysis, design, and fabrication of a 7.00-8 carbon/epoxy composite aircraft wheel were performed. The composite wheel was based on Modmor II carbon fiber and ERLA-4617 epoxy resin. Loads and design criteria for the composite aircraft wheel are presented. The stress analysis, material allowables, reinforcement orientation pattern and margins of safety are summarized. (Author)

A72-21690 **Design and construction of a large, fully automated tape placement machine for laying up aircraft structures from advanced composites.** E. E. Hardesty (Goldsworthy Engineering, Inc., Torrance, Calif.). In: Society of the Plastics Industry, Annual Conference, 27th, Washington, D.C., February 8-11, 1972, Proceedings. New York, Society of the Plastics Industry, Inc., 1972, p. 17-A,1 to 17-A,6.

The machine's primary function is constructing large helicopter rotor blades and spars entirely from composites, as well as other aircraft structures having compoundly-curved surfaces. Innovations incorporated in the machine's primary Tape Dispensing Head include an automatic tape-angle-cutoff device, an actuated tape shear which cleanly severs pre-impregnated composites without cutting the backup paper, a fluidic system for maintaining accurate tape alignment, and a method for the on-command slitting of full-width tape in narrow ribbons. G.R.

A72-21693 **Low-cost, 300 gallon aircraft wing tank.** A. L. Price, V. A. Chase (Whittaker Corp., Research and Development Div., San Diego, Calif.), and T. J. Reinhart, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Society of the Plastics Industry, Annual Conference, 27th, Washington, D.C., February 8-11, 1972, Proceedings. New York, Society of the Plastics Industry, Inc., 1972, p. 17-D,1 to 17-D,10. 6 refs.

A recent engineering study on fiber reinforced plastic tankage has shown that with the presently available low cost glass fiber reinforced materials and the existing manufacturing technology there is a potential 40% cost savings over metal tankage in the use of molded reinforced plastics for tankage. A program for the development of a 300-gallon plastic wing fuel tank for the A7D aircraft, as an interchangeable replacement for the present aluminum tank, is discussed. It was found that a plastic tank can be more efficiently manufactured than equivalent metal wing fuel tanks. Another advantage of a plastic tank is its higher burst pressure capability. G.R.

A72-21699 **U.S. Navy cartography.** J. H. Barton (U.S. Naval Air Station, San Francisco, Calif.). *Photogrammetric Engineering,* vol. 38, Feb. 1972, p. 147-151, 153, 154.

The U.S. Navy in the post World War II period has possessed a cartographic capability, enabling it to provide the necessary mapping and reconnaissance to support Navy and Marine Corps operations. Aerial camera systems have been adapted to such aircraft as the B-24, the P-2 'Neptune,' and the AJ 'Savage.' One of the present-day examples of this adaptation is the U.S. Navy's RA-3B Skywarrior, developed from the A3B strategic bomber. A crew of three and dual photographic viewfinders facilitate smooth, well-coordinated operations. The cameras are fired by a computer-controlled electronic pulse. G.R.

A72-21701 # **Calculation of inverse transforms in the problem of the motion of a wing near a solid surface (Obchislennia**

obernenikh peretvoren' dlia zadachi pro rukh krila poblizu tverdoi poverkhni). G. S. Lipovoi (Akademiia Nauk Ukrains'koi RSR, Institut Matematiki, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 33, Nov. 1971, p. 977-979. In Ukrainian.

Inverse integral Fourier transforms are obtained as a basis for solving the problem of the steady periodic motions of a wing close to a solid surface. Equations of lift and of the principal moment are derived for a wing in the process of cyclic motion. The dependence of the lift and the moment on the wing parameters and the wing motion parameters is discussed. V.Z.

A72-21798 Way of flying based on compressibility of fluids. M. Čadež (Beograd, Univerzitet, Belgrade, Yugoslavia). *Pure and Applied Geophysics,* vol. 93, no. 1, 1972, p. 187-190.

A quiet atmosphere divided by an infinitely large plane into two parts is considered. If the plane starts to move in the direction of its normal, a compression will result on one side of the plane and a rarefaction on the other. These two types of disturbances will travel away from the place of their origin. The force acting on the plane is considered. The possible application of such a force in flying is discussed, taking into consideration the design of an aircraft which makes use of a piston device equivalent in principle to an air pressure pump. G.R.

A72-21898 Olympus flight-testing. T. Frost (Rolls-Royce, Ltd., Derby, England). *Flight International,* vol. 101, Feb. 24, 1972, p. 292-294.

Review of the successful Olympus 593 program undertaken with aircraft in support of Concorde development. A case is made for the flexibility and realism afforded by actually flying an engine for development and handling assessment. Relighting and anti-icing, engine control, and noise and vibration are assessed. The icing work proved that it is feasible to set up icing test conditions on a flying test bench without the difficulties met in ground-based facilities. F.R.L.

A72-21899 Jet-STOL wing. J. H. Stevens. *Flight International,* vol. 101, Feb. 24, 1972, p. 295-297.

Discussion of the augmentor wing being developed by de Havilland Canada and NASA. The augmentor wing consists of a moderately thick airfoil with a full-span leading-edge slat, and an elaborate double-surface trailing edge flap. The two surfaces of the flap form a venturi-shaped slot across the rear of the wing, which traps and entrains the separated flow over the suction 'bubble' formed above the wing, and accelerates it to form a stable and forceful downwash far below the trailing edge of the flap. Bleed air is diverted into the wing and thence through the slot between the two-layer flaps. F.R.L.

A72-21900 Masterly Mystère. T. Hamill. *Flight International,* vol. 101, Feb. 24, 1972, p. 298-302.

Description of the flying characteristics of the Mystère 20 Series F. Visibility is very good and the glare shield is cut away so as to parallel the line of sight from a comfortable sitting height. Flight instruments are fully duplicated. Acceleration is brisk, and manual flying is not difficult, although lateral control is not a strong point at low speed. After engine shut down, relighting was found to be a simple matter of selecting 'air start' on the master switch and opening the high-pressure cock. Stall characteristics are discussed. F.R.L.

A72-21901 Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., November 3, 1970, Proceedings. *Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3. 128 p.

The papers deal with the generation, prediction, propagation, and simulation of the sonic boom, and its effects on terrain, water structures, animals, and humans. Sonic-boom generation theory and prediction methods, and sonic-boom simulation devices and techniques are reviewed. Attention is given to sonic-boom minimization, propagation through a stratified atmosphere, and the effects of atmospheric irregularities on sonic-boom propagation. The second part of the symposium deals with seismic and underwater responses to sonic boom, and the reactions of building structures, animals, and humans. -F.R.L.

A72-21902 * # Review of sonic-boom generation theory and prediction methods. H. W. Carlson and D. J. Maglieri (NASA, Langley Research Center, Hampton, Va.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 675-685. 26 refs.

The prediction techniques reviewed in the present paper permit the calculation of sonic booms produced by rather complex conventional supersonic aircraft designs performing level non-accelerated flight in a quiet atmosphere. Basic concepts of supersonic flow analysis, for representation of an airplane as a linear distribution of disturbances and for determination of the resultant pressure field complete with shocks, are outlined. Numerical techniques for implementation of the theory are discussed briefly, and examples of the correlation of theory with experimental data from wind tunnel and flight tests are presented. Special attention is given to presentation of a simplified method for rapid 'first-cut' estimation of farfield bow-shock overpressure. Finally, some problems encountered in attempts at applying the prediction techniques for the nearfield at high supersonic Mach numbers are recognized, and the need for further refinement of present techniques or the development of new systems is discussed. (Author)

A72-21903 * # Sonic-boom minimization. R. Seebass and A. R. George (Cornell University, Ithaca, N.Y.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 686-694. 29 refs. Grant No. NGR-33-010-054.

There have been many attempts to reduce or eliminate the sonic boom. Such attempts fall into two categories: (1) aerodynamic minimization and (2) exotic configurations. In the first category changes in the entropy and the Bernoulli constant are neglected and equivalent body shapes required to minimize the overpressure, the shock pressure rise and the impulse are deduced. These results include the beneficial effects of atmospheric stratification. In the second category, the effective length of the aircraft is increased or its base area decreased by modifying the Bernoulli constant a significant fraction of the flow past the aircraft. A figure of merit is introduced which makes it possible to judge the effectiveness of the latter schemes. (Author)

A72-21904 * # Sonic-boom propagation through a stratified atmosphere. W. D. Hayes (Princeton University, Princeton, N.J.) and H. L. Runyan, Jr. (NASA, Langley Research Center, Hampton, Va.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 695-701. 14 refs. Grant No. NGL-31-001-119.

Theoretical approach to the problem of predicting the sonic-boom signature due to a maneuvering aircraft, with outline of the resulting calculation method. This method includes the effects of a variable, stratified atmosphere, and is based on geometric-acoustic

principles. A nonlinear distortion is used to account for the weak shock field. The analytical results are compared with experimental data and excellent agreement was found, particularly with regard to signature length. F.R.L.

A72-21905 * # **Effects of atmospheric irregularities on sonic-boom propagation.** A. D. Pierce (MIT, Cambridge, Mass.) and D. J. Maglieri (NASA, Langley Research Center, Hampton, Va.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 702-721. 78 refs.

A review is given of information obtained in recent years concerning the effects on sonic-boom signatures of departures of the atmosphere from a perfectly stratified time invariant model. These effects include the observed random variations in boom overpressures from those expected for a stratified atmosphere, the anomalously large and variable rise times, and the occurrence of spiked or rounded waveforms rather than the characteristic N waves. The extent of the variability in data recorded during actual flight tests is summarized in the form of histograms, representing experimentally obtained probability density functions. The physical mechanisms believed to be responsible for the variations and the anomalous features in the signatures are described. These include refraction and subsequent wavefront rippling by turbulence, the possible focusing or defocusing of rays, the formation of caustics, and the phenomenon of wavefront folding, diffraction, and scattering. Recent statistical theories of shock propagation through a turbulent atmosphere proposed by Crow, George and Plotkin, Pierce, Horning, and others are reviewed. (Author)

A72-21906 * # **Review of sonic-boom simulation devices and techniques.** P. M. Edge, Jr. and H. H. Hubbard (NASA, Langley Research Center, Hampton, Va.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 722-728. 31 refs.

Research on aircraft-generated sonic booms has led to the development of special techniques to generate controlled sonic-boom-type disturbances without the complications and expense of supersonic flight operations. This paper contains brief descriptions of several of these techniques along with the significant hardware items involved and indicates the advantages and disadvantages of each in research applications. Included are wind tunnels, ballistic ranges, spark discharges, piston phones, shock tubes, high-speed valve systems, and shaped explosive charges. Specialized applications include sonic-boom generation and propagation studies and the responses of structures, terrain, people, and animals. Situations for which simulators are applicable are shown to include both small-scale and large-scale laboratory tests and full-scale field tests. Although no one approach to simulation is ideal, the various techniques available generally complement each other to provide desired capability for a broad range of sonic-boom studies. (Author)

A72-21907 # **Seismic and underwater responses to sonic boom.** J. C. Cook, T. Goforth (Teledyne, Inc., Dallas, Tex.), and R. K. Cook (National Bureau of Standards, Washington, D.C.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 729-741. 21 refs.

Sonic booms produced by aircraft moving at supersonic speeds apply moving loads to the earth's surface. In deep water, a moving underwater pressure field is observed to accompany the hyperbolic boom trace sweeping over the surface. The pressure waveform underwater near the surface is almost identical to that of the N wave in air, but it is rapidly smoothed and attenuated with depth, typically becoming one-tenth as large at a depth less than 0.6 of the N wavelength. Adequate quantitative theories for the underwater effect have been developed, and have been verified by scale-model experiments. On land, which is generally stratified, there are two major effects: the 'static' deformation field traveling with the surface load, and air-coupled Rayleigh wavetrains following each N-wave transient. Present quantitative theories for the major seismic effects agree reasonably well with the experiments. Seismic forerunner waves, which begin at least 7 sec before arrival of the sonic boom, might be exploited for automatic warnings to lessen the startle effect. Sonic booms probably cannot trigger earthquakes, but might possibly precipitate incipient avalanches or landslides in exceptional areas which are already stressed to within a few percent of instability. (Author)

A72-21908 * # **Sonic-boom-induced building structure responses including damage.** B. L. Clarkson (NASA, Langley Research Center, Hampton, Va.; Southampton, University, Southampton, England) and W. H. Mayes (NASA, Langley Research Center, Hampton, Va.). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 742-757. 61 refs.

Concepts of sonic-boom pressure loading of building structures and the associated responses are reviewed, and results of pertinent theoretical and experimental research programs are summarized. The significance of sonic-boom load time histories, including waveshape effects, are illustrated with the aid of simple structural elements such as beams and plates. Also included are discussions of the significance of such other phenomena as three-dimensional loading effects, air cavity coupling, multimodal responses, and structural nonlinearities. Measured deflection, acceleration, and strain data from laboratory models and full-scale building tests are summarized, and these data are compared, where possible, with predicted values. Damage complaint and claim experience due both to controlled and uncontrolled supersonic flights over communities are summarized with particular reference to residential, commercial, and historic buildings. Sonic-boom-induced building responses are compared with those from other impulsive loadings due to natural and cultural events and from laboratory simulation tests. (Author)

A72-21911 **Recent sonic-bang studies in the United Kingdom.** C. H. E. Warren (Royal Aircraft Establishment, Farnborough, Hants., England). *(Acoustical Society of America, Meeting, 80th, Sonic Boom Symposium, 2nd, Houston, Tex., Nov. 3, 1970.) Acoustical Society of America, Journal,* vol. 51, Feb. 1972, pt. 3, p. 783-789. 10 refs.

The paper summarizes the sonic-bang studies that have been made in the United Kingdom since 1965, which embrace flight trials, field experiments, and laboratory studies. The main flight trial concerns the measurement of the sonic bang from the Concorde. It is shown that, when the Concorde is flying at 45,000 ft, the waveform at the ground has attained its farfield N-wave shape, although this is not quite so when it is flying at 37,000 ft. The measured characteristic overpressures for these two altitudes and a Mach number of 1.3 are 110 N/sq m and 120 N/sq m, respectively. The effects of sonic bangs on cathedrals are discussed and the vibrational responses likely to be induced by the sonic bang are compared with those already arising from other environmental causes. Finally, the results of a study of the effects of simulated sonic bangs on some greenhouses are discussed; these results seem to indicate that most damages can be ascribed to a triggering effect. (Author)

A72-21920 **Artificial dispersion of fog over airports (Il dissolvimento artificiale della nebbia sugli aeroporti).** F. Timpone. *Rivista Aeronautica,* vol. 48, Jan. 1972, p. 81-102. 19 refs. In Italian.

Review of various means described in the literature for achieving fog dispersion over airports. The use of hygroscopic, polyelectrolytic, and surface active materials for dispersing warm fog is noted, as well

as the use of calcium salts, the combustion of fuel on the ground, the use of jet engines on the ground, the injection of hot air upwards, the use of long-chain alcohols, mechanical mixing, and the use of water-repellent materials. In the case of the dispersion of cold fog the use of cryogenic nuclei and the use of atomized liquid gases are noted. Some experiments in which a pumping system mounted on a truck was used to achieve seeding from the ground are described, and some experimental work being carried out by various agencies in Italy on a system for injecting hot air into the atmosphere, the use of polyelectrolytic and surface active materials, the use of laser beams, etc. is described. A.B.K.

A72-21938 The testing and development of pipe joints for the Olympus 593 in Concorde. T. F. Blenkiron and N. J. Wedlake (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). In: International Conference on Fluid Sealing, 5th, University of Warwick, Coventry, England, March 30-April 2, 1971, Proceedings. Cranfield, Beds., England, British Hydromechanics Research Association, 1971, p. F1-1 to F1-12. Research supported by the Ministry of Technology.

Because of the high temperatures associated with prolonged supersonic flight, it has been necessary to abandon the sliding 'O' seal joint, traditionally used in aircraft powerplants. The pipes now have rigid end fixings and expansion loops to absorb thermal differential movements. To achieve absolute sealing of the flange joints over long periods of time, extreme care has been necessary in the design of the joints. Attempts have been made to develop a very flexible metal seal. A fully automatic test facility has been constructed for subjecting joints to thermal and pressure cycling. G.R.

A72-21940 B.A.C. swaged pipe coupling - Design and development. P. W. Singleton (British Aircraft Corp., Ltd., Preston, Lancs., England). In: International Conference on Fluid Sealing, 5th, University of Warwick, Coventry, England, March 30-April 2, 1971, Proceedings. Cranfield, Beds., England, British Hydromechanics Research Association, 1971, p. F3-37 to F3-48.

Description of a metric swaged pipe coupling designed as a universal coupling capable of meeting the requirements of aircraft systems within the range of 27 MN/sq m and + 200 C operating conditions. The design of the complete range covers tube sizes from 5 to 25 mm diameter for high-pressure applications, and from 5 to 38 mm diameter for low-pressure applications, although for development purposes the range has been limited to maximum sizes of 20 and 28 mm, respectively. The development program covers a wide range of tube materials whose 0.2% proof strength varies from 65 MN/sq m for light alloy tubing to 410 MN/sq m for high-strength stainless-steel tubing. (Author)

A72-21941 Clam seals - A comparison with elastomers in static applications. R. R. Young and C. E. Rose (Clam Seals International Co., Ltd., Bourne End, Bucks., England). In: International Conference on Fluid Sealing, 5th, University of Warwick, Coventry, England, March 30-April 2, 1971, Proceedings. Cranfield, Beds., England, British Hydromechanics Research Association, 1971, p. F4-49 to F4-59.

A short description is given of the clam seal and its sealing principles followed by a direct comparison with elastomeric seals. Subjects discussed include approval for aircraft use, contamination, inspection criteria, service use, corrosion and erosion, surface finish, shelf life, service life, cost, use in ancillary equipment, performance under 'E' No. approval. There follows a short comparison with the metal 'O' ring and finally a note on limitations. (Author)

A72-22024 # Technology of control systems for flight vehicles (Tekhnologiia sistem upravleniia letatel'nykh apparatov). A. N. Gavrilov and I. A. Lebedev. Moscow, Izdatel'stvo Mashinostroenie, 1971. 484 p. 73 refs. In Russian.

The theoretical foundations of procedures used in the industry for preparing elements of control systems and in subsystem and system assembly are outlined in this textbook. Manufacturing and checking methods used in the production of mechanical, hydraulic, pneumatic, electric, and electronic elements are described. Particular attention is given to advanced techniques which make it possible to improve the quality and reliability of control systems and to reduce production costs. V.P.

A72-22130 # Shaft whirling in a twin-spool jet engine system. H. Ratcliffe (Glasgow, University, Glasgow, Scotland). In: Conference on Vibrations in Rotating Systems, London, England, February 14, 15, 1972, Proceedings. London, Institution of Mechanical Engineers, 1972, p. 127-141.

Investigation carried out to establish the accuracy of prediction of whirling frequencies of a two-shaft system and to examine how these frequencies were influenced by the shaft speeds as a result of gyroscopic effects. The experimental rig was a simple full-size model of the rear half of a typical twin-spool jet engine. A computer model was developed which would predict the natural frequencies of the rig within 5%. The variation of the frequencies was explored over a wide range of combinations of shaft speeds. Under certain conditions the frequencies were found to be influenced greatly by the speed of one or both shafts. At certain combinations of shaft speed the character of the mode of vibration of the two shafts was changed drastically by relatively small variations in the shaft speeds. (Author)

A72-22141 Human aspects of vibration and noise in helicopters. C. E. P. Jackson and W. F. Grimster (Westland Helicopters, Ltd., Yeovil, Somerset, England). *(British Acoustical Society, Spring Meeting, Birmingham, England, Apr. 5-7, 1971.) Journal of Sound and Vibration*, vol. 20, Feb. 8, 1972, p. 343-351.

A résumé is given of the types and sources of helicopter vibration. Methods of vibration testing and monitoring are dealt with, together with the relative merits of various methods of vibration reduction. The paper describes levels which are acceptable in service in terms of a velocity limit and the ISO/BSI proposals. Internal and external noise are briefly discussed and some information is given on results of internal cabin noise reduction. (Author)

A72-22150 # Civil air transport - The future of a maturing industry. *Astronautics and Aeronautics*, vol. 10, Mar. 1972, p. 20-27; Discussion, p. 27-33; Questions and Answers, p. 33, 34.

Factors favoring passenger and cargo growth include a growing world population, a growing international orientation of business, growth in worldwide per capita income, and a higher frequency of air travel per capita among travel prone young today. Aircraft sales commensurate with traffic forecasts have been estimated to total around $100-billion through 1985. World scheduled air freight should increase from 7300-million ton-miles in 1970 to 78,000-million ton-miles in 1985. A new aircraft for the 1980s may emerge as primarily a cargo carrier with excellent passenger capabilities. It is believed that a great new STOL market will develop before the end of the decade. STOL has the potential to serve almost 50-million passengers in 1980. G.R.

A72-22152 Multiplex electrohydraulic system for fly-by-wire actuators, with majority voting and pressure logic. C. R. Himmler. In: Fluid Power Symposium, 2nd, University of Surrey, Guildford, Surrey, England, January 4-7, 1971, Proceedings. Cranfield, Beds., England, British Hydromechanics Research Association, 1971, p. A5-73 to A5-88. 12 refs.

The double triplex hydraulic system described satisfies specifications regarding static and dynamic accuracy, resistance to vibrations, and behavior in the case of failure. The unit consists of a tandem cylinder and two triplicate electrohydraulic pressure transducers. Each module of the unit controls a power stage with an independent hydraulic supply. A redundant active/stand-by switch is used to switch from one system to the other. A hydraulic majority system with three hydraulic outputs was developed. A frequency response analysis is discussed together with aspects of the tests conducted with the new system. G.R.

A72-22160 Synthetic fire resistant hydraulic fluids. C. Staley (Geigy /UK/, Ltd., Industrial Chemicals Div., England). In: Fluid Power Symposium, 2nd, University of Surrey, Guildford, Surrey, England, January 4-7, 1971, Proceedings.
Cranfield, Beds., England, British Hydromechanics Research Association, 1971, p. F2-13 to F2-28. 8 refs.

There are basically two types of fire-resistant hydraulic fluids. The presence of water ensures fire resistance in one case, while the fire-resistant characteristics of fluids of the second type are connected with the chemical nature of the fluids themselves. Fluids of the first category include water-glycol mixtures and water-in-oil emulsions. Synthetic materials, in particular chlorinated hydrocarbons and phosphate esters, are liquids of the second type. Applications of fire-resistant hydraulic fluids are found in the metal working industry, in shipboard hydraulic systems, and in civil aircraft. G.R.

STAR ENTRIES

N72-15940*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INITIAL ROTATION-LOADING AND LOW SPEED FLUTTER TEST RESULTS FOR A STRAIGHT WING VERSION OF THE SPACE SHUTTLE VEHICLE
Robert W. Warner, Phillip R. Wilcox, and Bruno J. Gambucci Jan. 1972 74 p refs
(NASA-TM-X-62110) Avail: NTIS CSCL 01A

For three straight semispan model space shuttle wings, the maximum total load during rapid rotation from 66 deg to 0 deg angle of attack, at Mach numbers from 0.28 to 0.60, was essentially no higher than that measured for buffet. During slow rotation over the same angle range, there was no visible flutter. For one of the wings, however, unstable aerodynamic damping was established at two fixed angles of attack. Author

N72-15941*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
REVIEW OF DELTA WING SPACE SHUTTLE VEHICLE DYNAMICS Final Technical Report
J. Peter Reding and Lars E. Ericsson Oct. 1971 164 p refs
(Contract NAS9-11445)
(NASA-CR-115357; LMSC-D243938) Avail: NTIS CSCL 01A

The unsteady aerodynamics of the proposed delta planform, high cross range, shuttle orbiters, are investigated. It is found that these vehicles are subject to five unsteady-flow phenomena that could compromise the flight dynamics. The phenomena are as follows: (1) leeside shock-induced separation, (2) sudden leading-edge stall, (3) vortex burst, (4)bow shock-flap shock interaction, and (5) forebody-vorticity. Trajectory shaping is seen as the most powerful means of avoiding deterimental effects of the stall phenomena; however, stall must be fixed or controlled when traversing the stall region. Other phenomana may be controlled by carefully programmed control deflections and some configuration modifications. Ways to alter the occurrence of the various flow conditions are explored. Author

N72-15942*# Chrysler Corp., New Orleans, La. Space Div.
SURFACE PRESSURE AND INVISCID FLOW FIELD PROPERTIES OF THE MCDONNELL-DOUGLAS DELTA-WING ORBITER FOR NOMINAL MACH NUMBER OF 8, VOLUME 1
J. D. Warmbrod, M. R. Martindale, and R. K. Matthews Jan. 1972 81 p
(Contract NAS8-4016)
(NASA-CR-120037-Vol-1; DMS-DR-1225-Vol-1; NASA-Ser-H-1009; DRC-184-58) Avail: NTIS CSCL 20D

The results of a wind tunnel test program to determine the surface pressures and flow distribution on the McDonnell Douglas Orbiter configuration are presented. Tests were conducted in hypersonic wind tunnel at Mach 8. The freestream unit Reynolds number was 3.7 time one million per foot. Angle of attack was varied from 10 degrees to 60 degrees in 10 degree increments. Author

N72-15943*# Georgia Inst. of Tech., Atlanta.
EXPLORATORY INVESTIGATION OF SOUND PRESSURE LEVEL IN THE WAKE OF AN OSCILLATING AIRFOIL IN THE VICINITY OF STALL
Robin B. Gray and G. Alvin Pierce Washington NASA Feb. 1972 48 p refs
(Grant NGR-11-002-121)
(NASA-CR-1948) Avail: NTIS CSCL 20D

Wind tunnel tests were performed on two oscillating two-dimensional lifting surfaces. The first of these models had an NACA 0012 airfoil section while the second simulated the classical flat plate. Both of these models had a mean angle of attack of 12 degrees while being oscillated in pitch about their midchord with a double amplitude of 6 degrees. Wake surveys of sound pressure level were made over a frequency range from 16 to 32 Hz and at various free stream velocities up to 100 ft/sec. The sound pressure level spectrum indicated significant peaks in sound intensity at the oscillation frequency and its first harmonic near the wake of both models. From a comparison of these data with that of a sound level meter, it is concluded that most of the sound intensity is contained within these peaks and no appreciable peaks occur at higher harmonics. It is concluded that within the wake the sound intensity is largely pseudosound while at one chord length outside the wake, it is largely true vortex sound. For both the airfoil and flat plate the peaks appear to be more strongly dependent upon the airspeed than on the oscillation frequency. Therefore reduced frequency does not appear to be a significant parameter in the generation of wake sound intensity. Author

N72-15945*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF REYNOLDS NUMBER ON OVERALL PERFORMANCE OF A 3.7-INCH-DIAMETER SIX-STAGE AXIAL-FLOW COMPRESSOR
Laurence J. Heidelburg and Calvin L. Ball Washington Feb. 1972 21 p refs
(NASA-TN-D-6628; E-6522) Avail: NTIS CSCL 20D

A 9.4-centimeter (3.7-in.) diameter six-stage axial-flow compressor was tested in argon over a range of inlet pressures corresponding to a Reynolds number range of 30,600 to 160,000. The effect of Reynolds number on efficiency, pressure ratio, work input, maximum flow, and surge is shown. The Reynolds number effects are discussed in terms of changes in boundary-layer thickness, losses, and the resulting changes in throughflow velocity. Significant deviation was noted from the 0.2 power relation often used to express the variation of loss with Reynolds number. Author

N72-15947# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
ON THE INFLUENCE OF CAMBER AND NONPLANAR VORTEX WAKE ON AEROFOIL CHARACTERISTICS IN GROUND EFFECT
B. Maskew Oct. 1971 57 p refs
(TT-7112) Avail: NTIS

The theoretical influence of camber and nonplanar wake on the change of lift, vortex drag, and center of pressure of an airfoil with ground effect is discussed. Calculations are performed for both two and three dimensional potential flows for ground effect conditions which are fairly representative of a conventional aircraft in high lift configuration. The calculated results demonstrate the importance of including the influence of camber, incidence, and nonplanar wake in practical ground effect calculations. It is concluded that the effect can be unfavorable in terms of lift and less favorable in terms of vortex drag. Author

N72-15948# National Physical Lab., Teddington (England). Aerodynamics Div.
PRESSURES NEAR THE CENTRE-LINE OF LEEWARD SURFACES ON DELTA WINGS AND CONICAL BODIES AT HIGH SUPERSONIC SPEEDS
M. J. Larcombe Jun. 1970 26 p refs
(NPL-AERO-1319; ARC-32172) Avail: NTIS

Flow fields over the leeward surfaces of delta wings and conical bodies are calculated for conditions when the bow shock wave is detached from the leading edges. The parameters controlling the flow process are determined. An accurate semi-empirical method is developed for predicting pressure near the centerline of wings and bodies for Mach numbers greater than 2.5. Author (ESRO)

N72-15949# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
MEASUREMENTS OF SECTION PRESSURE DISTRIBUTION AT A MACH NUMBER OF 2.0 ON A WING OF 70 DEG SWEEP MOUNTED ON A WAISTED BODY
K. G. Winter and K. G. Smith London Aeron. Res. Council 1971 47 p refs Supersedes RAE-TR-68114; ARC-31322
(ARC-R/M-3661; RAE-TR-68114; ARC-31322) Avail: NTIS; HMSO: £1.15; PHI: $4.90

Pressure distribution was measured at one wing section and along the wing-body junction of a half model. The wing was from STAC 11 section (12% thick normal to the leading edge and of rooftop, upper surface design, pressure distribution). The chord Reynolds numbers were from 1.4 to 5.7 million. At high Reynolds number, the wing pressure correlates fairly well, based on conditions normal to the leading edge, with those on the same model with 60 deg sweep, and two dimensional section results with small differences leading to an increase in pressure drag. Author (ESRO)

N72-15950# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF THICKNESS ON THE SUBSONIC LONGITUDINAL STABILITY CHARACTERISTICS OF DELTA WINGS OF 70 DEG SWEEP-BACK
D. A. Kirby and D. L. I. Kirkpatrick London Aeron. Res. Council 1971 43 p Supersedes RAE-TR-69256; ARC-32156
(ARC-R/M-3673; RAE-TR-69256; ARC-32156) Avail: NTIS; HMSO: £1.50; PHI: $5.80

Measurements of lift, drag and pitching moment were made on five delta wing models to investigate the effects of thickness on the subsonic longitudinal characteristics of the 70 deg delta planform. For four of the wings the form of the thickness distribution was the same with the maximum thickness/chord ratios equal to 4, 8, 12 and 16 per cent respectively, but for the fifth wing a change in the type of thickness distribution was made while retaining the overall maximum thickness/chord ratio at 4 per cent. The results show that increase of thickness gives rise to losses in lift, reductions in lift-dependent drag and improvements in longitudinal stability. Author (ESRO)

N72-15951# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
AN IMPROVED TECHNIQUE OF STABILITY TESTING IN FREE FLIGHT AT TRANSONIC SPEEDS, APPLIED TO A NON-LIFTING SLENDER WING
A. P. Waterfall London Aeron. Res. Council 1971 43 p refs Supersedes RAE-TR-69239; ARC-32058
(ARC-CP-1174; RAE-TR-69239; ARC-32058) Avail: NTIS; HMSO: 60p; PHI: $2.55

It was found it is possible to fly slender wing models at zero lift on such a trajectory that the terminal velocity is close to Mach 1. This makes it possible to measure the stability at slowly varying transonic speeds and to obtain much more reliable results than previously obtained. The methods and interim results are presented. Author (ESRO)

N72-15952# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
THEORETICAL PRESSURE DISTRIBUTIONS ON FOUR SIMPLE WING SHAPES FOR A RANGE OF SUPERSONIC FLOW CONDITIONS
J. Pike London Aeron. Res. Council 1971 49 p refs Supersedes RAE-TR-71064; ARC-33040
(ARC-CP-1178; RAE-TR-70064; ARC-33040) Avail: NTIS; HMSO: £0.70; PHI: $2.95

Pressure distributions are presented for four conical wing shapes with attached shock waves at their leading edges. The influence on the pressure distribution of wing incidence, free stream Mach number or ratio of specific heats is demonstrated. Some pressure distributions over the upper surface are also presented, assuming an isentropic expansion at the leading edge. Author (ESRO)

N72-15954# ARO, Inc., Arnold Air Force Station, Tenn.
INVESTIGATION OF THE AEROELASTIC STABILITY OF THIN CYLINDRICAL SHELLS AT SUBSONIC MACH NUMBERS Final Report
Warren E. White AEDC Nov. 1971 33 p refs
(ARO Proj. PB0189; Task-01)
(AD-732291; ARO-PWT-TR-71-127; AEDC-TR-71-173) Avail: NTIS CSCL 01/3

Boundary-layer and static-pressure data were obtained over a rigid pressure shell at Mach numbers from 0.6 to 0.9 and Reynolds numbers per foot from 300,000 to 5,300,000. These data were obtained with and without the addition of air injected into the boundary layer through a circular slot upstream of the test shell. Static aeroelastic characteristics of thin cylindrical shells were obtained at Mach number 0.9 without the use of boundary-layer control and without shell axial-force loading. An aeroelastic buckling failure was induced on all three shells by reducing the cavity pressure. Flutter of the shell was not encountered during the test. Author (GRA)

N72-15955# Aerospace Corp., El Segundo, Calif. Systems Engineering Operations.
HYPERSONIC FLOW OF A REAL GAS ON THE WINDWARD SIDE OF A DELTA WING Technical Report, Jun. - Nov. 1970
B. E. Pearce 19 Apr. 1971 56 p refs
(Contract F04701-70-C-0059)
(AD-731763; TR-0059(6770-03)-1; SAMSO-TR-71-233) Avail: NTIS CSCL 01/3

The inviscid flow on the windward side of a flat, sharp-edged delta wing is studied for orbital entry at angles of attack near maximum lift. The solutions are numerical and use the one-strip approximation in the method of integral relations. Properties at the wing surface are given for air in thermodynamic equilibrium for angles of attack of 50 and 60 deg and sweep angles of 70, 75, and 80 deg. These solutions are used to illustrate the cross-flow at the wing surface and are shown to agree with those for a perfect gas with an appropriately chosen, constant effective specific heat ratio. Additional solutions for a perfect gas are given for angles of attack between 30 and 70 deg. Surface pressures at the centerline are shown to be accurately approximated by Newtonian theory or by those pressures on a circular cone with the same surface inclination for sweep angles greater than 75 deg. The cross-flow velocity gradient at the

centerline is found to be different from that on an equivalent circular disk. It is demonstrated that the solution for a two-dimensional, flat-faced body is a fair approximation of that obtained for a delta wing with large sweep. Author (GRA)

N72-15956# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
INVESTIGATION OF UNSTEADY AERODYNAMIC FLOWS OVER SPHERES AND DISKS Final Report, 19 May 1965 - 31 Aug. 1971
William W. Willmarth 31 Aug. 1971 4 p
(Contract DAHC04-68-C-0027; Grant DA-ARO(D)-31-124-G711; DA Proj. 200-611-02-B-33-G)
(AD-731862; AROD-5590-6-E) Avail: NTIS CSCL 20/4

The report summarizes the results and conclusions reached in an experimental study of the nature of the unsteady flow about bluff bodies. The flows studied included the flow about a sphere, a disk with face normal to the flow, and an autorotating two-dimensional airfoil. The studies included flow visualization, measurements of unsteady forces and moments, the development of a low Reynolds number towing tank with air bearing carriage and detailed studies of the unsteady inviscid flow field generated by shedding of wake vorticity. Author (GRA)

N72-15957# Royal Inst. of Tech., Stockholm (Sweden). Div. of Aeronautics.
ON THE INDUCED DRAG OF THIN PLANE DELTA WINGS. AN EXPERIMENTAL STUDY OF THE SPANWISE DISTRIBUTION OF THE LEADING EDGE FORCES AT LOW SPEEDS
Sven-Olof Ridder May 1971 58 p refs
(PB-202358; KTH-AERO-TN-57) Avail: NTIS CSCL 01C

Three 60 deg delta wings of identical planform, but with different leading edge radius spanwise distributions have had their induced drag characteristics investigated in a low speed wind tunnel. The spanwise distribution of the local leading edge forces has also been measured by means of a separate leading edge panel element mounted on a sensitive strain gage balance. Author (GRA)

N72-15959*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXTERNALLY-BLOWN-FLAP NOISE
Robert G. Dorsch, Walter J. Kreim, and William A. Olsen [1972] 19 p refs Presented at 10th Aerospace Sci. Meeting, San Diego, Calif., 17-19 Jan. 1972; Sponsored by AIAA
(NASA-TM-X-67991; E-6737) Avail: NTIS CSCL 01B

Noise data were obtained with a large externally blown flap model. A fan-jet engine exhaust was simulated by a 1/2-scale bypass nozzle supplied by pressurized air. The nozzle was pylon mounted on a wing section having a double-slotted flap for lift augmentation. Noise radiation patterns and spectra were obtained for nozzle exhaust velocities between 400 and 1150 ft/sec. The blown flap noise data are in good agreement with previous small model results extrapolated to test conditions by Strouhal scaling. The results indicate that blown flap noise must be suppressed to meet STOL aircraft noise goals. Author

N72-15960*# Virginia Univ., Charlottesville. Div. of Aerospace Engineering and Engineering Physics.
A PRELIMINARY STUDY OF CONTAINMENT CONCEPTS FOR AIRCRAFT LANDING ON ELEVATED STOL-PORTS
John Kenneth Haviland Oct. 1971 47 p refs
(Grant NGL-47-005-014)
(NASA-CR-125544; AEEP-4068-101-71U) Avail: NTIS CSCL 01E

A preliminary study of containment systems for aircraft landing on elevated STOL-ports was conducted as part of an overall study of human acceptance problems associated with STOL operations. The study included a survey and feasibility study of different concepts and a computer analysis of four arrestment systems. The principal conclusion was that a system referred to as the FAA system appears to offer the greatest promise. In this system, standard arresting gear cables are stretched across the roof-top, at roughly 100-foot intervals, but are shielded over the 100-foot-wide primary landing strip. Thus a pilot can land with an arresting hook down, but will not contact the cable unless he swerves off the landing strip, either because he has made a bad landing, or because his landing gear has failed. It was also noted that a suitable curb or guard rail should be developed. Presently available arresting gears and nylon net barriers were considered satisfactory for the overshoot problem. Author

N72-15961# Royal Aircraft Establishment, Farnborough (England).
RIDING QUALITIES OF AIRCRAFT
Jiro Koo Oct. 1971 24 p refs Transl. into ENGLISH from Natl. Aerospace Lab., Japan, report TW-181, Jun. 1970
(RAE-Lib-Trans-1605; BR-27696; UDC-629.1.073; UDC-629.735.017.2; TM-181) Avail: NTIS

The riding qualities of aircraft are investigated in comparison with other vehicles such as train, automobile and ship. The riding discomfort caused by mechanical vibration and swing motion is discussed. Passenger Rating is newly proposed by the author to classify the aircraft riding qualities from the standpoint of passenger comfort. Author

N72-15962# Boeing Scientific Research Labs., Seattle, Wash. Transportation Systems Research Lab.
A THEORETICAL MODEL FOR THE HEATING OF AN AIRPLANE WING FROM A LIGHTNING DISCHARGE
F. Edward Ehlers and Donald F. Winter Oct. 1971 25 p refs
(D180-14190-1) Avail: NTIS

The temperature response of a metal plate to a steady electric current input on its exterior surface was studied to determine the hazards of possible damage to aircraft structures by lightning. Based on experiments using cylindrical cathode with a blunted conical tip, normally directed toward a flat plate (anode) which was used to generate high intensity electric arcs, the solution of the heat equation was found for a Gaussian distribution of noraml heat flux. The analysis was used to find the maximum temperature on the insulated side of the plate on the arc axis for various total currents and pulse times. The results are in good agreement with those of Kofoid. F.O.S.

N72-15963# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
[FLIGHT MECHANICS] [FLUGMECHANIK]
1971 77 p refs In GERMAN; ENGLISH summaries Proc. of a DFVLR Conf. held at Brunswick, 21 Apr. 1971
(DLR-MITT-71-14) Avail: NTIS; DFVLR, Porz: 14,80 DM

Common flight mechanical aspects in aero- and astronautics, units and values in flight mechanics, and flight dynamics of V/STOL aircraft are discussed, including stability, noise, and ground effect.

N72-15964# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).

FLIGHT MECHANICAL PROBLEMS OF THE V/STOL TECHNIQUE
K. Wilhelm *In its* Flight Mech. 1971 p 7-18 refs In GERMAN; ENGLISH summary
Avail: NTIS; DFVLR, Porz: 14,80 DM

Problems of STOL performances and flying qualities are discussed, taking into account the take-off distance requirements. The main problems arise from the installation of additional engine power required for vertical take-off, e.g. high fuel consumption, noise generation, as well as thermic and aerodynamic effects. The influence of aerodynamic interference on the dynamics of VTOL aircraft during transition are also studied. Author (ESRO)

N72-15965# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
SOME COMMON ASPECTS OF FLIGHT MECHANICS IN AVIATION AND SPACE FLIGHT [UEBER GEMEINSAME ASPEKTE DER FLUGMECHANIK IN DER RAUM- UND LUFTFAHRT]
E. A. Bockemueller *In its* Flight Mech. 1971 p 19-30 refs In GERMAN; ENGLISH summary
Avail: NTIS; DFVLR, Porz: 14,80 DM

Aspects of flight mechanics of airplanes and reentry vehicles derived by a unified mathematical treatment are discussed. By introduction of suitable variables, a special form of equations of motion is applied to some problems of longitudinal motion of airplanes and atmospheric entry. Author (ESRO)

N72-15967# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
ON THE DRAG OF PARACHUTES ***c01***
H.-D. Melzig *In its* Flight Mech. 1971 p 39-56 refs In GERMAN; ENGLISH summary
Avail: NTIS; DFVLR, Porz: 14,80 DM

The drag coefficient of parachutes from Mach number up to 4.0 and Reynolds number up to 10 to 7th power is shown to be dependent on forebody, distance behind forebody, porosity, and parachute shape. Author (ESRO)

N72-15969# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
FUTURE WORK IN THE FIELD OF AIRCRAFT FLIGHT MECHANICS [ZUKUENFTIGE AUFGABEN DER FLUGMECHANIK DES FLUGZEUGS]
P. Hamel *In its* Flight Mech. 1971 p 69-76 In GERMAN

Avail: NTIS; DFVLR, Porz: 14,80 DM

Three main aspects of research are discussed: noise reduction, particularly at take off and landing; the use of an HBF 320 Hansa jet as a flying simulator and description of the test program; and the development of a gust moderator. ESRO

N72-15970# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
AN APPLICATION OF THE RAE WIND TUNNEL FLIGHT DYNAMICS SIMULATOR TO THE LOW SPEED DYNAMICS OF A SLENDER DELTA AIRCRAFT (HP 115)
D. W. Partridge and B. E. Pecover London Aeron. Res. Council 1971 40 p refs Supersedes RAE-TR-69168; ARC-31779
(ARC-R/M-3669; RAE-TR-69168; ARC-31779) Avail: NTIS; HMSO: £1.45; PHI: $5.80

The wind-tunnel/flight dynamics simulator was applied to a limited study of the dynamic response at low speeds of the Handley-Page HP 115 aircraft. Motions with six degrees of freedom were simulated. The technique provides full representation of the nonlinearities in the aerodynamic force and moment contributions due to translational velocity components. Good qualitative agreement with flight tests results was achieved. The amplitude damping characteristics of the Dutch roll oscillatory motion appear to be largely dependent on the translational velocities. Author (ESRO)

N72-15971# Royal Aircraft Establishment, Bedford (England). Aero Flight Dept.
A SIMULATION OF THE LOW SPEED HANDLING OF THE BAC 221 SLENDER-WING RESEARCH AIRCRAFT
T. Wilcock London Aeron. Res. Council 1971 45 p refs Supersedes RAE-TR-69257; ARC-32262
(RAE-TR-69257; ARC-R/M-3670; ARC-32262) Avail: NTIS; HMSO: £1.65; PHI: $6.75

A piloted flight simulator study of the low speed handling of the BAC 221 slender wing research aircraft was performed for validation of the simulation of slender wing supersonic transport aircraft. The lateral representation of the aircraft was satisfactory, and lateral control problems experienced on the real aircraft at high angles of incidence were reproduced on the simulator and investigated in more detail than would be practicable in flight. There were several discrepancies in the longitudinal characteristics of the simulation, some of which can be attributed to inadequate representation of visual cues: satisfactory explanation of other discrepancies was not obtained but further simulation may resolve these problems. Sidestep maneuvers and crosswind landings were studied, and the overall quality of the simulation is discussed in relation to previous supersonic transport aircraft simulations. Author (ESRO)

N72-15972# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
LOW-SPEED WIND-TUNNEL MEASUREMENTS OF THE OSCILLATORY LATERAL AERODYNAMIC DERIVATIVES OF A BAC 221 MODEL AND COMPARISON OF RESULTS WITH SIMILAR CONCORDE AND HP 115 DATA
C. O. OLeary London Aeron. Res. Council 1971 24 p refs Supersedes RAE-TR-70095; ARC-32314
(RAE-TR-70095; ARC-R/M-3671; ARC-32314) Avail: NTIS; HMSO: £0.85; PHI: $3.55

Oscillatory tests for measuring a complete set of low speed lateral derivatives for the BAC 221 slender ogee-wing research aircraft, are described. The tests cover the angle of attack range from 0 to 26 deg and, at some angles of attack, measurements are also made at sideslip angles of + or - 5 deg. Comparsion of the BAC 221 results with Concorde and HP 115 data shows that derivatives due to rate of roll are similar, the translational yawing moment derivative, (n sub v) and particularly the roll derivative (n sub p + n sub v sin alpha) increase markedly with angle of attack for the HP 115, but not for Concorde or BAC 221. ESRO

N72-15973# Royal Aircraft Establishment, Bedford (England). Aero Flight Dept.
POSSIBLE LOSSES IN AIRSPEED DURING TURNING MANOEUVRES IN GUSTY AIR
W. J. G. Pinsker and J. G. Jones Aeron. Res. Council London 1971 33 p refs Supersedes RAE-TR-70021; ARC-32211
(ARC-R/M-3672; RAE-TR-70021; ARC-32211) Avail: NTIS; HMSO: £1.20; PHI: $4.90

It is shown that when performing turning maneuvers in turbulent air, it is possible for an aircraft to suffer quasi-permanent

losses (or gains) in airspeed which persist even when the turbulence has ceased. Moreover, these speed changes can be substantially larger than the magnitude of the gust velocities responsible for their generation. Neither of these effects occur in rectilinear flight. This mechanism should be considered in the formulation of airworthiness requirements, and in the conduct of flying involving maneuvering at low altitude and low airspeed.
ESRO

N72-15974# Aircraft Research Association, Ltd., Bedford (England).
RESULTS OF A SERIES OF WIND TUNNEL MODEL BREAKDOWN TESTS ON THE TRIDENT 1 AIRCRAFT AND A COMPARISON WITH DRAG ESTIMATES AND FULL SCALE FLIGHT DATA
J. I. Simper and P. G. Hutton London Aeron. Res. Council 1971 84 p refs Supersedes ARC-32252; ARA-14
(ARC-CP-1170; ARC-32252; ARA-14) Avail: NTIS; HMSO: £1.10; PHI: $4.30

Wind tunnel measurements were made and compared with estimates of flight data for 1:18.86 scale model of Trident 1. Measured and estimated drags in general agree well except measured side nacelle drag increment. The general level of agreement between flight and wind tunnel results is within + or - 3% but is as much as 6% for low Mach numbers, probably because the propelling nozzles were unchoked. If the wind tunnel data are corrected to flight Reynolds numbers using the Prandtl-Schlichting relationship, the general level of the wind tunnel results is between 0 and 5% below the measured flight data. Appendices give details of corrections applied to wind tunnel data and tables showing the method of drag estimation.
Author (ESRO)

N72-15975# Royal Aircraft Establishment, Farnborough (England). Structures Dept.
ACHIEVEMENTS IN RECORDING AND ANALYSIS OF CIVIL AIRCRAFT OPERATIONS 1962-1969 Civil Aircraft Airworthiness Data Recording Programme
E. Marjorie Owen London Aeron. Res. Council 1971 54 p refs Supersedes RAE-TR-71034; ARC-33038
(RAE-TR-71034; ARC-CP-1181; ARC-33038) Avail: NTIS; HMSO: £0.75; PHI: $3.15

Analogue, continuous trace, and multi-parameter records of airworthiness data, representing more than 65000 flying hours, were taken from jet transport aircraft in regular airline service from 1962 to 1969. In Phase 1 (1962 to 1965) data were recorded on aircraft well proved in service; in Phase 2 (1966 to 1969) newer aircraft were instrumented and the records were augmented by additional parameters chiefly directed to obtaining more detailed landing data. More parameters were recorded than in any previous operational research program and much valuable information was acquired in the fields, among others, of airworthiness, flying hazards, operating practices (including autoland) and meteorology, and of assistance for accident investigations. The success of the program depended on close co-operation between representatives of ARB, BOAC, BEA, CI Data Centre Ltd., RAE and a number of other organizations. The work undertaken and the benefits derived by each organization, and by others using CAADRP data, are described. No plan is being made to acquire further data from specially installed analogue trace recorders. The need for new data has not abated, but further information is being and will be taken from digital versions of the mandatory recorders carried by all UK aircraft.
Author (ESRO)

N72-15976# Royal Aircraft Establishment, Farnborough (England). Structures Dept.
HARD LANDINGS ENCOUNTERED BY SUBSONIC CIVIL JET AIRCRAFT Civil Aircraft Airworthiness Data Recording Programme
G. B. Hutton London Aeron. Res. Council 1971 104 p refs Supersedes RAE-TR-70187; ARC-33031
(RAE-TR-70187; ARC-CP-1182; ARC-33031) Avail: NTIS; HMSO: £1.35; PHI: $5.45

A selection of events is described which involved hard landing occurring on two types of aircraft during the period December 1965 to October 1969. For this purpose a number of jet aircraft in normal airline service were fitted with recorders producing continuous trace records of 14 parameters. Throughout the recording period, representing 11462 scheduled airline flights, the records were searched for unusual occurrences, and each one studied to determine its nature and, where possible, factors contributing to its cause. The event descriptions include comments, most of which mention contributory causes of the hard landings. A particular study is made of the normal center of gravity acceleration at touchdown and of aircraft maneuvers during the flare. It is pointed out that all the hard landings followed abnormal flare maneuvers.
ESRO

N72-15977# Wyle Labs., Inc., Rockville, Md. Payne Div.
DEVELOPMENT OF A DYNAMIC ANALOG ANTHROPOMORPHIC DUMMY FOR AIRCRAFT ESCAPE SYSTEM TESTING Final Report, 1 Jul. 1968 - 24 Feb. 1971
Peter R. Payne and Edward G. U. Band Wright-Patterson AFB, Ohio AMRL Aug. 1971 65 p refs
(Contract F33615-68-C-1731; AF Proj. 7231; Task-7231-01)
(AD-730634; WR-71-15; AMRL-TR-71-10; Working-Paper-59103-1) Avail: NTIS CSCL 01/3

Development and operational tests of aircraft escape systems require the use of anthropomorphic dummies which simulate both the dynamic influence of the occupant on the escape system trajectory and the dynamic response of the occupant to the escape system accelerations. The report sets forth the criteria, design features, manufacturing techniques and materials used in the development of a unique anthropomorphic dummy.
Author (GRA)

N72-15978# Wyle Labs., Inc., Rockville, Md. Payne Div.
THE DYNAMICS OF AN EJECTION SEAT CATAPULT WITH A LIVE LOAD Final Report, 1 Mar. 1970 - 15 Apr. 1971
Edward G. U. Band Wright-Patterson AFB, Ohio AMRL Aug. 1971 30 p refs
(Contract F33615-70-C-1420; AF Proj. 7231; Task-7231-01)
(AD-730635; WR-71-14; AMRL-TR-71-18; Working-Paper-59111-14) Avail: NTIS CSCL 01/3

The report is aimed towards determining the effects on catapult performance of using it to propel a live load. The report describes how an analytical model is built up using a previously developed lumped parameter representation of the human body and ejection seat together with a simple direct stroking catapult. Using this catapult, which is characterized by a sinusoidal type development of propulsive force, the difference between the live load and an equivalent rigid load is, in fact, rather small. The importance of the work described in the report is considered to be rather in the development of the model, which can be used for a wide range of similar problems, than in the results of the small number of problems tested.
Author (GRA)

N72-15979# Pereira (William L.) Associates, Corona del Mar, Calif.
WORKBOOK, NATIONAL AVIATION CONCEPT PLAN FOR THE FEDERAL AVIATION ADMINISTRATION Final Report
17 Sep. 1971 210 p refs Revised
(Contract DOT-FA71WA-2590; WLPA Proj. 7114)
(AD-731858) Avail: NTIS CSCL 01/2

Transportation has played a vital role in the process of urbanization. This study examines this role with specific attention to the air mode. Air transportation benefits impact are described and reviewed. Author (GRA)

N72-15980# Bendix Corp., Teterboro, N.J. Flight Systems Lab.
EXPERIMENTAL DISPLAY REFERENCED FLIGHT CONTROL SYSTEM WITH PILOT CONTROL FORCE STEERING Final Technical Report
John T. Sliney Sep. 1971 95 p refs
(Contract F33615-69-C-1468; AF Proj. 8226; Task-822607)
(AD-731805; Rept-7211-356; AFFDL-TR-71-90) Avail: NTIS CSCL 01/3

The report describes an experimental flight control system that incorporates commands from the standard cockpit displays, aircraft control from a basic displacement type attitude referenced autopilot, and pilot supervision of control performance and command insertion via a cruise/approach mode force wheel steering system. For the purpose of flight research, a standard FD109 Flight Director was coupled to a commercial PB-20D Flight Control System via a program developed coupling box that provides the displacement, integration, signal switching, force wheel steering summation, and logic circuitry for interfacing the production autopilot and flight director systems. The system has been used, as illustrated with flight recordings in the text, for automatic landings and go-around, as well as on GCA type approaches through pilot control inputs in response to ground controller directions. Author (GRA)

N72-15981# Bendix Corp., Teterboro, N.J. Navigation and Control Div.
A PITCH AND HEADING COMMAND TECHNIQUE FOR CONTROL/DISPLAY SYSTEMS Final Technical Report, Jul. 1967 - Aug. 1969
John R. Woloshen and Richard V. Wible (AFFDL) May 1971 21 p
(Contracts F33615-67-C-1930; F33615-67-C-1468; AF Proj. 8226; Task-822607)
(731804; AFFDL-TR-71-59) Avail: NTIS CSCL 01/3

The report presents the engineering design of a data insertion technique for remotely operating heading select and attitude reference features of a control/display system from a centrally located control console, the aircraft control wheel. The control logic presented and the location of the controllers enables the pilot to conveniently and precisely insert heading and attitude data into the control/display system. The processed commands emanating from this data can be executed either manually or automatically. This approach to flight control data insertion frees the pilot from the physical activity associated with other insertion methods. Author (GRA)

N72-15982# Lockheed-California Co., Burbank.
ADVANCED ANTI-TORQUE CONCEPTS STUDY Final Report
J. L. Velazquez Ft. Eustis, Va. USAAMRDL Aug. 1971 205 p refs
(Contract DAAJ02-70-C-0043; DA Proj. 1F1-62203-A-143)
(AD-731493; LR-24295; USAAMRDL-TR-71-44) Avail: NTIS CSCL 01/3

A design study has been conducted by the Lockheed-California Company on advanced antitorque concepts intended to replace tail rotors on conventional single-main-rotor/tail-rotor helicopters. The principal design objectives were to reduce hazard to ground personnel and to reduce vulnerability of helicopters to terrain-contact damage. Secondary objectives were reduced vulnerability to small-arms fire and improvements in dynamic, reliability, maintainability and noise characteristics. Two systems were selected from a broad literature search and subsequent design studies. The first concept is based on a main-rotor-driven axial flow fan internally mounted in the aft fuselage delivering air under pressure to a variable geometry louvered exit for antitorque and/or forward-flight propulsion thrust. The second concept employs a main-rotor-driven ducted fan installed in a central pylon supporting a twin-fin empennage. Results of preliminary design studies applying these concepts to an existing Lockheed Model 286 helicopter are presented in this report, including performance and weight data. Improvements over the research vehicle that could result from applying these concepts to a totally new vehicle, using current state-of-the-art design technology, are also discussed. Author (GRA)

N72-15983# Assistant Secretary of the Navy (Installations and Logistics), Washington, D.C.
NAVY F-14 AIRCRAFT (BEING CONSTRUCTED BY GRUMMAN AEROSPACE CORPORATION) Final Environmental Impact Statement
10 Sep. 1971 43 p Revised
(PB-199851F) Avail: NTIS CSCL 01C

A summary of environmental impact and adverse environmental effects caused by operation of the F-14 aircraft are given. Effects include the following. Air pollution is caused by exhaust emissions and the aircraft produces noise while in flight. Also the possiblity of environmental contamination if a crash occurs is addressed. No intolerable environmental effects are foreseen and effects are incorporated in the development program to minimize the impact. An alternative considered is the continued use of the F-4J fighter aircraft which for defense purposes is considered an inferior weapons system to the threat proposed for the mid-70 period. Author (GRA)

N72-15984# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA, US GENERAL AVIATION CALENDAR YEAR 1969
28 Apr. 1971 177 p
(PB-201841; NTSB-ARG-71-1) Avail: NTIS CSCL 01B

The publication contains statistical information compiled from reports of 4757 general aviation accidents that occurred during the calendar year 1969. Included in the total number of accidents are 45 collisions between aircraft. By coding each aircraft involved in the collisions, an additional 45 records are produced, bringing the total accidents records to 4812. This figure reflects the true number of pilots and aircraft involved in the accidents. Author (GRA)

N72-15985# Human Engineering Labs., Aberdeen Proving Ground, Md.
BASELINE NOISE MEASUREMENTS OF THE OH-58A HELICOPTER
Donald L. Lince Apr. 1971 72 p refs
(AD-731467; HEL-TN-3-71) Avail: NTIS CSCL 20/1

Sound measurements were taken in the OH-58A (Kiowa) Helicopter under conditions of maximum performance take off and climb, normal cruise, descent and hover both with and without soundproofing installed. Measurements were taken of the noise produced by firing the XM27E1 minigun system. Intelligibility tests of the intercom system and one radio receiver were carried out. Results are presented and compared to Human Engineering Laboratories Standard S-1-63B. Hearing hazard presented by weapon firing is discussed. Author (GRA)

N72-16078# Factory Mutual Research Corp., Norwood, Mass.
EVALUATION OF NOVEL SLURRY-TYPE FIRE EXTINGUISHING AGENTS Final Technical Report, 1 Mar. - 31 Jul. 1971
Joseph L. Buckley Sep. 1971 16 p refs
(Contract F33615-71-C-129916; AF Proj. 3048; Task-304808)
(AD-730610; RC71-T-31; AFAPL-TR-71-70) Avail: NTIS CSCL 13/12

An experimental program was conducted wherein mixtures of two fire suppressing agents, and a gelling agent (bromotrifluoromethane, CBrF3, ammonium dihydrogen phosphate (ADP) and Cab-O-Sil) were prepared as a potential suppressing agent for habitable aircraft interiors. These mixtures, although capable of extinguishing a combination class A and B fire, yielded a large quantity of particulates causing a high degree of obscuration and were, therefore, considered unsuitable for this application. A mixture of Halon 2402, ADP and Cab-O-Sil was prepared and found to be an excellent suppressing agent against the combination class A and B fire. This agent may be suitable for this application after certain toxicological questions are resolved.
Author (GRA)

N72-16138# Mitre Corp., Bedford, Mass.
A SUMMARY OF SPECTRUM UTILIZATION AND A FREQUENCY ALLOCATION PLAN FOR THE INTEGRATED COMMUNICATIONS NAVIGATION IDENTIFICATION (CNI) SYSTEM
J. Clapper, Jr. Aug. 1971 81 p refs
(Contract F19628-71-C-0002; AF Proj. 6910)
(AD-731751; MTR-2063; ESD-TR-71-235) Avail: NTIS CSCL 20/14

Utilization of the radio frequency spectrum from 108 MHz to 1660 MHz for airborne radio navigation, air traffic control, and related communications and identification (CNI) purposes is examined with a view to identifying the most appropriate course of action to be followed in obtaining radio frequency allocations. On the basis of political, economic and electromagnetic compatibility considerations, combined with the necessity for the evolutionary introduction of CNI, an initial decision to concentrate TACAN operations on a lesser number of channels and reassigning the vacated spectrum space to CNI appears feasible in the 960-1215 MHz Aeronautical Radionavigation band. The 1535 MHz 1660 MHz portion of the spectrum appears attractive for an ultimate consolidation of space/aeronautical mobile and CNI concepts. Formal frequency allocation action at the United States national level to support these judgments is urged.
Author (GRA)

N72-16164# Naval Research Lab., Washington, D.C.
VOLTAGE LEVEL AND WIRING WEIGHT FOR AIRCRAFT ELECTRICAL POWER SYSTEMS
6 Oct. 1971 30 p refs
(AD-732001; NRL-7298; NRL-E02-06) Avail: NTIS CSCL 09/5

A method for computing the wiring weight, conductor weight, and conductor losses as a function of system voltage is described for aircraft electrical power systems. It is indicated that if phase voltage at the load is considered as system voltage then the number of wire conductors is equal to the number of phases. Hence, wiring weight, (I squared) R losses, and the number of conductors are directly proportional to the number of phases in a system and, for the same loads, the system voltage is inversely proportional to the number of phases. A 345-volt (three times the present 115-volt, three-phase voltage) single-phase system voltage would reduce the wiring weight, copper losses, and number of conductors to one-third their present value (on the three-phase ac system). A significant point, or criterion, for optimum system voltage is reached at a system voltage where the system wiring weight divided by system wiring losses is a minimum. Author (GRA)

N72-16185# Forschungsinstitut fuer Anthropotechnik, Meckenheim (West Germany).
CONTRIBUTIONS TO SIMULATION TECHNIQUES DURING 1968 [BEITRAEGE ZUR SIMULATIONSTECHNIK IM JAHRE 1968]
Feb. 1969 74 p refs In GERMAN
(Anthropotech-1/69) Avail: NTIS

Computerized approach and landing flight simulation, simulation interface and electronic switching for flight simulator C-11, and analog data recording for simulation devices are discussed.

N72-16186# Forschungsinstitut fuer Anthropotechnik, Meckenheim (West Germany).
STRUCTURAL CONCEPTION FOR A LANDING APPROACH VISUAL SIMULATOR USING THE INTERMEDIATE IMAGE PROJECTION METHOD [KONSTRUKTIVE KONZEPTION EINES LANDEANFLUG-SICHTSIMULATORS NACH DEM ZWISCHENBILD-PROJEKTIONSVERFAHREN]
K.-P. Gaertner and J. Wernicke *In its* Contrib. to Simulation Tech. during 1968 Feb. 1969 16 p In GERMAN
Avail: NTIS

The visual information is provided by landscape photography *onto a transparent material on which are reproduced the terrain* features. The image of the relevant region is then projected through a vario-objective (zoom) on a display device as an *intermediary image, which is then transmitted* by a television system. The simulation of vertical motion is performed by varying the focal length of the objective and simulation of forward motion of the aircraft relative to the ground by translating the transparent material. Simulation of any aircraft rotation is obtained by rotating the television camera. Values for the different parameters involved in the system are given and discussed. ESRO

N72-16200# Tech Development, Inc., Dayton, Ohio.
SCALE MODEL PROPULSION SIMULATOR FOR SUPERSONIC AIRCRAFT Final Report, 1 Jul. 1969 - 1 Jun. 1971
William R. Moffitt Wright-Patterson AFB, Ohio AFAPL Aug. 1971 70 p
(Contract F33615-69-C-1909; AF Proj. 668A)
(AD-731238; AFAPL-TR-71-57) Avail: NTIS CSCL 21/5

The purpose of the program was to develop an engine simulator which will provide simultaneous simulation of the inlet and exhaust flow fields in a full span, supersonic aircraft wind tunnel model. The simulator was designed to match the engine characteristics of exhaust nozzle pressure ratio and nozzle flow function vs. inlet corrected airflow. This match will exist over the full mission profile of altitude and Mach number including the full reheat, full dry and part power dry operation. Aerodynamically, the unit consists of two basic elements: A four-stage axial flow compressor with no bleed provisions, pressure ratio - 2.8; A single-stage high pressure drive turbine. A portion of the turbine exhaust is throttled into the exhaust nozzle inlet and mixed with the compressor discharge flow to obtain the required exhaust flow. Temperature is not simulated in this model, but a hydrogen burner could be added at a later date. The limited compressor performance data obtained are summarized.
Author (GRA)

N72-16205# National Aeronautical Establishment, Ottawa (Ontario). High Speed Aerodynamics Section.
HIGHER-ORDER THEORY OF TWO-DIMENSIONAL SUBSONIC WALL INTERFERENCE IN A PERFORATED WALL WIND TUNNEL
M. Mokry Oct. 1971 33 p refs
(LR-553; NRC-12370) Avail: NTIS

The analytic solution for the interference velocity potential due to a source and a vortex between perforated wind tunnel walls is extended to higher-order singularities. This allows a

more accurate construction of the primary perturbation potential at the walls produced by the tested airfoil, and the evaluation of wall interference on the model involving terms of higher powers of the airfoil chord/tunnel height ratio. The solution for the interference velocity at the position of the model is presented in the form of a series expansion, with Bernoulli polynomials of a suitably chosen function of wall porosity as coefficients. This approach provides a unified theory of various correction factors for perforated walls. The discussion is limited to subsonic flow and a thin airfoil of small camber and incidence, placed midway between the perforated walls. Author

N72-16227# Ohio State Univ. Research Foundation, Columbus.
BOUNDARY LAYERS ON AIRFOILS IN TRANSONIC FLOW AND THE CONTROL OF SHOCK-INDUCED SEPARATION Final Report, 1 Jun. 1967 - 30 Dec. 1970
John D. Lee Aug. 1971 73 p refs
(Contract DAHC04-67-C-0051; OSURF Proj. 2426; DA Proj. 200-61102-B-33-G)
(AD-731830; AROD-7113-1-E) Avail: NTIS CSCL 20/4

The transonic terminal shock wave is always oblique (rather than normal) at the surface and the associated deflection of the boundary layer corresponds to the maximum deflection permitted by the Mach number upstream of the shock. When the Mach number is near 1 the deflection is small, and the separated boundary layer will usually reattach leaving a bubble separation. At higher Mach numbers the separation becomes more severe and reattachment may be affected only by extremes in boundary layer controls, e.g., streamwise blowing and vortex generators were found to be useful. In many cases, a controlled attachment simply results in a postponement of the separation to a higher Mach number with an increased deflection and higher drag. The study was performed with the OSU 12-inch transonic wind tunnel using 6-inch chord airfoil models in the Mach number range from 0.4 to 0.9. Data taken were in the form of surface static pressures, wake pitot pressures, force balance outputs and schlieren photographs. GRA

N72-16315# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
INTEGRATED ENGINE INSTRUMENTATION SYSTEM STUDY: SELECTED STUDIES ON ENERGY MANAGEMENT Final Report, 1 May 1970 - 30 Jun. 1971
D. C. Sederstrom, N. R. Zagalsky, R. L. Schultz, L. J. Mueller, and R. P. Irons, Jr. Sep. 1972 116 p refs
(Contract N00014-67-C-0101; NR Proj. 213-070)
(AD-731713; Rept-12591-FR-2(R)) Avail: NTIS CSCL 05/8

A hybrid simulation of an F4 aircraft was developed for the purpose of evaluating display concepts and human operator techniques and capabilities in manual energy management. Time savings in achieving energy gains with the aids provided as compared with Flight Manual methods and reduction in pilot workloads were measured. Maximum-range prediction and minimum-time intercept, as elements of an energy management system, were investigated. Several approaches to inflight calibration were studied. Benefits of optimal fuel estimation by means of Kalman filtering and by linear blending of fuel flow and fuel quantity measurements were determined. Author (GRA)

N72-16350# Midwest Research Inst., Kansas City, Mo.
COMPARISONS OF EXPERIMENTAL AND THEORETICAL DYNAMIC ROTOR BEARING BEHAVIOR USING GAS LUBRICATION Technical Report, Dec. 1968 - May 1970
Ronald D. Dayton Nov. 1971 57 p refs
(Contract F33615-69-C-1265; AF Proj. 3048)
(AD-732211; AFAPL-TR-71-44) Avail: NTIS CSCL 13/9

The report presents the results of an investigation into the adequacy of presently available theory in predicting the dynamic behavior of a rotor supported in hydrostatic and hydrodynamic gas lubricated journal bearings. Measurements of critical speeds, threshold of instability speeds, gas flow rates, and rotor whirl frequencies for several rotors supported in hydrostatic and hydrodynamic journal bearings were made and compared to theoretical predictions. Variables investigated were bearing load, bearing supply pressure, bearing and gas temperature, and type of bearing supply gas. Good agreement between the experimental and theoretical results was obtained. Author (GRA)

N72-16355# Picatinny Arsenal, Dover, N.J.
EVALUATION OF THE ADHESIVE BONDING PROCESSES USED IN HELICOPTER MANUFACTURE. PART 1: DURABILITY OF ADHESIVE BONDS OBTAINED AS A RESULT OF PROCESSES USED IN THE UH-1 HELICOPTER
Raymond F. Wegman, Marie C. Ross, Stanley A. Slota, and Edward S. Duda Sep. 1971 111 p refs
(AD-732353; PA-TR-4186; AMCMS-Code-4010.28.9.02003)
Avail: NTIS CSCL 13/8

The methods used to prepare adherends for components of UH-1 aircraft (prior to bonding) were evaluated for their effect upon the durability of the bonded joint. The phosphate-fluoride method for titanium produces a surface which, when bonded was 7.5 to 10 times more durable than joints prepared from titanium surfaces that were alkaline cleaned. Upon aging, the surface structure of the phosphate-fluoride treated specimens showed signs of conversion to the less durable structure found on the alkaline-cleaned titanium. The method used to anodize aluminum produced a surface which, when bonded, exhibited essentially the same durability as the bonds using phosphate-fluoride-etched titanium. Bonds to glass-resin-composite adherends are as durable as the composite itself and failures were found to be interlaminar. Author (GRA)

N72-16419*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
NEW MATERIALS FOR MANNED SPACECRAFT, AIRCRAFT, AND OTHER APPLICATIONS
Matthew I. Radnofsky *In its* Conf. on Mater. for Improved Fire Safety 1971 p 91-102 refs
Avail: NTIS; SOD $2.25 CSCL 11D

The application of fire resistant spacecraft materials to the interior design of commercial aircraft is discussed. The use of such materials for curtains, upholstery, carpets, decorative panels, cabinets, paper products, and oxygen lines is examined. It is concluded that the highest degree of nonflammability can be obtained with inorganic fibers such as asbestos and fiber glass. The application of various chemical compounds for specific purposes is presented. Author

N72-16501# Armament Development and Test Center, Eglin AFB, Fla.
AN OBJECTIVE AID FOR FORECASTING FOG/STRATUS AT EGLIN AIR FORCE BASE Final Report, 1 Nov. 1970 - 31 May 1971
George D. Greenly, Jr. and James E. Bralley Oct. 1971 15 p refs
(AD-732289; ADTC-TR-71-130) Avail: NTIS CSCL 04/2

An objective forecast aid is presented to forecast the occurrence of fog/stratus during the period 1 November through 31 May. Parameters conducive to fog/stratus formation are identified and subjectively weighted by points. The point total delineates three categories of occurrence or non-occurrence, with a fourth category being non-applicable due to wind speeds. Three winter seasons of independent data were used to check the study (1968-1969, 1969-1970, and 1970-1971). Author (GRA)

N72-16510*# General Electric Co., Schenectady, N.Y. Corporate Research and Development.
VHF RANGING AND POSITION FIXING EXPERIMENT USING ATS SATELLITES: FINAL REPORT ON PHASES 1 AND 2, 25 NOVEMBER 1968 - 1 MAY 1971
1 May 1971 349 p refs
(Contract NAS5-11634)
(NASA-CR-125538; S-71-1109) Avail: NTIS HC $3.00/MF $0.95 CSCL 17G

The testing program with the ATS-1 and ATS-3 spacecraft showed that geostationary satellites can provide superior communications and position surveillance for mobile craft. Inexpensive modifications to conventional mobile communications equipment aboard the craft can provide reliable, high quality voice and digital communications with distant ground stations and other vehicles, and automatic surveillance of the positions of all the craft by a ground facility. The tests also demonstrated the location and automatic readout of remote data collection platforms. Frequency modulation signals with the narrow audio and radio frequency bandwidths of terrestrial mobile radio communications were relayed through the VHF transponders of the geostationary satellites. The voice and digital communications were far superior in reliability and quality to long-distance mobile communications by other means. It was shown that one satellite can provide nearly uniform high quality performance over approximately one-third of the earth's surface. Position fixes by range measurement from the two satellites were accurate to approximately one nautical mile, except near the equator and the poles. Author

N72-16511*# General Electric Co., Schenectady, N.Y. Corporate Research and Development.
VHF RANGING AND POSITION FIXING EXPERIMENT USING ATS SATELLITES: EXECUTIVE SUMMARY OF FINAL REPORT ON PHASES 1 AND 2, 25 NOVEMBER - 1 MAY 1971
1 May 1971 29 p ref
(Contract NAS5-11634)
(NASA-CR-125537; S-71-1109) Avail: NTIS CSCL 17G

The VHF transponders of the ATS-1 and ATS-3 geostationary satellites were used in ranging and position fixing experiments. An interrogation signal was transmitted from a ground terminal to ATS-3, which relayed it to the vehicle transponders. The vehicle that was addressed repeated the signal and its response was relayed back through both satellites to the ground terminal, where propagation times were measured; lines-of-position and fixes were computed. The 0.43 second tone-code ranging signal contained a single audio tone frequency. Ambiguity was resolved and user craft identified by a simple digital code. Seven vehicles were used in the test: three aircraft, two ships, an oceanographic buoy, and a truck. Ionospheric and multipath effects were studied. It is concluded that a VHF system could have an accuracy of + or - one nautical mile for ships and aircraft if calibration transponders are used to monitor the ionosphere. Author

N72-16685# Advisory Group for Aerospace Research and Development, Paris (France).
INLETS AND NOZZLES FOR AEROSPACE ENGINES
Dec. 1971 503 p refs Partly in ENGLISH and FRENCH
Presented at the 38th Meeting of AGARD Propulsion and Energetics Panel, Sandefjord, Norway, 13-17 Sep. 1971
(AGARD-CP-91-71; UDC-533.697) Avail: NTIS HC $6.00/MF $0.95

Conference papers are presented on five topics: engine-airplane interference representation in wind tunnel testing; thrust vectoring and control; V/STOL inlets and nozzles; supersonic inlets, nozzles, and applications; and subsonic and transonic aeropropulsion.

N72-16686# New York Univ., N.Y. Aerospace Lab.
REVIEW OF THE CONCLUSIONS OF THE AGARD AD HOC COMMITTEE ON ENGINE AIRPLANE INTERFERENCE AND WALL CORRECTIONS IN TRANSONIC WIND TUNNEL TESTS **c01**
Antonio Ferri *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 10 p
Avail: NTIS HC $6.00/MF $0.95

A program for the study of problems of engine-airplane interference is outlined. Engine simulators, nozzle design, and dynamic characteristics of the inlet are considered. K.P.D.

N72-16687# National Aerospace Lab., Amsterdam (Netherlands).
INLETS-AIRPLANE TESTING IN TRANSONIC WIND TUNNELS **c01**
F. Jaarsma *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 15 p refs
Avail: NTIS HC $6.00/MF $0.95

The results and recommendations on inlet testing in transonic wind tunnels are discussed in detail. Special attention is directed towards mass flow measurements, external drag determination, boundary layer representation for diverters and bleeds, and non-steady flow phenomena in inlets. Author

N72-16688# Naval Postgraduate School, Monterey, Calif.
NOZZLE AND EXHAUST TESTING IN TRANSONIC FLIGHT REGIME **c01**
Allen E. Fuhs *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 32 p refs
Avail: NTIS HC $6.00/MF $0.95

A survey of engine-airframe interference is presented. In the early stages of development, wind tunnel tests of nozzles and exhausts were conducted, both alone and in models of the afterbody. Thrust measurements were made in test facilities at sea level and various altitudes, followed by flight tests. Drag (of nozzle, boattail, etc.) was determined, as well as thrust. Simulation of exhaust of hot and cold gases, ejectors, and powered simulators is an important facet of testing. Nonsteady aerodynamics of internal and external flow and aeroelastic phenomena need to be examined. These topics are discussed for both podded and buried engines. Major conclusions of the study related to exhausts and nozzles are given. Author

N72-16690# Centre d'Essais de Propulseurs, Saclay (France).
TEST METHODS AND EXAMPLES FROM THE PROPULSION TEST CENTER **c11**
Jean-Claude Ripoll and Jean-Bernard Cocheteux *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 17 p In FRENCH
Avail: NTIS HC $6.00/MF $0.95

The Propulsion Test Center is a French government establishment which participates in the development of aeronautical engines, using industrial test methods of flight simulation. Equipment at the facility includes principally exhaust air and gas treatment apparatus (using either electricity or vapor), a complex network of conduits, 8 engine test cells for flight simulation, and 7 test jets. Measurements are controlled by a central coordinator. Among tests made on air inlets and nozzles, tests on the Concorde aircraft are noted, as well as those on noise and thrust. Transl. by K.P.D

N72-16691# National Gas Turbine Establishment, Farnborough (England).
MEASUREMENT FULL-SCALE OF PROPELLING NOZZLE PERFORMANCE IN AN ATTITUDE TEST FACILITY **c01**
J. C. Ascough *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 12 p ref

Avail: NTIS HC $6.00/MF $0.95

Full scale thrust performance tests are described which were made in an altitude test cell on a prototype two-stream propelling nozzle fitted to a turbojet engine installed within a simulated aircraft nacelle. The tests were made at conditions representing flight at Mach 2 at 20 km altitude. Nozzle thrust efficiency obtained from these full scale tests was compared with that from a 1/10 scale model test rig. The preliminary analysis gave unexpectedly low full scale efficiencies and, to investigate this, special tests were made with the secondary part of the nozzle removed. As a result of the primary nozzle tests, corrections were made to secondary nozzle test points, which yielded satisfactory agreement between full scale and model.

Author

N72-16692*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

INLET-ENGINE-NOZZLE WIND TUNNEL TEST TECHNIQUES c12

D. N. Bowditch *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 16 p refs

(NASA-TM-X-67494) Avail: NTIS CSCL 20D

Experimental investigations of the inlet, engine, and exhaust nozzle of a supersonic propulsion system are described. Exhaust nozzle results are presented which are compared with wind tunnel and flight results to assess the accuracy of flight measurements. Comparisons are also presented for nozzle performance obtained with a cold jet, a powered turbojet simulator, and a solid jet boundary simulator. The effect of the local boundary layer on nozzle performance is also discussed. The need for good dynamic measurements during inlet-engine testing is illustrated for transients such as inlet unstart and engine stall. The transient nature of inlet distortion and its effect on the engine are presented for two different operating conditions.

Author

N72-16693# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.

WIND TUNNEL TESTING OF V/STOL ENGINE MODELS: SOME OBSERVED FLOW INTERACTION AND TUNNEL EFFECTS

R. A. Tyler and R. G. Williamson *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 12 p refs

Avail: NTIS HC $6.00/MF $0.95

The interpretation of force measurements on V/STOL-related models incorporating inflows and/or outflows is discussed in relation to investigations concerned mainly with the transition performance of lift fan configurations. These utilize balance-mounted, powered models of about 1000 hp in the closed test section of a 10 ft x 20 ft V/STOL propulsion tunnel. With models producing strong downwash, an overriding testing limit arises in closed wind tunnels from the formation of a stable floor vortex system due to the interaction of stagnating model flow with the mainstream. An experimental study of this effect as it relates to downward directed jets is described. Vortex formation limits are correlated in terms of a jet force coefficient for a wide range of jet inclinations to the vertical, and for both single and paired jets. Interference velocity measurements, with limited data from the main program and other sources, are used to deduce corresponding tunnel flow breakdown limits. These testing limits are shown to be sensitive to model characteristics.

Author

N72-16694# LTV Aerospace Corp., Dallas, Tex.

VECTORED THRUST IN AIR COMBAT

C. R. James *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 8 p ref

Avail: NTIS HC $6.00/MF $0.95

Advantages of thrust vectoring in air combat are evaluated using a manned air combat simulator. This simulator consists of two fighter cockpits linked by digital computer-driven visual displays which present each pilot with a properly oriented image of the opponent aircraft. Real time digital computation permits each pilot to fly his aircraft anywhere within the performance and strength limits of the airframe as he strives to maneuver into position to fire his weapons. Engagements include three cases: (1) a baseline conventional fighter, (2) a vectored thrust version of the baseline, and (3) the vectored thrust configuration with a 1500-pound weight penalty. The conventional fighter is the common opponent for all engagements. Engagements are scored by relative time in advantageous positions and by win-lose-draw results. Advantages of thrust vectoring are quantified and the sensitivity of advantages to weight penalty is determined. The experiments are described, results are summarized and analyses presented based on aircraft performance parameters. Results are also correlated with previous experiments.

Author

N72-16695# Motoren-Und Turbinen-Union Muenchen G.m.b.H. (West Germany).

AERODYNAMICS OF THRUST REVERSER DESIGN c01

W. J. Lewis (Rolls-Royce, Ltd., Bristol, Engl.) and H. Prechter *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 11 p ref

Avail: NTIS HC $6.00/MF $0.95

For a number of applications the clamshell target-type thrust reverser is an attractive solution for producing a braking force from a jet engine. This type of reverser consists of a pair of buckets which, in the stowed position, form part of the aircraft fuselage or engine nacelle and are moved into the jet efflux downstream from the final nozzle to provide thrust reversal. The important geometric design parameters can be determined from consideration of the flow in the thrust reverser system. Their effect on the aerodynamic performance was established from model tests and is discussed in detail. For the optimization of the operating mechanism in connection with fail-safe requirements, the load on the bucket and its point of application is important and is related to the reverser geometry. The problem of hot gas and debris ingestion into the engine intake is pointed out. Several solutions to overcome this problem are investigated, together with the implications they have for performance and design.

Author

N72-16697# Royal Aircraft Establishment, Bedford (England).

SOME APPLICATIONS OF BOUNDARY-LAYER CONTROL BY BLOWING TO AIR INLETS FOR V/STOL AIRCRAFT c02

I. McGregor *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 13 p refs (See N72-16685 07-28)

Avail: NTIS HC $6.00/MF $0.95

The use of jet blowing as a means of boundary layer control in intakes appears to have several advantages for V/STOL aircraft. The principles involved are discussed, giving two examples: a two-dimensional inlet under static conditions, and a ducted lifting fan at low forward speed. Some results of the effects of slot blowing on the behavior of the intakes of a model of a V/STOL strike aircraft at subsonic speeds are presented, and compared with those obtained using a naturally-aspirated suction bleed. It is concluded that boundary layer control by blowing could lead to a small improvement in net thrust and a significant reduction in flow distortion at entry to the compressor. Sensitivity of intake performance to incidence is also much reduced.

Author

N72-16698*# De Havilland Aircraft Co., Ltd., Downsview (Ontario).

SOME ASPECTS OF PROPULSION FOR THE AUGMENTOR-WING CONCEPT
D. C. Whittley *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 14 p refs Sponsored in part by NASA, Defence Res. Board of Canada, and Canadian Dept. of Ind.

(NASA-CR-125540) Avail: NTIS CSCL 21E

Many modern concepts for STOL and V/STOL aircraft rely on integration of the propulsion system with the wing to create favorable lift interactions, and are known as powered lift concepts. A study of powered lift, concerning management and control of the various propulsive streams or jets is presented, each concept having its own particular objectives and requirements. Some specific objectives of this kind are described which relate to the augmentor wing. Consideration is given to three aspects of the subject, namely the augmentor flap itself, the wind ducting and augmentor primary nozzle, and the choice of powerplant or engine cycle. More generally, comments are made regarding noise attenuation and the prospect for achieving a low overall noise level for jet-STOL aircraft of the future. Author

N72-16699# Rolls-Royce, Ltd., Derby (England). Engine Div.
RAPID MIXING NOZZLES FOR V/STOL APPLICATIONS **c02**
C. M. Chesters *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 11 p refs
Avail: NTIS HC $6.00/MF $0.95

If the maximum potential of a V/STOL aircraft is to be achieved, it must be capable of operating from a variety of both prepared and unprepared sites. The use of high thrust-to-weight ratio jet lift engines with convergent or annular nozzles restricts this capability due to ground erosion, debris and hot gas recirculation, and noise. Model and full scale tests demonstrated the benefits to be obtained from the use of rapid mixing nozzles with acceptable thrust lost and engine length penalties. The scope of the investigation extended to an examination of the possibilities of thrust vectoring and of the performance of thrust augmentors using rapid mixing nozzles. Author

N72-16700# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Luftsaugende Antriebe Eng. Dec. 1971 10 p
THE PROPULSION JET OF A VTOL AIRCRAFT
E. Schwantes *In* AGARD Inlets and Nozzles for Aerospace refs

Avail: NTIS HC $6.00/MF $0.95

The three regions of a vertical takeoff propulsion jet (the free jet, the wall jet and the zone of separation of the wall jet from the ground due to wind effects and buoyancy forces) were investigated with a three-dimensional model jet. Behind the convergent nozzle the jet accelerates up to supersonic velocity maintaining the core nearly five nozzle diameters. Because of the lower turbulence of the jet with high speed, jet decay and the three-dimensional spread are lower than those of the jet with small nozzle velocity. At the hot wall jet there is a strong influence of nozzle distance from the ground on velocity profile. The decisive parameter characterizing the recirculation flow is the radius of separation of the wall jet from the ground. The behavior of the radius of separation for different jet parameters and several wind velocities is presented. Author

N72-16702# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
FLOW DISTORTION AND PERFORMANCE MEASUREMENTS ON A 12 INCH FAN-IN-WING MODEL FOR A RANGE OF FORWARD SPEEDS AND ANGLE OF ATTACK SETTINGS **c01**
Uwe W. Schaub and Robert W. Bassett *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 13 p refs

Avail: NTIS HC $6.00/MF $0.95

The model, comprising a 12-in. diameter fan buried in a N.A.C.A. 0015 section wing with a constant chord of 40-in., was tested at various angles of attack and air speeds in the 10x20-ft closed propulsion wind tunnel. Tunnel interference corrections were estimated. Typical corrections were indicated for the whole testing range which became limited at very low crossflow ratios as a result of uncertainty in the correction in angle of attack. Flow distortion due to crossflow occurred in both the inlet and exit planes. In the crossflow ratio range zero to 0.27, inflow distortion was observed to be velocity distortion at essentially constant total pressure, whereas outflow distortion appeared to be a distortion of the exit plane static pressure field. Author

N72-16703# Boeing Co., Seattle, Wash.
THE DESIGN, DEVELOPMENT, AND TESTING OF A SUPERSONIC TRANSPORT INTAKE SYSTEM **c02**
E. Tjonneland *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 17 p refs
Avail: NTIS HC $6.00/MF $0.95

The performance criteria, including engine airflow matching requirements, of an axisymmetric mixed-compression intake for a supersonic transport application are described and related to the selection of the design features of the intake variable-geometry components. Viscous technology is applied to the design and development of the boundary layer control system to account for intake viscous interactions and to scale model results to full-scale designs. Small, low-angle bleed holes 20 deg to the surface yield high flow coefficients. Hole diameters of approximately half the height of the boundary layer displacement thickness are used to improve the cleanliness of the supersonic diffuser flow and to maximize pressure recovery of the bleed air. Vortex valves are incorporated in a fluidic normal shock stability system to allow operation at peak intake recovery and remain started during atmospheric or engine transients. Author

N72-16704# National Gas Turbine Establishment, Pyestock (England). Engine Test Dept.
FREE-JET TESTS OF A FULL SCALE SUPERSONIC INTAKE/ENGINE COMBINATION **c02**
P. F. Ashwood *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 19 p refs
Avail: NTIS HC $6.00/MF $0.95

Results are presented from an experimental investigation on a full-scale Concorde power plant in 5 ft x 5 ft free-jet test facility to investigate intake/engine compatibility at supersonic speeds under both steady-state and transient conditions. The main aim of the test program was to study the behavior of the power plant when running under the control of its flight systems, in particular during the transients that result from the sudden application of side-slip or from rapid engine power changes. Initial tests with the intake alone enabled surveys to be made of the engine face pressure distribution and fluctuation over a wide range of test conditions. The major part of the program was undertaken with an Olympus 593 two-spool turbojet engine coupled to the intake in a test configuration which reproduced the precise geometry of the port outer power plant of the prototype Concorde aircraft. Author

N72-16705# British Aircraft Corp., Filton (England). Commercial Aircraft Div.

CONCORDE POWERPLANT DEVELOPMENT
C. S. Leyman and D. P. Morriss *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 32 p refs

Avail: NTIS HC $6.00/MF $0.95

The development of the Concorde power unit is described, with particular reference to the problems encountered during flight testing. The extent to which these problems were predicted by altitude test cell experience and the use of such facilities in the development of the design are also discussed. Author

N72-16706# Boeing Co., Seattle, Wash.
CONTROL CONCEPT AND WIND TUNNEL TESTING OF A SUPERSONIC INTAKE CONTROL SYSTEM c02
H. N. Larsen and R. G. Schweikhardt *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 23 p refs

Avail: NTIS HC $6.00/MF $0.95

The controller is independent of other intake controllers and of airplane data systems. During started intake operation, throat Mach number is controlled with a translating centerbody and variable position cowl throat doors; normal shock position is controlled with secondary air valves and overboard bypass doors. These two control loops use intake duct pressure ratio signals for feedback. The desired pressure ratio reference value is scheduled with centerbody position and biased with intake controller error signals to provide for varying intake Mach number and angle of sideslip. Using vortex valves as an auxiliary normal shock stability system, model tests showed that the controller can maintain peak intake recovery while accommodating the required disturbances. Hot- and cold-day engine/intake air flow matching is automatically controlled with increased secondary valve air flow or an intake-activated engine rpm trim control. An external compression mode which maintains stable intake air flow with low compressor face distortion provides for unstarted supersonic intake operation. Author

N72-16707# General Dynamics/Fort Worth, Tex. Convair Aerospace Div.
AN AERODYNAMIC DRAG STUDY OF JET ENGINE NOZZLES
Dave Bergman *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 12 p refs
Avail: NTIS HC $6.00/MF $0.95

To aid nozzle analysis in areas where analytical methods are lacking, a wind tunnel program was conducted to investigate and measure the external drag characteristics of several nozzles at both on- and off-design exhaust conditions. This study involves nozzles of the centerbody plug, the convergent, and the convergent-divergent types. Flow-through-nacelle nozzles and solid-wall jet plume simulators, each used frequently in airplane model tests, were included in the program. Results show large changes in external drag with variations in exhaust flow, and describe the behavior of jet plume shape and entrainment effects. The results also provide insight into methods for simulating exhaust flow effects on airplane models which do not incorporate high-pressure exhaust flow. Author

N72-16708# British Aircraft Corp., Preston (England).
JET EFFECTS ON BOATTAIL PRESSURE DRAG AT SUPERSONIC SPEEDS c01
J. A. P. Stoddart *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 11 p refs
Avail: NTIS HC $6.00/MF $0.95

An analysis is presented of supersonic boattail pressure drag measurements in the presence of single or twin propulsive jets. Using theoretical inviscid pressure distributions as a datum, the decrease in boattail pressure drag coefficient with increasing nozzle pressure ratio is shown to be a function of the difference between the measured base pressure coefficient and a reference base pressure coefficient. The boattail shapes are shown to fall into two groups, one of which experiences a much stronger influence of the propulsive jet than does the other. Correlations of measured base pressure coefficient in the presence of a propulsive jet are also presented for convergent and con-di nozzles. Author

N72-16709*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
A FLIGHT INVESTIGATION OF STEADY STATE AND DYNAMIC PRESSURE PHENOMENA IN THE AIR INLETS OF SUPERSONIC AIRCRAFT c12
Frank W. Burcham, Jr. and Donald R. Bellman *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 12 p refs

(NASA-TM-X-67495) Avail: NTIS CSCL 20D

The difficulty of achieving adequate inlet performance and stability and avoiding engine compressor stalls at supersonic speeds has led to the investigation of pressure phenomena in the inlets of several supersonic aircraft. Results of tests with the F-111A airplane are presented showing the inlet steady state and dynamic performance. The inlet total pressure distortion that causes compressor stall is discussed, and the requirement for high response instrumentation is demonstrated. A duct resonance encountered at Mach numbers near 2.0 is analyzed and shown to be due to a normal shock oscillation at the duct fundamental frequency. Another type of resonance, in the engine fan duct, is shown to be a possible cause of reduced engine stall margin in afterburning operation. Plans for a comprehensive inlet study of the YF-12 airplane are discussed including flight tests and full scale, 1/3 scale, and 1/12 scale wind tunnel tests. Author

N72-16710# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
SUPERSONIC INLET PERFORMANCE AND DISTORTION DURING MANEUVERING FLIGHT c02
L. E. Surber and D. J. Stava *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 18 p refs

Avail: NTIS HC $6.00/MF $0.95

Several possible vehicle configurations are presented and discussed to point out inherent advantages and disadvantages in terms of airframe-inlet integration and mission accomplishment. Features of the forebody and forebody/wing configurations are presented, together with wind tunnel test data comparing the inlet flow fields of these models. Techniques are described for design air inlets for the airframe flow fields. It also describes the instrumentation employed to document inlet performance. Air inlet performance and duct flow distortion from wind tunnel tests of different model designs are compared to show the effects of aircraft geometry, air inlet design, and maneuver condition over the 0.6 to 2.5 Mach number range. Author

N72-16711# Pratt and Whitney Aircraft, West Palm Beach, Fla.
INLET-ENGINE COMPATIBILITY ANALYSIS
S. H. Ellis *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 10 p refs
Avail: NTIS HC $6.00/MF $0.95

The destabilizing factors considered in compatibility analysis are reviewed; instrumentation and test techniques are discussed; and examples of compatibility data are given for a propulsion system consisting of a supersonic inlet and a turbofan engine. The primary destabilizing factor, inlet distortion, is measured with

high response instrumentation capable of describing complex time-variant distortion patterns. The maximum-time variant distortions, determined from model inlet tests, are simulated during component and engine testing to define both loss in stall margin with distortion and the attenuation of distortion as it passes through the engine. The losses in stall margin due to engine causes, such as throttle transients, control tolerances and component interactions, are analyzed by dynamic simulations to identify potential system problems prior to system testing. Attention is focused on potential problems by compatibility audits that show the allocation of stall margin between destabilizing influences and identify areas where component improvement is needed. Author

N72-16713# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

VELOCITY DISTRIBUTION AT A SUPERSONIC COMPRESSOR INLET c12

Bernard Ledoux and Roger Bagot *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 10 p In FRENCH; ENGLISH summary

Avail: NTIS HC $6.00/MF $0.95

A direct method is derived in which the ideal, compressible flow in the duct is established from the duct and the cowl shapes. The computed pressure distributions are compared with those on the external shroud and cowl during wind tunnel tests. The velocity distribution in the duct is deducted. An indirect method is also presented, starting from the pressure distribution on the external wall and leading to the flow field. The calculation is checked by comparing the streamline corresponding to the set-up inlet with the front cowl meridian shape. Author

N72-16714# A.S. Kongsberg Vapenfabrikk (Norway). Gas Turbine Div.

THE ANALYSIS OF A SUBSONIC AXISYMMETRIC INLET FOR COMPRESSOR MATCHING c12

R. E. Stanley *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 13 p ref

Avail: NTIS HC $6.00/MF $0.95

The measured velocity distribution for the original inlet is compared to the distribution obtained by a method of numerical analysis. It is shown that the favorable results of this comparison led to the development of the inlet by a method of numerical analysis in preference to a model testing technique. The recommendations are presented, together with the results of an experimental analysis of the redesigned inlet configuration. The method of compressor matching is touched upon. Author

N72-16717# Technische Hochschule Aachen (West Germany). Inst. fuer Strahlantriebe und Turboarbeitsmaschinen.

A NEW CONCEPT OF THE INLET DESIGN AND OF THE THERMODYNAMIC CYCLE OF THE TURBOJET ENGINE AT HIGH FLIGHT MACH NUMBERS

W. Dettmering and B. Becker *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 10 p refs

Avail: NTIS HC $6.00/MF $0.95

At high supersonic speeds the efficiency of the inlet strongly depends on the diminution of the Mach number before the normal shock. Theoretical investigations show that this deceleration can be increased by replacing the internal compression in the bladeless channel by a supersonic rotor. Due to the deceleration of the relative flow and the increase of the circumferential velocity from rotor inlet to outlet, a significant augmentation of the static pressure ratio is achieved. Moreover, the Mach number can be decreased by the transfer of mechanical energy to the rotor. After the transition to subsonic velocities in the stator, the energy was returned to the flow either by a conventional compressor, or by a second supersonic rotor accelerating the flow between the combustion chamber and the nozzle. Static pressures and temperatures in this turbojet engine, which operates with subsonic combustion, are comparable to those of the supersonic combustion ramjet. Author

N72-16718# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

WIND TUNNEL INVESTIGATIONS OF A SUPERSONIC AIR INTAKE WITH VARIOUS AUXILIARY INTAKES AT LOW SPEEDS c12

Herbert Eibl and Reinhard Friedrichs (DFVLR, Brunswick) *In* AGARD Inlets and Nozzles for Aerospace Eng. Dec. 1971 12 p

Avail: NTIS HC $6.00/MF $0.95

In the low-speed tunnel, model tests were carried out on a twin-engine aircraft configuration with air intakes located on the upper side of the fuselage next to the trailing edge of the wing. The measurements refer to the flow field in the compressor inlet area of a supersonic intake at which the influence of auxiliary intakes of different shapes were investigated. The results are presented as isobars of the total pressure distribution in the compressor inlet area. The pressure loss and distortion parameters are discussed, strongly dependent on the inflow incidence and on the intake flow mainstream ratio. Author

N72-16719*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE NASA QUIET ENGINE PROGRAM

James J. Kramer and Francis J. Montegani 1972 25 p refs Proposed for presentation at the 17th Ann. Intern. Gas Turbine Meeting, San Francisco, 26-30 Mar. 1972; sponsored by ASME (NASA-TM-X-67988; E-6729) Avail: NTIS CSCL 21E

Initial studies on the design and testing of the quiet engine are described. The principal noise sources considered in the engine selection were the fan machinery noise and the fan and core jet noise. Nacelle acoustic linings are also mentioned. Fan and engine tests are discussed briefly and results indicate that it is possible to achieve or exceed noise reduction objectives of 15 to 20 PNdb below the levels of 707/DC-8 long-range transport aircraft. N.E.N.

N72-16721*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF OPERATING CONDITIONS ON THE EXHAUST EMISSIONS FROM A GAS TURBINE COMBUSTOR

Daniel Briehl, Leonidas Papathakos, and Richard J. Strancar Washington Feb. 1972 54 p refs

(NASA-TN-D-6661; E-6432) Avail: NTIS CSCL 21E

Exhaust concentrations of total unburned hydrocarbons, carbon monoxide, and nitric oxide were measured from a single J-57 combustor liner installed in a 30 diameter test section. Tests were conducted over a range of inlet total pressures from 1 to 20 atmospheres, inlet total temperatures from 310 to 590 K, reference velocities from 8 to m/sec, and fuel-air ratios from 0.004 to 0.015. Most of the data were obtained using ASTM A-1 fuel; however, a limited number of tests was performed with natural gas fuel. Combustion efficiency and emission levels are correlated with operating conditions. Sampling error at operating conditions for which combustion efficiency was below about 90 percent resulted in abnormally low readings for hydrocarbon emissions. Author

N72-16722*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

GENERALIZED SIMULATION TECHNIQUE FOR TURBOJET ENGINE SYSTEM ANALYSIS
Kurk Seldner, James R. Mihaloew, and Ronald J. Blaha Washington Feb. 1972 66 p refs
(NASA-TN-D-6610; E-5998) Avail: NTIS CSCL 21E

A nonlinear analog simulation of a turbojet engine was developed. The purpose of the study was to establish simulation techniques applicable to propulsion system dynamics and controls research. A schematic model was derived from a physical description of a J85-13 turbojet engine. Basic conservation equations were applied to each component along with their individual performance characteristics to derive a mathematical representation. The simulation was mechanized on an analog computer. The simulation was verified in both steady-state and dynamic modes by comparing analytical results with experimental data obtained from tests performed at the Lewis Research Center with a J85-13 engine. In addition, comparison was also made with performance data obtained from the engine manufacturer. The comparisons established the validity of the simulation technique. Author

N72-16723*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A BICONE INLET DESIGNED FOR MACH 2.5 WITH INTERNAL DISTRIBUTED COMPRESSION AND 40 PERCENT INTERNAL CONTRACTION
Joseph F. Wasserbauer and David A. Choby Washington Feb. 1972 68 p refs
(NASA-TM-X-2416; E-6579) Avail: NTIS CSCL 21E

The inlet was designed to have the minimum internal contraction consistent with high total-pressure recovery and low cowl drag. Without a bypass system, the peak pressure recoveries increased from 0.890 to 0.936 when the supercritical bleed mass flow ratio was varied from 0.035 to 0.060. With an operating bypass system and installed centerbody vortex generators, a slight increase in peak pressure recovery was obtained. The values of steady-state distortion and dynamic distortion were below 0.10 and 0.02, respectively, near critical operation. Simulation of a turbofan engine with concentric pipes showed no effect on compressor face flow profiles with varying bypass flow ratio. Author

N72-16724*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF TWO TYPES OF HELIUM CIRCULATORS ON THE PERFORMANCE OF A SUBSONIC NUCLEAR POWERED AIRPLANE
William C. Strack Washington Mar. 1971 29 p refs
(NASA-TM-X-2237; E-5811) Avail: NTIS CSCL 21E

Two types of helium circulators are analytically compared on the bases of their influence on airplane payload and on propulsion system variables. One type of circulator is driven by the turbofan engines with power takeoff shafting while the other, a turbocirculator, is powered by a turbine placed in the helium loop between the nuclear reactor and the helium-to-air heat exchangers inside the engines. Typical results show that the turbocirculator yields more payload for circulator efficiencies greater than 0.82. Optimum engine and heat exchanger temperatures and pressures are significantly lower in the turbocirculator case compared to the engine-driven circulator scheme. Author

N72-16728# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FIRST FLIGHT TESTS OF RAMJET ENGINES
Yu. A. Pobedonostsev 17 Aug. 1971 25 p refs Transl. into ENGLISH from Hist. of Rockets and Astronaut., 18th Intern. Astronaut. Congr., Belgrade, 25-29 Sep. 1967 p 109-121
(Contract F33657-71-D-0057; Proj. JCR-AAH9; DIA-Task-T65-04-19A)
(AD-732275; FTD-AC-23-735-71) Avail: NTIS CSCL 21/8

The report presents a brief history of ramjet engines. GRA

N72-16766 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
THE DYNAMIC CENTURY
D. Zonars *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., no. 41, pt. 2 Dec. 1970 p 1-3

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

An analysis of problems encountered in aerospace engineering is presented. Noise pollution and its relation to structural failure, flight in the transonic range of speeds, and aircraft design are considered. K.P.D.

N72-16778 Lord Mfg. Co., Erie, Pa.
IMPROVING RELIABILITY AND ELIMINATING MAINTENANCE WITH ELASTOMERIC DAMPERS FOR ROTOR SYSTEMS c02
J. L. Potter *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., no. 41, pt. 2 Dec. 1970 p 141-149 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

Elastomeric dampers are described which are designed to prevent helicopter and/or VTOL rotor system instability. The damper employs a highly damped viscoelastic polymer, vulcanized and bonded to metallic members. Deformation of the viscoelastic material produces a total resisting force composed of a damping and an elastic component operating 90 degrees out of phase due to the hysteresis inherent in the polymer. Damper service life can be in the range of 1500 to 2000 flight hours with no maintenance or lubrication required. Lubrication and elimination of maintenance are accomplished through use of the viscoelastic material, design simplicity, and no sliding surfaces. Operation is possible throughout a temperature range of -65 to +200 F. Author

N72-16792 Wyle Labs., Inc., Huntsville, Ala.
MULTI-DEGREE OF FREEDOM MOTION SIMULATOR SYSTEMS FOR TRANSPORTATION ENVIRONMENTS c11
T. K. DeClue, R. A. Arone, and C. E. Deckard *In* Shock and Vibration Inform. Center Shock and Vibration Bull., Pt. 3 Dec. 1970 p 119-132
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D.C. 20390; $15.00/Set

A discussion on multi-degree of freedom motion simulation systems as used to simulate ground transportation and aircraft environment is presented. Described is the approach used to design vibration test environments from which meaningful test results can be obtained. A description of four types of systems, two presently in operation and two under study, is presented. Author

N72-16793 State Univ. of New York at Buffalo.
DESIGN AND FABRICATION OF AN AIRCRAFT SEAT CRASH SIMULATOR c11
Nelson M. Isada *In* Shock and Vibration Inform. Center Shock and Vibration Bull., Pt. 3 Dec. 1970 p 133-147 refs

(Grant EC-00287)
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D.C. 20390; $15.00/Set

The design and fabrication of a variable slope inclined plane crash simulator is described for the purpose of testing models and prototypes of aircraft seat and passenger-restraint systems, and for validating mathematical models of the dynamics of

aircraft seats and restraint systems. The crash simulator consists of: (1) a crash cart; (2) a swiveled inclined ramp with tracks; (3) a decelerating device of sandwich coil springs; (4) a reinforced concrete abutment; and (5) accessory equipments such as quick release and latching mechanisms. Author

N72-16802 Shock and Vibration Information Center (Defense), Washington, D.C.
THE SHOCK AND VIBRATION BULLETIN NO. 41. PART 4: VIBRATION
Dec. 1970 221 p refs Presented at 41st Symp. on Shock and Vibration, Air Force Academy, Colo., 27-29 Oct. 1970
(AD-723349; Bull-41-Pt-4) Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set CSCL 20/11

The effects of vibration and shock on various structures including aircraft, spacecraft, helicopters, and chain bridges are reported. Detailed summaries are given for the effects of gunfire, grenade launcher and rocket launcher fire, and M61 fire on various structures.

N72-16815 *Vought Aeronautics, Dallas, Tex.*
EFFECTS OF FLIGHT CONDITIONS UPON GUNFIRE INDUCED VIBRATION ENVIRONMENT
J. A. Hutchinson and B. G. Musson *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 41, Pt. 4 Dec. 1970 p 133-140 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

The statistical characteristics of the structural response measured on the A-7 airplane while firing the M61 rapid-fire gun are given. The amplitude versus frequency plots from narrowband analysis and amplitude histogram plots which are presented provide a graphic presentation of the gunfire signal characteristics. A discussion of the relationship between the flight conditions and the measured gunfire vibration levels along with the significance of these relationships in terms of qualification requirements is also presented. Author

N72-16817 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
THE NOISE ENVIRONMENT OF A DEFLECTED-JET VTOL AIRCRAFT c02
F. L. McFarland and D. L. Smith *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 41, Pt. 4 Dec. 1970 p 161-171 ref
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

A noise survey conducted on a deflected-jet VTOL aircraft is described. The test aircraft was mounted on a vertical thrust stand with the nozzles oriented in the hover-stop position while engine runs were made at different power settings. Forty one (41) microphones were located in the field on the port side of the aircraft and six (6) microphones were located at positions near the aircraft skin. The height of the field microphones was varied (5 ft, 10 ft, and 15 ft). One-third octave band spectra obtained from all microphones and for all engine power settings were flat and did not exhibit the haystack shape which is characteristic of a free jet. Typical one-third octave band sound pressure level spectra and contours of overall sound pressure levels are presented. Estimates of jet total acoustic power are developed from the measurements and related to engine operating parameters. Expressions are derived from the measurements to predict the one-third octave band spectra at positions in the field and on the vehicle from similarly configured aircraft for various engine operating conditions. Author

N72-16821 Frankford Arsenal, Philadelphia, Pa.
STRUCTURAL VIBRATIONS IN THE BELL AH-1G HELICOPTER DURING WEAPON FIRING c02
R. J. Holland (Kinetic Systems, Inc., Boston, Mass.), D. Marcus, and J. Wiland *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 41, Pt. 4 Dec. 1970 p 195-207
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

A test program carried out on the AH-1G Helicopter in which structural response measurements were made during firing of the minigun and the 40mm grenade launcher is described. Measurements were obtained on the gun turret, the aircraft structure near the gunner's station, and on a wing mounted pod. The resulting data is presented both in the form of acceleration time histories and shock spectra. A discussion of the transient response due to the firing of each round is presented as well as the steady state vibration at the weapons' firing rate. Author

N72-16822 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
CHARACTERISTICS OF GUNFIRE INDUCED VIBRATION IN HELICOPTERS c02
C. E. Thomas and V. C. McIntosh *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 41, Pt. 4 Dec. 1970 p 209-219
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

Flight measurements of vibration induced by armament fire on three types of helicopters are described. Instrumentation and data analysis procedures are discussed briefly. Overall vibration levels as a function of distance from the gun muzzles are presented. The increase in vibration levels during gunfire over those encountered in normal flight, and the variation in vibration spectra with rate of gunfire are illustrated. Amplitude probability density curves and oscillograms of acceleration time histories are utilized to indicate the degree of randomness of armament fire vibration in various frequency bands. Author

N72-16823 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
INFLIGHT VIBRATION AND NOISE STUDY OF THREE HELICOPTERS c02
Phyllis G. Bolds and John T. Ach *In* Shock and Vibration Inform. Center The Shock and Vibration Bull., No. 41, Pt. 4 Dec. 1970 p 221-232 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

The individual and collective characteristics of these helicopters are determined as a function of dynamic measurement levels. These levels are then related to sources, i.e., rotor aerodynamics, and engine; and performance characteristics, i.e., hover, take off, and speed range. The spatial distribution from vehicle to vehicle are also considered. The measured data used in this study covers jet engine powered helicopters. The data was examined to determine whether it is generally random (distribution of amplitudes) or sinusoidal in nature. The specifications relating to personnel and equipment for vehicles of these general types were examined, and changes were recommended as indicated by these data. Author

N72-16834 Honeywell, Inc., Hopkins, Minn.
THE DEVELOPMENT OF SHOCK TEST CRITERIA FOR AIRCRAFT DISPENSER WEAPON EJECTION MECHANISMS
K. D. Denton, K. A. Herzing, and S. N. Schwantes *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. 41, part 5 Dec. 1970 p 89-99
(Contract F08635-70-C-001)
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

A test program and the associated analysis which were conducted to develop both an impact shock test criteria and a shock spectrum simulation test for externally carried aircraft ordnance are described. Typical external sources of excitation such as boundary layer pressure fluctuations or shock excitation from hard or arrested landings are discussed. The effects if self-induced dynamic environments are investigated. Author

N72-16854 Bell Helicopter Co., Fort Worth, Tex.
HELICOPTER FUSELAGE VIBRATION RESPONSE ANALYSIS USING THE HYBRID COMPUTER c02
James D. Cronkhite *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. 41, part 7, Dec. 1971 p 131-139 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

The hybrid computer method is described as an efficient and accurate design calculation tool enabling the dynamicist to accurately assess the effects of vibration control techniques, such as absorbers, suppressors, pylon isolators, and structural parameters during the preliminary design stage. The use of the analytical method in treating a typical design problem is shown, *along with effects of antivibration measures.* Author

N72-16861 Shock and Vibration Information Center (Defense), Washington, D.C.
THE SHOCK AND VIBRATION BULLETIN NO. 40, PART 5: DAMPING AND ISOLATION
Dec. 1969 312 p refs Proc. of the 40th Symp. on Shock and Vibration, Fort Monroe, Va. and Hampton, Va., 21-23 Oct. 1969 7 Vol.
(AD-723344; Bull-40-Pt-5) Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set CSCL 20/11

Dynamic responses of aerospace structures to mechanical shock and vibrational damping are considered. The use of elastomeric damping materials in vibration isolators is projected.

N72-16862 Air Force Materials Lab., Wright-Patterson AFB, Ohio.
REDUCTION OF VIBRATIONS IN AEROSPACE STRUCTURES BY ADDITIVE DAMPING
David I. G. Jones, John P. Henderson, and Ahid D. Nashif *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. no. 40, pt. 5 Dec. 1969 p 1-18 refs

(AF Proj. 7351)
(Task-735106) Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

Additive damping utilizing viscoelastic materials is considered from the point of view of its application to specific aircraft field vibration problems, including aircraft UHF and IFF antennas subjected to gunfire induced excitation, a chemically milled weapons dispenser web subjected to cavity resonance excitation and a remote compass transmitter subjected to aerodynamically induced excitation. In each problem, the effect of temperature on the performance of the damping treatment or device is emphasized and development procedures for optimum performance over the operational temperature range are discussed. Author

N72-16865 Lockheed-California Co., Burbank.
SONIC FATIGUE RESISTANCE OF STRUCTURES INCORPORATING A CONSTRAINED VISCOELASTIC CORE
M. D. Lamoree and W. L. LaBarge *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. no. 40, pt. 5 Dec. 1969 p 49-60 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

Results of acoustic tests on specimens representative of typical aircraft structure and on specimens with skin panels containing a constrained layer of viscoelastic material are presented. The reduction in the structural response levels to acoustic excitation due to the added damping is correlated with theory. The effects of various joint designs on the sonic fatigue life of the panels are discussed. Author

N72-16874 Boeing Co., Philadelphia, Pa.
REDUCTION IN VIBRATION OF THE CH-47C HELICOPTER USING A VARIABLE TUNING VIBRATION ABSORBER c02
James J. OLeary *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. no. 40, pt. 5 Dec. 1969 p 191-202 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

An absorber with a variable tuning capability was developed, designed, bench tested and flight tested successfully in the CH-47C. A control system to make this variable tuning absorber self tuning was incorporated and successfully demonstrated. Because of this development the CH-47C helicopter can operate over a range of rotor speeds with no adverse effect on the acceptability of the primary airframe vibration. Author

N72-16877 North American Rockwell Corp., Los Angeles, Calif.
RATIONAL ANALYSIS OF A TWO DEGREE OF FREEDOM FLEXURE TORSION SYSTEM FOR REDUCTION OF CERTAIN TYPES OF FLUTTER
Martin J. Klepl and Raymond C. Binder (Univ. of Southern Calif., Los Angeles) *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. no. 40, pt. 5 Dec. 1969 p 235-244 refs

Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

The study of flutter is the study of the roots of the frequency equation. A novel method of obtaining the roots and evaluating how the parameters affect the roots constitutes the subject matter of this paper. The frequency equation of the two-degree-of-freedom flutter model is derived to cast it into a particular form. The roots of this suitably formulated frequency equation are graphically obtained by the root locus method. The advantage of this method is that the influence of system parameters in the two branches of the frequency-velocity plot is readily evaluated. Three closed-form solutions of the frequency equation are obtained by suitable assumptions on the parameters. In the conclusion, concrete suggestions are made to reduce flutter. Author

N72-16881 North American Rockwell Corp., Los Angeles, Calif.
THE USE OF POLYURETHANE FOAM FOR SHOCK AND VIBRATION ISOLATION OF AVIONIC COMPONENTS
W. E. Arthur, T. Carrell, and J. Nirschl (Army Electron. Command, Fort Monmouth) *In* Shock and Vibration Inform. Center The Shock and Vibration Bull. no. 40, pt. 5 Dec. 1969 p 285-289 refs
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D.C. 20390; $15.00/set

A special shock and vibration isolator, using polyurethane foam, was developed for use in the aerial radiac system to isolate a taut band meter from severe vibrations. The mount showed excellent vibration isolation properties and other sources indicated excellent shock attenuation. The actual data recorded in the test program are reported as well as the construction details of the polyurethane isolator. Author

N72-16899 Air Force Academy, Colo. Dept. of Engineering Mechanics.
ANALYSIS OF THE MOTION OF A LONG WIRE TOWED FROM AN ORBITING AIRCRAFT
S. A. Crist *In* Shock and Vibration Inform. Center (Defense) The Shock and Vibration Bull., no. 41, pt. 6 Dec. 1970 p 61-73 refs
(Contract N00014-66-C-0357; Task-NR321-013)
Avail: Director, Navy Publ. and Printing Serv. Office, Naval District of Washington, Bldg. 157-2, Washington Navy Yard, Washington, D. C. 20390; $15.00/set

A lumped mass model of a long trailing wire antenna is presented and Lagrange's equations of motion derived. These equations were solved numerically for the case of vertical aircraft oscillations in a constant radius and altitude orbit. A slack condition was found at the drogue for certain magnitude oscillations. The equations were also solved for the case of aircraft transition from orbit to straight and level flight. Both tension at the aircraft and instantaneous positions of the cable are presented. Author

N72-16937*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A SMALL ANNULAR TURBOJET COMBUSTOR DESIGNED FOR LOW COST
James S. Fear Washington Feb. 1972 40 p refs
(NASA-TM-X-2476; E-6320) Avail: NTIS CSCL 20M

Performance investigations were conducted on a combustor utilizing several cost-reducing innovations and designed for use in a low-cost 4448-N thrust turbojet engine for commercial light aircraft. Low-cost features included simple, air-atomizing fuel injectors; combustor liners of perforated sheet; and the use of inexpensive type 304 stainless-steel material. Combustion efficiencies at the cruise and sea-level-takeoff design points were approximately 97 and 98 percent, respectively. The combustor isothermal pressure loss was 6.3 percent at the cruise-condition diffuser inlet Mach number of 0.34. The combustor exit temperature pattern factor was less than 0.24 at both the cruise and sea-level-takeoff design points. The combustor exit average radial temperature profiles at all conditions were in very good agreement with the design profile. Author

N72-16955# Denver Research Inst., Colo. Mechanical Sciences and Environmental Engineering Div.
CALCULATION OF SELF-SUSPENDED FLARE TRAJECTORIES Final Report, 1 Jun. 1969 - 31 Dec. 1970
Harry Peterson 16 Sep. 1971 117 p refs
(Contract N00164-69-C-0216; DRI Proj. 4260)
(AD-731683; DRI-4260-7102-F; NAD-CR-RDTR-193) Avail: NTIS CSCL 19/1

The report summarizes and describes the work accomplished on Contract N00164-69-C-0216 (D.R.I. Project 4260 - Digital Computer Simulation and Calculation of Trajectories of Self-Suspended Flares) during the period June 1, 1969 thru December 31, 1970. The work was divided into two phases: The study of the effects of aerodynamic coefficients, launch velocity and burning rate on flare trajectory, and the study of the effects of aerodynamic moments on the flare trajectory. The description and documentation of the computer programs for two dimensional trajectory, and three dimensional trajectory are presented in Appendix A of the report. Author (GRA)

N72-16991# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A FORCE SURVIVAL MODEL FOR ANALYSIS OF STRATEGIC BOMBER BASING CONCEPTS IN THE PRELAUNCH SURVIVAL MODE M.S. Thesis
Douglas D. Cochard and Robert E. Riggs Sep. 1971 140 p refs
(AD-732193; GSM/SM/71-3) Avail: NTIS CSCL 15/7

The prelaunch survival of strategic bombers will continue to be an important problem as long as they are to remain a viable part of the deterrent triad for the United States. Improving enemy technology and changing enemy strategies call for continued analysis of the problem. This study examines the parameters which govern prelaunch survival of strategic bombers. A model is developed to allow computation of total bomber force survival given the values for the necessary parameters. Several basing concepts and other means of improving force survival are analyzed with the aid of the model. Cost effectiveness analysis of the concepts discussed should be accomplished, and the results compared to other possible means of improving survival, e.g., ABM systems, before conclusions are made from the results of this study. Author (GRA)

N72-16992# Office of the Secretary of Transportation, Washington, D.C. Office of Noise Abatement.
CONFERENCE ON AIRCRAFT AND THE ENVIRONMENT, PART 2
Jun. 1971 24 p refs Conf. held at Wash., D.C., 8-10 Feb. 1971
(Contract DOT-OS-10025)
(PB-202038; OST-ONA-71-3-Pt-2) Avail: NTIS CSCL 13B

The proceedings of a conference on the air and noise pollution aspects of aircraft operation are presented. Subjects discussed are: (1) aircraft and airports as sources of pollution, (2) legal aspects of aircraft noise and sonic booms, (3) regulation of pollutant emissions from aircraft exhaust, (4) planning for compatibility of aircraft and environment, and (5) airport planning for environmental quality. P.N.F.

N72-16993# RAND Corp., Santa Monica, Calif.
USE OF WEATHER INFORMATION IN DETERMINING COST/PERFORMANCE AND FORCE-MIX TRADEOFFS: WEATHER AND WARPLANES, 1
R. E. Huschke Jun. 1971 50 p refs
(Contract F44620-67-C-0045)
(AD-731749; R-740-PR) Avail: NTIS CSCL 15/7

The report presents a selective overview of weather-effect studies over the past 20 years, and proposed methods for incorporating weather factors into the force planning and acquisition process. So-called all-weather systems have higher cost and, often, lower effectiveness than simpler systems, and may be stopped by sufficiently bad weather. Force deployment decisions could be tailored to the operational environment, if the weather sensitivities of systems and subsystems were realistically tested at the various stages of development, and sufficient research were done to enable these sensitivities to be translated into gross weather and climate parameters. Military aircraft are

tested in nearly perfect weather, while nearly every type of weather in the world can be found somewhere in the U.S. Appendixes, coauthored respectively by C5 Schutz and R. R. Rapp, document the need for weather sensitivity tests, and present a preliminary mathematical model for including weather factors in force planning. Author (GRA)

N72-16997*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPARISON OF HINGE MOMENTS FOR A SIMPLE DELTA WING AND A DELTA-WING ORBITER CONCEPT AT MACH 6
George C. Ashby, Jr. Washington Feb. 1972 19 p refs
(NASA-TN-D-6657; L-8103) Avail: NTIS CSCL 01A

Elevon hinge moments were determined from measured surface pressures on a typical delta-wing shuttle orbiter model at selective deflection angles for comparison with the extensive experimental and analytical hinge-moment data previously reported for a simple 75 deg delta wing with a trailing-edge control. The angles of attack were from 0 to 55 deg at elevon deflection angles of -45.5, 0, and 20 deg. The results show that the elevon hinge moments on the shuttle orbiter are essentially the same as those measured earlier for the more basic model. Also included is an appendix describing a cubic spline function technique used to determine the hinge moments from elevon surface-pressure measurements. Author

N72-16999# Federal Aviation Administration, Oklahoma City, Okla.
AIRCRAFT ACCIDENTS INVESTIGATION AND PREVENTION SELECTED REFERENCES
Sep. 1971 187 p
(AD-730979; FAA-Bibliographic-List-4) Avail: NTIS CSCL 01/2

The listing of references was compiled at the request of the Transportation Safety Institute, Aeronautical Center. It up-dates the library's Bibliographic List no. 1 of aircraft accident refereoces dated January, 1964. Indexes and bibliographic lists through 1970 were checked and considerable material prior to 1963 which did not appear in the earlier list has been included, but comprehensive coverage is not claimed. Author (GRA)

N72-17000# Office of Naval Research, London (England).
AERONAUTICS AT GENOA, PISA, AND ROME
Richard D. Mathieu 22 Sep. 1971 16 p refs
(AD-731998; ONRL-R-35-71) Avail: NTIS CSCL 01/2

The basic academic program and some of the aeronautical and aerospace research activities at the following three Italian universities are described briefly: University of Genoa; University of Pisa; University of Rome. Author (GRA)

N72-17001# Army Missile Command, Redstone Arsenal, Ala. Aeroballistics Directorate.
CORRELATION OF EXPERIMENTAL AERODYNAMIC COEFFICIENTS ON THE BASIS OF CURVE FITTING IN THE THREE-DIMENSIONAL CARTESIAN ALPHA, C SUB N, C SUB m SPACE
Helmut H. Korst and A. L. Addy 13 Jul. 1971 36 p ref
(DA Proj. 1M2-62303-A-214)
(AD-732834; RD-TR-71-16) Avail: NTIS CSCL 12/1

A method is presented for curve fitting experimental aerodynamic normal-force and pitching-moment coefficient data as a function of angle of attack. The method is based on the postulation of the existence of a single (C sub N)-(C sub m)-alpha space curve that has a common offset value of the angle of attack for which the normal-force and pitching-moment coefficients simultaneously vanish. The curve fits in the (C sub N)-(alpha) and (C sub m)-(alpha) planes are based on minimizing the squared error between the fitted curves and the experimental data by proper selection of the curve-fit coefficients and the common angle-of-attack offset value. Author (GRA)

N72-17003# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.
AN EXPERIMENTAL STUDY OF A FLAT-BOTTOMED SEMI-CIRCULAR WING IN VERY CLOSE PROXIMITY TO THE GROUND Final Report
John N. Pepin, Shelia E. Widnall, and Timothy M. Barrows Sep. 1971 27 p refs
(Contract DOT-c-85-65)
(PB-203602; FRA-RT-72-23) Avail: NTIS CSCL 01C

An experimental investigation of a semicircular wing flying very close to a solid boundary is performed to verify recent analytical results. Comparison is made between first order theory and data through plots of lift coefficient versus angle of attack for various clearances. Reasonable agreement is obtained for these cases within the limitations of the theory. Lift/drag ratio plots are also presented which show the potential of such a technique for support vehicles. A brief outline of the theoretical development is also included to give some insight into the type of analysis which was used. GRA

N72-17004*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
LF336 LIFT FAN MODIFICATION AND ACOUSTIC TEST PROGRAM
S. B. Kazin and L. J. Volk Washington NASA Dec. 1971 144 p refs
(Contract NAS2-5462)
(NASA-CR-1934) Avail: NTIS CSCL 01B

A NASA-sponsored research program was conducted to investigate life fan noise reduction by configuration modifications. An existing lift fan, the 1.3-pressure-ratio, 36-inch-diameter LF336/A, was the test vehicle. Modifications tested included three outlet stator vane rows (including one with lean), two rotor-stator spacings, and addition of acoustic treatment and acoustic exit louvers. The tests were conducted at the Edwards Flight Test Center, using a test site constructed specifically for acoustic testing. Incorporation of all these modifications reduced the aft quadrant fundamental and second harmonic power levels by 19.6 dB, and 10.7dB respectively, and reduced the 150-foot arc peak PNL by 13.5 PNdB. Author

N72-17005*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DITCHING INVESTIGATION OF A 1/30-SCALE DYNAMIC MODEL OF A HEAVY JET TRANSPORT AIRPLANE
William C. Thompson Washington Feb. 1972 80 p refs
(NASA-TM-X-2445; L-7841) Avail: NTIS CSCL 01B

An investigation was made to determine the ditching characteristics of a heavy jet transport airplane. A 1/30-scale dynamic model was used for the tests which were made with the landing gear retracted and with the landing gear extended in various positions. The test results indicated that the most favorable condition for ditching is a 70 landing attitude with the flaps down 40 deg, a landing speed of 137 knots, the nose gear retracted, and the main gear fully extended. There will most likely be some damage to the fuselage bottom and most of the main landing gear will probably be torn away. Author

N72-17006*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
A STUDY OF THE MARKOV GAME APPROACH TO TACTICAL MANEUVERING PROBLEMS
Sheldon Baron, David L. Kleinman, and Saul Serbin Washington

NASA Feb. 1972 82 p refs
(Contract NAS1-9910)
(NASA-CR-1979; Rept-2179) Avail: NTIS CSCL 01B

The results of a study to apply a Markov game approach to planar air combat problems are presented. The underlying approach is reviewed and a sophisticated computer program (MAGPIE) developed to solve the planar problems is discussed. Numerical results for highly idealized versions of the problem are presented with a view towards improving understanding of the basic approach. Typical results in the form of optimal costs, strategies and trajectories are also obtained for a realistic version of the planar combat problem. The solution to this problem demonstrates the feasibility of using the Markov game approach for solving meaningful problems. Analysis indicates, however, that straightforward extension to three-dimensional air combat problems may be impractical from the standpoint of the computation time required. Alternative approaches are suggested. Author

N72-17007*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF AIRCRAFT TIRE DAMAGE AGE RESULTING FROM TOUCHDOWN ON GROOVED RUNWAY SURFACES
Thomas A. Byrdsong, John Locke McCarty, and Thomas J. Yager Washington Mar. 1972 21 p refs
(NASA-TN-D-6690; L-7883) Avail: NTIS CSCL 01C

Simulated landing impact tests were conducted to study chevron-cutting damage to the tread of aircraft tires resulting from touchdown on grooved runway surfaces. The study, involved impacting new and retreaded tires at several inflation pressures, vertical loadings, and sink rates on concrete and asphalt surfaces having a variety of transversely grooved patterns at ground speeds up to approximately 110 knots. Chevron cutting occurs at the spot on the tire which initially contacts the surface and the damage is the result of the scrubbing action of the tire as it skids over the grooves prior to rotation. The extent of chevron cutting was found to be primarily a function of the airplane ground speed at touchdown - the higher the speed, the greater the damage. Chevron-cutting damage is essentially independent of the grooving patterns generally considered for airport use but is dependent upon the nature of the surface finish. Tests with different tires of the same size also indicate that the tread rubber compounding significantly affects the extent of chevron cutting damage. Author

N72-17008# Federal Aviation Agency, Washington, D.C. Engineering and Manufacturing Div.
AIRCRAFT FIRE DETECTION
1971 217 p Conf. held at Washington, D. C., 16-17 Nov. 1970
(AD-730179) Avail: NTIS CSCL 13/12

A symposium on aircraft fire detector systems was held to familiarize Federal Aviation Administration Regional personnel with the characteristics, capabilities, and limitations of the currently available detector systems. A number of presentations were made by representatives of leading fire detector, helicopter, and small airplane manufacturers, and by representatives of the military and the FAA National Aviation Facilities Experimental Center. All aspects of aircraft fire detection were reviewed.
Author (GRA)

N72-17009# National Aviation Facilities Experimental Center, Atlantic City, N.J.
AN ACCURACY EVALUATION OF A TAXI SPEED AND DISTANCE MEASURING DEVICE Final Report, Jan. 1970 - Jun. 1970
Sep. 1971 28 p
(FAA Proj. 320-212-06(X))
(AD-730096; FAA-NA-71-19; FAA-RD-71-53) Avail: NTIS CSCL 01/3

A taxi speed and distance measuring device was evaluated for accuracy. The device used a modified skid detector assembly as a sensor. The skid detector assembly was mechanically coupled to the aircraft wheel and thus sensed wheel rotation. Accuracy measurements were made on the device and it was found to meet design accuracy specification for distance measurement. In two cases, speed errors occured which were in excess of the design specification, but it was felt that this would not degrade the operational usability of the speed measuring equipment. The distance measuring portion of the equipment would require modifications to overcome some limitations before the utility of the distance measuring portion of the device in category 3 conditions could be investigated. Author

N72-17010# TRW Systems Group, Redondo Beach, Calif.
DYNAMIC RESPONSE TESTS OF AN AIR CUSHION SUSPENSION SYSTEM FOR THE LINEAR INDUCTION MOTOR (LIM) OF THE TRACKED AIR CUSHION RESEARCH VEHICLE (TACRV) Final Report
Stephen G. Meisenholder, Herbert R. Graham, and Joseph Birchill Jul. 1971 293 p refs
(Contract DOT-FR-0-0044)
(PB-204440; TRW-17617-6003-RO-00; FRA-RT-72-24) Avail: NTIS CSCL 13F

The air cushion and secondary suspension are designed for the support and guidance of the linear induction motor (LIM) on the 300 mph tracked air cushion research vehicle (TACRV). The tests simulate the motion of the suspension system on the TACRV moving over a guideway with sinusoidal surface irregularities. The test variables included oscillatory excitation amplitude, air supply system admittance, air cushion skirt configuration, and reaction rail flexibility. Test results are compared augmentation system. Responses obtained may be classified as those which are desirable and yield good handling qualities.
Author (GRA)

N72-17011# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DAMAGE CRITERIA FOR PARKED AIRCRAFT
Robert N. Schumacher Sep. 1971 22 p
(DA Proj. 1T0-61102-A-33-E)
(AD-732427; BRL-MR-2128) Avail: NTIS CSCL 01/3

The report presents three damage categories and their definitions for parked aircraft. Included are recommendations for selecting generic classes of aircraft for both fixed wing and rotary wing configurations. For one of the generic aircraft (fighters) detailed damage criteria for the three damage categories are presented and include the structure and systems that are susceptible and the degree to which they have to be affected.
Author (GRA)

N72-17012# Aerospace Systems, Inc., Burlington, Mass.
A STUDY OF TECHNIQUES FOR REAL-TIME, ON-LINE OPTIMUM FLIGHT PATH CONTROL. MINIMUM-TIME TURNS TO A SPECIFIED TRACK Final Report, Nov. 1970 - Jul. 1971
William C. Hoffman and Arthur E. Bryson, Jr. Sep. 1971 59 p refs
(Contract F44620-71-C-0016; AF Proj. 9749)
(AD-732938; ASI-TR-71-4; AFOSR-71-2874TR) Avail: NTIS CSCL 01/2

The initial phase of a study of techniques for real-time, on-line optimum flight path control is described. A review of the historical development of aircraft performance optimization during the past three decades is presented. This review indicates that climbing maneuvers in the vertical plane (zero bank angle) have received considerable study, while relatively little work has been done on turning maneuvers. Real-time, on-line flight path optimization requirements and features, which indicate the need for a better understanding of maneuvers out of the vertical plane, are discussed. The equations of motion for variable-velocity turning maneuvers in the horizontal plane are presented.

Necessary conditions are derived for a constant-altitude, minimum-time turn to a specified track and final velocity. The formulation is shown to be a generalization of other recently-published investigations of variable-velocity turns independent of final position, and constant-velocity turns onto a specified track. Numerical solution techniques implemented in a digital computer program for the CDC-6600 computer are described. Example results are included for a supersonic aircraft representative of an early model of the F-4. Variable-velocity optimum turns are found to be significantly faster than the corresponding constant-velocity turns, even though their average velocity is considerably lower. Author (GRA)

N72-17013# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DESIGN OF A HELICOPTER STABILITY AND CONTROL AUGMENTATION SYSTEM USING OPTIMAL CONTROL THEORY M.S. Thesis
Alvin Rudolph Lang Sep. 1971 103 p refs
(AD-732911; GGC/EE/71-13) Avail: NTIS CSCL 01/3

The report presents the design of a helicopter stability and control augmentation system using optimal control techniques. The helicopter used as an example was the Sikorsky H-53, but the design procedure is applicable to other helicopters as well. Only the longitudinal dynamics are considered. A technique is described for the design of multivariable feedback controllers based upon results in optimal control theory. For a specified performance index the feedback controller is obtained by solving the matrix Riccati equation. A model is used in the forward controller such that the response of the model to pilot inputs approximates the desired helicopter response. A fixed gain controller is obtained which may be used over the entire helicopter flight envelope. The results show that optimal control theory can be used to design a helicopter stability and control augmentation system. Responses obtained may be classified as those which are desirable and yield good handling qualities.
Author (GRA)

N72-17014# Douglas Aircraft Co., Inc., Long Beach, Calif.
A FLIGHT SIMULATOR STUDY OF STOL TRANSPORT DIRECTIONAL CONTROL CHARACTERISTICS Final Report
Robert A. Berg, W. Allen Shirley, Gary L. Teper, and Samuel J. Craig Jun. 1971 136 p refs
(Contract DOT-FA70WA-2395)
(AD-732570; FAA-RD-71-81) Avail: NTIS CSCL 01/3

A systematic investigation was conducted of STOL transport terminal area directional control characteristics to identify the significant considerations and to establish appopriate directional control criteria. The investigation consisted of an analysis of existing data and a moving-base flight simulator transport simulator. The simulator test program covered a broad range of lateral and directional aerodynamic characteristics representative of typical STOL transport aircraft. This effort is the second phase of an extensive STOL simulation program, the first phase of which was devoted to the investigation of lateral control characteristics. The present study revealed the existence of an appreciable interaction between the roll and the heading control tasks which suggests that roll-mode damping requirements should be specified in terms of the heading delay characteristics. Lateral control sensitivity tests were conducted which corroborated the results of the first phase of the program. Author (GRA)

N72-17015# Department of Transportation, Washington, D.C. Office of the Assistant Secretary for Safety and Consumer Affairs.
GENERAL AVIATION SAFETY
15 Sep. 1971 36 p
(PB-202928) Avail: NTIS CSCL 01B

A study was made to analyze those factors contributing to general aviation safety for the purpose of finding ways to reduce current accident rates. The study was to include consideration of existing regulatory policies and practices, organizational matters, and other factors relating to general aviation, primarily with respect to the operation of small airplanes. To limit the area of investigation, general aviation for the study included only those operations conducted on a not-for-compensation or hire basis.
Author (GRA)

N72-17016# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA, US AIR CARRIER OPERATIONS, CALENDAR YEAR 1969
18 Aug. 1971 120 p refs
(PB-203183; NTSB-ARC-71-1) Avail: NTIS CSCL 01B

The publication contains statistical, cause/factor and injury tables, accident rates and the briefs of accidents involving U.S. air carriers and an analysis of the operation and safety record of these carriers by type of power and class of carrier.
Author (GRA)

N72-17017# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCICENT REPORTS: BRIEF FORMAT, SUPPLEMENTAL ISSUE 1969, ACCIDENTS
Jul. 1971 63 p
(PB-202940; NTSB-BA-71-2) Avail: NTIS CSCL 01B

The publication, containing reports of 108 accidents, is a supplemental issue for 1969. The accident reports contained in this issue were delayed pending supplemental data, additional study, or because of difficult areas in the investigation. Twenty-seven of the reports cover foreign registered aircraft accidents that occurred in the United States or its possessions.
Author (GRA)

N72-17025# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
WHY EJECTORS FOR AIRCRAFT PROPULSION-LIFT SYSTEMS AND WHERE WE STAND Final Report
Richard B. Fancher Aug. 1971 41 p refs
(AF Proj. 7116)
(AD-732842; ARL-71-0140) Avail: NTIS CSCL 13/11

The thrust augmentation, lift augmentation and noise reduction characteristics of compact ejectors make them potentially attractive for propulsion lift systems; however in the past, poor thrust augmentation results have negated the other benefits. This report covers the general characteristics of ejectors pointing out what makes them attractive and why only certain types of ejectors are of interest. It reviews the key requirements for high performance thrust augmentation. It also presents a summary of the performance results achieved thus far and proposes some possible applications for various types of V/STOL aircraft. Author (GRA)

N72-17126# Lincoln Lab., Mass. Inst. of Tech., Lexington.
STUDY OF ANTENNA PATTERN COUVERAGE FOR A UHF ANTENNA SYSTEM ON AN AIRCRAFT
Alan J. Simmons 13 Sep. 1971 33 p refs
(Contract F19628-70-C-0230; AF Proj. 649L)
(AD-732291; TN-1971-41; ESD-TR-71-263) Avail: NTIS CSCL 09/5

An idealized study of theoretical patterns of a four-element crossed-slot array on a cylinder approximating the fuselage of a KC-135 aircraft has been carried out. The objective is to obtain complete hemispherical coverage with at least 6 dB gain for circular polarization over the band from 250 to 400 MHz. The

study shows that 15 beam positions, requiring switching each antenna between 0 degrees and three values of phase shift, will give nearly the desired coverage. Coverage is limited over a small portion of the region, primarily in the fore-aft directions, because of the drop in gain of the individual array elements in these directions. An optimum location for the array on the side of the fuselage is chosen at an angle of 60 degrees from the zenith. A similar array is required on the opposite side of the aircraft to give coverage on the other side. The effects of multipath reflections are calculated and found to bb negligible because of the circular polarization discrimination of the antenna.
Author (GRA)

N72-17183* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
WIND TUNNEL TEST SECTION Patent
John W. Davis and Olen E. Hill, inventors (to NASA) Issued 7 Sep. 1971 6 p Filed 31 Dec. 1969

(NASA-Case-MFS-20509; US-Patent-3,602,920; US-Patent-Appl-SN-889557; US-Patent-Class-73-147) Avail: US Patent Office CSCL 14B

A test section for use in a short duration wind tunnel capable of simulating very-high Reynolds numbers over the transonic speed range is described. An exterior circular tube contains a perforated concentrically disposed sleeve assembly forming an annular flow plenum between the exterior tube and the sleeve assembly. The main flow stream through the wind tunnel is through the sleeve assembly with sucking off occurring through the holes in the walls of the sleeve assembly into the plenum. Flow into the plenum is adjustable to obtain the desired main stream flow velocity and the optimum cancellation of shock and expansion waves produced when the gas flow strikes the test model in the test section.
Official Gazette of the U.S. Patent Office

N72-17199# Naval Air Engineering Center, Philadelphia, Pa. Engineering Dept.
SHIPBOARD OPERATIONAL EVALUATION OF CARRIER LANDING AID STABILIZATION SYSTEM
Wesley F. Davis 18 Oct. 1971 40 p refs
(Contract N00156-69-C-0710)
(AD-732446; NAEC-ENG-7712) Avail: NTIS CSCL 01/5

A prototype Carrier Landing Aid Stabilization System (CLASS) has undergone two shipboard operational evaluations. CLASS operation was compared to the current FLOLS MK6 Mod 1 Stabilization system. Review of the test data reveals CLASS provides significantly improved performance and operational advantages. Author (GRA)

N72-17201# Federal Aviation Administration, Washington, D.C.
GROVE CITY AIRPORTS, GROVE CITY, PENNSYLVANIA Final Environmental Impact Statement
1 Oct. 1971 25 p
(PB-203247-F) Avail: NTIS CSCL 01E

The project proposes to acquire land for airport development; to construct runways and taxiways terminal apron and taxiway turnarounds; to construct access road; to install medium intensity lighting system including VASI, stub taxiway lighting and rotating beacon, and lighted wind cone and segmented circle. The proposed development will provide a paved and lighted airport which will enhance the overall economy of the area served and improve the industrial and commercial growth of the community. Author (GRA)

N72-17202# Federal Aviation Administration, Washington, D.C. Airport Service.
SANTA BARBARA MUNICIPAL AIRPORT, SANTA BARBARA, CALIFORNIA: ENVIRONMENTAL IMPACT STATEMENT
7 Oct. 1971 127 p
(PB-201533-F) Avail: NTIS CSCL 01E

The project proposes to construct a portion of a parallel taxiway to serve the main instrument runway at the Municipal Airport. The proposed taxiway improvement is not expected to affect the environment of the surrounding area or hinder the ecological balance of Goleta Slough. Author (GRA)

N72-17203# Air Force Dept., Washington, D.C.
ENVIRONMENTAL STATEMENT FOR 1550TH AIR TRAINING AND TEST WING (MAC), HILL AIR FORCE BASE, UTAH Final Environmental Impact Statement.
2 Nov. 1971 48 p
(PB-198764-F; AF-ES-71-1F) Avail: NTIS CSCL 01E

The effects are considered of the consolidation of all Air Force advanced helicopter training at Hill AFB, Utah. Major training areas will be in Weber, Davis, Salt Lake, Box Elder, and Tooele counties. This new mission will create an approximately 4% increase in average daily air traffic in the Salt Lake Valley, with consequent increase in aircraft engine emissions. There will be some air pollutant emissions from the fire/rescue training area and visible smoke emitted during the training period. There will be minimal impact on water quality. Author (GRA)

N72-17206# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
PROBLEMS OF MEASUREMENT ON MODEL OF THE THRUST OF A SUPERSONIC AIRCRAFT AFTER-BODY STANDARD NOZZLES
Bernard Masure 1971 16 p refs In FRENCH; ENGLISH summary Presented at the AGARD Meeting on Inlets and Exhaust of Aerospace Propulsion Systems, Sandefjord, Norway, 13-17 Sep. 1971
(ONERA-TP-978) Avail: NTIS

A technique for measuring the thrust of an afterbody in a wind tunnel, through an upstream cyclindrical strut, is described. This measurement permits the correction of global measurements made on complete models with simplified hollow nacelles. Precision was checked by various calibrations, including tests on a standard convergent-divergent nozzle. Checking and analysis of the results for complex configurations, including a primary convergent nozzle, were based on knowledge of flow ratio and thrusts of corresponding sonic nozzles. Data concerning such nozzles are presented for a wide varity of shapes for tests performed within the atmosphere, without external flow. The results are compared with theoretical data. Author

N72-17207*# Boeing Co., Seattle, Wash. Commercial Airplane Group.
FLOW FIELD ANALYSIS OF AIRCRAFT CONFIGURATIONS USING A NUMERICAL SOLUTION TO THE THREE-DIMENSIONAL UNIFIED SUPERSONIC/HYPERSONIC SMALL DISTURBANCE EQUATIONS, PART 1
R. C. Gunness, Jr., C. J. Knight, and E. DSylva Washington NASA Feb. 1972 115 p refs
(Contract NAS1-9562)
(NASA-CR-1926; D6-25124-Pt-1) Avail: NTIS CSCL 20D

The unified small disturbance equations are numerically solved using the well-known Lax-Wendroff finite difference technique. The method allows complete determination of the inviscid flow field and surface properties as long as the flow remains supersonic. Shock waves and other discontinuities are accounted for implicity in the numerical method. This technique was programed for general application to the three-dimensional case. The validity of the method is demonstrated by calculations on cones, axisymmetric bodies, lifting bodies, delta wings, and a

conical wing/body combination. Part 1 contains the discussion of problem development and results of the study. Part 2 contains flow charts, subroutine descriptions, and a listing of the computer program. Author

N72-17208*# Boeing Co., Seattle, Wash. Commercial Airplane Group.
FLOW FIELD ANALYSIS OF AIRCRAFT CONFIGURATIONS USING A NUMERICAL SOLUTION TO THE THREE-DIMENSIONAL UNIFIED SUPERSONIC/HYPERSONIC SMALL-DISTURBANCE EQUATIONS, PART 2
E. DSylva Washington NASA Feb. 1972 300 p refs
(Contract NAS1-9562)
(NASA-CR-1927; D6-25124-Pt-2) Avail: NTIS CSCL 20D
For abstract, see N72-17207.

N72-17302# Dayton Univ. Research Inst., Ohio.
MEDIUM ALTITUDE CRITICAL ATMOSPHERIC TURBULENCE (MEDCAT) DATA PROCESSING AND ANALYSIS Final Report, 1 May 1969 - 31 May 1971
John P. Ryan, Alan P. Berens, Arthur C. Robertson, Robert J. Dominic, and Kurt C. Rolle 31 Jul. 1971 633 p refs
(Contract F33615-69-C-1750; AF Proj. 1469)
(AD-732878; AFFDL-TR-71-82) Avail: NTIS HC $9.00/MF $0.95 CSCL 04/1

The report describes the processing and analysis phases of the Medium Altitude Critical Atmospheric Turbulence (MEDCAT) Project. The primary objective of this project was to collect true gust velocity in the 20,000 to 40,000 foot altitude regime to be used to establish, validate, and/or modify future aerospace vehicle design criteria. The data, collected by the Air Force from seven bases in the Continental United States, consists of 278 flights performed in the regions of the MEDCAT altitude band predicted by a meteorologist as being most likely to contain clear air turbulence. Two turbulence-instrumented aircraft, an F-106A, and an F-100F, were used to collect the data. Of the 40 hours judged as being in turbulence, 81 percent was characterized as being of less intensity than 1.5 ft/sec rms true gust velocity. Author (GRA)

N72-17319# General Motors Corp., Indianapolis, Ind. Detroit Diesel Allison Div.
COLLECTION AND ASSESSMENT OF AIRCRAFT EMISSIONS BASE-LINE DATA TURBOPROP ENGINES (ALLISON T56-A-15) Final Technical Report, 1 Jun. - 16 Aug. 1971
J. M. Vaught, W. M. Parks, S. E. J. Johnsen, and R. L. Johnson Sep. 1971 70 p refs
(Contract CPA-68-04-0029)
(PB-202961; EDR-7200) Avail: NTIS CSCL 13B

Exhaust emissions data were collected and evaluated from eleven new T56-A-15 military turboprop engines during their production-line performance evaluation. The normal production test schedule was used. Experimental data were analyzed by converting the concentration values measured for each engine to mass emissions over a landing and takeoff (LTO) cycle representative of a commercial flight with T56-type engines and then performing a statistical analysis to obtain mean and standard deviation values. Author (GRA)

N72-17326* Sylvania Electronic Systems-Central, Williamsville, N.Y.
ALTITUDE SENSING DEVICE Patent
John A. Meyer, inventor (to NASA) Issued 7 Sep. 1971 6 p Filed 16 Dec. 1968 Sponsored by NASA Continuation-in-part of abandoned US Patent Appl. SN-417848, filed 11 Dec. 1964
(NASA-Case-XMS-01994-1; US-Patent-3,603,683; US-Patent-Appl-SN-814212; US-Patent-Class-356-4) Avail: US Patent Office CSCL 14B

A device for signaling critical altitude of a flight vehicle above a landing surface is described that is formed by a high intensity light source. It contains an optical system for reflecting the light beam downwards towards the landing surface and a pair of optical systems that receive reflected images of the illumination produced by the beam. This light responsive electrical system generates a usable voltage signal when the vehicle is at the critical altitude. Official Gazette of the U.S. Patent Office

N72-17445# National Aviation Facilities Experimental Center, Atlantic City, N.J.
TEST AND EVALUATION OF A DAYTIME COCKPIT FOG SIMULATOR Final Report, Apr. 1969 - May 1971
Morris Ritter Nov. 1971 37 p refs
(FAA Proj. 073-323-04(X); FAA Proj. 430-301-09(X))
(AD-732621; FAA-NA-71-44; FAA-RD-71-82) Avail: NTIS CSCL 14/2

An evaluation was conducted at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N. J., to determine the suitability of Daytime Cockpit Fog Simulator to accurately and realistically simulate category 2 and category 3 weather conditions to the pilot during flight approaches. Thirteen pilots, using a DC-7 aircraft, participated in the program. The fog simulator was evaluated during atmospheric meteorological visibilities ranging from 1 1/2 to over 12 miles. Technical data, as well as completed pilot questionnaires, comprised the data analyzed. Although the simulator shows merit insofar as projecting realism, a redesign of the unit is necessary to correct deficiencies in various optical, electronic, and mechanical areas. Author

N72-17549# Boeing Co., Philadelphia, Pa. Vertol Div.
DETERMINATION OF PHYSICAL AND STRUCTURAL PROPERTIES OF MIXED-MODULUS COMPOSITE MATERIALS Final Report
Robert L. Pinckney and Richard B. Freeman Jun. 1971 70 p
(Contract DAAJ02-69-C-0059)
(AD-732489; D210-10196-1; USAAVLABS-TR-71-7) Avail: NTIS CSCL 11/4

The objective of the program was to determine the physical and structural properties of mixed-modulus composite materials using combinations of graphite and S-glass fibers under static and fatigue loading conditions. This report covers the work completed under Phase I and Phase II of the program and summarizes the data obtained for solid laminates, tubular specimens and sandwich beams in which the S-glass material was oriented parallel to the longitudinal axis of the specimens and the graphite fibers were oriented at plus or minus 45 degrees to the same axis. The test results are tabulated in appropriate engineering format. S-N curves are included to illustrate the fatigue performance of the materials. Stress-strain and S-N curves are compated to appropriate data on pure S-glass and pure graphite material where such data contributes to an understanding of the mixed materials performance. The data indicates that the mixed-modulus system of S-glass and graphite is compatible with the structural and failure mode requirements of helicopter rotor blades. Author (GRA)

N72-17579# Federal Aviation Administration, Washington, D.C.
FAA SYMPOSIUM ON TURBULENCE Final Report
24 Mar. 1971 116 p Symp. held at Washington, D. C., 22-24 Mar. 1971
(AD-732117) Avail: NTIS CSCL 04/1

The symposium covered wake turbulence, clear air turbulence, wind shear, upsets, thunderstorms, and turbulence plotting. Presentations were given by experts from the academic community, airlines, and government organizations, ranging from

reports of tests made on aircraft wake turbulence to scientific studies of the turbulence in the atomosphere and ways of transmitting turbulence information to pilots. The final report of the symposium includes a summary of each presentation.
Author (GRA)

N72-17592# National Aviation Facilities Experimental Center, Atlantic City, N.J.
MEASUREMENT AND ANALYSIS OF EN ROUTE ATC DIGITAL RADAR SYSTEM ERRORS Interim Report, Jul. 1970 - Mar. 1971
Clifford Chapman Sep. 1971 26 p refs
(FAA Proj. 012-605-03(X))
(AD-730056; FAA-NA-71-16; FAA-RD-71-63) Avail: NTIS CSCL 17/7

Prior to the conduct of tests pertinent to radar separation standards, a review of previous efforts was accomplished to ascertain the application of existing data towards the establishment of separation criteria within the en route Air Traffic Control National Airspace System, Model 1 complex at Jacksonville, Florida. Data analyses and presentation were directed towards the range and azimuth resolution characteristics and aircraft-separation measurement capability of the secondary-radar/digitizer subsystem. Author(GRA)

N72-17594# Federal Aviation Administration, Washington, D.C. Office of Systems Engineering Management.
TECHNICAL PROGRAM PLAN FOR HEADQUARTERS AIR TRAFFIC SERVICE AUTOMATION Final Report
Aug. 1971 130 p refs Prepared for presentation at US Intern. Transportation Exposition, Washington, D. C., 27 May - 4 Jun. 1972
(AD-731722; FAA-EM-71-2) Avail: NTIS CSCL 17/7

A technical program plan to automate certain headquarters air traffic service functions was developed. The plan recommended a method of automating operational functions concerned with the nationwide monitoring of the air traffic control system and the control of air traffic flows. Functional descriptions, data processing design and size estimates for a representative system, estimated development and operating costs, and a recommended development and implementation plan are contained in the document. Author (GRA)

N72-17595# National Aviation Facilities Experimental Center, Atlantic City, N.J.
INVESTIGATION OF A AIRBORNE MARKER BEACON Final Report, Jun. 1970 - Sep. 1971
Louis A. Dvorsky Nov. 1971 104 p
(FAA Proj. 341-004-03(X))
(AD-732312; FAA-NA-71-29; FAA-RD-71-80) Avail: NTIS CSCL 17/7

Ground and airborne tests of flight inspection marker beacon receiving system were made to identify and correct variations in marker pattern measurement from time to time and from aircraft to aircraft. The tests were made with both the T-29 Convair and DC-3 aircraft. Based on the flight test results, new receiver calibration and antenna system ramp calibration procedures were devised. Author (GRA)

N72-17598# Lincoln Lab., Mass. Inst. of Tech., Lexington.
TECHNICAL DEVELOPMENT PLAN FOR A DISCRETE ADDRESS BEACON SYSTEM Final Report
Washington FAA Oct. 1971 111 p
(Contract DOT-FA71WAI-210; FAA Proj. 034-241-012)
(AD-732585; FAA-RD-71-79) Avail: NTIS CSCL 17/7

The requirement for a Discrete Address Beacon System (DABS) to provide improved surveillance and ground-air communications in support of air traffic control automation is discussed. A technical development plan for such a system is presented. The DABS technical development plan identifies the critical issues and technical options, presents a program for their resolution, followed by the development and test of a prototype model of the system, and describes the management structure to coordinate and carry out the many tasks involved in the implementation of the plan. Author (GRA)

N72-17599# National Aviation Facilities Experimental Center, Atlantic City, N.J.
MODELING AND ANALYSIS OF AIR TRAFFIC CONTROL VOICE COMMUNICATION CHANNEL LOADING Interim Report, May 1969 - May 1971
Allen C. Busch Nov. 1971 56 p
(FAA Proj. 012-604-01(X); FAA Proj. 187-601-01(X))
(AD-732619; FAA-NA-71-42; FAA-RD-71-78) Avail: NTIS CSCL 17/7

An effort to analyze and model by means of a nonreal-time simulation programming language, in this case GPSS, some of the characteristics of an air traffic control (ATC) air/ground/air voice communications channel is discussed. The functional entities or parameters are described. A comparison is made between the modeling outputs and real field derived measures of system output or performance. The conclusions are that this type of modeling and analysis can be a powerful and efficient tool for ATC simulation and system analysis provided that the model parameters adequately coincide with real system parameters and that real operational data are used to quantify the dependent and independent variables in the model. Author (GRA)

N72-17719*# Atomic Weapons Research Establishment, Aldermaston (England).
EVALUATION OF 2 POSSIBLE FURTHER DEVELOPMENTS OF THE UK IN-FLIGHT RADIATION WARNING METER FOR SSTS c14
I. J. Wilson and R. C. Eustace *In* NASA, Washington Proc. of the Natl. Symp. on Nat. and Manmade Radiation in Space Jan. 1972 p 874-883 refs
Avail: NTIS HC $10.00/MF $0.95 CSCL 14B

A mass reduction of the moderator and the response to the nucleon flux, responsible for the tissue-star component of the total-dose equivalent rate using a high atomic number material, are discussed. Radiation situations at SST cruising altitudes (approximately 20 km) due to solar proton flares were simulated in the stratosphere and on the ground. Actual stratospheric situations due to galactic cosmic radiation with a limited range of quality factor values (2-4) were encountered during slow ascents by balloons to 36 km. Synthetic situations obtained from high and low energy acclerator radiations were used to obtain radiation distributions having a larger range of quality factor values (11/2-9) than experienced in the stratosphere. The measurements made in these simulations related to the directly ionizing, neutron and tissue-star components of dose-equivalent rate. Due to the restricted range of neutron spectra encountered in the stratosphere, a significant mass reduction of the moderator by 4 kg was made, with the moderator clad with cadmium or some other slow neutron absorber. Author

N72-17721*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RADIATION MEASUREMENTS AND DOSES AT SST ALTITUDES c13
Trutz Foelsche *In its* Proc. of the Natl. Symp. on Nat. and Manmade Radiation in Space Jan. 1972 p 894-901 refs
(See N72-17601 08-22)
Avail: NTIS HC $10.00/MF $0.95 CSCL 04A

Radiation components and dose equivalents due to galactic and solar cosmic rays in the high atmosphere, especially at SST altitudes, are presented. The dose equivalent rate for the flight personnel flying 500 hours per year in cruise altitudes of 60,000-65,000 feet (18-19.5 km) in high magnetic latitudes is about 0.75-1.0 rem per year averaged over the solar cycle, or about 15-20 percent of the maximum permissible dose rate.
Author

N72-17722*# Air Force Weapons Lab., Kirtland AFB, N.Mex.
DOSE AND LINEAR ENERGY TRANSFER SPECTRAL MEASUREMENTS FOR THE SUPERSONIC TRANSPORT PROGRAM c14
Richard B. Philbrick *In* NASA, Washington Proc. of the Natl. Symp. on Nat. and Manmade Radiation in Space Jan. 1972 p 902-907 refs
Avail: NTIS HC $10.00/MF $0.95 CSCL 14B

The purpose of the package, called the high altitude radiation instrumentation system (HARIS), is to measure the radiation hazard to supersonic transport passengers from solar and galactic cosmic rays. The HARIS includes gaseous linear energy transfer spectrometer, a tissue equivalent ionization chamber, and a geiger meuller tube. The HARIS is flown on RB-57F aircraft at 60,000 feet. Data from the HARIS are reduced to give rad and rem dose rates measured by the package during the flights. Results presented include ambient data obtained on background flights, altitude comparison data, and solar flare data.
Author

N72-17759# National Aviation Facilities Experimental Center, Atlantic City, N.J.
EVALUATION OF CRYOGENIC NITROGEN AS A FIRE EXTINGUISHING AGENT FOR AIRCRAFT POWERPLANT INSTALLATIONS Final Report, 1968 - 1971
George Chamberlain and Eugene P. Klueg Nov. 1971 70 p refs
(FAA Proj. 502-301-15(X))
(AD-732622; FAA-NA-71-3; FAA-RD-71-58) Avail: NTIS CSCL 13/12

Testing was conducted to determine the feasibility of using LN2 as an aircraft power plant fire-extinguishing agent and also to determine the characteristics of LN2 when used as an extinguishment. The tests were conducted in a fire test facility using a full-scale aircraft turbojet engine and nacelle for subsonic low altitude flight condition simulation and also in a mockup engine/nacelle facility where nacelle volume and air flow could be varied. All fire tests were conducted using JP-4 jet fuel which was spray released and spark ignited. The effects of an inadvertent discharge on engine components, the effects of a damaged cowling, and the cooling of potential reignition sources are also described.
GRA

N72-17845*# General Electric Co., Cincinnati, Ohio.
HIGHLY LOADED MULTI-STAGE FAN DRIVE TURBINE: PLAIN BLADE CONFIGURATION DESIGN
D. C. Evans and G. W. Wolfmeyer Washington NASA Feb. 1972 112 p refs
(Contract NAS3-14304)
(NASA-CR-1964; GE-R71-AEG-242) Avail: NTIS CSCL 21E

The constant-inside-diameter flowpath was scaled for testing in an existing turbine test facility. Blading detailed design is discussed, and design data are summarized. Predicted performance maps are presented. Steady-state stresses and vibratory behavior are discussed and the results of the mechanical design analysis are presented.
Author

N72-17927# Aeronautical Research Labs., Melbourne (Australia).
COMMENTS ON CREEP DEFLECTIONS IN AIRCRAFT STRUCTURES
G. L. Belcher Apr. 1971 17 p refs
(ISBN-642-97693-7) Avail: NTIS

A survey of structural creep tests is presented including constant load-constant temperature tests, and tests conducted under variable conditions. Analyses of creep and thermal stress in structures at elevated temperatures are also included.
F.O.S.

N72-17930*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EVALUATION OF MASSLESS-SPRING MODELING OF SUSPENSION-LINE ELASTICITY DURING THE PARACHUTE UNFURLING PROCESS
Lamont R. Poole and Earle K. Huckins, III Washington Feb. 1972 30 p refs
(NASA-TN-D-6671; L-8097) Avail: NTIS CSCL 20K

A general theory on mathematical modeling of elastic parachute suspension lines during the unfurling process was developed. Massless-spring modeling of suspension-line elasticity was evaluated in detail. For this simple model, equations which govern the motion were developed and numerically integrated. The results were compared with flight test data. In most regions, agreement was satisfactory. However, poor agreement was obtained during periods of rapid fluctuations in line tension.
Author

N72-17937# North American Rockwell Corp., Los Angeles, Calif.
THE EARLY DETECTION OF FATIGUE DAMAGE Final Technical Report, 1 Jul. 1968 - 30 Jun. 1971
John F. Mooer, Schillings Tsang, and George Martin Sep. 1971 179 p refs
(Contract F33615-68-C-1706; ARPA Order 1244)
(AD-730348; NA-71-590) Avail: NTIS CSCL 20/11

The report is the final technical report for a program directed at the development of nondestructive test NDT methods for the detection of early fatigue and fracture damage in metals and alloys. The program is based on an interdisciplinary approach designed to interrelate the factors of early damage with measurable physical phenomena. The program initially concentrated on a comprehensive study of the existing knowledge of fatigue phenoma in metals, and the results of the study are described in terms of fatigue and fatigue-associated phenomena, metallurgical structure, effect of interrelating fatigue phenomena on physical properties, and the availability of appropriate measurement techniques and equipment. Next, the program developed a series of controlled fatigue experiments to quantitatively measure the fatigue effects in selected metal specimens. These tests also included a systematic metallographic evaluation to determine the actual depth and character of the surface layer affected by progressive fatigue, particularly in the early stages of fatigue. Finally, NDT methods were evaluated in terms of their potential detection and measurement capability of the observed fatigue-related effects and damage as determined by the study and fatigue evaluation tests.
Author

N72-17949*# Dynamic Science, Irvine, Calif.
IGNITION OF FUEL VAPORS BENEATH TITANIUM AIRCRAFT SKINS EXPOSED TO LIGHTNING Final Report
T. C. Kosvic, N. L. Helgeson, and M. Gerstein Sep. 1971 110 p refs
(Contract NAS3-12009)
(NASA-CR-120827) Avail: NTIS CSCL 20M

Hot-spot and puncture ignition of fuel vapors by simulated lightning discharges was studied experimentally. The influences of skin coating, skin structure, discharge polarity, skin thickness, discharge current level, and current duration were measured and interpreted. Ignition thresholds are reported for titanium alloy constructed as sheets, sheets coated with sealants, and sandwich skins. Results indicated that the ignition threshold charge

transfer for coated sheets, honeycomb, and truss skins is respectively about 200%, 400%, 800% that of bare alloy sheet of 102 cm (.040 in.)-thickness. It was found that hot-spot ignition can occur well after termination of the arc, and that sandwich materials allow ignition only if punctured. Author

N72-17964# Army Air Mobility Research and Development Lab., Fort Eustis, Va.

EXPERIMENTAL DETERMINATION OF THE IGNITION LIMITS OF JP-4 FUEL WHEN EXPOSED TO CALIBER .30 INCENDIARY PROJECTILES

Charles M. Pedriani Jul. 1971 34 p

(AD-730343; USAAMRDL-TR-71-48) Avail: NTIS CSCL 21/2

The report describes experimental efforts to define the ignition limits of JP-4 vapors subject to caliber .30 incendiary projectiles. A test fixture was fabricated which allowed a functioning incendiary projectile to pass through a known, uniform fuel/air vapor mixture. The resultant reaction was observed using high-speed photography. Ignitions between fuel/air ratios of 0.5 and 3.0 % JP-4 volume were observed. Additional tests were conducted to observe the flame suppression properties of reticulated polyurethane foam RPF and to determine that the impact flash from inert projectiles can ignite combustible fuel/air vapors. Author (GRA)

N72-17977# Army Aviation Systems Command, St. Louis, Mo.

DIRECTORATE OF SYSTEMS AND COST ANALYSIS: AIRCRAFT DESIGN OPTIMIZATION

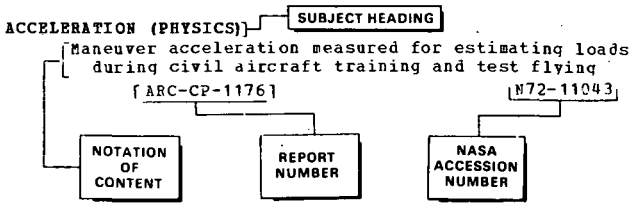
Jack T. Markin Jun. 1971 17 p refs

(AD-730338; USAAVSCOM-TR-XS-71-4) Avail: NTIS CSCL 05/1

The performance and cost of an aircraft are related to its subsystem parameters. Parameter values are selected which require performance production at minimum cost. This method is also used for studying the effect on performance and cost of trade-offs between subsystems. GRA

SUBJECT INDEX

Typical Subject Index Listing



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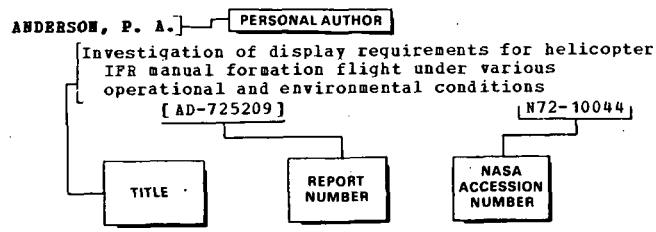

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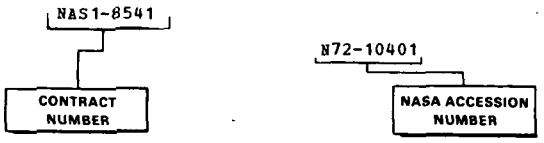

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
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4. Title and Subtitle	5. Report Date
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	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
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