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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 36

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

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 628 reports, journal articles, and other documents originally announced in September 1973 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

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

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

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

An annual cumulative index will be published.

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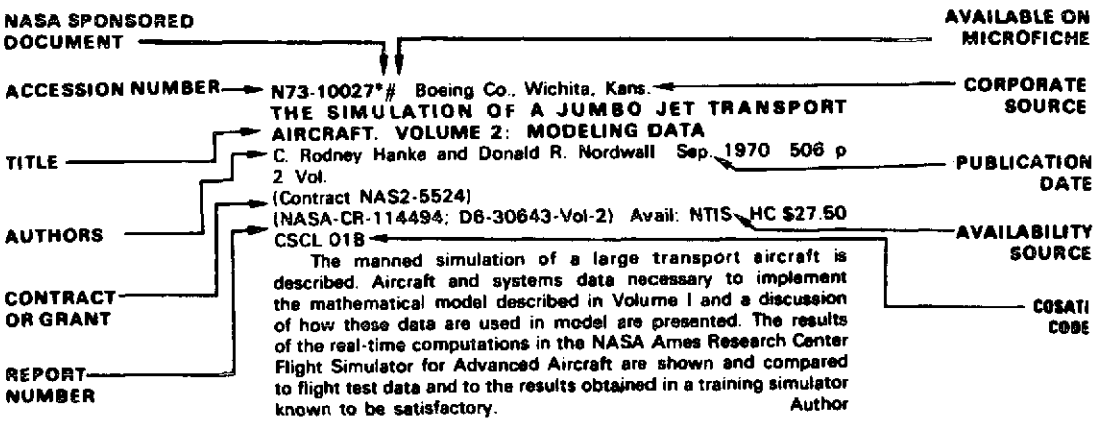

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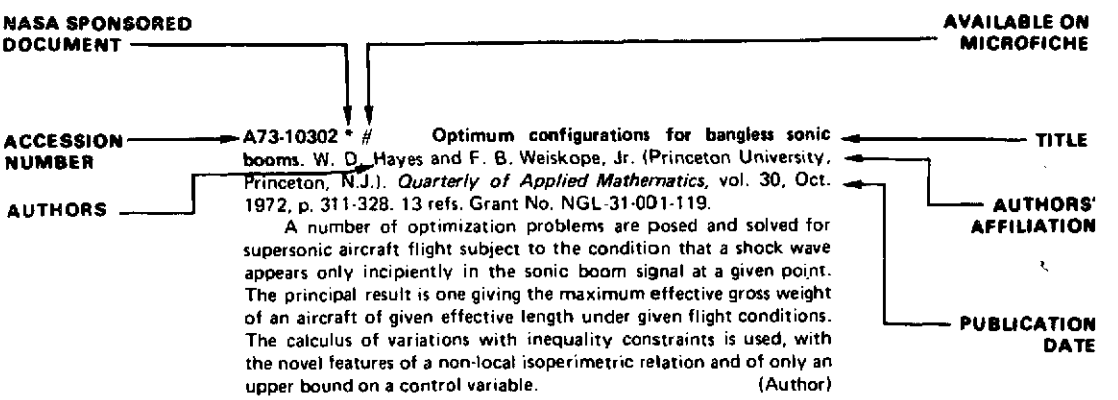

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 36) OCTOBER 1973

IAA ENTRIES

A73-34076 **Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972.** Symposium sponsored by the British Air Line Pilots Association. Hayes, Middx., England, British Air Line Pilots Association, 1973. 272 p.

Systems for safety, accident survival, the effects of fatigue on health and flight safety, and design to detect and avoid failure are treated. Safety margins and aircraft performance; the designer's view of aircraft maintenance; weather hazards to safe flight; safety in the accident-prone flight phases of takeoff, approach and landing; safe expedition of air traffic; and safety information systems are considered.

F.R.L.

A73-34077 # **Safety in operation and human error.** P. J. A. Harper (British Air Line Pilots Association, Hayes, Middx., England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 13-20.

The complication of the modern aircraft places great emphasis on the requirement for effective, efficient training in order to eliminate human error early in some phases. Once a pilot is competent, the important thing is to design operating techniques so that possibilities of blunder are reduced and that all critical actions are cross-checked. As far as automatic landing is concerned, it is the first time that the pilot is going to put himself and his aircraft in a position from which he cannot all by himself recover. Because there is very little experience with supersonic aircraft, much more will be required before the Concorde operates in a routine fashion, and the project itself is a rival of automatic landing in its associated difficulties. It is considered to be possible to reduce the load on the pilot and the air traffic controller by careful planning and constant attention to simplification. F.R.L.

A73-34079 # **Safety by survival of accident.** N. N. Shapter (FAA, Washington, D.C.). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 46-52; Discussion, p. 53-61.

Cabin safety is discussed with particular reference to protection of persons on board the airplane from the minor or so-called 'survivable' crash landing environment. Fire protection is a paramount aspects of crashworthiness. Of the crashworthiness provisions applicable to the cabin of an airplane, those for emergency evacuation are the most conspicuous to the casual observer and are designed for use by untrained, often confused, passenger evacuees. Developmental work in various fields is discussed in some detail. Aspects of planned and unplanned crash landing in water are considered. F.R.L.

A73-34081 # **Design to detect and avoid failure - One airline's viewpoint.** M. Lalas (Qantas Airways, Ltd., Sydney, Australia). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 88-93; Discussion, p. 94-99.

Many areas of aircraft systems and access for maintenance still require improvement to reduce maintenance costs without prejudicing safety. With accelerating rates of technology improvements, design for maintenance must also accelerate to keep maintenance costs within economical limits. Emphasis is given to the distinction between safety and reliability. Generally, an unacceptable reliability level is reached long before safety is affected. In studying the safety situation, present methods are briefly reviewed. Several targets are studied for improvements in manufacture. Some items are examined in detail and specific design solutions are suggested. F.R.L.

A73-34082 # **Safety margins and aircraft performance.** L. J. W. Hall (Civil Aviation Authority, England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 100-105; Discussion, p. 106-113.

Some of the areas where safety might be improved are identified, and are discussed in the order they occur in flight. Accelerate-stop, continued takeoff, approach, landing, continued airworthiness, and coordination are considered. Raising standards for the future is believed to mostly a process of not increasing safety margins but making the margins more effective by exploiting aids and equipment which lead to a more precise or more reliable operation and reduce pilot workload in critical phases of flight. If airworthiness standards are to be raised and maintained there is a need for direct knowledge of the operation and close coordination between authorities and operators on flight and engineering standards. Airports need improvement by means of better runway surfaces, and also by making the immediate surroundings less lethal. F.R.L.

A73-34083 # **The designer's view of aircraft maintenance.** S. C. Caliendi (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 114-143; Discussion, p. 144-148.

The high aircraft operational safety standards presently demanded may only be achieved if great attention is given to maintenance procedures, and if these are considered in detail during the design stage. Safety is a condition created by the elimination of risk. As knowledge is gained from past experience on the modes and frequencies of failures of complex systems, it is now often possible

to estimate the probability of failure of new designs provided they utilize existing concepts. The object of aircraft maintenance is to prevent deterioration of the inherent safety and reliability levels of the equipment and, if possible, to increase these levels by modification action as deficiencies are recognized during the operation of the aircraft. Design for safety, fault diagnosis, redundancy, maintenance analysis, service data, and equipment specifications are discussed. F.R.L.

A73-34084 # **Weather hazards to safe flight.** M. N. Morss (International Federation of Air Line Pilots Associations, London, England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 149-167; Discussion, p. 168-177.

With the increasing pressure on airlines to improve the reliability and regularity of their schedules, it has become increasingly important to understand in detail why the atmosphere assumes certain forms, so that accurate and timely forecasts can be made of their occurrence. Major attention is given to low level wind shear and clear air turbulence (CAT). Various accidents and incidents attributable to wind shear are discussed. There is a need for better information on vertical wind shear in the terminal area. At present, pilot reports are the most immediate means of obtaining this information. In the case of CAT, it is evident that as traffic increases and is compressed in the same airspace, the frequency of encounters will increase. It is suggested that when there are sufficient reports of CAT to warrant it, the affected airspace should be blocked off. Aspects of fog are considered in some detail, and some suggestions for a better weather service are made. F.R.L.

A73-34085 # **Safety in the accident prone flight phases of take-off, approach and landing.** L. C. White (International Air Transport Association, Montreal, Canada). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 178-210; Discussion, p. 211-218. 5 refs.

It is considered that if the annual jet accident rate is not reduced, not only will the airline industry be ignoring its moral obligations to passengers and crews but will also face economic suicide. Charts are presented, with discussion, showing the accident experience from 1959 to the present. It is suggested that the airline's top management must be the catalyst for the generation of safety awareness. Adherence to standard operating procedures is a major factor in achieving better safety. Training, monitoring of performance, information exchange, and facilities are discussed. F.R.L.

A73-34086 # **Safe expedition of air traffic.** C. D. Colchester (Marconi Radar Systems, Ltd., Chelmsford, Essex, England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 219-224; Discussion, p. 225-229.

Major attention is given to air traffic control, the equipment involved, the controllers, and the man-machine interface. The phenomenon of multipath with ILS is discussed. It is well understood, though not always preventable, and may be studied without the need for expensive flying by modeling at much higher frequencies or using computer programs. It is a considerable help to the controller if he can have his flight progress strips prepared before he has an aircraft actually on his hands. Aspects of primary, secondary, and moving target indicator radars are treated. F.R.L.

A73-34087 # **Safety information systems.** H. Caplan (International Risk Management Services, Ltd., London, England). In: Outlook on safety; Proceedings of the Thirteenth Annual Technical Symposium, London, England, November 14-16, 1972. Hayes, Middx., England, British Air Line Pilots Association, 1973, p. 230-238.

A system of providing information concerning incidents involving safety is proposed which consists of reporting to a neutral party with guaranteed immunity by statute from any criminal or disciplinary proceedings. In air transport, any system for information recording must be international. It is suggested that pilots themselves have to devise better systems for making their candid experiences freely available for analysis. It is held that airline pilots by their training and experience are well suited to point the way to comprehensible standards of the future. F.R.L.

A73-34100 **Brazed honeycomb structures.** M. M. Schwartz (Rohr Industries, Chula Vista, Calif.). *WRC Bulletin*, Apr. 1973, p. 1-28. 36 refs.

Review of recent accomplishments and developments in the design and fabrication of brazed honeycomb structures. The methods used to carry out brazing of honeycomb structures are cited, including the use of furnaces with a sealed retort container, vacuum furnaces, blanket techniques, radiant lamps, and exothermic brazing. The fixturing used for positioning the work during the brazing operation is discussed. Techniques used in the joint design, filler metal selection, and the choice of brazing cycle are reviewed for a number of base metals and alloys, including beryllium, aluminum, stainless steels, nickel-base and cobalt-base alloys, iron and nickel-base alloys, titanium and its alloys, certain refractory metals and their alloys, and ceramic honeycomb-sandwich structures. Six design rules for achieving practical economical and producible brazed honeycomb sandwich are presented. New inspection techniques, such as holography and acoustic emission, are cited. Future applications of brazed honeycomb construction in space nuclear generators, manned aircraft, and high-performance aircraft engines are envisioned. A.B.K.

A73-34124 **Fire protection technology in aviation. Volume 1 - Foundations of aviation and fire-protection technology (Brandschutztechnik in der Luftfahrt. Volume 1 - Luftfahrttechnische und brandschutztechnische Grundlagen).** L. Scheichl (Ministerialrat, Bonn, West Germany). Bad Honnef, West Germany, Osang Verlag, 1973. 317 p. 114 refs. In German. $43.75.

Basic aspects of aviation equipment and devices are considered, taking into account a classification of aircraft into various types, aircraft propulsion systems, functional systems on board of an aircraft, booster rockets, spacecraft, aircraft which are lighter than air, and aviation ground installations. Fundamental processes taking place during a fire are examined together with criteria regarding the risks of fire or explosion, the types of fire, and approaches for decreasing the risk of fire. Methods for extinguishing a fire are discussed, giving attention to the use of water, carbon dioxide, surface active agents, fine powders, halogen compounds and foams. G.R.

A73-34139 # **Behavior of a wing panel under transient conditions in a gas flow (Povedenie paneli kryla pri perekhodnom rezhime v potoke gaza).** A. S. Vol'mir, A. T. Ponomarev, and S. A. Popytalov. *Prikladnaia Matematika i Mekhanika*, vol. 37, Mar.-Apr. 1973, p. 247-253. In Russian.

The Bubnov-Galerkin method is applied to derive equations describing the dynamic reaction of an elastic wing skin panel to abrupt changes in flow parameters during rapid shifts of the angle of attack. A thin carrying surface is substituted for a wing skin panel in the calculation of the distribution of aerodynamic pressure over such a panel under transient airflow conditions of this type. V.Z.

A73-34179 # **Discrete vortex method of two-dimensional jet flaps.** J. Sato (National Aerospace Laboratory, Tokyo, Japan). *AIAA Journal*, vol. 11, July 1973, p. 968-973. 12 refs.

A jet flap theory is developed with the aid of a classical conformal mapping of airfoils onto unit circles which is free of any restrictions on the airfoil thickness, camber, or angle of attack. The jet sheet is assumed to be infinitesimally thin and is approximated by a finite number of discrete vortices placed on a stagnation streamline. The strengths of vortices are determined by an iterative procedure which is set up between the transformed and the physical plane. Any one of the classical incompressible airfoil theories, such as Theodorsen and Garrick's direct method (1933) or Lighthill's inverse one (1945), can be applied to determine the mapping function of airfoils onto unit circles. The present approximation will converge to the exact incompressible potential flow theory of two-dimensional airfoil sections with infinitesimally thin jet flaps, if the number of vortices is increased and the distances between the adjacent vortices decreased indefinitely. Furthermore, the classical Blasius formulas are modified for jet flaps with discrete vortex approximations, and lift, drag and moment of airfoils are obtained. (Author)

A73-34181 # **Interaction of an air-cushioned vehicle with an elastic guideway.** J. H. Ginsberg, E. C. Ting, and J. Genin (Purdue University, West Lafayette, Ind.). *AIAA Journal*, vol. 11, July 1973, p. 980-983. 15 refs.

A73-34191 # **Supersonic combustion aid for liquid and gaseous fuels.** J. J. Isaac and R. A. Cookson (Cranfield Institute of Technology, Cranfield, Beds., England). *AIAA Journal*, vol. 11, July 1973, p. 1036, 1037. 6 refs. Contract No. F61062-70-C-0025.

Investigation of some possible aids for liquid and gaseous hydrocarbon fuel combustion at low-enthalpy conditions. The results obtained include the finding that the addition of a very small amount of hydrogen causes kerosene and methane to ignite under flow conditions which would not normally support autoignition of these fuels. M.V.E.

A73-34251 Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings (Zukunftstechnik und Wirtschaftlichkeit der VTOL-Fluggeräte; Internationales Hubschrauberforum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings). Forum sponsored by the Heeresfliegertruppe of West Germany and Hubschrauberzentrum. Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 130 p. In German and English.

Topics discussed include future developments which will make the helicopter more economical to operate; a low-cost, compact, and easily maintainable turboshaft engine for use in helicopters; a proposed VTOL configuration with low disk loading; the application of the Aerodyne concept to the design of an unmanned reconnaissance craft; the possibility of achieving more economical versions of VTOLs through the use of advanced concepts; the commercial applicability of a jet-powered VTOL transport aircraft; and the characteristics of the navigation aids required for nighttime and bad-weather operation of helicopters under combat conditions. A.B.K.

A73-34252 # **Future technical developments and efficiency of helicopters and their derivatives (Zukünftige technische Weiterentwicklungen und Wirtschaftlichkeit der Hubschrauber und deren Ableitungen).** J. Andres (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marseille, France). In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings. Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 15 p. In German.

A73-34253 # **Commercial turboshaft engine readied.** M. L. Yaffee (Avco Corp., Avco Lycoming Div., Stratford, Conn.). In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings. Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 2 p.

Description of a proposed low-cost turboshaft engine intended primarily for use in five- to eight-passenger single- and twin-engine helicopters. The engine is designed for optimum performance and specific fuel consumption at a part power load of 75% of its maximum continuous power rating. The engine will be equipped with a particle separator, an integral overrunning clutch in the gearbox, antiicing, and a 3-qt-capacity oil system capable of handling the engine's low heat-rejection rate of 725 Btu per minute. Without the particle separator, the proposed engine will offer a sea-level standard performance, at a constant output speed of 6000 rpm, of 592 shp and 0.567 specific fuel consumption. Maximum continuous rating will be 505 shp with a specific fuel consumption of 0.582. A.B.K.

A73-34254 # **Progress in the development of a practically applicable VTOL aircraft with low disk loading (Fortschritt in der Entwicklung eines praktisch verwendbaren VTOL-Flugzeuges mit niedriger Kreisflächenbelastung).** S. Martin, Jr. (Bell Helicopter Co., Fort Worth, Tex.). In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings. Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 9 p. In German.

A73-34255 # **Some results of an experimental study of the Aerodyne concept (Einige Ergebnisse der Experimentalstudie zum AERODYNE-Konzept).** W. Melzer (Dornier-System GmbH, Friedrichshafen, West Germany). In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings. Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 5 p. In German.

Results of a study of the feasibility of applying the Aerodyne concept to the design of an unmanned reconnaissance craft. The Aerodyne is a wingless flight vehicle which possesses a hover capability but can also fly like a conventional aircraft by means of an internal flow duct which creates the required lift. The results of tests of a particular configuration of the Aerodyne concept are presented which concern the control and attitude stabilization of the experimental craft, its behavior during landing, its maneuverability, and the possibility of adapting it to transition flights. A.B.K.

A73-34256 # **Efficiency through advanced technology in rotor-powered VTOLs (Wirtschaftlichkeit durch Zukunftstechnik bei** traditional commercial sense but also the idea of weapons effectiveness during armed combat. While noting the high efficiency of the helicopter during missions requiring long hover times, the use of a vehicle with characteristics approaching those of a fixed-wing aircraft (the so-called convertiplane) is recommended when greater transport efficiency in forward flight is desired. Some speed-limiting physical effects in helicopters are also noted - namely, the so-called Mach number effects in forward-running blade tips and problems of reverse flow on back-running blades. A number of devices which overcome this speed limitation but at the price of a weight handicap are cited, in particular, the jet-lift device. Finally, a number of improvements in helicopter performance likely to result from the use of improved engines and new materials and technology are discussed. A.B.K.

A73-34257 # **Advanced technology and efficiency of jet-powered VTOL transport aircraft (Zukunftstechnik und Wirtschaftlichkeit strahlgetragener VTOL-Transportflugzeuge).** M. Lichte (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings.

Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 20 p. In German.

Results of a study of the commercial applicability of a jet-powered VTOL transport aircraft with a delta wing but without a special elevator unit. The helicopter lift engine system consists of 16 quiet running lift engines arranged in two rows on both sides of the fuselage. The control of the helicopter during hover flight with the aid of this system is discussed, as well as the problem of restoring balance after failure of one or two engines. An estimate is made of the direct operating costs of the proposed aircraft, showing the greatest expenditure to be that required for the lift engine system, which produces four times the thrust of the two flight engines.

A.B.K.

A73-34258 # **Technical possibilities of expanding the nighttime and bad-weather flight capability of helicopters (Technische Möglichkeiten der Erweiterung der Nacht- und Schlechtwetterflugfähigkeit von Hubschraubern).** In: Future technology and economy of the VTOL aircraft; International Helicopter Forum, 10th, Bückeburg, West Germany, June 5-7, 1973, Proceedings.

Bückeburg, West Germany, Heeresflieger Waffenschule, 1973. 17 p. In German.

Consideration of the possibilities of realizing the navigation aids required for nighttime and bad-weather helicopter flights under combat conditions. The characteristics required by a ground-independent navigation system for low flight are discussed, as well as those necessary for an obstacle warning system, a formation flight monitoring system, an automatic terrain-following or terrain-avoidance system, and a blind landing system, including radar sensors and optoelectronic sensors (a passive night-viewing television system, a semiactive gated-viewing system, and forward-looking infrared devices). A.B.K.

A73-34259 # **Future technology and economy of VTOL aircraft (Zukunftstechnik und Wirtschaftlichkeit der VTOL-Fluggeräte).** B. Gmelin and P. Hamel (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Hubschrauberzentrum, Internationales Hubschrauberforum, 10th, Bückeburg, West Germany, June 5-7, 1973, Paper.* 24 p. 6 refs. In German.

The various VTOL concepts are compared, giving attention to disk loading, flight velocity, aerodynamic qualities, and the compound helicopter. The main drawback of present helicopter designs is related to the nonsymmetrical rotor flow characteristics. Approaches for increasing the forward speed of the helicopter are examined. Speeds up to 500 km/hr can be reached with a compound helicopter. Flight velocities above 500 km/hr can be obtained by eliminating with the aid of various design approaches the speed-reducing effects produced by the presence of the rotor in its conventional form. G.R.

A73-34292 # **Test techniques for high lift, two-dimensional airfoils with boundary layer and circulation control for application to rotary wing aircraft.** R. J. Englar and R. M. Williams (U.S. Naval Material Command, Ship Research and Development Center, Washington, D.C.). *Canadian Aeronautics and Space Journal*, vol. 19, Mar. 1973, p. 93-108. 28 refs.

A73-34293 # **Further developments in surface effect takeoff and landing system concepts - Application to high performance aircraft.** A. E. Johnson and W. B. Maguire (U.S. Naval Material Command, Ship Research and Development Center, Washington, D.C.). *(Canadian Aeronautics and Space Institute, Canadian Symposium on Air Cushion Technology, 6th, London, Ontario, Canada, June 12-14, 1972.) Canadian Aeronautics and Space Journal*, vol. 19, Mar. 1973, p. 109-119. ARPA-sponsored research.

A73-34294 # **Further developments in surface effect takeoff and landing systems concepts - A multicell system.** F. W. Wilson (U.S. Naval Material Command, Ship Research and Development Center, Washington, D.C.). *(Canadian Aeronautics and Space Institute, Canadian Symposium on Air Cushion Technology, 6th, London, Ontario, Canada, June 12-14, 1972, Paper 76/11b.) Canadian Aeronautics and Space Journal*, vol. 19, Mar. 1973, p. 121-128.

A73-34325 # **Contribution to the theory of biplane wing sections.** W. J. Prosnak (Warszawa, Politechnika, Warsaw, Poland). *Académie Polonaise des Sciences, Bulletin, Série des Sciences Techniques*, vol. 21, no. 3, 1973, p. 15 (235)-18 (238).

Conformal representation of two profiles onto two circles is considered in the paper, the mapping function being assumed to be in the form of a series of rational functions. Relations between constant parameters of this function and suitably chosen coordinates of the profiles are established. They represent a generalization of formerly published ones. (Author)

A73-34347 # **Successive approximations for calculating supersonic flow past wings with subsonic leading edges (Sukzessive Approximationen zur Berechnung der Überschallströmung um Flügel mit Unterschall-Vorderkanten).** E. Leiter (Wien, Technische Hochschule, Vienna, Austria). *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 53, May 1973, p. 247-259. 12 refs. In German.

A73-34371 **Overland downlook radar is key element of AWACS.** R. E. Hendrix (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). *Westinghouse Engineer*, vol. 33, July 1973, p. 98-105.

The USAF Airborne Warning and Control System (AWACS) will substantially increase the effectiveness of U.S. air defense and tactical forces. The most critical component of the AWACS concept, the downlook radar that must pick out low-flying aircraft from ground clutter hundreds of miles away, was identified during the initial AWACS studies. As a result of a fly-off demonstration, the AWACS radar concept is now based on the use of high pulse repetition frequency (PRF) pulse Doppler coverage to detect and track high- and low-altitude targets in the severe clutter environment at ranges up to and beyond the horizon. The high-PRF pulse Doppler coverage is supplemented by a conventional low-PRF pulse mode to enhance coverage of targets beyond the horizon. The systems are described in some detail. F.R.L.

A73-34376 **Conference on Heat and Fluid Flow in Steam and Gas Turbine Plant, University of Warwick, Coventry, England, April 3-5, 1973, Proceedings.** Conference sponsored by the Institution of Mechanical Engineers. London, Institution of Mechanical Engineers (IME Conference Publication, No. 3), 1973. 291 p.

Experimental and theoretical research on heat transfer and flow characteristics in steam and gas turbine machinery is described in papers dealing with instrumentation, testing procedures, data evaluation, and theoretical models. Topics considered include flow of steam-water mixtures through sharp-edged orifices, reintrainment of deposited liquid from steam turbine fixed blades, effects of bulk heat transfers in aircraft gas turbines on compressor surge margins, prediction of fog-drop size in wet steam turbines, studies of incidence loss models for radial and mixed-flow turbomachinery, rotating stall effects, flow turbulence measurements, and effects of axial velocity variation on subsonic flow through compressor cascades.

T.M.

A73-34381 **Development of experimental turbine facilities for testing scaled models in air or freon.** V. T. Forster (GEC Turbine Generators, Ltd., Manchester, England), B. V. Archer, and R. G.

Unsworth (GEC Turbine Generators, Ltd., Rugby, Warwicks., England). In: Conference on Heat and Fluid Flow in Steam and Gas Turbine Plant, Coventry, England, April 3-5, 1973, Proceedings. London, Institution of Mechanical Engineers, 1973, p. 84-93. 5 refs.

In this paper a description is given of a variable density supersonic cascade-wind tunnel which has been uprated and extended to incorporate scaled model turbines into the circuit. Details are given of the design and instrumentation for one such turbine, and some experimental results from both models and steam turbines in the field are presented. Finally, development of the most advanced steam turbines of the future will be assisted by a changeover to the use of Freon or a Freon-air mixture as the working fluid, and the many advantages of this provision are discussed. (Author)

A73-34382 Effect of 'bulk' heat transfers in aircraft gas turbines on compressor surge margins. N. R. L. Maccallum (Glasgow, University, Glasgow, Scotland). In: Conference on Heat and Fluid Flow in Steam and Gas Turbine Plant, Coventry, England, April 3-5, 1973, Proceedings. London, Institution of Mechanical Engineers, 1973, p. 94-100. 12 refs.

During transients of gas turbines, bulk heat transfers take place in the compressors and turbines to, or from, the air or gas streams. The effects these have on the compressor surge lines and on the steady-running conditions have been investigated theoretically for four typical transients of a twin-spool bypass engine. The two most serious situations found occur in the low-pressure (LP) compressor during an altitude deceleration and in the high-pressure (HP) compressor when attempting an acceleration immediately following a rapid deceleration. In these two cases the appropriate surge margins are reduced by 18 and 35 per cent respectively. (Author)

A73-34388 Mist-cooled turbines. M. J. Goodyer and R. M. Waterston (Southampton, University, Southampton, England). In: Conference on Heat and Fluid Flow in Steam and Gas Turbine Plant, Coventry, England, April 3-5, 1973, Proceedings. London, Institution of Mechanical Engineers, 1973, p. 166-174. 16 refs. Research supported by the Science Research Council.

Some of the thermodynamic advantages of the use of high gas temperatures at turbine entry are discussed together with the use of high compressor pressure ratios, taking into account the jet engine and the shaft power engine. It is shown that conventional techniques of air cooling cannot cope with the cooling requirements which will arise if the engines are to be developed to reach ultimately desirable cycles, unless metallurgical advances permit the use of higher component temperatures. It is suggested that the use of water to augment air cooling might be a practical proposition for some gas turbine engines. It is proposed that water be added to the stream of cooling air in order to augment the thermal capacity. It seems most desirable to spray the water into the air to form a mist. G.R.

A73-34435 * # Hypersonic transports - Economics and environmental effects. R. H. Petersen and M. H. Waters (NASA, Ames Research Center, Aeronautical Missions and Technology Branch, Moffett Field, Calif.). *Journal of Aircraft*, vol. 10, June 1973, p. 334-341. 27 refs.

An economic analysis of hypersonic transports is presented to show projected operating costs (direct and indirect) and return on investment. Important assumptions are varied to determine the probable range of values for operating costs and return on investment. The environmental effects of hypersonic transports are discussed and compared to current supersonic transports. Estimates of sideline and flyover noise are made for a typical hypersonic transport, and the sonic boom problem is analyzed and discussed. Since the exhaust products from liquid hydrogen-fueled engines differ from those of kerosene-fueled aircraft, a qualitative assessment of air pollution effects is made. (Author)

A73-34436 # Potential payoffs of variable geometry engines in fighter aircraft. P. Czysz, F. C. Glaser, and S. A. LaFavor (McDonnell Aircraft Co., St. Louis, Mo.). *Journal of Aircraft*, vol. 10, June 1973, p. 342-349.

The design and control characteristics of military aircraft engines are generally established to perform a specific design mission. For any such mission, there is one engine type which will produce the thrust levels and mission fuel requirements which minimize aircraft size. No single engine type can, however, optimally perform all missions. Variable geometry can improve engine performance at specific operating conditions. For missions which require significant operation at those operating conditions, variable geometry engines can be superior to fixed geometry designs. Using multitechnology computer techniques, aircraft sizing studies compared two advanced, fixed-geometry augmented engines (a turbojet and a turbofan), and an advanced, variable-geometry turbine, augmented turbojet. Sensitivities in takeoff gross weight are compared for a number of mission and aircraft performance elements. Results of the application of variable geometry engines to the various mission roles are summarized. (Author)

A73-34437 # A view of air traffic control in future terminal areas. W. E. Wilhelm (Ohio State University, Columbus, Ohio) and J. W. Schmidt (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Journal of Aircraft*, vol. 10, June 1973, p. 366-372. 9 refs. NSF Grant No. 323439-1.

A view of the nature of future terminal-area ATC operations is proposed by reasoned consideration of the FAA's ten year plan. The crucial, decision-making role of the air traffic controller in this environment is investigated. An analytical model of the ATC-pilot-aircraft control loop is presented and shown to meet certain a priori requirements of such a model. Application of the model indicates several characteristics of aircraft flow. (Author)

A73-34438 # Vortex-lift prediction for complex wing planforms. R. G. Bradley, C. W. Smith, and I. C. Bhateley (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *Journal of Aircraft*, vol. 10, June 1973, p. 379-381. 7 refs. Research supported by the General Dynamics Independent Research and Development Funds.

As an extension of the suction analogy concept proposed by Polhamus (1966), a method for analyzing sharp-edged flat wings of arbitrary planform is presented. Calculations for a double-delta wing and an ogee wing are compared with experimental data. The agreement between theory and experiment is very good for angles of attack below that for which vortex breakdown is occurring over the wing. M.V.E.

A73-34440 # The influence of pitch and twist on blade vibrations. M. I. Young (Delaware, University, Newark, Del.). *Journal of Aircraft*, vol. 10, June 1973, p. 383, 384. 7 refs. Grant No. DA-ARO(D)-31-124-71-G112.

A method based on a suitable energy formulation is presented for analyzing the influence of pitch and twist on blade vibrations. The formulation provides a simple calculation procedure employing a correction function for modifying the idealized uncoupled modes of an untwisted blade rotating at flat pitch. The approach is shown to be especially well suited for preliminary design in that it makes possible a rapid evaluation of the effects of the aerodynamic requirements on the structural dynamic design and behavior of these blades. A sample calculation is given for illustration. M.V.E.

A73-34441 Social acceptability of heliports particularly from the standpoint of noise. R. J. Stephenson (Greater London Council, London, England). *(Royal Aeronautical Society and British*

Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal, vol. 77, May 1973, p. 217-220.

One of the main factor which decides whether the introduction of a new source of noise will be acceptable in a particular area is the level of background noise which already exists. Results of surveys indicate that in busy urban areas the noise levels inside living rooms should not exceed 50 dBA for more than 10% of the time, and inside bedrooms at night not more than 35 dBA for more than 10% of the time. Noise level at Battersea Heliport has produced few complaints. The noise level of individual helicopters is discussed, and problems of acceptability are assessed. Attention is given to atmospheric pollution from helicopters and downwash and dust movement caused by rotors. F.R.L.

A73-34442 **Noise and the helicopter pilot.** A. C. Gordon (Bristow Helicopters Group, Ltd., Redhill Aerodrome, Surrey, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 220-224.

Subject to the economics being satisfactory, the widespread use of helicopters in passenger transport might easily be seriously inhibited by restrictive noise limitations. Pilots can help avoid this if they operate the present generation of noisy helicopters with due regard to this problem. It is noted that at the higher PNdB levels, i.e., below 1000 ft distances, a few hundred feet increase in altitude or increase in horizontal distance can easily bring unacceptable noise levels to within quite acceptable standards. The use of navigational aids such as Decca can ensure specific routing over areas which are not noise sensitive. Steep approach and climb-out paths are beneficial. An important aspect of helicopter noise is blade slap. F.R.L.

A73-34443 **Setting up a downtown heliport.** P. J. Landi (Port Authority of New York and New Jersey, New York, N.Y.). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 225-229.

A number of heliports and helipads located in the New York metropolitan area are examined, giving ample evidence of the feasibility of the downtown facility. The facilities are on the Port of New York Authority Building, at West 30th St. and 12th Ave., at Wall St., at 60th St., and at Center St., Newark. An additional heliport is planned for the World Trade Center. To bring these heliports into being it was found that the dominant public concerns were fear, noise, and economics. All were valid concerns about which the public needed to be satisfied, and it is shown that this may be done quite reasonably and honestly. It is 'downtown' that the unique value of the helicopter lies, hence heliports must be built in those areas. F.R.L.

A73-34444 **The design aspects of heliports.** A. E. Stocombe (British Airways Helicopters, Ltd., Gatwich Airport, Surrey, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 230-233. 6 refs.

An attempt is made to show what would be necessary for a heliport suitable for scheduled helicopter services should a vehicle become available which proves economically viable for intercity services. Design and location are inseparable considerations in the provision of heliports; the nature of the site is likely to determine the heliport design. The additional costs at restricted city center sites have to be compared with less costly designs at greater distances from the city center; less easily accessible locations are unlikely to be justified on commercial grounds. F.R.L.

A73-34445 **The use and usage of helicopters.** G. E. Ford (British Executive Air Services, Ltd., Oxford, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 233, 234.

Helicopters find extensive application in the transport of directors and senior executives, who have cause to travel far more frequently than in the past. They not only need to travel to city and town centers, but on occasion to isolated locations which are not readily accessible by road or rail or fixed-wing aircraft. The use of helicopters by oil companies, for filming, by police, and for ambulance service is briefly discussed. F.R.L.

A73-34446 **Flight procedures into and out of heliports.** H. E. Wood (National Air Traffic Service, London, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 235-239.

Major attention is given to helicopter operations in the London area, setting the scene by describing the layout of the controlled airspace which contains the helicopter route system. The helicopter routes in the London Control Zone are designed to avoid congested areas and insofar as is practicable they are aligned through open spaces. Procedures at the Westland Heliport, the only licensed one in the London area, are discussed. Possible future developments are assessed in some detail. F.R.L.

A73-34447 **Small engines - Big business /1972 Halford Memorial Lecture/.** J. E. B. Perkins (Rolls-Royce, Ltd., Small Engine Div., Derby, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal*, vol. 77, May 1973, p. 240-248.

Small gas turbines, defined as those in the power range up to around 3000 shp and 4000 lb thrust, i.e., engines for general aviation, corporate, and executive aircraft, and limited trainer operations and helicopters are discussed. The background of the small engine business in market and technical terms is developed to highlight a number of features of the small engine business as it exists today. The technical progress made to date is reviewed, examining aspects of fuel consumption, power, weight, and price. Some future market trends for small engines, and the likely solutions in terms of supporting technology are discussed, and the ways in which the industry's structure might develop to support profitably this part of the business are examined. F.R.L.

A73-34448 **The prevention of separation and flow reversal in the corners of compressor blade cascades.** B. S. Stratford (Rolls-Royce, Ltd., Derby, England). *Aeronautical Journal*, vol. 77, May 1973, p. 249-256. 7 refs.

A73-34451 **Flight dynamics of rigid and elastic airplanes. Parts 1 & 2.** J. Roskam (Kansas, University, Lawrence, Kan.). Lawrence, Kan., Roskam Aviation and Engineering Corp., 1972. Pt. 1, 512 p. 68 refs.; Pt. 2, 484 p. 85 refs. Price of two parts, $30.; $17.

The subject of aeroelasticity deals with the integrity of the structure during steady aerodynamic loads (static aeroelasticity), and during unsteady aerodynamic loads (dynamic aeroelasticity). The classical linear theory of rigid airplane stability and control is reviewed, with emphasis on a systematic treatment of the subject. Problems associated with coupling phenomena and nonlinear effects are discussed. For elastic airplanes the general equations of motion are derived and are then reduced to steady state forms and perturbed state forms. An introduction to frequency response methods of analyzing the motions of airplanes is given. Five chapters are devoted to automatic flight control systems because of their increasing importance. The behavior of the human pilot as part of an airplane flight control system is analyzed in some detail. F.R.L.

A73-34460 **Lectures in transportation noise.** R. H. Lyon (MIT, Cambridge, Mass.). Harvard, Mass., Grozier Publishing, Inc., 1973. 265 p. 130 refs. $20.

Aspects of the description of transportation noise are discussed together with the basic theory of sound propagation, sound sources and noise producers, questions of outdoor sound propagation, the noise of jet aircraft, noise produced by airfoils, the propagation of landing and takeoff noise, problems of sonic boom generation, and the propagation of sonic booms. Other subjects investigated include turbulent boundary layer noise, aircraft cabin noise, criteria for passenger compartments, criteria for community exposure to aircraft noise, automotive noise propagation in open areas, and urban noise propagation. Noise and vibration produced by rail vehicles are considered along with the transmission of subway noise, vibration and motion criteria for air and surface vehicles, and the acoustics of rooms and closed spaces. G.R.

A73-34471 **Gas turbine theory /2nd edition/.** H. Cohen (Cambridge University, Cambridge, England), G. F. C. Rogers (Bristol, University, Bristol, England), and H. I. H. Saravanamuttoo (Carleton University, Ottawa, Canada). New York, Halsted Press, 1973. 347 p. 57 refs. $24.75.

An introduction into the theory is provided, giving attention to open cycle single-shaft and twin-shaft arrangements, compounding, closed cycles, aircraft propulsion, applications, and gas turbine design procedure. Shaft power cycles are considered together with gas turbine cycles for aircraft propulsion, centrifugal compressors, axial flow compressors, combustion systems, and axial flow turbines. Other subjects discussed include the prediction of performance of simple and more complex gas turbines along with some aspects of gasdynamics, taking into account compressibility effects, adiabatic flow, plane normal shock waves, and oblique shock waves. G.R.

A73-34474 * # **Parameters controlling nitric oxide emissions from gas turbine combustors.** J. B. Heywood and T. Mikus (MIT, Cambridge, Mass.). *NATO, AGARD, Meeting on Atmospheric Pollution by Aircraft Engines, London, England, Apr. 9-13, 1973, Paper.* 15 p. 30 refs. Grant No. NGL-22-009-378.

Nitric oxide forms in the primary zone of gas turbine combustors where the burst gas composition is close to stoichiometric and gas temperatures are highest. It has been found that combustor air inlet conditions, mean primary zone fuel-air ratio, residence time, and the uniformity of the primary zone are the most important variables affecting nitric oxide emissions. Relatively simple models of the flow in a gas turbine combustor, coupled with a rate equation for nitric oxide formation via the Zeldovich mechanism are shown to correlate the variation in measured NO sub x emissions. Data from a number of different combustor concepts are analyzed and shown to be in reasonable agreement with predictions. The NO sub x formation model is used to assess the extent to which an advanced combustor concept, the NASA swirl can, has produced a lean well-mixed primary zone generally believed to be the best low NO sub x emissions burner type. (Author)

A73-34475 # **Recommended basic characteristics for airborne radio homing and alerting equipment for use with emergency locator transmitters /ELT/.** Washington, D.C., Radio Technical Commission for Aeronautics (Document No. DO-154), 1973. 15 p. 9 refs. $6.00.

A73-34476 # **The functions of regional airports and the resulting requirements for the ground installations (Aufgaben der Regionalflugplätze - Daraus resultierende Anforderungen an die Bodenanlagen).** G. Ruff (Ministerium für Wirtschaft, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 14 p. In German.

Regional airports are an effective means for improving the regional economic structure. German laws and regulations concerning the classification of airports are examined. Differences regarding the functions of large airports and regional airports are responsible for the differences in the design for the two types of airports. Three design stages for regional airports are described, giving also attention to installations for providing flight safety and the required meteorological data. Problems of runway construction in connection with the weight of the aircraft to be served by the airport are discussed along with questions of costs and the profitability of the required investments. G.R.

A73-34477 # **A monitor display for automatically controlled steep landing approaches (Ein Monitordisplay für automatisch geregelte Steilanflüge).** H.-D. Schenk and J. Thomas (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 8 p. In German.

Description of a monitor display capable of indicating to the pilot the relation between the aircraft position and the desired flight profile during steep landing approaches with curved segments. The proposed display provides a side view of the curved approach profile with a moving aircraft symbol and a rotating flight path vector. A number of improvements in the original design of the display, resulting from flight simulator tests, are noted. A.B.K.

A73-34478 # **Considerations concerning the design of an electronic landing display for STOL aircraft (Gedanken zur Auslegung eines elektronischen Landedisplays für STOL-Flugzeuge).** W. Holstein (Berlin, Technische Universität, Berlin, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 38 p. 13 refs. In German.

A73-34479 # **Possibilities for improving conventional ILS systems (Verbesserungsmöglichkeiten des konventionellen Instrumentenlandesystems /ILS/).** H. Fricke (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 18 p. In German.

The possibilities are discussed to correct or neutralize the errors occurring in ILS-controlled aircraft-landing approach and glide path. These errors result from interferences caused by multipath propagation and (for the glide path only) by disturbances due to variations in the reflective properties of the ground. The three prerequisites to their correction are shown to be: (1) the detection of trouble at the very onset of reflected wave radiation; (2) an immediate reflected wave and phase amplitude determination by way of an analysis of the radiation field at the point of reception accurate enough for suppressing the disturbance; and (3) neutralization of the glide-path affecting influences arising from variations in the reflective properties of the ground. Various approaches to the fulfillment of these prerequisites are discussed. M.V.E.

A73-34480 # **Digital synchronization of synchronous collision prevention systems in aviation (Digitale Synchronisation für zeitsynchrone Kollisionsschutzsysteme der Luftfahrt).** P. Form (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 18 p. 9 refs. In German.

Discussion of the usability of the digital synchronization concept for reducing the complexity and costs of the airborne equipment required in synchronous aircraft collision avoidance systems. Following a review of data transmission and measurement techniques currently favored for synchronous aircraft collision avoidance systems, the synchronization function itself is examined in terms of primary, incipient secondary, and continuously secondary synchronization, and the problems involved in the synchronization of a multitude of collision-avoidance system participants in motion are considered. The digital phase and frequency error correction or synchronization system is then described and its collision-prevention effectiveness and cost efficiency pointed out. M.V.E.

A73-34481 # **Bad-weather landing today - Its problems and limitations (Schlechtwetterlandung heute - Ihre Probleme und Grenzen).** D. Brunner (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 13 p. In German.

Review of the achievements made and the unsolved problems remaining in the field of bad weather landing. The three stages in which it is hoped to reach complete independence of weather conditions are described, and criteria are presented for the determination of the operating limits during precision landing approaches. A number of problems arising during bad-weather landing approaches are discussed, including problems connected with the landing system, problems arising during CAT II landing approaches due to false visual impressions of the pilot, and problems related to CAT III landings with the aid of automatic landing systems. A.B.K.

A73-34482 # **Longitudinal motion of a transport aircraft during steep landing approaches (Zur Längsbewegung eines Verkehrsflugzeugs bei steilen Anflügen).** G. Brüning, J. Lademann, and D. Schafranek (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 24 p. In German.

Attempt to determine the feasibility of the execution of steep landing approaches by present-day transport aircraft and the way in which the dynamic longitudinal stability changes with increasing descent path angle. It is shown that steeper landings then those customary are possible with the passenger aircraft currently in use. In this case the descent speed increases, while the path speed remains unchanged. In order to prevent excessive throttling of the engines, extensible air brakes must be employed. The dynamic longitudinal stability is affected only negligibly. To prepare for landing, it is recommended that a transition to a 3-deg glide path be made shortly beforehand by means of a pullout maneuver. A.B.K.

A73-34483 # **Flight control problems during steep landing approaches (Flugführungsprobleme des Steilanfluges).** R. Brockhaus (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 35 p. 21 refs. In German.

Consideration of the problems arising during STOL landing approaches, including an indication of how these problems can be solved by means of navigation aids. Three lines of development of steep landing approaches are noted, and the results of research performed in this area in both the U.S. and West Germany are cited. The situation of the pilot during steep landing approaches is reviewed, including recommendations to keep the pilot's work load from becoming more strenuous than in conventional flight. The instrument readings and control aids that can be used to assist the pilot during steep landing approaches are described, and the division of labor between the pilot and the flight control system is discussed. Some problems still remaining to be solved in connection with STOL navigation and flight safety are cited. A.B.K.

A73-34484 # **Improvement of the standard ILS while retaining compatibility (Verbesserung des Standard-ILS unter Beibehaltung der Kompatibilität).** *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 7 p. In German.

Description of two systems which improve the standard ILS through additions of various magnitudes while retaining the ILS basis function so that the systems remain compatible with the existing two-carrier system. The first system, called Compatible Instrument Landing System (CILS), consists of standard ILS for clearance and microwave ILS for the approach sector. Compatibility is achieved by emitting the microwave oscillator frequency as a pilot signal. The other system, called Precision Instrument Landing System (PILS), involves the use of linear antenna arrays consisting of a number of emitter elements which successively emit appropriate signals. A.B.K.

A73-34485 Effects of new landing approach procedures on cockpit design and possibilities of taking them into account (Auswirkungen neuer Anflugverfahren auf die Cockpitauslegung und Möglichkeiten ihrer Berücksichtigung). Mr. Häuser (Messerschmitt-Bölkow-Blohm GmbH, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 23 p. In German. (MBB-UH-07-73)

Consideration of the effect of new maneuvering procedures during landing approach on the arrangement of the flight control instruments in the cockpit. After describing the problem of cockpit design, the constraints imposed on such design are specified, and the possibilities of practical application of these specified values in all phases of the design development are demonstrated. In addition, the parameters characterizing these constraints are indicated, as well as methods of determining them. Examples of alterations of these specified parameters resulting from the introduction of new landing approach procedures are presented. A.B.K.

A73-34486 Control techniques for steep landing approaches of rotary wing aircraft (Regelungstechnik bei Steilanflügen von Drehflüglern). W. Kubbat (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 26 p. In German. (MBB-UFE-1021)

Consideration of the problem of controlling flexible landing approach profiles by using the high maneuver capability of rotary wing aircraft. A study is made of a concept which makes it possible to follow a spatially variable pre-assigned flight path and to fulfill a flight speed requirement related to the flight path. A review of the problems arising from this concept and of the methods of solution is presented. The solutions obtained are illustrated with results of simulation studies concerning rectilinear, curved, and spatially curved approaches. A.B.K.

A73-34487 Mixed CTOL-QTOL traffic (Gemischter CTOL/QTOL-Verkehr). F. Schönberger (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 30 p. In German. (MBB-UH-05-73)

Review of the mixed-traffic problems that are to arise at the QTOL-aircraft introduction time in 1979/1980 and may be expected to persist through the undeterminably long transition period during which CTOL aircraft will be phased out. Special attention is given to the repercussions of mixed traffic for the tasks of air traffic controllers in terminal areas around airports. The effects of mixed traffic upon the microwave landing system that is to supersede the current ILS system, as well as on planned future radio navigation systems, are also discussed. Significant aspects of the impact of mixed traffic on airport operation and ground equipment are likewise examined. M.V.E.

A73-34488 Noise-abating approach and departure procedures for STOL aircraft (Lärmreduzierende An- und Abflugverfahren für STOL-Flugzeuge). K. Weise and H. Anders (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 43 p. 9 refs. In German. (MBB-UH-06-73)

Investigation of the possibilities for reducing the noise generated by STOL aircraft at landing approach and departure. In particular, the observance of various departure and landing-approach procedures was studied in terms of its effects upon the intensity and propagation patterns of the noise generated by STOL aircraft. A so-called 'three-segment start profile' departure procedure is described whose post-takeoff thrust reductions at certain altitudes are shown to lead to noise abatement over airport adjacent and neighboring areas at the cost of slight noise level enhancement over remoter areas. Noise abatement requirements during landing approach are shown to consist essentially in the steepest descent and most prolonged low-drag flight (i.e., most delayed landing flap and gear deployment) consistent with safety. M.V.E.

A73-34489 Ground visual aids for the approach and landing of STOL aircraft. D. Johnson and A. J. Smith (Royal Aircraft Establishment, Farnborough, Hants., England). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 20 p. (RAE-TM-AVIONICS-136/BLEU/)

An attempt has been made by the Blind Landing Experimental Unit (BLEU) of the Royal Aircraft Establishment to assess the visual aids requirements for STOL aircraft. For the purposes of the study it was assumed that a typical civil STOL aircraft will approach at a glidepath angle of 6 deg at a speed of 90 kt to a runway that is 30 to 45 m wide and 600 to 1200 m long. The sort of markings and lighting that will be required to support steep gradient approaches are described. Flight trials and simulator experiments have been carried out to evaluate some elements of the proposed systems. A form of glideslope indicator using sharp-transition two-color units has been evolved and flight trials have shown that the flight path performance is within limits that will probably be satisfactory for operations with passenger aircraft. The flight trials have also shown that following a manual approach pilots can successfuly flare and land the aircraft from heights as low as 10 m. F.R.L.

A73-34490 The interface of new approach techniques with existing ATC systems. N. H. Hughes (Royal Aircraft Establishment, Farnborough, Hants., England). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, Paper.* 28 p. 6 refs. (RAE-TM-AVIONICS-135/BLEU/)

The terminal control area R/STOL air traffic control environment is examined, and the flight control system characteristics likely to be required in the R/STOL vehicle for intermediate and final approach are identified. The airspace requirements for holding for conventional aircraft are first discussed, and the potential advantages from reduction of airspace requirements for R/STOL holding, by means of deployment of area navigation in R/STOL aircraft, are considered. A comparison is then made between conventional intermediate approach patterns and those likely to be required for R/STOL aircraft, and it is shown that R/STOL patterns are likely to be significantly more complex at some sites. To achieve sufficiently predictable flying times within the terminal control area for effective approach sequencing, without excessive aircrew workload, may demand equipping the R/STOL aircraft with area navigation, possibly including the fourth dimension - or 'time slot' - control. The system design problems associated with time slot following are therefore also examined. (Author)

A73-34491 # Flight operations and guide beam system (Flugbetrieb und Leitstrahlsystem). T. Bohr (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-011.* 13 p. In German.

The development of guide beam systems comprises three phases. The first phase, beginning in 1920 and ending in 1945, includes the introduction of the guide beam system, involving first tests and the design of fully operational systems. The introduced systems were further improved during the second phase, which ended in 1966. The guide beam systems are being extended during the third phase to meet growing operational requirements. This phase will presumably be concluded in 1977. The present state of development of guide beam system is discussed in detail and the new operational requirements are examined, giving attention to approach, landing, and questions of accuracy. G.R.

A73-34492 # Flight-path control device for generating curvilinear flight path profiles using microwave landing systems (Flugbahnführungsgerät zum erzeugen gekrümmter Flugbahnprofile an Mikrowellen-Landesystemen). G. Schänzer (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-016.* 36 p. 12 refs. In German.

A73-34493 # Special features of the DLS and SETAC landing aids (Einige Besonderheiten der Landenhilfen DLS und SETAC). K. D. Eckert and G. Peuker (Standard Elektrik Lorenz AG, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-019.* 34 p. In German.

Description of two proposed advanced approach and landing systems for use by military aircraft. The SETAC system is based on the use of the TACAN landing aid and thus constitutes a so-called 'air-derived system.' It consists of two ground stations and an onboard instrument addition to a TACAN onboard system. The use of TACAN frequencies and a TACAN signal format broadened with the aid of time-division multiplex procedures makes it possible to employ the TACAN onboard system designed for medium-range navigation for the approach and landing phase. Two special features of SETAC are noted - namely, the use of a 15-kHz omnidirectional beacon which makes possible azimuth measurement with 360-deg coverage and precision distance measurement in the terminal area, and the use of virtual diagrams for angle-of-elevation measurement. The DLS system is based on L-band DME, the interrogations transmitted from the aircraft are received by special circular antenna arrays, flexibility is achieved through the use of a ground-derived system, and the channel allocation problem is minimized by the possibility of CW operation. A.B.K.

A73-34494 # **A novel electronics landing system for regional airports (Ein neuartiges Elektronik-Lande-System für Regionalflugplätze).** R. Kissling (Elektronik für Luftfahrzeuge Stuttgart GmbH, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-020.* 8 p. In German.

A landing system for satisfying IFR landing requirements for air traffic under certain specified conditions is proposed. The operations possible with the new system include simulated GCA and simulated ILS. The requirements of the intended users can be satisfied by the system without the installation of new onboard equipment. Only small antennas with a receiving frequency of 1 GHz are needed for the ground installation. The introduction of a new transponder frequency at about 4 GHz is considered. G.R.

A73-34495 # **Tasks of a noise abatement official (Aus der Arbeit eines Lärmschutzbeauftragten).** H. Borsdorff. *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-022.* 13 p. In German.

Description of the history and functions of the office of noise abatement supervisor in the Federal Republic of Germany, and consideration of some significant aspects of aircraft noise control on the regional, national, and European level. The author's personal experience, as the Stuttgart Airport's noise abatement supervisor since 1969, is discussed in terms of the procedures used, problems encountered, and improvements achieved in the course of noise abatement efforts. Specific recommendations are presented for enhancing the effectiveness of noise abatement efforts in Germany and throughout Europe. M.V.E.

A73-34496 # **Flight mechanics problems associated with landing approaches using direct lift control, as examplified by the HFB 320 Hansa aircraft (Flugmechanische Probleme beim Landeanflug mit direkter Auftriebssteuerung am Beispiel der HFB 320 Hansa).** D. Hanke and H.-H. Lange (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-024.* 33 p. 11 refs. In German.

A73-34497 **Limitations on steep-angle approaches for helicopters (Über die Grenzen von Steilanflügen mit Drehflüglern).** M. Rade (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-026.* 8 p. 16 refs. In German. (MBB-UD-101-73)

Limiting conditions and flight circumstances influencing steep-angle approaches of helicopters are reviewed, along with the limitations they impose on instrument-guided steep approaches. Actual flight performance results are also described. At a 15-degree flight path angle, considerable advantages are shown to be achievable over the well known ILS approach. Some essential prerequisites for instrument-guided steep-angle landing approaches are pointed out and briefly discussed. M.V.E.

A73-34498 # **Problems concerning the implementation of an integrated flight control system, giving particular attention to curved flight path profiles (Realisierungsprobleme eines integrierten Flugregelungssystems unter besonderer Berücksichtigung gekrümmter Flugbahnprofile).** H. Böhret (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über neue Anflugverfahren, Düsseldorf, West Germany, May 2-4, 1973, DGLR Paper 73-030.* 32 p. 7 refs. In German.

A73-34523 **Hydraulic techniques stop 'Murphy.'** J. W. Lebold and R. W. Dyer (Lockheed-California Co., Burbank, Calif.). *Hydraulics and Pneumatics,* vol. 26, June 1973, p. 87-90.

The L-1011 aircraft has for its hydraulic system designed-in layout and installation techniques which greatly reduce Murphy's law errors during servicing. Problems of modular design with plug-in cartridges are discussed together with plug-in features, hydraulic service centers, check valve configurations, permanently connected B-nuts, and plumbing installations. Orbital welding, swaging tools, and processes were developed for in-place repair in the aircraft. The actuator attachment end of the hydraulic tubing system has multiple plumbing connections which use a manifold-flange-type face seal. G.R.

A73-34534 **The financing of aircraft procurement.** R. S. Sowter. *Aeronautical Journal,* vol. 77, Apr. 1973, p. 171-174.

It is suggested that for aerospace manufacturers, governments should fund civil projects or provide research and development through defense projects, preferably on an international competitive tender basis. Risk capital by the manufacturers must be provided alongside government funds for civil projects. Governments should consider providing domestic funds for the purchase of aircraft on the lines of the shipping industries loans in the U.K. For airlines, IATA should be considered as the airline operators' association for all levels of air travel. Governments must endorse and enforce decisions on fare structures taken by representatives of all airlines. The fare levels must permit airlines to earn a reasonable return on investment, depending upon the type of operation. F.R.L.

A73-34535 **The financing of essential communication, navigation and terminal aids.** F. J. H. Johnston (International Air Transport Association, Geneva, Switzerland). *Aeronautical Journal,* vol. 77, Apr. 1973, p. 175-180.

The communications networks used to enable the international air transport industry to function are, first, company owned circuits which enable each airline to fulfil its normal commercial requirements. Second are airline jointly owned organizations such as ARINC in the U.S. and International Aeradio elsewhere. Third are the government financed networks termed by ICAO as the Aeronautical Fixed and Aeronautical Mobile systems. Determination of costs and their allocation, recovery of costs, and solution of the global problem are discussed. It is considered that the financing problem can only be solved ultimately through a worldwide approach. F.R.L.

A73-34536 **Revised calculations of the NACA 6-series of low drag aerofoils.** T. R. F. Nonweiler (Glasgow, University, Glasgow, Scotland). *Aeronautical Journal,* vol. 77, Apr. 1973, p. 190-192.

A recent study by digital computer of the theoretical characteristics of a family of low drag airfoil sections was prompted by the need to redesign a particular NACA 6-series airfoil of high camber, which was not producing the desired pressure distribution. This new family of airfoils, designated the GU series, was patterned on the NACA sections, and designed to provide the characteristic region of uniform velocity over the forward portion of one surface at the extreme of the low drag region, followed by a compression region of roughly constant adverse pressure gradient. The GU series is a 5-parameter family with one of the parameters controlling nose radius, and another the trailing edge angle; the remaining three bear some relation to the three parameters of the NACA 6-series, though they are not identical. F.R.L.

A73-34538 **Beyond the buffet boundary.** D. G. Mabey (Royal Aircraft Establishment, Bedford, England). *Aeronautical Journal,* vol. 77, Apr. 1973, p. 201-215. 58 refs.

An examination of the physical processes at work above the buffet boundary is made when the boundary layer has separated. Buffeting is defined as the structural response to the aerodynamic excitation produced by separated flows. It is shown how buffeting criteria can influence the choice of wing loading for transport and fighter type aircraft. A broad classification of wings with separated flows that excite buffeting is used as a framework for the discussion. Attention is given to unswept and swept wings, and excitation and buffeting measurements, and the onset and severity of buffeting are treated. Slender wings with sharp leading edges can operate up to quite high angles of incidence, and hence achieve reasonably high lift coefficients without experiencing strong excitation. F.R.L.

A73-34539 Analysis of meteorological conditions for aviation (Analiz meteorologicheskikh uslovii dlia aviatsii). Edited by K. G. Abramovich. Leningrad, Gidrometeoizdat (Gidrometeorologicheskii Nauchno-Issledovatel'skii Tsentr, Trudy, No. 95), 1972. 64 p. In Russian.

Studies of weather conditions which restrict aircraft landing capabilities are covered. Limited visibility in radiation fog, cloud cover bottom height, turbulence in the troposphere and stratosphere, and aircraft icing are discussed as landing constraints.

V.Z.

A73-34540 # Analysis of visibility conditions during aircraft landing in radiation fog (Analiz uslovii vidimosti pri posadke samoletov v radiatsionnom tumane). Iu. G. Konovalov and M. Ia. Ratsimor. In: Analysis of meteorological conditions for aviation. (A73-34539 17-20) Leningrad, Gidrometeoizdat, 1972, p. 3-8. 5 refs. In Russian.

Description of a procedure for calculating the slant visibility range of ground objects when the atmosphere transparency varies with altitude. The method is applied to a two-layer atmosphere containing a radiation fog layer and a more transparent layer on top of it. Errors which could handicap the pilot during landing in fog when ground object detection was made at a high altitude at a large angle to horizon are discussed. V.Z.

A73-34545 # Icing conditions of modern transport aircraft according to cruise flight data (Ob usloviiakh obledeneniia sovremennykh transportnykh samoletov po dannym reisovykh poletov). O. K. Trunov and S. P. Khachatrian. In: Analysis of meteorological conditions for aviation. Leningrad, Gidrometeoizdat, 1972, p. 44-50. In Russian.

Statistical analysis of the occurrence of icing recorded by Soviet airliners on international flights from Moscow. Air temperature, flight altitude, cloud types, and season, as factors of icing, and icing zone extents and icing intensities are discussed. V.Z.

A73-34546 # The permissible scale of spatial averaging of geopotential values in the stratosphere when the impact of wind on the flight of a supersonic aircraft is taken into account (O dopustimom masshtabe prostranstvennogo osredneniia znachenii geopotentsiala v stratosfere pri uchete vliianiia vetra na polet sverkhzvukovogo samoleta). S. V. Solonin and G. I. Mazurov. In: Analysis of meteorological conditions for aviation. Leningrad, Gidrometeoizdat, 1972, p. 51-59. In Russian.

Analysis of the impact of wind variations in the stratosphere on the assigned flight trajectory of a supersonic transport aircraft at prescribed altitudes. Simulated flight data at different supersonic speeds on an isobaric surface of 100 mb are used in the estimation of permissible averaging scales for baric field values vs airspeed. The range of permissible geopotential averaging scales which provide an adequate flight precision for supersonic transport aircraft is assessed. V.Z.

A73-34601 International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Symposium sponsored by the Instrument Society of America. Edited by B. Washburn (California, University, Los Alamos, N. Mex.). Pittsburgh, Pa., Instrument Society of America (Instrumentation in the Aerospace Industry. Volume 19), 1973. 301 p. Members, $15; nonmembers, $18.

New developments in measurement instrumentation and procedures are described in papers dealing with aircraft engine testing, air traffic control, space vehicle measurements, in-flight monitoring equipment, automotive safety testing, and monitoring of the environment. Design, construction, and calibration aspects are discussed for various types of equipment, including a satellite IR temperature profile radiometer, solid-state sensors for flight control measurements, reentry-vehicle heat shield thermodynamic instrumentation, impact gauges for meteoroid detection, differential temperature sensors for aircraft engine fluids, microwave landing systems, wake vortex sensing equipment, and a digital strobe control system for model helicopter testing.

T.M.

A73-34603 High reliability solid state force sensors for flight control systems. R. D. Palfreyman (Bendix Corp., Teterboro, N.J.) and A. N. Waldman (Kulite Semiconductor Products, Inc., Ridgefield, N.J.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 49-57.

A novel solid-state force sensor employed in the flight control systems for the Douglas DC-10 and the Lockheed S-3A uses a design approach that insures high reliability. This paper deals with specially designed flight control levers that detect pilot's force effort in roll and pitch directions. Two full 4-arm semiconductor strain gage bridges are applied for each channel (axis) to insure redundancy within a severely restricted space, eliminating the need for complex linkages and electrically noisy motion sensors. A description of the techniques used for gage selection, gage installation, wiring and testing is also included. (Author)

A73-34604 Performance measurements of aircraft electrical systems having highly distorted voltage and current waveforms. D. M. Brockman, L. H. Eccles, and G. E. Klos (Boeing Co., Seattle, Wash.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 59-62.

Measuring the performance of aircraft electrical systems having highly distorted voltage and current waveforms is possible using solid state devices and analog computer techniques. These measurements involve accepting definite conditions of the generator system and the instrumentation environment and using two types of active devices, multipliers, and operational amplifiers. In describing the instrumentation system, consideration is given to measuring real power, rms current, rms voltage, harmonic content, frequency modulation, average frequency, amplitude modulation, and to calibration procedures. (Author)

A73-34607 Differential temperature measurements in aircraft engine fluids. L. H. Eccles and W. F. Rubart (Boeing Co., Seattle, Wash.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 109-111.

In aircraft testing, it has been difficult to accurately determine small differential temperatures in mediums such as engine oils and aircraft fuels which may vary in temperature over several hundred degrees. A new method of measuring this temperature with an electronic circuit utilizing platinum probes is presented which is capable of measuring temperature differentials as low as 2.5 C. This

method utilizes two platinum element probes connected in series driven by a constant current generator. An electronic circuit holds the midpoint of the probes at virtual ground minimizing common mode voltages across the probes. A differential amplifier provides an output proportional to the differential temperature. The mismatching and nonlinearity of the platinum sensors is compensated. Voltage sensed across one probe provides an output proportional to the temperature of the medium. (Author)

A73-34609 Pressure measurements for establishing inlet/engine compatibility. W. C. Eggers (McDonnell Aircraft Co., St. Louis, Mo.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 123-128.

During the development of a sophisticated aircraft propulsion system, the compatibility of the engine with the variable geometry inlet must be verified. This must be accomplished early in a development program. A series of full scale inlet/engine wind tunnel tests was performed on a McDonnell Aircraft Company F-15 Fighter Aircraft propulsion system. An instrumented inlet duct and engine, configured like those in the flight test vehicle, were used as the test article. Measurement of the pressure interface between the engine and duct was accomplished by using an engine face rake. This paper discusses calibration, data acquisition, and data reduction associated with the instrumentation system used with the face rake. (Author)

A73-34610 A performance data acquisition and analysis system for turbine engine component testing. R. E. Gorton (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 129-135.

Over a period of years, compressor, burner, and turbine development test stands were equipped with data logging systems for recording automatically all the pressures and temperatures required for performance calculations. More recently these existing systems, plus some new ones, have been integrated into a computer-oriented central system. This provides on-line processing of the data and presents the analytical results promptly to the test operator. This integrated system is described. Emphasis is on the requirements of the user and how they have been satisfied, rather than on details of the hardware. Built-in checking and calibration features important to assurance of accuracy are described. (Author)

A73-34611 The microwave landing system /MLS/ development program. S. Everett (FAA, Microwave Landing System Branch, Washington, D.C.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 137-145.

Background information is presented that reviews the history of present landing systems, discusses the need for a microwave landing system (MLS), and describes the chronology of events culminating in the formulation of the national plan for development of the MLS. This is followed by a summary of the development program, including program objectives, system description, and outline of major program activities. Finally, a status report is presented that briefly describes the results of the completed program phase and planned accomplishments in the current program phase. (Author)

A73-34612 From ATCRBS to DABS/ADL. R. M. Buck (FAA, Communications Div., Washington, D.C.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 147-152. 5 refs.

As the ATC radar beacon system environment changed due to the increasing number of interrogators and transponders, so did the aircraft position sensor requirements change due to the transition from a manual toward an automated ATC system. A concept evolved that championed discrete addressing in order to minimize the ATCRBS problem of decoding garbled messages caused by the simultaneous or near simultaneous receipt of two or more messages. Included in this paper are (1) the status of this evolving discrete address beacon system and data link (DABS/ADL), (2) the program schedule for the foreseeable future, and (3) a brief overview of possible interfaces with other parts of the ATC system. (Author)

A73-34613 Wake vortex sensing, processing and display. K. F. Bierach (FAA, Systems Research and Development Service, Washington, D.C.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 153-164. 15 refs.

The FAA has embarked upon a program to develop a wake vortex avoidance system (WVAS) to permit airport operations to function at optimum capacity commensurate with safety requirements. Computer modeling has identified a system concept based upon vortex prediction and detection in a closed-loop configuration. In concept, the vortex position, in defined arrival and departure corridors, is predicted from existing and projected meteorological conditions. The vortex movement is sensed within specified vertical scan planes to update this prediction. Aircraft arrivals or departures are then scheduled according to the prevailing vortex predictions and knowledge of the aircraft involved. This paper describes the system concept and potential techniques that are available to satisfy the sensor, data processing, and display subsystem requirements. (Author)

A73-34614 FAA Omega/VLF navigation development program. G. H. Quinn (FAA, Washington, D.C.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 165-168.

This paper describes fundamentals of aircraft navigation with very low frequency (VLF) signals, and the VLF development projects sponsored by the Federal Aviation Administration (FAA) Systems Research and Development Service. Included as techniques are navigation with Omega signals and with VLF communications signals. Present VLF airborne equipment evaluations included are those of the Northrop AN/ARN-99 Omega system, and the Global Navigation, Inc. GNS-200 system. Nearing completion is an investigation of Omega signals as received in Canada, including those traversing the Greenland ice cap; and an analysis of the potential operational significance of propagation modal effects on Omega signals. Planned projects include evaluations of differential Omega, 3.4 kHz difference frequency Omega, and advanced techniques which use unique frequency VLF signals from each VLF transmitter. (Author)

A73-34615 Exhaust emissions analysis system for aircraft gas turbine engines. N. Harvey, W. P. Houben, M. B. Johnston, and G. S. Turner (Beckman Instruments, Inc., Fullerton, Calif.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings.
Pittsburgh, Pa., Instrument Society of America, 1973, p. 179-186.

Test procedures recently specified for determining aircraft exhaust emission levels require continuous sampling-analysis systems, including infrared, flame ionization, and chemiluminescence analyzers. The present work summarizes proposed government emission standards and test procedures, and describes a sampling system for gas turbine engines that exceeds the government

requirements. The analyzer and indicator systems are outlined, and tables show performance specifications in terms of linearity, repeatability, and response speed. T.M.

A73-34622 A digital strobe control system for model helicopter testing. J. F. Devlin (Boeing Vertol Co., Philadelphia, Pa.). In: International Aerospace Instrumentation Symposium, 19th, Las Vegas, Nev., May 21-23, 1973, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1973, p. 253-261.

The Digital Slip Sync Strobe/Camera Control System (DSSS/CCS) has been designed and built specifically to aid in the testing of powered wind tunnel helicopter models. This completely solid-state control system employs many of the features of other systems together with unique features of its own. Front-panel controls allow changing from a single to multiple image which can be used to track the tip path of blades on rotor models having from two to six blades. Positioning of the image can either be performed manually or by slipping at a rate proportional to the input frequency. The Digital Slip Sync Strobe/Camera Control System features a design to control four strobe lights sequentially, thus raising the upper frequency limit of a strobe system. This system is useful in any test system that can provide the required input pulses and can be used in conjunction with still photography or pulse photography to obtain valuable information about the system under test. (Author)

A73-34651 Status of international noise certification standards for business aircraft. R. L. Paullin (U.S. Department of Transportation, Washington, D.C.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730286.* 7 p. 7 refs. Members, $1.25; nonmembers, $2.00.

A73-34652 Progress in the development of optimally quiet turboprop engines and installations. R. N. Tedrick and R. W. Heldenbrand (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730287.* 14 p. Members, $1.25; nonmembers, $2.00. USAF-sponsored research.

A73-34653 New low-pressure-ratio fans for quiet business aircraft propulsion. F. B. Metzger and R. Worobel (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730288.* 12 p. 11 refs. Members, $1.25; nonmembers, $2.00.

A73-34654 'Quiet' aspects of the Pratt & Whitney Aircraft JT15D turbofan. J. C. Plucinsky (United Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730289.* 8 p. 12 refs. Members, $1.25; nonmembers, $2.00.

Description of the engine design details of the Pratt & Whitney JT15D-1 engine as related to noise generation. Design principles and factors contributing to the very low-noise levels on the Cessna Citation aircraft are illustrated. Noise testing experiences and data from static tests on the United Aircraft of Canada Ltd. flight test aircraft and from both static and flight tests on the Citation aircraft are discussed. Lessons learned from these tests and some future probabilities are outlined. (Author)

A73-34657 FAA General Aviation Crashworthiness Program. A. F. Madayag (FAA, Washington, D.C.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730293.* 10 p. 8 refs. Members, $1.25; nonmembers, $2.00.

A73-34658 Wake turbulence and its elimination. J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730294.* 7 p. 16 refs. Members, $1.25; nonmembers, $2.00.

The results of a detailed wind tunnel study of the structure of the trailing vortex to distances of 30 chord lengths downstream of the wing are reported. Five different means of reducing the dangerous high-swirl velocities in a vortex are described, and their effects on the wake are illustrated. The effects of these possible vortex 'fixes' on the wing itself, as well as the possibility of using these or other devices to accelerate the dissipation of wake turbulence, are discussed. It is concluded that vortex dissipation within 20 to 30 chord lengths downstream of the generating wing will be possible in the very near future. (Author)

A73-34659 Flight test studies of the formation and dissipation of trailing vortices. H. Chevalier (Texas A & M University, College Station, Tex.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730295.* 10 p. Members, $1.25; nonmembers, $2.00. Army-supported research.

A73-34660 Aircraft-vortex penetration. R. C. Nelson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and B. W. McCormick (Pennsylvania State University, University Park, Pa.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730296.* 11 p. 11 refs. Members, $1.25; nonmembers, $2.00.

During the past several years the problem of wake turbulence has received considerable attention. As a result of research programs sponsored by the Federal Government and private industry, the hazard of wake turbulence to light aircraft has been well documented. In this paper it is emphasized that relatively large aircraft can also be susceptible to vortices generated by large jet transports. This conclusion is based upon a review of accident records and the results from a computer simulation of the aircraft-vortex interaction. The computer simulation consists of the equations of motion with six degrees of freedom as well as control input by the pilot. Procedures are recommended for avoiding dangerous vortex encounters. (Author)

A73-34661 Some effects of camber on swept-back wings. M. H. Snyder, Jr. (Wichita State University, Wichita, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730298.* 12 p. 19 refs. Members, $1.25; nonmembers, $2.00.

The effects of camber of airfoil sections and wings on the pitching moment coefficient (Cm) and on lift coefficient are examined. Except for changes in Cm caused by the wing planform, not-so-slender wings behave similarly to be airfoil sections. The effects of wing planform geometry, however, often overpower the section characteristics. This is particularly true of slender wings with their highly cambered sections which may have multiple sets of coronet vortices. Wind tunnel tests are compared with the tests of Nangia and Hancock to investigate the mechanism of vortex lift on a cambered wing. (Author)

A73-34662 Electric trim systems - Design and certification considerations under FAR 23.677 /CAM 3.337-2/. J. L. Irwin and H. W. Holdeman (Edo Corp., Mineral Wells, Tex.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730299.* 18 p. 13 refs. Members, $1.25; nonmembers, $2.00.

The FAA uses the Federal Aviation Regulations (FARs) as the criteria for the approval and certification of all aircraft and appliance designs. In addition to assuring that systems will perform their

intended function, the FARs attempt to maximize safety and utility. Recent changes in the official interpretation of the Regulations have caused changes in the performance and certification procedures of electric trim systems. An understanding of these changes is essential for anyone working in the design and/or certification of these systems. (Author)

A73-34663 **What is your altitude.** S. R. Teigland (Bendix Corp., Southfield, Mich.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730301.* 5 p. Members, $1.25; nonmembers, $2.00.

Description of the development and design of an altimeter capable of generating the proper coded altitude information for mode-C transmission by a transponder to an automated radar terminal system (ARTS). Emphasis is placed on the rotating pointer and subdial display on a light-modulating commutator disk used to generate the altitude code signals. T.M.

A73-34664 **Control-configured general aviation aircraft.** F. H. Lutze and E. M. Cliff (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730303.* 10 p. 10 refs. Members, $1.25; nonmembers, $2.00.

The concept of designing general aviation aircraft to take advantage of recent advances in control technology is presented. Particular attention is paid to relaxing the inherent static stability requirements of the airframe and assuming that stability can be maintained by the control system. As an example, the longitudinal static stability of a typical twin-engine business aircraft is considered. It is shown that the horizontal tail area can be reduced 60% by considering only longitudinal control requirements. This reduction in tail area leads to improvements in the selected performance parameters of range, rate of climb, and maximum level speed. In addition, it is shown that there is more freedom in center of gravity position with the aft limit determined by control power requirements rather than by the usual static stability requirement. (Author)

A73-34665 * **Separate surfaces for automatic flight controls.** J. Roskam (Kansas, University, Lawrence, Kan.), M. R. Barber, and P. C. Loschke (NASA, Flight Research Center, Edwards, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730304.* 13 p. 11 refs. Members, $1.25; nonmembers, $2.00.

The purpose of this paper is to describe an investigation of separate surface stability augmentation systems for general aviation aircraft. The program objective were twofold: first, a wind tunnel program to determine control effectiveness of separate surfaces in the presence of main surfaces, and hinge moment feedback from separate surfaces via the main surfaces to the pilot; second, a theoretical study to determine the minimum performance of actuators and sensors that can be tolerated, the best slaving gains to be used with separate surfaces, and control authority needed for proper operation under direct pilot control, under autopilot control, and in failure situations. On the basis of the results obtained, it has been concluded that separate surface systems are feasible and advantageous for use in general aviation aircraft. (Author)

A73-34666 **Automated prediction of light aircraft performance and riding and handling qualities.** F. O. Smetana, D. C. Summey, and W. D. Johnson (North Carolina State University, Raleigh, N.C.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730305.* 12 p. Members, $1.25; nonmembers, $2.00.

A73-34667 **Use of honeycomb and bonded structures in light aircraft.** A. C. Marshall and J. Brentjes (Hexcel Corp., Dublin, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730307.* 8 p. Members, $1.25; nonmembers, $2.00.

Discussion of the state of the art and prospects in the application of various honeycomb and bonded materials in light aircraft structures. Metal-to-metal joints, fiberglass laminates, and honeycomb sandwich are indicated as component materials providing a substantial freedom and versatility in aircraft designs. It is pointed out that particular care is needed regarding low cost requirements, minimum rate of rejects, and maximum service life when these materials are used. V.Z.

A73-34668 **Stepped aluminum extrusions - Designing for business aircraft.** E. C. Sundberg (Kaiser Aluminum and Chemical Corp., Oakland, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730308.* 16 p. 5 refs. Members, $1.25; nonmembers, $2.00.

A73-34669 **How to be healthy, wealthy and wise through fastening analysis - The 'how to' of living with fasteners.** W. H. Trembley (VSI Corp., Culver City, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730309.* 13 p. Members, $1.25; nonmembers, $2.00.

A73-34670 **Development of a lower cost radome.** J. Peck (Cessna Aircraft Co., Wichita, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730310.* 6 p. Members, $1.25; nonmembers, $2.00.

By use of new materials and processes, a new radome was developed which was less costly, more rigid, and lighter in weight than previous models. This was accomplished by inplant fabrication, autoclave cure, and use of thin honeycomb core. In describing the development of the new radome, the author presents design objectives, evaluates various material possibilities, and explains the selection of materials in the final structure. Treatment of the outside surface of the radome is also described. Finally, the fabrication process is discussed in detail. (Author)

A73-34671 **Filiform corrosion associated with commonly applied aircraft metal pretreatments and finishes.** M. Gann (Cessna Aircraft Co., Wichita, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730311.* 10 p. Members, $1.25; nonmembers, $2.00.

A73-34673 **VLF radio navigation.** J. A. Wilson. *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730313.* 8 p. 11 refs. Members, $1.25; nonmembers, $2.00.

The fundamentals of radio navigation are reviewed together with the propagation characteristics of the VLF portion of the radio spectrum and the historical background of present-day VLF navigation systems. Features and performance of the Omega system and the Global Navigation System are compared to illustrate the current state of the art, and developments which can be reasonably expected in the future are discussed. T.M.

A73-34674 **Weathervision memory radar system.** R. W. Thwing, Sr. (Bendix Corp., Southfield, Mich.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730316.* 8 p. 14 refs. Members, $1.25; nonmembers, $2.00.

A new concept in commercial airborne weather radars was developed for the turbo and pure jet-powered general-aviation aircraft. This radar presents a steady, nonfading weather or ground picture, without using the conventional direct-view storage tube, by utilizing digital processing techniques. Careful treatment of the radar design parameters allows 200 nautical mile range operation while only requiring a few amperes of 28 V dc from the aircraft power bus. These techniques are being applied to a family of radar systems. (Author)

A73-34675 * NASA in general aviation research: Past - present - future. R. L. Winblade (NASA, Washington, D.C.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730317.* 57 p. 49 refs. Members, $1.25; nonmembers, $2.00.

The history of aeronautical research efforts within NACA/NASA is briefly traced to identify the foundation for the current NASA general aviation technology programs. Future program trends are discussed in general terms emphasizing relevance to the industry requirements. An appendix summarizes the research reports that have been generated under the current program. (Author)

A73-34676 * Applications of advanced aerodynamic technology to light aircraft. H. L. Crane, R. J. McGhee (NASA, Langley Research Center, Hampton, Va.), and D. L. Kohlman (Kansas, University, Lawrence, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730318.* 25 p. 7 refs. Members, $1.25; nonmembers, $2.00.

This paper discusses a project for adapting advanced technology, much of it borrowed from the jet transport, to general aviation design practice. The NASA funded portion of the work began in 1969 at the University of Kansas and resulted in a smaller, experimental wing with spoilers and powerful flap systems for a Cessna Cardinal airplane. Some flight data and research pilot comments are presented. The project was expanded in 1972 to include a light twin-engine airplane. For the twin there was the added incentive of a potential increase in single-engine climb performance. The use of a new high-lift Whitcomb airfoil is planned for both the wing and the propellers. Preliminary data on the characteristics of the new airfoil are discussed. The configuration of an experimental wing for a Piper Seneca PA-34 and estimated airplane performance with this wing are discussed. (Author)

A73-34677 * Development of airframe design technology for crashworthiness. E. T. Kruszewski and R. G. Thomson (NASA, Langley Research Center, Hampton, Va.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730319.* 4 p. Members, $1.25; nonmembers, $2.00.

This paper describes the NASA portion of a joint FAA-NASA General Aviation Crashworthiness Program leading to the development of improved crashworthiness design technology. The objectives of the program are to develop analytical technology for predicting crashworthiness of structures, provide design improvements, and perform full-scale crash tests. The analytical techniques which are being developed both in-house and under contract are described, and typical results from these analytical programs are shown. In addition, the full-scale testing facility and test program are discussed. (Author)

A73-34678 * Stall/spin studies relating to light general-aviation aircraft. J. S. Bowman, Jr. and S. M. Burk, Jr. (NASA, Langley Research Center, Hampton, Va.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730320.* 15 p. Members, $1.25; nonmembers, $2.00.

The present paper discusses the NASA Langley Research Center stall/spin research program to improve the design and the evaluation techniques relative to stall/spin characteristics of general-aviation aircraft. The program encompasses model wind-tunnel tests, spin-tunnel and radio-control model tests, and full-scale airplane spin tests. Initial spin-tunnel results on models with several tail designs representative of light airplanes and several testing techniques are discussed. (Author)

A73-34679 * Application of advanced control system and display technology to general aviation. M. R. Barber (NASA, Flight Research Center, Edwards, Calif.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730321.* 12 p. 20 refs. Members, $1.25; nonmembers, $2.00.

A73-34680 * Shrouded fan propulsors for light aircraft. M. H. Waters, T. L. Galloway (NASA, Advanced Concepts and Missions Div., Moffett Field, Calif.), C. Rohrbach, and M. G. Mayo (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730323.* 20 p. 11 refs. Members, $1.25; nonmembers, $2.00.

Continued growth of general-aviation over the next 10-15 years is dependent upon continuing improvement in aircraft safety, utility, performance, and cost. An attractive, compact, low-noise propulsor concept, the Q-FAN, when matched to reciprocating or rotary combustion engines, opens up the exciting prospect of new, cleaner airframe designs for the next generation of general-aviation aircraft, which will provide these improvements and meet the expected noise and pollution restrictions of the 1980 time period. In this paper, Q-FAN propulsion system performance, weight, noise, and cost trends are discussed. The impact of this propulsion system on the complete aircraft is investigated for two representative aircraft size categories. Examples of conceptual designs for Q-FAN/engine integration and aircraft installations are presented. (Author)

A73-34681 The development of reciprocating engine installation data for general aviation aircraft. F. Monts (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730325.* 11 p. Members, $1.25; nonmembers, $2.00.

A73-34682 Some aspects of STOL aircraft aerodynamics. J. L. Loth (West Virginia University, Morgantown, W. Va.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730328.* 8 p. 11 refs. Members, $1.25; nonmembers, $2.00. Contract No. N00014-68-A-0512.

STOL aircraft obtain their unique performance by incorporating in their design any one or all of three design aspects: increase of the powerplant size to minimize the weight-to-thrust ratio, increase of the wing area to reduce the wing loading, and/or increase of the maximum obtainable lift coefficient. A special powered STOL light aircraft wing has been developed at West Virginia University. This wing combines several STOL features such as: circulation control through blowing around a circular trailing edge, boundary layer control through suction, leading edge modification and slats, 20% increase in chord length in the STOL mode, blown and drooped ailerons, and fences for maximum spanwise lift distribution. The wing design features and anticipated performance are described. (Author)

A73-34683 Feasibility and optimization of variable-geometry wing for jet amphibian business aircraft. D. J. Ritchie (Embry-Riddle Aeronautical University, Daytona Beach, Fla.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730330.* 12 p. Members, $1.25; nonmembers, $2.00.

A73-34684 * Development of a low-cost flight director system for general aviation. S. W. Gee (NASA, Flight Research Center, Edwards, Calif.) and N. A. Servais (Astronautics Corporation of America, Milwaukee, Wis.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730331.* 10 p. 10 refs. Members, $1.25; nonmembers, $2.00.

A73-34685 * Computer aided parametric analysis for general aviation aircraft. T. L. Galloway and M. H. Waters (NASA, Advanced Concepts and Missions Div., Moffett Field, Calif.). *Society*

of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730332. 14 p. 14 refs. Members, $1.25; nonmembers, $2.00.

A73-34686 A stall/spin prevention device for general-aviation aircraft. H. Chevalier and J. C. Brusse (Texas A & M University, College Station, Tex.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730333.* 8 p. Members, $1.25; nonmembers, $2.00. Army-supported research.

Stall/spin airplane accidents result in a significant number of fatalities each year within the general-aviation community. The most effective method of reducing this type of accident is to prevent airplane stalls. The device described in this report has been shown to be effective in preventing stall of a Piper PA-18, 150 airplane, and it should also be effective on other airplanes. The system incorporates a small spoiler mounted on the under surface of the stabilizer near the elevator hinge line. The spoiler is deployed automatically by means of a servo system that receives its commands from an angle of attack tensor mounting in the wing leading edge. Thus, the operation of the system is independent of pilot reactions. The spoiler deploys to limit tail power near the wing stall angle of attack, thereby preventing the wing from reaching the angle of attack required for stalling. (Author)

A73-34689 Structural cost effectiveness of composites. C. W. Bert and K. H. Bergey (Oklahoma, University, Norman, Okla.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730338.* 12 p. 26 refs. Members, $1.25; nonmembers, $2.00.

This paper describes a rational basis for making tradeoff decisions on cost and weight for structures made of various materials. Unit cost and empty weight data have been gathered for a variety of consumer products and of aircraft. As examples illustrating potential applications of filamentary composites, the cost/weight tradeoff ratios were calculated for three typical aircraft structural components: a landing-gear cantilever-spring strut, an I-beam, and a shear panel. In addition, weight analyses of fuselage structures were made for designs using a variety of materials and these structural concepts: monocoque, sandwich, and ring-and-stringer-stiffened cylinders. (Author)

A73-34690 Composites for noise control. N. Ganesan (Gates Learjet Corp., Wichita, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730339.* 8 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Consideration of the use of composite structures for soundproofing an aircraft. The transmission loss characteristics of a typical aircraft fuselage are discussed, and a number of methods of applying damping to a structural element vibrating during bending are cited. It is shown that the actual wall system in a modern aircraft is more complicated than either a simple panel or a panel with some kind of damping. The findings of Beranek and Work (1949) and Mangiarotty (1963) regarding the damping of flexural waves in composite structures are reviewed. A.B.K.

A73-34691 A comparison of structural test results with predictions of finite element analysis. R. O'Donnell (Gates Learjet Corp., Wichita, Kan.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730340.* 14 p. Members, $1.25; nonmembers, $2.00.

A73-34692 An inexpensive, full-scale aircraft fatigue test system. J. H. Simmons (Piper Aircraft Corp., Lock Haven, Pa.). *Society of Automotive Engineers, Business Aircraft Meeting, Wichita, Kan., Apr. 3-6, 1973, Paper 730341.* 8 p. 8 refs. Members, $1.25; nonmembers, $2.00.

Description of an inexpensive, full-scale, two-channel fatigue test apparatus for light aircraft. The heart of the semiautomatic loading system is a high-quality servo-controller which constitutes a solid-state amplifier that accepts high-level input, single-ended command signals, and low-level, differential input feedback signals from the load cells and generates an output signal to control the servo valve. A.B.K.

A73-34693 Engine cycle considerations for future transport aircraft. R. P. Gerend, J. P. Roundhill, and A. D. Welliver (Boeing Co., Seattle, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730345.* 11 p. 8 refs. Members, $1.25; nonmembers, $2.00.

Recent noise technology advancements have provided an increased understanding of true engine noise 'floor' levels. This has led to changes in necessary engine cycle requirements for low-noise commercial aircraft. Updated prediction techniques for the core and jet noise sources are described, and lining technology improvements are reviewed. The need for further work in the core noise area is emphasized. The impact of these noise technology revisions on the best engine cycle for obtaining low noise is presented. It is concluded that engines with lower bypass ratios than previously anticipated may be acceptable. (Author)

A73-34694 Refanned commercial gas turbine engines. G. M. McRae (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730346.* 8 p. Members, $1.25; nonmembers, $2.00.

A NASA sponsored program to develop noise-reduction modifications for the JT3D and JT8D engines was initiated in August 1972. New higher flow single-stage fans are attractive and result in higher bypass ratios with improved thrust and fuel consumption and reduced jet velocities. Fly-over noise reductions as great as 20 EPNdB are shown for the modified engines with nacelle treatment. Engine certification can be completed and production hardware for fleet retrofit or new aircraft can be provided by late 1975. (Author)

A73-34695 Profitable transport engines for the environment of the eighties. N. Epstein and B. J. Gordon (General Electric Co., Aircraft Engine Group, West Lynn, Mass.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730347.* 13 p. Members, $1.25; nonmembers, $2.00.

A73-34696 B-1 technology applications to advanced transport design. E. O. Schnakenburg (Rockwell International Corp., Aneheim, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730348.* 14 p. Members, $1.25; nonmembers, $2.00.

Several unique design approaches have been used to configure the B-1 strategic bomber. These innovations are applicable to future advanced supersonic transport (AST) design approaches. The combined aerodynamic/structural efficiency of the B-1 is enhanced by using the blended wing/body concept. Structural mode control has been incorporated to alleviate structural motion, because the B-1 will be involved in considerable low-altitude, high-turbulence flying. Application of this system should be considered for the AST to reduce the structural penalties inherent at the high-speed portion of the flight envelope. The B-1 is the first aircraft to be designed to a specified fracture mechanics requirement. Several B-1 subsystem advancements applicable to the AST program scope are discussed. In particular, the B-1's flight control systems incorporate many unique features to enhance its safety, mission success, and survivability/vulnerability characteristics. (Author)

A73-34697 **Second-generation SST.** L. T. Goodmanson and B. Williams (Boeing Commercial Airplane Co., Renton, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730349.* 10 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Discussion of the design objectives and a development cycle for a second-generation supersonic transport. The environmental impact of technological advancement and the rapidly changing economic market produce a wide divergence of possible programs for the 1985 time period. Areas of technological advancement that can move in the direction of the second-generation design objectives will be included. Some of these advances require development of methodology to be able to reduce the technical risk of application to a commercial SST and some require exploratory development. (Author)

A73-34698 **The Concorde manufacturing consortium - An exercise in international engineering collaboration.** E. H. Burgess (British Aircraft Corp., Ltd., Commercial Aircraft Div., Weybridge, Surrey, England). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730350.* 12 p. Members, $1.25; nonmembers, $2.00.

A73-34699 **Introduction of Concorde.** P. Besson (Compagnie Nationale Air France, Paris, France). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730351.* 8 p. Members, $1.25; nonmembers, $2.00.

In 1975, Concorde service will be initiated mainly from Europe to the American continent. Service will then be progressively extended to Africa, Japan, South-East Asia and Australia. By the end of 1975, nine aircraft will be operated by two airlines. The Concorde at Mach 2 will place any point in the world at less than 12 hours from Paris. Operating costs for the Concorde are discussed together with the interior layout, onboard passenger service, passenger and baggage handling at the airports, aircraft maintenance, and crew training. G.R.

A73-34700 **Transport cargo aircraft concepts.** R. C. Hornburg (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730352.* 15 p. Members, $1.25; nonmembers, $2.00.

Some transport cargo aircraft and ground systems concepts which may conceivably satisfy the future market demands are considered. Parameter studies, and takeoff, cruise and landing requirements on which these concepts are based are given an overview. Particular attention is given to the economic constraints which will have to be overcome for attainment of a realistic market potential for this type of aircraft. V.Z.

A73-34701 **Development of the A300B wide-body twin.** A. Howes (European Aerospace Corp., New York, N.Y.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730353.* 14 p. Members, $1.25; nonmembers, $2.00.

The A300B is a wide-body, twin-engined aircraft developed jointly by leading aviation companies throughout Europe and the United States. It has been built for the major intra-European route structures and the short-haul route networks of North America. Engineering of the aircraft maximizes reliability and economy on the exacting short-range operations. The first A300B off the line flew on Oct. 28, 1972, just 3-1/2 years after go-ahead, and by the end of 1972 had flown 98 hr. During 1973, that first aircraft will be joined in flight testing by three others, in a program leading to certification by the end of 1973. Initial deliveries to airlines will be made early in 1974. (Author)

A73-34702 **Key factors in developing a future wide-bodied twin-jet transport.** J. S. Clauss, Jr. (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730354.* 27 p. 5 refs. Members, $1.25; nonmembers, $2.00.

A73-34703 **747 developments.** R. Brown. *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730355.* 12 p. Members, $1.25; nonmembers, $2.00.

Changes in air transport operating environment are examined to show how they are beginning to change the design and use of transport aircraft. The essential requirement of the changing market is seen to be a new flexibility to provide (1) versatility in the quantity of normal on-demand seats provided in each market, (2) suitability for high-capacity seasonal bulk class operations, and (3) suitability for expanding the cargo load capability on selected passenger flights. Aircraft characteristics and advanced technology to satisfy the requirements of the new operating flexibility are discussed. (Author)

A73-34704 **Airtransit - The Canadian demonstration inter-urban STOL service.** R. B. McCormack (Air Canada, Montreal, Canada). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730356.* 11 p. Members, $1.25; nonmembers, $2.00.

Funds have been made available by the Canadian Government for a STOL demonstration program to last approximately two years starting in early 1974. It is to be the initial phase of a major national program to develop a complete STOL air transport system including aircraft, STOLports, navigation aids, air traffic control, regulations, operating procedures, and other supporting services. Using specially modified de Havilland Twin Otter aircraft, the commercial demonstration service will be operated by a subsidiary company of Air Canada between STOLports located near the urban centers of Montreal and Ottawa. (Author)

A73-34705 **STOL in low density operations.** R. A. Ausrotas (MIT, Cambridge, Mass.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730357.* 10 p. 6 refs. Members, $1.25; nonmembers, $2.00.

A discussion of air transportation in low-density areas is presented, with emphasis on STOL operations. Low-density market characteristics in the United States are described, and aircraft suitable for these markets are compared. Some existing STOL operations are reviewed, including the Norwegian STOL services in some detail. It is concluded that a STOL system is an attractive investment in the isolated, low-density areas of the world. (Author)

A73-34706 **Thrust reversers for civil STOL aircraft.** R. H. Colley and J. M. D. Sutton (Rolls-Royce, Ltd., London, England). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730358.* 15 p. Members, $1.25; nonmembers, $2.00.

Assuming future STOL aircraft of 60 to 200 seats, 0.7 to 0.85 cruise Mach number, and landing at around 90 knots on runways down to 2000 ft in length, an examination is made of the need for reversers and what special requirements and constraints will apply. It is concluded that reversers are very likely to be used, both in flight (for descent thrust control) and on the ground. A description is given of a fast-selection control system and several thrust reverser designs, aimed at high performance, low specific weight, compatibility with acoustic and other requirements, and suitability for high bypass engines. (Author)

A73-34707 * Integrated Propulsion Control System program. C. E. Bentz (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and J. R. Zeller (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730359.* 30 p. 14 refs. Members, $1.25; nonmembers, $2.00.

Description of a three-year exploratory research program for the design, development, and flight evaluation of an Integrated Propulsion Control System (IPCS). The primary objectives of this program are to establish through flight test the potential improvements in steady-state and transient propulsion system performance that can be achieved as a direct result of new modes of control, more direct sensing of engine and inlet parameters, and the use of more sophisticated, high-speed digital computation. A F-111 E aircraft with the left inlet and engine modified to the IPCS configuration will be used to conduct the flight evaluation. (Author)

A73-34708 Navy development of low-cost supersonic turbojet engines. D. W. Walker (U.S. Naval Weapons Center, China Lake, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730362.* 8 p. Members, $1.25; nonmembers, $2.00.

In 1971, the Navy started its Supersonic Expendable Turbine Engine (ETE) program to develop the technology required for a low-cost engine capable of flying Mach 1.5 at sea level. The program objectives include the establishment of realistic engine design requirements and specifications for performance, qualification, and acceptance which reflect the intended applications for the engine. The phases of the program plan are discussed together with details of the ETE program status. G.R.

A73-34710 The Air Force/Boeing advanced medium STOL transport prototype. J. J. Foody (Boeing Aerospace Co., Seattle, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730365.* 16 p. Members, $1.25; nonmembers, $2.00.

A73-34711 Technical basis for the STOL characteristics of the McDonnell Douglas/USAF YC-15 prototype airplane. M. D. Marks (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730366.* 7 p. Members, $1.25; nonmembers, $2.00.

A73-34712 Air Force propulsion maintenance concepts. A. B. Richter and L. Matkins (USAF, Logistics Command, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730373.* 6 p. Members, $1.25; nonmembers, $2.00.

Some of the engine maintenance practices the Air Force has used in the past are identified, showing how these practices are being improved to obtain engine on-condition maintenance. Reviews of the Air Force Spectrometric Oil Analysis Program, Nondestructive Inspection Program, and engine diagnostics efforts are presented. (Author)

A73-34713 The development of a turbine engine maintenance program from a new reliability model. T. M. Edwards, Jr. and H. Lew, Jr. (United Air Lines, Inc., Chicago, Ill.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730374.* 12 p. Members, $1.25; nonmembers, $2.00.

A73-34714 Review of engine maintenance concepts applied to wide body jets. J. F. Rudolph (FAA, Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730375.* 8 p. 5 refs. Members, $1.25; nonmembers, $2.00.

In the early design stages of the advanced technology high-bypass-ratio engines, it became evident that maintainability considerations and more effective maintenance concepts would be necessary to achieve higher reliability and more economically successful power plants. The major design considerations are reviewed from a maintainability standpoint, and the concepts developed specifically to provide more effective maintenance for the wide-body jets are described. The effectiveness of these programs is discussed, and an insight is provided into new philosophies and trends envisioned by the Federal Aviation Administration for future maintenance management programs. (Author)

A73-34715 Fundamental aspects of noise reduction from powered-lift devices. R. E. Hayden (Bolt Beranek and Newman, Inc., Cambridge, Mass.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730376.* 43 p. 25 refs. Members, $1.25; nonmembers, $2.00.

Proposed powered-lift STOL aircraft are expected to require noise reductions on the order of 20 dB to meet community noise goals. A review of noise source mechanisms associated with various powered-lift concepts is presented and current state-of-the-art of prediction technology is assessed for each important source. Sources are rank-ordered for the various classes of lift-augmenting concepts. Parametric dependence of source levels on design and operating parameters is discussed. Fundamental concepts for noise reduction are developed, and current progress toward implementation of these noise reduction concepts is reviewed. (Author)

A73-34716 * Status of current development activity related to STOL propulsion noise reduction. R. J. Rulis (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730377.* 15 p. 10 refs. Members, $1.25; nonmembers, $2.00.

The noise goal of 95 PNdB for STOL aircraft imposes severe technology demands on propulsion systems. Effects of this goal on the design of the propulsion system are reviewed. Results from recent development programs associated with STOL noise reduction, such as high bypass fan tests, 25 PNdB acoustic suppression tests, sonic inlets, and powered lift system noise tests, are presented. Integrated propulsion system designs for the blown flap and augmentor wing powered lift systems capable of meeting the noise goal are shown, and the performance, installation, and economic penalties are assessed. (Author)

A73-34717 Design studies of low-noise propulsive-lift airplanes. H. S. Sweet, H. R. Leslie, and J. A. Bennett (Lockheed-Georgia Co., Marietta, Ga.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730378.* 15 p. 11 refs. Members, $1.25; nonmembers, $2.00.

A review is presented of low-noise airplanes designed for operation in the 1980 time period. Aircraft with parametric engines covering a range of fan pressure ratios and noise levels were developed conceptually in connection with the Quiet Clean STOL Experimental Engine Study Program. Powered-lift concepts included externally blown flap, augmentor wing, internally blown flap, and over-the-wing upper surface blowing. Performance, sizing, and costs are described for 148-passenger airplanes with design field length varying from 2000 to 4000 ft. Techniques for reducing noise are evaluated in terms of aircraft performance, weight, and cost. Experimental data on decayer nozzles are presented and assessed with respect to effectiveness in exhaust noise reduction and aircraft performance penalties. Noise footprints for aircraft with different lift concepts and different field length capabilities are discussed from the standpoint of community acceptance of STOL short-haul service at existing carrier airports, general aviation airports, or dedicated new STOL ports. Recommendations are made for further work in development of rational criteria for short-haul noise levels and for areas that hold promise of further noise reduction. (Author)

A73-34718 **An airline view of the future of auxiliary power systems.** J. E. McMillen (Eastern Air Lines, Inc., New York, N.Y.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730379.* 4 p. Members, $1.25; nonmembers, $2.00.

In an effort to relieve some of the environmental and economic pressures placed upon operation of commercial air transport equipment, several future aircraft designs have been discussed which consider in-flight use of the auxiliary power unit (APU). Justification for such a system is logical, considering the depth of analysis conducted to date. But it must be remembered that it is the ultimate consumer, the traveling public, who must be satisfied. There can be no compromise on safety and reliability. Future studies of in-flight use of the APU must take this into account. (Author)

A73-34719 **Advanced aircraft power systems utilizing coupled APU/ECS.** G. J. Amarel and J. G. Castor (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730380.* 11 p. Members, $1.25; nonmembers, $2.00. Contract No. F33615-71-C-1343.

Demonstration that excess power from the environmental control system (ECS) can be used to supplement the power input requirement of the accessory drive gearbox on an advanced strike bomber aircraft. The feasibility of connecting the expansion turbine of the conventional system to the gearbox is discussed. Two methods of attaining a coupled ECS are compared with the conventional system relative to weight, volume, and takeoff gross weight. From evidence presented, it is concluded that a coupled simple-cycle system would be the most advantageous. (Author)

A73-34720 **The role of the auxiliary power unit in future airplane secondary power systems.** K. T. Tanemura and B. C. Hainline (Boeing Commercial Airplane Co., Renton, Wash.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730381.* 12 p. Members, $1.25; nonmembers, $2.00.

A73-34721 **AIRTRANS - Intra-airport transportation system.** A. Corbin, Jr. (LTV Aerospace Corp., Washington, D.C.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730384.* 18 p. Members, $1.25; nonmembers, $2.00.

The AIRTRANS system now under construction at the new Dallas/Fort Worth Airport is truly a complete intra-airport transportation system. It is designed to carry passengers and employees (in separate cars), transport all interline baggage and mail, remove all trash from the terminals to a central dump, and deliver commissary supplies from a common warehouse to the terminals. It is a fully automatic system with guarantees on trip times and mechanical performance. The system contains some 13 miles of guideway within the airport, 68 vehicles plus service vehicles, and a central control point to provide surveillance over the automatic operation. Automatic container handling equipment is also included in the airlines operations area to ease the task of the airlines. (Author)

A73-34722 **JFTOT - A new fuel thermal stability test /A summary of a Coordinating Research Council activity/.** J. A. Bert and L. J. Painter (Chevron Research Co., Richmond, Calif.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730385.* 46 p. Members, $1.25; nonmembers, $2.00.

The Jet Fuel Thermal Oxidation Test (JFTOT) represents another method for rating the deposit-forming tendencies of fuels. The apparatus considered consists essentially of a closed loop fuel system with a heater tube section including a test filter together with associated equipment for controlling and measuring the heater tube temperature. It utilizes the same principle as the ASTM CRC Coker with certain improvements and is expected to be comparable to the Coker in ranking fuels. The advantages of the JFTOT over the Coker include a smaller sample size, shorter test time, easier operation, better tube temperature control, and higher temperature capability. G.R.

A73-34725 * # **A simplified fuel control approach for low cost aircraft gas turbines.** H. Gold (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, National Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper.* 31 p.

Cost reduction in aircraft turbine engines may be obtained through performance reductions that are acceptable for ranges that are considerably shorter than the range for which current and costly engines were developed. Cost reduction in the fuel control for these cost engines must be achieved without significant performance reduction. This paper describes a fuel control approach that appears to meet this requirement and reviews the work that has been performed on it over the past few years. (Author)

A73-34731 **Failure analysis used to vindicate JANTX components.** R. K. Peoples (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: Electronic Components Conference, 23rd, Washington, D.C., May 14-16, 1973, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 349-354.

With increased emphasis on reliability in government contracted systems, more stringent requirements have been placed on semiconductor components, resulting in the MIL-S-19500-JANTX, MIL-S-38510, and MIL-STD-883 specifications. These specifications add processing and power conditioning to 100% of the components in a lot submitted for acceptance as a JANTX type prior to inspection tests to verify Lot Tolerance Percent Defective (LTPD). The post mortem examination of JANTX component rejection occurring during the various stages of test in the manufacturing of an airborne electronics system has shown that the failures were mainly associated with circuit design, manufacturing, and test problems, and these were resolved through appropriate corrective action. Analysis of these failures played a central role in determining the most effective corrective action, and in verifying that the corrective action had achieved the desired result. F.R.L.

A73-34801 # **The history of reinforced plastics in aerospace applications.** L. N. Phillips (Royal Aircraft Establishment, Farnborough, Hants., England). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 11 p. 34 refs.

The use of phenol-formaldehyde resins to obtain strong laminates is considered together with the employment of cellulose, work with asbestos, and the development of glass/polyester materials. Developments in design methods and fabrication technology for military equipment proceeded parallel to research of a purely chemical nature. Studies of whiskers are also discussed along with the production of boron and similar multiphase fibers, the development of an oriented continuous carbon fiber, and research on materials utilizing novel resin matrices. G.R.

A73-34806 **The behaviour of reinforced plastics under rain erosion conditions.** A. A. Fyall and R. B. King (Royal Aircraft Establishment, Farnborough, Hants., England). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 13 p. 23 refs.

The problem of rain erosion of reinforced plastics is defined. Problem areas are delineated, and practical applications are reviewed. Test procedures and parameters and the erosion characteristics of this class of materials are discussed, including effects of velocity, angle of impact, intensity of rainfall, and drop size. Protective techniques such as aerodynamic breakup and the use of energy-absorbent coatings, including the detailed effects of thickness and adhesion are presented. Temperature effects are briefly mentioned, and conclusions are drawn as to the role of reinforced plastics under such environmental conditions. (Author)

A73-34813 # **Propeller and turbine engine fan blades from glass and carbon reinforced plastics.** J. G. Russell (Dowty Rotol, Ltd., Gloucester, England). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 18 p.

Two totally different types of reinforced plastic propeller blade have been developed, and operating experience has been obtained on civil and military hovercraft. One type of blade features a glass fiber reinforced plastic (GFRP) foam filled monocoque construction, fitted over a metal bell at the root. The other, a hollow spar, primarily of carbon reinforced plastic, with a wedge type joint to a metal root, and with a shell of GFRP to provide the airfoil contour. Small solid CFRP fan blades with a wedge type root have been developed and used successfully in six different variable-pitch test rig applications, running at high tip speeds and high loadings. Details of the development of these different types of blade and the experience obtained with them are given. (Author)

A73-34814 # **Successful use of composites in aircraft.** G. Lubin, A. August, and S. Dastin (Grumman Aerospace Corp., Bethpage, N.Y.). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 19 p.

The major advanced filamentary composites being presently considered for aircraft structures are boron/epoxy and graphite/epoxy. The use of fiberglass in aircraft has now reached a stage where it can be considered an economical method of construction and a reliable and reproducible product. It has successfully replaced aluminum for aircraft secondary structures and is unique for radome applications. There are three basic types of composites used for aircraft applications: sandwich construction with either honeycomb or foam core, sheet-stringer construction with bonded or riveted reinforcements, and filament-wound, shell-type construction. Boron/epoxy material manufacture and inspection, boron/epoxy composite structure, and graphite/epoxy composite structures are discussed in detail. Probably the greatest advantage of boron/epoxy and graphite/epoxy composites over metal is their superior fatigue resistance. F.R.L.

A73-34815 # **The successful use of composites in the L-1011 TriStar commercial transport.** D. R. Paschal (Lockheed-California Co., Burbank, Calif.). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 15 p.

The development of composites for use in the L-1011 TriStar has been primarily concerned with a new organic fiber, PRD-49. Over a period of four years it has been determined that layup and cure procedures are basically the same as those for fiberglass. Drilling, countersinking, and trimming of laminates require new manufacturing techniques. A series of parts have been produced under a NASA sponsored program and are undergoing a five-year service evaluation. As a result, PRD-49 has been incorporated into the L-1011 for production units, and additional applications are being evaluated. (Author)

A73-34816 # **Applications and concepts for the incorporation of composites in large military transport aircraft.** L. W. Lassiter (Lockheed-Georgia Co., Marietta, Ga.). *Plastics Institute, Conference on Reinforced Plastics in Aerospace Applications, London, England, Apr. 5, 6, 1973, Paper.* 39 p.

A summary of conventional composite applications to large transports is given, showing an easy transition of advanced composites into secondary structure. Company-funded and contractual programs for the development of secondary structures, and later primary structures, are discussed. Design concepts for wing and fuselage components, utilizing both all composite and composite reinforcement, are presented. An evolutionary account of composite materials in large transports is given. The relative ease of transition from conventional composites to advanced composites is shown from flight experience with C-5A leading edge slats and design studies for commercial transports. (Author)

A73-34817 **Annual Simulation Symposium, 5th, Tampa, Fla., March 8-10, 1972, Record of Proceedings.** Edited by K. W. Gohring, N. D. Swain, and R. L. Sauder. New York, Gordon and Breach, Science Publishers, Inc. (Progress in Simulation. Volume 2), 1972. 370 p. $19.75.

Simulation of a surface traffic control system for an airport is discussed together with aspects of behavioral simulation, the simulation of the compounder in a single base propellant process, and questions of visual scene simulation with computer generated images. Other subjects considered include digital discrete simulation languages, the simulation of airport traffic flow with interactive graphics, warehouse network planning using digital simulation, and a railroad car scheduling system incorporating simulation. An interactive method for simulating a computer time sharing network is also examined along with the simulation of a component inventory maintenance system. G.R.

A73-34818 **Simulation of a surface traffic control system for John F. Kennedy International Airport.** S. P. Aranoff (LFE Corp., Waltham, Mass.) and F. D. D'Alessandro (Computer Sciences Corp., Los Angeles, Calif.). In: Annual Simulation Symposium, 5th, Tampa, Fla., March 8-10, 1972, Record of Proceedings. New York, Gordon and Breach, Science Publishers, Inc., 1972, p. 1-15.

When defining aircraft capacity, other factors in addition to runways have to be taken into account. Consideration must be given to the interrelationship between runways, taxiways, and terminal structure. After landing, the pilot on the way to a terminal is guided at each taxiway intersection by a computer-controlled surface traffic control system. The effectiveness of this system is verified with the aid of a simulation model. G.R.

A73-34820 **Visual scene simulation with computer generated images.** W. M. Bunker (General Electric Co., Daytona Beach, Fla.). In: Annual Simulation Symposium, 5th, Tampa, Fla., March 8-10, 1972, Record of Proceedings. New York, Gordon and Breach, Science Publishers, Inc., 1972, p. 91-114. 5 refs.

Computed image techniques are almost completely unconstrained in absolutely realistic simulation of any dynamics and in the flexibility of the response of a scene to simulation or training events. System requirements are considered, taking into account a computer generated runway scene with simulation of heavy fog, the field-of-view, the number of channels, resolution, color or black-and-white, the number of moving objects, and questions of scene detail. Aspects examined in connection with a discussion of the computational system include an environment definition, a view window definition, problems of environment preselection, channel assignment, priority determination, and scan-line rate functions. G.R.

A73-34821 **Simulation of airport traffic flows with interactive graphics.** F. P. Testa, W. T. James, Jr. (IBM Corp., Federal Systems Div., Washington, D.C.), and W. G. Barker (U.S. Department of Transportation, Washington, D.C.). In: Annual Simulation Symposium, 5th, Tampa, Fla., March 8-10, 1972, Record of Proceedings. New York, Gordon and Breach, Science Publishers, Inc., 1972, p. 143-165. 18 refs. U.S. Department of Transportation Contract No. TSC-169.

This paper discusses the Airport Surface Traffic Simulator (ASTS) which was developed to aid in studying the airport surface capacity problem. ASTS consists of a general airport surface model, interactive graphics displays, and an interface between the model and the graphics. The model includes landing, taking off, taxiing, and gate activity. Graphics allows review and modification of model input, dynamic review of model progress, and periodic reports of model status. (Author)

A73-34822 **PLANET scheduling algorithms and their effect on availability.** J. E. Barker (Honeywell, Inc., Minneapolis, Minn.). In: Annual Simulation Symposium, 5th, Tampa, Fla., March

8-10, 1972, Record of Proceedings. New York, Gordon and Breach, Science Publishers, Inc., 1972. p. 215-222. 7 refs.

Methods of determining availability through modeling techniques are described, giving attention to the use of a large-scale generalized simulation model (PLANET). The determination of the availability of a postulated Army helicopter is considered. Three scheduling algorithms are discussed along with their effects on several definitions of availability. It is found that a single definition of availability does not yield a total picture of system behavior. The scheduling policy used with a system definitely affects the availability exhibited by that system. G.R.

A73-34848 # **Jet fuel specifications.** L. Gardner and R. B. Whyte (National Research Council, Fuels and Lubricants Laboratory, Ottawa, Canada). *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin,* no. 1, 1973, p. 21-34.

Various military and civil jet fuel specifications are compared and their differences noted, particularly with reference to different types of additives which are used on a mandatory or optional basis. Specification test procedures and their importance in relation to limits are discussed and the increased complexity of quality control over the years since the first jet fuel specifications is noted. (Author)

A73-34849 # **VLF navigation development at NAE.** C. D. Hardwick (National Aeronautical Establishment, Ottawa, Canada). *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin,* no. 1, 1973, p. 35-43.

The advantage of VLF over other types of radio navigation is that with relatively low power vast areas of the globe are covered by very few stations. The carriers of all stations used for navigation are synchronized to Universal Time by means of cesium clocks. The Omega system is discussed together with the VLF communications stations. The use of an airborne atomic clock to allow range-range operation instead of the present hyperbolic mode is proposed. G.R.

A73-34873 A scheme for estimating aircraft velocity directly from airborne range measurements. B. Lee (McDonnell Aircraft Co., St. Louis, Mo.). *Navigation,* vol. 20, Spring 1973, p. 29-40. 6 refs.

A scheme for estimating aircraft velocity directly from airborne air-to-ground range measurements is discussed. The idea is based on the premise that the motion of an aircraft can be represented by a polynomial in time, having stationary coefficients over intervals relatively long compared to the measurement sampling interval. The coefficients of the polynomial are estimated by processing range measurements. Radial velocities to two known radio stations at a given location of the aircraft are sufficient to determine aircraft velocity in the plane containing the aircraft and the two radio stations. The results of a study showed that with favorable data rates, a worst case trajectory can be fitted very accurately by a series of connected third order polynomials in time. A proposed two-stage Kalman-Bucy filter implementation for estimating the ground speed vector from aircraft heading information and data from two VOR/DME stations, is described. (Author)

A73-34881 An overview of fatigue and fracture for design and certification of advanced high performance ships. G. Sorkin, C. H. Pohler (U.S. Navy, Ships Systems Command, Washington, D.C.), A. B. Stavovy (U.S. Naval Material Command, Ship Research and Development Center, Washington, D.C.), and F. F. Borriello (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). *(Symposium on Fracture and Fatigue, George Washington University, Washington, D.C., May 3-5, 1972.) Engineering Fracture Mechanics,* vol. 5. June 1973, p. 307-352. 69 refs.

Reliability of structures is an overriding consideration in the design of surface ships, submarines, and aircraft, particularly for high-performance, weight-critical vehicles which require design with new materials having high strength-to-weight ratios. These high-strength materials can be susceptible to catastrophic failure in the presence of small flaws, so that the initiation and propagation of cracks by cyclic loading of the structure is of the utmost concern. Techniques for dealing with these problems, as they relate to structural reliability are discussed, and the close relationship between problems of high-performance ships and aircraft are examined. The current need to rely on large-scale validation testing of vehicle structure and structural details is examined, with particular attention to the requirements for high-performance ship structures. (Author)

A73-34888 The residual strength characteristics of stiffened panels containing fatigue cracks. H. Vlieger (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). *(Symposium on Fracture and Fatigue, George Washington University, Washington, D.C., May 3-5, 1972.) Engineering Fracture Mechanics,* vol. 5, June 1973, p. 447-477. 10 refs.

Description of a method that relates the crack resistance of a stiffened panel to that of an unstiffened sheet. It takes full account of sheet-stringer interaction in the cracked region. A criterion for crack arrest is put forward. Ultimate panel failure after crack arrest is initiated either by subsequent unstable crack growth or by stiffener failure. Critical load conditions for both failure modes are presented. In case crack arrest does not occur, the residual strength of the unstiffened panel constitutes a safe lower bound. Computational results of the interacting rivet forces by both analytical and numerical (finite element) methods are presented. From these the load concentration in the stiffener and the reduction of the stress intensity at the crack tip can be determined. This enables the complete residual strength characteristics to be predicted. The results of residual strength tests on bonded and riveted panels with symmetric strip stiffeners or eccentric Z-stringers fully substantiate the method proposed for residual strength calculations. (Author)

A73-34889 On the influence of single and multiple peak overloads on fatigue crack propagation in 7075-T6511 aluminum. D. M. Corbly and P. F. Packman (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *(Symposium on Fracture and Fatigue, George Washington University, Washington, D.C., May 3-5, 1972.) Engineering Fracture Mechanics,* vol. 5, June 1973, p. 479-497. 21 refs.

A73-34900 # **Aerodynamics and flight dynamics of turbojet aircraft /2nd revised and enlarged edition/ (Aerodinamika i dinamika poleta turboreaktivnykh samoletov /2nd revised and enlarged edition/).** T. I. Ligum. Moscow, Izdatel'stvo Transport, 1972. 320 p. 17 refs. In Russian.

The special features of the design and operation of turbojet passenger aircraft are reviewed. The physical bases of high-speed aerodynamics are investigated, as well as the effect of air compressibility on wing and aircraft aerodynamic characteristics. Among the topics considered are the takeoff characteristics of turbojet aircraft and methods of improving these characteristics, engine failure during takeoff and the selection of characteristic speeds, optimal climbing regimes, climbing speeds, level flight, descent, landing approach and landing, turning and banking, stability and control, and the characteristics of turbojet aircraft power plants. A.B.K.

A73-34960 Electronics in the automation of services; International Congress on Electronics, 20th, Rome, Italy, March 28-31, 1973, Proceedings (L'elettronica nell'automazione dei servizi;

Congresso Internazionale per l'Elettronica, 20th, Rome, Italy, March 28-31, 1973, Atti). Congress sponsored by the Ministero delle Poste e Telecomunicazioni. Rome, Rassegna Internazionale Elettronica e Nucleare, 1973. 513 p. In Italian and English.

Topics discussed include automation of air traffic control systems using satellites, automated broadcasting of weather data, automation of clinical analyses and diagnoses, a TDMA prototype being developed for use in communications via the Intelsat 4 satellite, and a hypothetical broadband communication system to replace the telephone. Also considered are the possibilities of automation of electroretinographic, electrocardiographic, and electroencephalographic analyses.

A.B.K.

A73-34961 # Prospects of automation of air traffic control systems using satellites for radio navigation (Prospettive di automazione dei sistemi di controllo del traffico aereo con satelliti per la radionavigazione). P. Monti and C. Cirilli. In: Electronics in the automation of services; International Congress on Electronics, 20th, Rome, Italy, March 28-31, 1973, Proceedings.
Rome, Rassegna Internazionale Elettronica e Nucleare, 1973, p. 41, 43-50. 7 refs. In Italian.

Review of the fundamental principles of air traffic control systems using navigation satellites suitable for extensive automation of flight control operations. The principle of aircraft tracking with the aid of two synchronous satellites is reviewed, and the operative possibilities offered by an inertial navigation system, particularly from the standpoint of automation of air traffic control operations, are ascertained, as well as the structure that must be assumed by the ground control terminals. In particular, a servo-controlled inertial navigation system is considered which is capable of achieving automatic radio navigation by means of central computers connected to each other and coordinated by a supervisory system. A.B.K.

A73-34962 # An automatic system for broadcasting weather data to international civil aviation (Un sistema automatico di diffusione delle informazioni meteorologiche alla aviazione civile internazionale). C. Giallombardo (Aeronautica Militare, Servizio Meteorologico, Rome, Italy). In: Electronics in the automation of services; International Congress on Electronics, 20th, Rome, Italy, March 28-31, 1973, Proceedings. Rome, Rassegna Internazionale Elettronica e Nucleare, 1973, p. 115, 117-120. In Italian.

Description of a fully automated international telegraph network for the dissemination of operational weather data required by European civil aviation. The system described consists of a main ring circuit composed of duplex telegraphic circuits connected in series, two diagonal duplex telegraphic circuits, and a number of tributary telegraphic circuits for collection and broadcasting. The message volume handled by this system is discussed, as well as the technical and operational characteristics of the system and the procedures used for operating and programming the system. A.B.K.

A73-34980 Grease lubrication of helicopter transmissions. J. B. Christian (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio) and B. R. Simmons (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Society of Lubrication Engineers, Annual Meeting, 28th, Chicago, Ill., Apr. 30-May 3, 1973, Preprint 73AM-2A-1.* 10 p. Members, $1.50; nonmembers, $2.00.

Experimental results are presented for certain heavy load-carrying, antiwear grease formulations with reference to their suitability for the lubrication of helicopter transmissions. Screening tests were performed on a total of seventeen grease formulations, using an aircraft gear fatigue tester to determine their temperature stabilization and retention characteristics. Two greases were chosen for testing in actual helicopter transmissions. Full-scale testing with modified S-61 helicopter intermediate and tail gearboxes demonstrated that one lubricant, now covered by Military Specification MIL-G-83363 (USAF), Helicopter Transmission Grease, was able to provide stabilized gearbox operation at a continuous power level significantly higher than the normal mission prorate power. In addition to 300 hours of operation at constant power, a 90-hour high-load test and a 50-hour low-temperature test were successfully conducted. At the conclusion of all tests, the gearbox components were in excellent condition, with no evidences of significant wear, scoring, or thermal damage. (Author)

A73-34981 Experimental investigation of air bearings for gas turbine engines. S. B. Malanoski and W. Waldron (Mechanical Technology, Inc., Latham, N.Y.). *American Society of Lubrication Engineers, Annual Meeting, 28th, Chicago, Ill., Apr. 30-May 3, 1973, Preprint 73AM-2B-1.* 7 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Because of the high temperatures and high rotational speeds, conventional oil lubrication techniques may not be adaptable to the next generation of small gas turbine engines. If this should be the case, new lubrication methods will be required, one such being the air-lubricated (gas) bearing. The prime results of an experimental air bearing evaluation indicate that self-acting tilting-pad journal bearings can carry simulated jet engine loads of 35 psi at film thicknesses of 200 micro-in. successfully. A hybrid (combined externally pressurized and spiral-grooved self-pumping) thrust bearing can carry simulated jet engine thrust loads in excess of 15 psi successfully. Present-day gas bearing technology (theory) compares well with the experimental data obtained. F.R.L.

A73-35009 # Performance of low-aspect-ratio diffusers with fully developed turbulent inlet flows. I - Some experimental results. O. J. McMillan and J. P. Johnston (Stanford University, Stanford, Calif.). *American Society of Mechanical Engineers, Applied Mechanics and Fluids Engineering Conference, Atlanta, Ga., June 20-22, 1973, Paper 73-FE-12.* 8 p. 20 refs. Members, $1.00; nonmembers, $3.00. Research supported by the General Motors Corp., General Electric Co., Caterpillar Tractor Co., Boeing Aircraft Co., Vidar Corp., Curtiss-Wright Corp., and U.S. Air Force.

A73-35010 # Performance of low-aspect-ratio diffusers with fully developed turbulent inlet flows. II - Development and application of a performance prediction method. O. J. McMillan and J. P. Johnston (Stanford University, Stanford, Calif.). *American Society of Mechanical Engineers, Applied Mechanics and Fluids Engineering Conference, Atlanta, Ga., June 20-22, 1973, Paper 73-FE-13.* 8 p. 9 refs. Members, $1.00; nonmembers, $3.00. Research supported by the General Motors Corp., General Electric Co., Caterpillar Tractor Co., Boeing Aircraft Co., Vidar Corp., Curtiss-Wright Corp., and U.S. Air Force.

A73-35023 * # A method of measuring three-dimensional rotating wakes behind turbomachinery rotors. B. Lakshminarayana and A. Poncet. *American Society of Mechanical Engineers, Applied Mechanics and Fluids Engineering Conference, Atlanta, Ga., June 20-22, 1973, Paper 73-FE-31.* 7 p. 6 refs. Members, $1.00; nonmembers, $3.00. Grant No. NGL-39-009-007.

A73-35026 # Diffusers for mixed-flow supersonic compressors. J. Friberg and J. M. Merigoux (CIT-ALCATEL, Bruyères-le-Chatel, Essonne, France). *American Society of Mechanical Engineers, Applied Mechanics and Fluids Engineering Conference, Atlanta, Ga., June 20-22, 1973, Paper 73-FE-35.* 8 p. 8 refs. Members, $1.00; nonmembers, $3.00. Research supported by the Direction des Recherches et Moyens d'Essais.

Mixed flow supersonic compressors with shock waves both in the rotor and the stator are described. Problems encountered in the

diffusers of such compressors are emphasized, and the operating conditions of these diffusers are discussed. Experimental results obtained on a Freon supersonic compressor test bed are presented. The diffusers give a static pressure ratio of 1.80 with less than 6 per cent total pressure losses. Such compressors give pressure ratios of the order of 2.3 per stage with efficiencies over 90 per cent. The investigated diffusers are very suitable for centrifugal or axial supersonic compressors whenever the space available is sufficiently large. (Author)

A73-35051 An investigation of the flow field and drag of helicopter fuselage configurations. J. Gillespie, Jr. (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 700.* 10 p. Members, $1.00; nonmembers, $2.00.

An investigation has been made to analytically determine the flow field about a helicopter fuselage and to apply the results to the prediction of parasite drag. The analytical methods are currently restricted to nonlifting bodies in nonyawed flow. The flow field is determined by using the Douglas-Neumann computer program for the potential field and a boundary layer analysis based upon the small cross-flow assumption. Pressure distributions from test data and the Douglas-Neumann program correlate very well except for areas of separated flow. Also, boundary layer velocity profiles obtained from test data and the boundary layer analysis agree very well. An empirical approach based on test data is used to approximate the pressure in the separated region. (Author)

A73-35052 Influence of design parameters on fan-in-fin static performance. J. E. Fairchild (Texas, University, Arlington, Tex.), N. N. Batra (Bell Helicopter Co., Fort Worth, Tex.), and R. L. Stewart (U.S. Army, South Korea). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 701.* 9 p. 54 refs. Members, $1.50; nonmembers, $2.00.

Results of a simplified theoretical and experimental analysis of the influence of aerodynamic design parameters on the static performance of short ducted fans for helicopter tail-rotor applications. The theoretical analysis is based on McCormick's suggestion of replacing the duct with a vortex ring located at the duct quarter-chord and defining the circulation strength such that the flow conditions are satisfied at the three-quarter chord, similar to Weissinger's approximation used in wing theory. The effects of duct design on thrust and induced power are analyzed to arrive at correction factors to conventional rotor performance methods and estimating fan-in-fin static performance. The experimental apparatus used a one-foot, adjustable-pitch fan and tested solidity, duct-chord-to-diameter ratio, duct diffuser half-angle, and fan-blade pitch angle. The tests verified the trends predicted by the analysis; the duct-thrust-to-total-thrust ratios varied from 0.3 for short-chord ducts to over 0.5 for the large-chord ducts. The total thrust attained with the ducted fans was almost twice that of the open rotor. (Author)

A73-35053 A detailed experimental analysis of dynamic stall on an unsteady two-dimensional airfoil. J. M. Martin, R. W. Empey, W. J. McCroskey, and F. X. Caradonna (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 702.* 8 p. 8 refs. Members, $1.50; nonmembers, $2.00.

A73-35054 * Experimental investigation of model variable-geometry and ogee tip rotors. A. J. Landgrebe and E. D. Bellinger (United Aircraft Research Laboratories, East Hartford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 703.* 16 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-10906.

An experimental investigation was conducted to systematically explore the effects of inter-blade spatial relationships and pitch variations on rotor performance and wake geometry. Variable-geometry rotors consisting of various combinations of blade length, axial spacing, azimuth spacing, and collective pitch were tested at model scale in hover and forward flight. In addition, a hover test of a rotor with an ogee blade tip design was conducted to determine its performance and wake characteristics. The results of this investigation indicate that several variable-geometry rotor configurations can offer substantial improvements in hover performance without adversely affecting forward flight performance. (Author)

A73-35055 The application of circulation control aerodynamics to a helicopter rotor model. J. B. Wilkerson, K. R. Reader, and D. W. Linck (U.S. Naval Material Command, Ship Research and Development Center, Bethesda, Md.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 704.* 15 p. 9 refs. Members, $1.50; nonmembers, $2.00.

A higher harmonic circulation control rotor model, based on several years of two-dimensional research in the field of circulation control airfoils, was designed, built and tested at the Naval Ship Research and Development Center. Unique features of the model included blades with elliptical shaped circulation control airfoils, and a simple cyclic control mechanism based on blade pressure variation rather than blade pitch variation. The model proved that trimmed flight could be achieved without any moving parts other than the rotating blades. It further demonstrated that the high lift capability and efficiency of circulation control airfoils could be extended into the three-dimensional regime. Aerodynamic trends displayed by the model have been coupled with two-dimensional results to improve the theoretical programs used to predict model performance. (Author)

A73-35056 The Heavy Lift Helicopter rotor blade. T. Scarpati, R. Sandford (Boeing Vertol Co., Philadelphia, Pa.), and R. Powell (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 710.* 17 p. Members, $1.50; nonmembers, $2.00.

The Boeing Heavy Lift Helicopter rotor blade is an application of advanced technology encompassing improved airfoil and geometry distribution and composite materials. The selected airfoils, twist distribution, and the use of control system pitch damping result in a considerable reduction in rotor system size and weights. The design consists of a fiberglass and titanium spar and provides fail safety by means of a closed spar delta pressure system. This paper describes the blade's aerodynamic and structural features, fabrication methods, and design support tests. (Author)

A73-35057 Design and development of the Westland Sea Lynx. D. K. Berrington (Westland Helicopters, Ltd., Yeovil, Somerset, England). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 711.* 12 p. Members, $1.50; nonmembers, $2.00.

The Westland Lynx is designed to have a multi-service, multi-role, application and this paper deals more specifically with the naval variant. The paper highlights the influence of the desire for high reliability and ease of maintenance on design solutions and also illustrates the highly specialized solutions to the particular problems associated with small ship operations. (Author)

A73-35058 Establishing a designer's cost target. M. Dubey and A. R. Yackle (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 712.* 9 p. Members, $1.50; nonmembers, $2.00.

The foundation of a good design-to-a-cost program is an early start. Once the design is under way it is often too late to correct bad guesses. The second criteria for setting cost targets is a good data bank, based on past programs, supplier quotations, government documents, and cost estimating practices. Third, the cost of providing functional requirements should be correlated with hardware costs, so that a rationale can be developed concerning the reasonable cost of the requirement. And finally, a responsive and dynamic method for tallying and tracking the costs is necessary if the target is to be achieved and verified when the production items are delivered. (Author)

A73-35059 Development of the H-53 elastomeric rotor head. W. J. Dutton (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 713.* 21 p. 7 refs. Members, $1.50; nonmembers, $2.00.

Description of an improved nonlubricated production main rotor head for the model CH-53D helicopter. Interchangeable with the existing oil lubricated rotor head, the new elastomeric rotor head has been tested with both the present production aluminum blade and the new high-performance titanium main rotor blades. The heart of this rotor head is a spherical elastomeric bearing, which carries the centrifugal force of a blade while it absorbs the full range of blade motion by elastic shear deformation of the layers of rubber. Elastomeric centering bearings are used to transmit blade root shear loads to the hub, and elastomeric rod end bearings are used on the lag dampers. The objective of the elastomeric rotor head is to improve reliability while reducing maintenance. The elastomeric bearings eliminate periodic lubrication requirements and unscheduled down time caused by seal leakage. All the elastomeric bearings are inspectable in place. Bearing endurance tests have yielded inspection criteria to detect incipient failure, allowing bearing replacements to be scheduled several hundred hours in advance. (Author)

A73-35060 Multiblade ring rotor design. H. R. Velkoff (Ohio State University, Columbus, Ohio). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 714.* 12 p. 13 refs. Members, $1.50; nonmembers, $2.00.

The concept of using a ring at the tip of a helicopter rotor was studied. In the configuration considered, the rotor blades are mounted on spokes that connect the rotor hub to the ring. The blades pivot around the spokes for pitch change. The ring rotates with the blades. Experiments of ring drag during rotation were made, and a model rotor using a ring was tested in a hover condition. Tradeoff studies were made, comparing the ring rotor with conventional rotors. Preliminary study of structural and dynamic factors revealed that buckling could pose a significant design problem for the ring rotor when it is not rotating. These studies point to the conclusion that the concept appears to have particular merit as a tail rotor. (Author)

A73-35062 Redundant system design and flight test evaluation for the TAGS digital control system. F. G. Kilmer and J. R. Sklaroff (IBM Electronics Systems Center, Owego, N.Y.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 721.* 19 p. Members, $1.50; nonmembers, $2.00.

A73-35063 Pilot-in-the-loop control systems /A different approach/. K. W. McElreath (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), J. A. Klein, and R. C. Thomas (Collins Radio Co., Cedar Rapids, Iowa). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 722.* 7 p. Members, $1.50; nonmembers, $2.00.

The V/STOL IFR Control/Display Technology Program conducted by the Air Force Flight Dynamics Laboratory has developed a control system to overcome the pilot limitations while enhancing his performance and decision-making flexibility as an active control element. This system includes a highly flexible V/STOL aircraft flight director which feeds only the high-frequency control inputs to a simple, limited-authority automatic stability augmentation system. The low-frequency control commands are displayed to the pilot to be excuted manually. Using the techniques of analysis, simulation, and flight testing, this concept has been verified to improve performance and decrease workload while retaining the natural pilot flexibility. (Author)

A73-35064 The application of system analysis techniques for the solution of complex helicopter crew station design problems. J. J. Belcher (Litton Systems, Inc., Woodland Hills, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 723.* 12 p. Members, $1.50; nonmembers, $2.00.

A73-35065 Image and superimposed symbology - An integrated display for helicopters. T. A. Dukes (Princeton University, Princeton, N.J.), W. P. Keane, and C. M. Tsoubanos (U.S. Army, Avionics Laboratory, Fort Monmouth, N.J.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 724.* 11 p. 5 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAB07-72-C-0161.

Image displays to be used for flying under low visibility conditions (e.g., low light level TV, infra-red) can be enhanced by the superposition of symbology conveying quantitative measured information. A hierarchy of symbolic displays with increasing horizontal and vertical information content for superposition on an image display has been established. The paper presents this hierarchy and a unique integration of image and symbolic display developed as an aid in approach and in precision hovering. Significant levels in the hierarchy are represented by a terrain marker without and with velocity vector information, based on aircraft-derived (self-contained) measurements, and a modification of an integrated trajectory error display developed earlier. (Author)

A73-35066 A study of stall-induced flap-lag instability of hingeless rotors. R. A. Ormiston and W. G. Bousman (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 730.* 17 p. 10 refs. Members, $1.50; nonmembers, $2.00.

An experimental investigation with a 1.81-m model rotor was conducted to check the validity of a simplified linear theory for flap-lag stability in hover. At pitch angles below stall, the results were in favorable agreement with the theory. For the configuration with weak elastic coupling (R = 0.08) the destabilizing effects of inertial and aerodynamic coupling terms were confirmed for operating speeds where flap and lead-lag frequencies were nearly equal. For the configuration with strong elastic coupling (R = 0.96), the large increase in lead-lag damping predicted by theory was also confirmed by the experiments. In the stall regime, large discrepancies between theory and experiment were encountered including stall-induced instabilities unlike classical flutter or torsional stall flutter. (Author)

A73-35067 Effect of torsion-flap-lag coupling on hingeless rotor stability. H. B. Huber (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 731.* 15 p. 11 refs. Members, $1.50; nonmembers, $2.00. Research supported by the Bundesministerium der Verteidigung.

Torsional moments due to flapwise and inplane blade bending are analyzed in terms of bending moment distributions and fundamental blade characteristics. The analytical model, which accounts for the fundamental flexibilities of the individual blades, as well as for the airframe flexible and rigid flight dynamic motions, is

described. It uses forward flight aerodynamics with stall, reverse flow, and compressibility effects. Some physical insights of the coupling phenomena are gained by considering pitch-flap-lag motions of a soft inplane, hingeless rotor with elastically coupled blades in both steady trim conditions and in free blade oscillations. Correlations are made to virtual pitch-flap and pitch-lag coupling effects. (Author)

A73-35068 * On the question of adequate hingeless rotor modeling in flight dynamics. K. H. Hohenemser and S.-K. Yin (Washington University, St. Louis, Mo.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 732.* 15 p. 13 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-4151.

The somewhat controversial question of which elastic blade modes are essential in the flight mechanics of hingeless rotorcraft is studied on the basis of quasi-steady linear aerodynamics including reversed flow effects and uniform inflow. The modes are for the rotating blade, and intermode aerodynamic coupling terms are retained. The criteria for judging elastic mode effects include 19 hub moment and force derivatives, rotor trim data, rotor stability charts for lagged hub moment feedback, step gust and random gust responses. Fixed hub and constant chord blades with widely differing elasticity and inertia and with moderate twist are assumed. (Author)

A73-35069 Reduction of helicopter control system loads with fixed system damping. R. Taylor, J. Fries (Boeing Vertol Co., Philadelphia, Pa.), and H. I. MacDonald (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 733.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ01-72-C-0840(P40).

A73-35070 Investigation of reactionless mode stability characteristics of a stiff inplane hingeless rotor system. W. D. Anderson (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 734.* 13 p. 12 refs. Members, $1.50; nonmembers, $2.00.

A73-35071 An investigation of the vibratory and acoustic benefits obtainable by the elimination of the blade tip vortex. R. P. White, Jr. (Rochester Applied Science Associates, Inc., Rochester, N.Y.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 735.* 13 p. 24 refs. Members, $1.50; nonmembers, $2.00. Research sponsored by Rochester Applied Science Associates.

A73-35072 Application of antiresonance theory to helicopters. F. D. Bartlett, Jr. and W. G. Flannelly (Kaman Aerospace Corp., Bloomfield, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 736.* 7 p. 7 refs. Members, $1.50; nonmembers, $2.00.

Antiresonance theory is the principle underlying nonresonant nodes in a structure and covers both nonresonant nodes occurring naturally and those introduced by devices such as dynamic absorbers and antiresonant isolators. A new and convenient technique is presented to numerically calculate antiresonant frequencies. It is shown that antiresonances are eigenvalues and that they can be determined by matrix iteration. Novel applications of antiresonance theory to helicopter engineering problems, using the antiresonant eigenvalue equation introduced in this paper, are suggested. (Author)

A73-35073 A frequency response approach to flying qualities criteria and flight control system design. N. Albion and W. Larson (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 740.* 12 p. 10 refs. Members, $1.50; nonmembers, $2.00.

There is an increasing dependency upon automatic flight control systems to provide satisfactory flying qualities characteristics. As a result of this requirement, it is particularly important to understand the relationship between system design requirements and flying qualities criteria. To help satisfy this need, a frequency response methodology has been developed. Through use of a series of composite charts, this methodology clarifies the relationship between flying qualities specifications, physiological characteristics, and airframe and flight control system responses. System design specifications, such as sensor performance characteristics, allowable system noise levels, and system authority limits, can then be defined using superposition techniques. (Author)

A73-35074 Handling qualities comparison of two hingeless rotor control system designs. A. J. Potthast and J. T. Blaha (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 741.* 12 p. 10 refs. Members, $1.50; nonmembers, $2.00.

Two hingeless rotor control designs applicable to both helicopters and compound helicopters have been developed and tested on the Cheyenne (AH-56A) at Lockheed under Army contract. The flap feather feedback and the direct flap feedback designs are briefly described. Simple analytic expressions are used to define the gyro controlled rotor concept and to relate applicable characteristics of each design to specific handling qualities. Flight test data for each design are presented and compared with analytic trends. Analytic and test results show that in particular, the direct flap feather system design provides excellent handling qualities. (Author)

A73-35075 * A manual-control approach to development of VTOL automatic landing technology. J. R. Kelly, F. R. Niessen, and J. F. Garren, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 742.* 12 p. Members, $1.50; nonmembers, $2.00.

The operation of VTOL aircraft in the city-center environment will require complex landing-approach trajectories that insure adequate clearance from other traffic and obstructions and provide the most direct routing for efficient operations. As part of a larger program to develop the necessary technology base, a flight investigation was undertaken to study the problems associated with manual and automatic control of steep, decelerating instrument approaches and landings. The study employed a three-cue flight director driven by control laws developed and refined during manual-control studies and subsequently applied to the automatic approach problem. The validity of this approach was demonstrated by performing the first automatic approach and landings to a predetermined spot ever accomplished with a helicopter. The manual-control studies resulted in the development of a constant-attitude deceleration profile and a low-noise navigation system. (Author)

A73-35076 Flight simulator evaluation of control moment usage and requirements for V/STOL aircraft. E. W. Vinje (United Aircraft Research Laboratories, East Hartford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 743.* 13 p. 9 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-71-C-1722.

Fixed- and moving-base flight simulator experiments were conducted to evaluate V/STOL aircraft control-moment usage for hovering and low-speed flight tasks. The longitudinal, lateral, and combined (longitudinal plus lateral) control moments used with effectively unlimited moments available were measured for a variety of configurations. The percent times that various levels of control moments were exceeded were computed from the control-moment-usage data and analyzed. Results are presented which show the effects on control-moment usage of (1) aircraft and control system configuration, (2) aircraft flying qualities level, (3) turbulence intensity, and (4) flight task. The relationship between individual axis and simultaneous pitch and roll control-moment usage is also discussed. (Author)

A73-35077 **ABC helicopter stability, control, and vibration evaluation on the Princeton Dynamic Model Track.** D. H. Halley (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 744.* 10 p. Members, $1.50; nonmembers, $2.00. Research supported by the United Aircraft Corp.

This paper presents the results of an experimental program conducted to investigate the low speed dynamics and aerodynamics of an ABC co-axial rotor helicopter. The test program was conducted in three phases: (1) static test; (2) dynamic test; and (3) vibration evaluation. The static test phase was conducted with the model mounted on a six component strain-gage balance. Analysis of these data has confirmed the high level of ABC rotor cyclic control power predicted by theory; and has shown that selection of the proper control system phasing permits straightforward trimming of the ABC helicopter from hover through transition. The dynamic test phase was conducted with the model mounted on a gimbal system that provided single or multiple angular degrees of freedom. Analysis of model transient motions confirmed high levels of ABC pitch and roll damping. The vibration results do not indicate the presence of any significant vibration problems at low advance ratios. (Author)

A73-35078 **Recognition and control of abusive machining effects on helicopter components.** W. A. Thomas (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 750.* 5 p. Members, $1.50; nonmembers, $2.00.

Transformation hardening steels are unique in their response to abusive machining practices. Common machining methods have the potential of locally reheat treating the surface and creating brittle untempered martensite. Left untreated, this surface condition results in high residual tensile stresses, reduced fatigue strength, and increased susceptibility to hydrogen embrittlement. Low alloy steels are specifically covered with emphasis placed on the effects of abusive machining on residual stress and fatigue strength. Process control methods of eliminating and/or reducing the detrimental aspects of abusive machining are reviewed. (Author)

A73-35079 **The human side of quality assurance /as viewed from helicopter manufacturing experiences/.** G. M. Powell (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 751.* 10 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Review of the people-factor in quality assurance experiences related to over 18,000 aircraft. Retention of these experiences has provided the opportunity to draw certain conclusions and to make recommendations for quality assurance programs. Performance of the individuals as they relate to the manufacturing and inspection situations can be predictable, generally. Considerations of the human limitations are presented as the most significant factor for added quality assurance emphasis. Some simulated situations are presented for the reader to test his own performance as an illustration of our experiences. It is concluded that situations affecting people performance can be predicted and considered to better align the quality assurance program. (Author)

A73-35080 **Development and qualification of a magnetic technique for the nondestructive measurement of residual stress in CH-47 A rotor blade spars.** F. H. Bray and H. H. Fitz, III (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 752.* 10 p. Members, $1.50; nonmembers, $2.00.

A73-35081 **Computer graphics used in numerical control programming.** R. N. Hayes (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 753.* 26 p. Members, $1.50; nonmembers, $2.00.

Description of the development and usage of a computerized graphic display and interfacing system for programming numerical control operations involving tooling and part machining in aircraft production. Emphasis is placed on steps and methods employed to prepare numerical control tapes. Direct conversation with the computer through graphics consoles is shown to improve programming efficiency. T.M.

A73-35082 **Low cost manufacturing methods for highly reliable ballistic-tolerant composite helicopter flight control components.** L. A. Fry (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.) and R. L. Van Auken (Whittaker Corp., San Diego, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 754.* 12 p. Members, $1.50; nonmembers, $2.00.

A73-35083 **Wind tunnel test technique to establish rotor system aeroelastic characteristics.** F. D. Harris (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 760.* 13 p. Members, $1.50; nonmembers, $2.00.

The Boeing V/STOL Wind Tunnel, in the course of doing powered model rotor testing over the last four years, has evolved a simple testing technique that illuminates the key dynamic properties of a rotor blade in its rotating environment. The technique takes advantage of the full range in rotor RPM that is permissible in a wind tunnel test (but not in flight test) to vary the non-dimensional rotor dynamics while maintaining nearly constant rotor aerodynamic conditions. Experimental data from a 14-foot diameter, four-bladed articulated model rotor are used to illustrate the test technique. (Author)

A73-35084 **Flight test development of the tactical aircraft guidance system.** J. C. Deardorff, A. L. Freisner, and N. Albion. *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 761.* 11 p. Members, $1.50; nonmembers, $2.00.

The Tactical Aircraft Guidance System (TAGS) is a full-time, full-authority electrical flight-control system designed to provide extensive stabilization of a helicopter flight path while maintaining pilot-in-the-loop control. The stabilization comprises heading hold, lateral and longitudinal velocity hold, and vertical velocity hold. Design characteristics, flight test approach, and major test results of the TAGS development are described. T.M.

A73-35085 **Development of conical Teflon-lined journal bearings.** F. Robinson (Hughes Tool Co., Culver City, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 762.* 7 p. Members, $1.50; nonmembers, $2.00.

This paper describes a test program to develop a better Teflon-lined bearing for use in tail rotor teeter-hinges. This application is especially severe as it includes high-frequency oscillatory loads. The high surface speeds produce bearing temperatures which, together with the oscillatory loading, make conventional bearing testing and rating techniques unreliable. The paper goes on to describe a new type of conical Teflon-lined bearing which was developed during this program. This type of bearing is unique in that it allows both the axial and radial preload to be easily adjusted during normal service. This characteristic could be of considerable value for a variety of helicopter applications where bearing slop or looseness cannot be tolerated during the normal life of the bearing. (Author)

A73-35086 **Army helicopter vibration survey methods and results.** E. J. Laing (U.S. Army, Aviation Systems Test Activity,

Edwards AFB, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 763.* 10 p. 9 refs. Members, $1.50; nonmembers, $2.00.

This paper presents helicopter vibration data for instruments, avionics, selected component parts, and the pilot station. The data are from United States Army Aviation Systems Test Activity tests on the OH-58A, UH-1H, CH-54B, and OH-6A helicopters. Test methods are discussed and results are presented. An average of 8000 vibration data records from 50 triaxial accelerometer locations were recorded for each helicopter. Both nonfiring and firing flight conditions were tested. The data are presented in the form of spectral analyses which are summarized by statistical methods. The transmissibility of vibration isolators, seat cushions, and the pilot is also presented. (Author)

A73-35087 Tail rotor performance in presence of main rotor, ground, and winds. W. Wiesner and G. Kohler (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 764.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A test of a model helicopter rig with an 8-ft-diam main rotor and 1.57-ft-diam tail rotor was conducted in a V/STOL wind tunnel to investigate the characteristics of tail rotor performance in the presence of the main rotor. The effects of vertical and longitudinal tail rotor placement, direction of rotation, relative fin location, and fin-tail rotor separation on tail rotor thrust developed and power required were determined. Tests were conducted in wind speeds from zero to 35 knots, and in wind azimuth positions from 0 (headwind) to 270 degrees (left side flight). Operation at various heights both in ground effect and out of ground effect was included. Horizontal stabilizer loads were measured in forward and rearward flight. Correlation of directional control limits with full-scale flight tests was obtained. In addition, tuft board and smoke photographs were taken of the ground and wing-tip vortices. (Author)

A73-35088 * Elastohydrodynamic principles applied to the design of helicopter components. D. P. Townsend (NASA, Lewis Research Center, Cleveland, Ohio). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 770.* 11 p. 26 refs. Members, $1.50; nonmembers, $2.00.

Elastohydrodynamic principles affecting the lubrication of transmission components are presented and discussed. Surface temperatures of the transmission bearings and gears affect elastohydrodynamic film thickness. Traction forces and sliding as well as the inlet temperature determine surface temperatures. High contact ratio gears cause increased sliding and may run at higher surface temperatures. Component life is a function of the ratio of elastohydrodynamic film thickness to composite surface roughness. Lubricant starvation reduces elastohydrodynamic film thickness and increases surface temperatures. Methods are presented which allow for the application of elastohydrodynamic principles to transmission design in order to increase system life and reliability. (Author)

A73-35089 T700 fuel and control system - A modern system today for tomorrow's helicopters. J. J. Curran (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 771.* 13 p. Members, $1.50; nonmembers, $2.00.

Review of innovative design features, implementation, and experience of the T700 fuel and control system. Overall system operational features, safety criteria, and reliability and maintainability design features are discussed. (Author)

A73-35090 A dynamics approach to helicopter transmission noise reduction and improved reliability. R. M. Hartman (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 772.* 13 p. 10 refs. Members, $1.50; nonmembers, $2.00.

A73-35091 Power transfer systems for future helicopters. R. B. Bossler, Jr. (Kaman Aerospace Corp., Bloomfield, Conn.) and W. R. Harris, Jr. (U.S. Naval Air Systems Command, Washington, D.C.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 773.* 16 p. Members, $1.50; nonmembers, $2.00.

Conventional and advanced power transfer system concepts are analyzed in terms of weight reduction and reliability improvement for application in future Navy helicopters. Details are given on a power transfer system design for a 200,000 pound cargo transport helicopter. Weight estimates are given for its engine, power transfer system, rotor and structure. Payloads are discussed for the specified 2,000,000 pound gross weight. V.Z.

A73-35092 Vibratory compatibility of rotary-wing aircraft propulsion components. J. M. Vance (Florida, University, Gainesville, Fla.) and J. Gomez, Jr. (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 774.* 10 p. 11 refs. Members, $1.50; nonmembers, $2.00.

Problems related to vibration and dynamic loads in helicopter propulsion systems have been studied. It has been found that engine vibration and dynamic instabilities seriously limit helicopter performance and reliability. Significant improvements in these two areas can be obtained in turboshaft-powered helicopters by improving the dynamic compatibility of engines, drive shafts, and transmissions with each other and with the airframe. Specific research and development is prescribed in three sub-areas: (1) establishment of more realistic and meaningful vibration limits for turboshaft engines in helicopter applications, (2) development of better methods for engine/airframe interface design and analysis, and (3) development of improved methods for torsional stability analysis of helicopter drive trains with automatic fuel control. (Author)

A73-35093 The integration of NASTRAN into helicopter airframe design/analysis. D. A. Gallian and H. E. Wilson (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, reprint 780.* 14 p. 6 refs. Members, $1.50; nonmembers, $2.00.

The integration of the finite element computer program NASTRAN (NASA Structural Analysis) into the helicopter design/analysis loop is described. To reduce engineering modeling time, automated data generation of structures was developed. The problem of nonstructural mass distribution was also solved by the use of preprocessor programs which operate on the already available helicopter weight tabulation in a MIL-STD form. Post-processor programs were developed to allow selective data presentation of the significant load conditions, high stress members, or other areas of particular interest. The methods employed in developing these pre- and post-processor programs and their interface with NASTRAN are discussed in detail. (Author)

A73-35094 A consistent crashworthiness design approach for rotary-wing aircraft. G. Wittlin (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 781.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A consistent crashworthiness design approach for rotary-wing aircraft is presented by which proper interface is maintained among the essential structural elements (such as crushable structure), occupant restraint system, engine, and transmission and thus affords the occupants the greatest opportunity for survival for an acceptable weight penalty. The major considerations of the concept are: a multidirectional crash environment, human tolerance limits, a verified analytical method for use in predicting dynamic responses, treatment of large structural deformation, incremental weight, cost and geometry penalties, and applicability to a range of helicopter configurations. The results of a recent study are discussed which

included a full-scale drop test of a UH-1H utility helicopter and the development and verification of a digital computer program to compute dynamic responses in which combined vertical and lateral impact velocities are present. (Author)

A73-35095 The twin beam composite rotor blade. M. J. Salkind (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 782.* 6 p. Members, $1.50; nonmembers, $2.00.

The twin beam rotor blade derives its name from the fact that it incorporates two separate unidirectional glass fiber epoxy spar beams to carry centrifugal and bending loads. Each spar beam has its own titanium root end attachment, and the twin beams represent redundant load paths for improved reliability. The aerodynamic surface of the blade consists of plus or minus 45 deg graphite epoxy for torsional stiffness and strength and spanwise glass fiber epoxy for improved bending fatigue capability. Fatigue tests of full scale H-53-size blade sections have verified the structural integrity of the twin beam blade construction and have indicated excellent damage tolerance. As predicted from small specimen testing, the composite blades exhibit twice the fatigue strain capacity of comparable aluminum blades. In addition, crack propagation is considerably slower and critical crack size larger in the composite blade. (Author)

A73-35096 Development of the CH-53D high performance titanium main rotor blade. J. Bettino, R. Tracy (U.S. Naval Air Systems Command, Washington, D.C.), and R. Zincone (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 783.* 24 p. Members, $1.50; nonmembers, $2.00.

An Improved Rotor Blade (IRB) for production H-53 helicopters has been designed, manufactured and tested by the Naval Air Systems Command and Sikorsky Aircraft. The new blade has a continuous titanium spar, fiberglass cover and a Nomex honeycomb core. The titanium spar technology, first developed for the Sikorsky ABC rotor, is the key to the improvements of the rotor. The blade has a 11-1/2% wider chord and torsional rigidity 40% higher than the standard CH-53D aluminum blade with no blade weight increase. The Sikorsky SC 1095 cambered airfoil and a high nonlinear twist have been incorporated. This paper traces the history of the new blade through design, fabrication, and test. The impact of the test results on the H-53 performance and blade structural reliability are summarized. (Author)

A73-35097 Advanced technologies as applied to the design of the HLH rotor hub. C. D. McCall, D. M. Field (Boeing Vertol Co., Philadelphia, Pa.), and H. Reddick (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 784.* 12 p. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ01-71-C-0840.

A heavy lift helicopter advanced technology component program featuring development and testing of critical components is being conducted. Innovative design approaches, new material systems and advanced technology concepts are being demonstrated for use on the Heavy Lift Helicopter (HLH). During the rotor hub design development, data has been generated to define the characteristics of a reduced size spherical elastomeric flap-lag-pitch bearing, a centering bearing which reacts blade shear forces, and material properties of large alpha plus-beta Ti 6Al-4V forgings. Fail-safe design criteria have been established and are being employed in structural component design. Fracture mechanics and finite element technologies have been used to size main hub components. To improve damper performance in mixed frequency environments, a frequency selective blade damper is being developed and tested. (Author)

A73-35098 An advanced composite tailboom for the AH-1G helicopter. H. Zinberg (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National Forum, 29th, Washington, D.C., May 9-11, 1973, Preprint 785.* 10 p. Members, $1.50; nonmembers, $2.00.

This paper describes a program for the design, manufacture, and testing of an advanced composite tailboom for the AH-1G Cobra helicopter. The program was undertaken to gain experience in the design and manufacture of a major primary structure in advanced composite materials. It evaluated several materials and structural configurations, and chose a honeycomb sandwich of Nomex core and Modmor III graphite faces. Two tailbooms were fabricated; one for structural test, one for possible flight test. The former has been tested and found to be about 11% stiffer than predicted. Described here are the analytical work which led to the final configuration, the fabrication process, and the test program. (Author)

A73-35126 Computational Fluid Dynamics Conference, Palm Springs, Calif., July 19, 20, 1973, Proceedings. Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1973. 193 p. Members, $11.00; nonmembers, $15.

Numerical methods for fluid dynamics problems and solutions of specific problems are described in papers dealing with the general categories of transonic, supersonic, viscous boundary-layer, and general viscous flows. Expected future developments in computer hardware are reviewed. Some topics considered include relaxation solutions for inviscid axisymmetric transonic flow over blunt or pointed bodies, numerical calculation of three-dimensional transonic flow over a yawed wing, relaxation factors for supercritical flows, application of the generalized Galerkin method, application of the finite element method for analysis of unsteady flow around airfoils, linearized implicit schemes for the computation of viscous incompressible flow, and procedures for calculating boundary conditions. T.M.

A73-35129 * # Numerical calculation of the three dimensional transonic flow over a yawed wing. A. Jameson (New York University, New York, N.Y.). In: Computational Fluid Dynamics Conference, Palm Springs, Calif., July 19, 20, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 18-26. 10 refs. Grant No. NGR-33-016-167.

Results are presented of calculations of the three dimensional steady transonic flow over a finite yawed wing. The full potential flow equation is solved in a transformed coordinate system which permits the boundary conditions to be satisfied exactly. The correct differential properties are enforced by rotating the difference scheme to conform with the flow direction, and fast convergence is assured by simulating a time dependent equation designed to settle quickly to a steady state. Computed lift drag ratios are consistent with the results of wind tunnel tests of a yawed wing conducted by R. T. Jones (1972). (Author)

A73-35138 * # Computational considerations in application of the finite element method for analysis of unsteady flow around airfoils. T. Bratanow and A. Ecer (Wisconsin, University, Milwaukee, Wis.). In: Computational Fluid Dynamics Conference, Palm Springs, Calif., July 19, 20, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 109-122. 17 refs. Grant No. NGR-50-007-001.

Difficulties related to the application of the finite element method for numerical solution of the Navier-Stokes equation are discussed. The unsteady flow around a stationary and oscillating NACA 0012 airfoil was analyzed. In an effort to establish the range

of applicability of the developed numerical method, the accuracy and stability problems in representing unsteady flow patterns and determining pressure distribution around the airfoil were investigated. Error involved in determining the velocity field and in the numerical integration of the discretized equations were analyzed in terms of geometry of the finite element gridwork, boundary conditions for stationary and oscillating airfoils, angles of attack and flow conditions. (Author)

A73-35144 # **A new shock capturing numerical method with applications to some simple supersonic flow fields.** F. Walkden, G. T. Laws, and P. Caine (Salford, University, Salford, Lancs., England). In: Computational Fluid Dynamics Conference, Palm Springs, Calif., July 19, 20, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 173-181. 9 refs.

A method of predicting three-dimensional steady flow past aerodynamic shapes is described. Finite difference equations which smooth real shock discontinuities are derived from a semi-characteristic representation of equations of motion in a non-conservation law form such that stream surfaces form two families of co-ordinate surfaces. Accurate boundary conditions are applied systematically. Numerical results for a faired wedge, an axisymmetric body and a simple delta wing with sharp supersonic leading edges show that the non-conservation law method has good overall performance. (Author)

A73-35150 # **Two causality correlation techniques applied to jet noise.** R. Rackl. Vancouver, British Columbia, University, Dept. of Mechanical Engineering, Doctor of Philosophy Thesis, 1973. 140 p. 60 refs. National Research Council of Canada Grant No. 67-7106; Defence Research Board of Canada Grant No. 66-9603.

Two techniques for investigating experimentally the generation of noise by turbulent jets using a recently developed method of cross correlation (Siddon, 1971) are described. The first method used, the image technique, cross correlates the pressure on a surface close to the jet with the radiated sound in the far field. This enables the deduction of the acoustic source strength per unit surface area which in turn gives an indication of the approximate location of the sound sources in the jet. The second method directly cross correlates the hydrodynamic pressure fluctuation in the turbulent jet flow with the far field sound, allowing the deduction of the local acoustic source strength per unit volume and the associated power spectral density. F.R.L.

A73-35201 **NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973.** Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, Inc., 1973. 478 p. Members, $12.; nonmembers, $15.

Recent progress in the theory and implementation of aerospace electronics systems is described in papers covering major categories of digital avionics, electronic warfare, navigation, engineering management, signal and sensor processing, digital flight control, integrated electronics, modeling of the human visual system, aerospace systems electrical interfaces, high-power airborne electrical systems, reliability and cost effectiveness, air vehicle related electronics, and airborne reconnaissance. Topics included cover new sensors, antennas, inertial navigation systems, system architecture concepts, on-board digital computers, software development, and design procedures. T.M.

A73-35202 **DAIS - The first step.** J. C. Ruth (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 14-21.

This paper describes a new approach to solving the dilemma facing the avionics system designer. It is based on the information systems approach to the design and development of total on-board avionics systems. This approach has evolved from studies and analyses performed by the Air Force Avionics and Flight Dynamics Laboratories and others starting in the early sixties. During this evolution, it has received various names but it is now known as the Digital Avionics Information System (DAIS). (Author)

A73-35203 **Software - From satan to saviour.** W. L. Trainor (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 22-29. 9 refs.

Characteristic of avionics mission software in present day aircraft systems is that it is unstructured, poorly documented, extremely expensive to modify, and completely dependent upon the specific computer or sensor hardware. This dependency, coupled with the unique and incompatible support (ground-based) software required for each aircraft system, has resulted in expensive software and little or no reuse of avionics software from one aircraft system to another. Trends in avionics systems will focus on the automation of more and more mission functions and the increased use of complex processing hardware, sensors, and displays. These trends to more complex digital avionics systems will result in even more complex software, since the avionics system software embodies the total system behavior and control. (Author)

A73-35204 **System architecture for aircraft avionic and electrical systems.** J. G. Gregory (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 30-36. 10 refs.

A digital mechanization of a systems architecture for the information flow of control and sensor data for on board aircraft systems is described. The architecture provides for a central management of dedicated modular subsystems. The architecture permits dynamic system reconfiguration and redundant combinations to provide fault tolerant electronic systems. The system architecture includes all aspects of aircraft power, flight controls, instrumentation, environmental controls, and weapons/mission payload functions. The architecture permits modularity between different aircraft systems, and modularity between major subsystems aboard the same aircraft. The architecture permits the intelligent interconnection of aircraft subsystems for maximum efficiency, flexibility, modularity, and minimum maintenance. (Author)

A73-35205 **The black box approach - Here to go.** J. A. Hastings (Lockheed-California Co., Burbank, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 37-44.

The conventional black box approach to packaging avionics is costly. It is costly not only in terms of excessive packaging weight, inefficient cooling, and multiplicity of hardware qualification programs, but use of the black box approach inhibits exploitation of new circuit technology, better component cooling and expanded employment of digital avionics. The solution to this problem is to adopt a revolutionary departure from the usual proliferation of black boxes. The approach taken is to modularize and consolidate the electronics packaging into relatively few compartments which, among other things, accommodates the advancing circuit technology and affords better cooling resulting in improved reliability. (Author)

A73-35209 **Solid state null tracking Doppler sensor.** L. Weinberg and J. W. Creutz (RCA, Missile and Surface Radar Div., Moorestown, N.J.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 68-75. 7 refs. Contract No. F33615-71-C-1367.

A need exists for a new generation Doppler radar ground velocity sensor that is highly accurate over the high altitudes and velocity ranges of supersonic weapon delivery aircraft. Precision tactical bombing requires 3-axis velocity estimation within 0.05% with smoothing times of less than 0.5 sec. The Doppler processing must nullify terrain and over-water bias in the central frequency estimation. A low-pass digital equivalent of Smith's null tracker has been designed and tested in a computer simulation. Velocity accuracy of .05% with smoothing times of 0.5 sec was verified at 2000 knots. A digital low-pass filter whose band width varies with aircraft speed is recommended to control sea bias at all speeds. This tracker is approximately three times more accurate and sea bias is reduced to 1% of that for lobe trackers. (Author)

A73-35210 **Calibrating the drift rates of strapdown electrostatic gyroscopes.** A. Andrews (Rockwell International Corp., Autonetics Div., Anaheim, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 76-81. 7 refs.

A technical approach to the problem of calibrating the precession rates of the spin axis of a strapdown electrostatic gyroscope (ESG) is presented. The problem is complicated by the fact that the spin axis is not constrained in direction with respect to its support bearing, and the precession rates depend upon this direction. The virtual work technique is used for modeling the bearing torques on the rotor. This has the advantages that the model equations are applicable to any ESG design, and that the functional form of the model is more transparent than that obtained by the force/lever-arm technique for defining torques. This approach also leads to an appropriate functional analysis for unmodeled torques. The resulting calibration problem is linearized and lends itself to conventional statistical methods. (Author)

A73-35211 **Strapdown inertial navigation practical considerations.** H. Halamandaris (Teledyne Systems Co., Northridge, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 82-91. 7 refs.

This paper delineates a concept of strapdown navigation using dry inertial instruments and a high speed, general purpose digital computer. Distinct life cycle cost advantages are shown for both support-to-acquisition cost and cost-per-flying hour for the strapdown system. Further, the strapdown system is compared to gimbaled systems using dry instruments characteristic of the present technology and floated instruments employed in current systems. Several redundant instrument configurations are presented with their attendant relative merits. The strapdown system imposes additional computer constraints since the attitude matrix must be propagated in real time. Primary constraints are duty cycle and storage requirements. Two basic attitude propagation algorithms are presented. These two mechanizations are direction cosines and quaternions. (Author)

A73-35212 **The LN-33 inertial navigation system.** R. S. Throckmorton (Litton Systems, Inc., Woodland Hills, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 92-95.

The LN-33 inertial navigation system represents the latest production state-of-the-art in airborne inertial navigation hardware. In addition to the simple, low-cost precision instruments representing the most current development in that area, and a miniaturized general-purpose digital computer, it features comprehensive built-in calibration and test capability which minimizes the field maintenance aspects of equipment cost-of-ownership. (Author)

A73-35213 **Austere navigation data processor and display.** D. A. Williams (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 96-100.

In 1972, a study sponsored by the Air Force was performed by Magnavox Research Laboratory, Torrence, California, to define and design an austere navigation data processor and display for use with the ICNI system. The result was a low cost processor and display which can be used with ICNI, DME/TACAN, LORAN or any range/range difference radio navigation system. The system provides accurate navigation for the austere user. (Author)

A73-35218 **Management approach to integration of B-1 avionics system.** T. C. Hall (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 136-142.

Brief discussion of the management approach to integration of avionics subsystems into the B-1 strategic bomber, integration activities, and associated engineering management problems. Interface requirements such as electronic multiplex, avionics multiplex, cooling, central integrated test systems, etc., are discussed with emphasis on the data base and the need for better definition of interface requirements. The effects of transition from newly developed equipment to government-furnished-equipments are also discussed. The avionics flight test program management is described. (Author)

A73-35222 **The application of dedicated processors to digital fly-by-wire flight control systems.** M. L. Sutton and G. M. Soderlund (Lear Siegler, Inc., Santa Monica, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 169-175.

Results of studies carried out to define a primary digital fly-by-wire flight control system. System performance following failures was postulated, and the level of redundancy required to satisfy the system performance was determined. Candidate configurations were defined and evaluated primarily with respect to performance, survivability, reliability, cost, size, and weight. Based on these tradeoffs, a four-channel redundant configuration was selected as the preferred system. The implementation of the redundant system was formulated. Methods for interchannel and intrachannel communication were investigated. Asynchronous control of the redundant processors was selected to avoid problems associated with redundant clock synchronization. A voting and monitoring concept which isolates the faulty unit and prevents propagation of failures between channels was developed. The voter-monitor utilizes a hard-wired algorithm to reduce the program time requirements. (Author)

A73-35223 **Application of the Aerospace Multiprocessor to the A-7D flight control system.** R. R. Summers and G. B. Lamont (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics

Conference, Dayton, Ohio, May 14-16, 1973.
New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 176-181. 14 refs.

The application of the Aerospace Multiprocessor as the flight control computer for a digital fly-by-wire control system for the A-7D aircraft is described. After comparing the characteristics of the Aerospace Multiprocessor with the general requirements for a digital flight control computer, the present A-7D flight control system is discussed, and this is followed by a description of software development. Results of laboratory tests are cited, and conclusions are presented regarding the use of the Aerospace Multiprocessor in a flight control application. (Author)

A73-35224 The effects of sampling rate in digital flight control systems. J. G. McGough (Bendix Corp., Navigation and Control Div., Teterboro, N.J.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 182-191.

Discussion of the effects of sampling rate on (1) intersample ripple, (2) spectral folding and distortion, and (3) system bandwidth, indicating techniques for alleviating these undesirable characteristics without necessarily increasing the sampling rate. It is concluded that intersample ripple and spectral folding effects can be reduced by a judicious choice of sampling rate together with continuous filtering of all inputs and outputs of the digital controller. (Author)

A73-35225 Flight test and demonstration of digital multiplexing in a fly-by-wire flight control system. J. G. Mrazek (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.) and T. D. Lewis (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 192-197.

Airworthy multiplexing hardware was designed, tested, installed, and flight tested in the total inflight simulator aircraft. The purpose of this test program was to demonstrate the adequacy of a preferred multiplexing concept in a real flight environment. A digital data bus concept was employed that included provision for four data update rates: 400, 200, 100, and 50 per sec. Control signals were multiplexed in all three axes of control and in the feel system, side-force, and direct-lift flap loops. The test engineer had the capability to switch the multiplexing in and out of several data paths without informing the evaluation pilot. The pilot was not able to detect the presence of multiplexed signals in the dynamic response of the aircraft or feel system. (Author)

A73-35227 Approaches to custom LSI. W. Chu, J. Doyle, D. Greer, and C. Neugebauer (General Electric Co., New York, N.Y.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973.
New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 203-208.

A study was conducted to obtain a basis for a more effective utilization of custom LSI in low volume avionic systems. The problems which have to be solved for an enhanced employment of custom LSI are discussed together with the principal features of the various LSI technologies. Attention is given to universal array logic approaches, custom chip design by handcrafting, master cell approaches, MOS cell library approaches, full wafer technology, weighting criteria for a comparison of different technologies, and LSI costs. G.R.

A73-35230 An information transfer system design approach for DAIS. B. P. Barnes (Radiation, Inc., Melbourne, Fla.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973.
New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 222-229.

An appeal to the architects of the Information Transfer System (ITS) segment of the Digital Avionics System (DAIS) to reduce information transfer. The information to be transferred within the framework of an air vehicle does not amount to gigabits if care is exercised in partitioning signals into the multiplexed ITS. It is true that if every signal contained in an air vehicle were converted to its digital equivalent in bits per second and these bits per second were added together, the total data rate would be several gigabits. However, this total was allowed to accrue in the absence of a sound partitioning scheme. It is shown how the signals of the candidate DAIS air vehicle con be handled by the combination of a baseband TDM system and a simple video distribution system. The system concept presented is characterized by low technical risk and low cost. It satisfies the goals and objectives set forth for the ITS segment of DAIS. (Author)

A73-35231 Data bus techniques for digital avionics. J. P. Gross, Jr. (SCI Systems, Inc., Huntsville, Ala.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 230-237.

The advent of microminiaturization has led to a new generation of avionics equipment of smaller size and greater complexity, adding to the already significant problems of data transfer within a complex aircraft. This problem has in recent years led to an increasing interest in multiplex data bus techniques for digital avionics. A summary is made of over 35,000 man-hours of study devoted to multiplex techniques for aircraft during the past few years. (Author)

A73-35232 LSI data bus for avionics. L. M. Bello and T. C. Berg (TRW Systems Group, Redondo Beach, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 238-244. 5 refs.

Description of a modular MOS LSI data bus system designed as a solution to integration problems associated with the interconnection of numerous avionics systems and sensors in aerospace vehicles. The system consists of (1) a bus control unit containing a modem to interface with the data bus and logic to interface the modem with a digital processor unit, (2) twisted-pair shielded transmission lines, and (3) remote terminal units which consist of a modem, control logic, and a modular input/output section. By continually monitoring the system status, the digital processor automatically disables faulty remote terminal units and activates the redundant standbys. Control logic and digital output registers were implemented using PMOS LSI. T.M.

A73-35233 Review of different approaches to the standard interface problem. F. L. Pensworth (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 245-252. 7 refs.

Design considerations for a multiplex data bus system for aircraft are described. Five different design approaches to the multiplex data bus and the bus interface unit are reviewed. The parameters and system operation for the five systems are discussed. The results of the review show that a standard multiplex system and a remote terminal can be developed that will work on all data bus systems. A standard remote terminal that can operate on all systems is needed in order to make the data bus systems cost-effective. A sample standard remote terminal is designed and discussed. Recommendations for a Military Standard are made. (Author)

A73-35234 **Integrated digital displays and controls using liquid crystals.** L. E. Tannas, Jr., A. P. Truban, and L. L. Rosen (Rockwell International Corp., Anaheim, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 253-259. 14 refs.

Integrated digital programmable displays and controls offer the solution to a number of problems and limitations which exist in most display and control systems for the digital avionics of today's high-performance aircraft. These problems and limitations can be divided into two general areas - efficiency and flexibility. Each of these areas is examined with the intent of showing how integrated flat-panel digital-matrix displays are needed. The virtues of a flat-panel digital-matrix display are argued. The requirements for such a display are summarized, and available technologies are presented. The unique advantages of liquid crystals as the display medium are shown. Finally, a specific liquid-crystal display approach is described which satisfies all the needs discussed. (Author)

A73-35235 **DIGISPLAY - The flat digital CRT in avionics applications.** J. R. Rusk and B. L. Landrum (Northrop Corp., Palos Verdes Peninsula, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 260-265. Army-USAF-supported research.

The principles of operation of the DIGISPLAY are briefly reviewed, and recent improvements are discussed. The device incorporates a new method for controlling one or more electron beams. Installation of DIGISPLAY in military systems is expected to be substantially easier than conventional CRTs for a number of reasons. The thin configuration minimizes demands for a deep panel. Driving circuitry can be small and remotely located if necessary. The compact configuration is rugged from shock, vibration, and temperature aspects. Test results are presented. Both circuits and tube operation are relatively insensitive to noise and/or voltage fluctuation. Cost of ownership, in general, is discussed. Examples of recently completed devices are presented. (Author)

A73-35236 **Display systems integration through digital avionics.** N. A. Kopchick (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 266-272. 6 refs.

Description of the progress being made toward the implementation of a digitally integrated crew station, noting future trends in computer controlled and generated display systems for airborne application. Preliminary results and recommendations are presented of a recently conducted mission/human performance simulation program in which an advanced (1975-1980 technology) one-man fighter cockpit was used as a baseline. Progress and plans of related development programs are given to demonstrate the feasibility of implementing a realistic prototype system in the 1975-1977 time period. (Author)

A73-35243 **Jet engine malfunction diagnosis - The sensing problem, candidate solutions and experimental results.** J. E. Minnear and W. J. Harris (Garrett Corp., Los Angeles, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 323-328.

A73-35244 **Active flutter suppression - A practical application.** T. E. Noll and L. R. Felt (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 329-334A. 14 refs.

Evaluation of the potential of actively suppressing flutter with automatic, electronic, feedback control systems. A practical application of active flutter suppression technology to prevent wing/external store flutter is presented. Recent, related active flutter suppression programs and future applications and limitations are discussed. (Author)

A73-35245 **Ride control system for the CCV B-52.** R. D. Poyneer and C. R. Stockdale (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 335-340.

This paper summarizes an analytical study conducted by the Control Configured Vehicles (CCV) technical staff to synthesize a CCV ride control system (RCS) for the Load Alleviation and Mode Stabilization (LAMS) B-52 airplane. The RCS is a fully automatic feedback control system designed to reduce the accelerations at the pilot station due to flight through atmospheric turbulence. Atmospheric turbulence transmits energy to the aircraft by exciting its rigid body and structural bending modes. The RCS reduces pilot station acceleration by artificially increasing the damping of the airplane structural modes. The damping is increased by actuating canards proportional to modal velocities. The modal velocities are the integrated signals from accelerometers. (Author)

A73-35246 **Multiplexing in aircraft subsystems.** T. Murrow (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and J. L. Perry (SCI Systems, Inc., Huntsville, Ala.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 343-350.

The Air Force has become increasingly plagued by a proliferation of non-standard avionics equipment. To solve this problem, they are investigating the establishment of standard interfaces based on the use of digital TDM techniques to integrate the avionics equipment. This paper describes the major advantages to be gained through the use of multiplexing, and current Air Force activities directed toward the establishment of multiplexing standards for aircraft subsystems. In addition, it summarizes some of the more important results of a recent Air Force sponsored study concerned with electrical power control signal multiplexing (EMUX), and its relationship to other subsystems in the aircraft. (Author)

A73-35247 **Application of multiplexing to the B-1 aircraft.** J. R. Courter (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 351-354.

The B-1 aircraft employs the use of multiplexing for the transfer of discrete, digital and digitized analog data in three subsystems. The subsystems include avionics, electrical power distribution, and central integrated tests. Each multiplex system is autonomous, employing its own data link and its own data link control. The failure detection and fault isolation procedures are programmed into the computer of the central integrated test subsystem. G.R.

A73-35248 **Expanded built-in-test for advanced electrical systems for aircraft.** J. R. Perkins, H. W. Heinzman, and W. T. Turnage (LTV Aerospace Corp., Dallas, Tex.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference,

Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 355-359.

This paper presents an approach for utilizing the data handling portion of SOSTEL to provide a more complete built-in-test capability for aircraft electrical systems. The SOSTEL system divides the aircraft electrical power distribution system into three basic segments; i.e., signal sources, data handling and power switching. The data handling segment has built-in-test to isolate failures to the line replaceable unit (LRU) processor, multiplexer or demultiplexer. A technique has been evolved, called Switched Impedance BITE, which permits extension of automated testing to the signal sources and power controllers. Major advantages of this technique are simplicity, significant power reductions, and full time testing. The expanded BITE concept, implementation techniques and considerations are discussed along with advantages of the approach. (Author)

A73-35249 Common avionic subsystem considerations. J. G. Gregory and M. A. Geyer (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 360-367. 8 refs.

Westinghouse has performed many studies in digital aircraft subsystems for the power, flight controls, payload, and management. In particular, Westinghouse has concentrated on the methods and problems of integrating these subsystems into aircraft systems for minimum life cycle costs. This paper considers the interfacing needs for the subsystems and discusses operational, functional, and physical considerations for common avionic subsystems. Different aircraft electrical management subsystem designs are used for examples of integration problems which can be encountered in electrical and electronic systems in aircraft. (Author)

A73-35250 Computer analysis of the influence of solid state distribution on aircraft power generation. W. U. Borger (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 368-373. 5 refs.

The newly developed aircraft solid state electrical distribution system has electrical characteristics entirely different than the characteristics of conventional aircraft electrical distribution systems. To determine how the characteristics of the new distribution systems affect the aircraft power generation system, a detailed study program was begun. The basic analysis tool in the study is the digital computer. All fundamental components of both the solid state distribution system and the conventional distribution system are modeled mathematically. These models include generators, loads, overload protection equipment, and feeders. The modeling stage of the program has been completed and work is presently being done on the computer analysis phase. (Author)

A73-35252 U.S. SST electrical power system test program. W. A. Crossgrove and A. W. Schmidt (Boeing Commercial Airplane Co., Seattle, Wash.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 380-387.

The system under test consists of four variable-speed, constant-frequency ac sources and a dual channel standby system. The test system is uniquely designed to satisfy the power requirements of fail-operative flight-critical systems. Compatability with these systems is achieved by means of the split-isolated power system configuration, the standby system logic, and by design features to accommodate load equipment with dual (redundant) input power provisions. The fail-operative phase of the test program included a test and demonstration of the ability to maintain flight-critical functions. (Author)

A73-35253 150 KVA integrated drive generator for aircraft electrical systems. P. J. Strick (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 388-392.

Large capacity electrical power generating systems are now available as a result of an Aeronautical Systems Division component improvement program. Two systems are presently available which are more reliable and lighter in weight as compared to existing 120 KVA power generating systems. Only one of these systems, the Sundstrand system which uses an integrated drive generator (IDG) is discussed in this paper. Test results to date show that it is feasible to use 150 KVA power generating systems in existing and future aircraft systems. (Author)

A73-35254 Features of a high voltage airborne superconducting generator. J. L. McCabria and C. C. Kouba (Westinghouse Electric Corp., Aerospace Electrical Div., Lima, Ohio). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 399-402. Contract No. F33615-71-C-1591.

The strong magnetic field in a superconducting generator makes it possible to build an armature with a very high voltage rating. The features of the armature which are compatible with the generation of a high terminal voltage are the absence of magnetic steel between the coils, the presence of an insulating oil, and the isolation of the conductors of the same phase into a separate group. A design concept of a superconducting generator with a 5 MW, 37 kW rating is described. (Author)

A73-35260 Parts standardization - A computerized approach. G. W. Wood (Aerojet Electrosystems Co., Azusa, Calif.). In: NAECON 73; Proceedings of the National Aerospace Electronics Conference, Dayton, Ohio, May 14-16, 1973. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 443-451.

Standardization of parts and components for new design purposes is one of the most practical approaches for satisfying current pressures for reduced cost of procurement, increased reliability, and reduced logistics and warehousing problems. Optimal selection of parts and components for new designs now requires a comprehensive but systematic approach such as a large computer makes possible. A computerized approach suitable for a medium-sized company is discussed, including the establishment of selection criteria, preparation of raw data, processing, and final parts selections. Relative costs, availability information, performance feedback, handling of nonstandard parts, and updating of selections are also covered. A sample of a computerized data search tab run is included and described. (Author)

A73-35303 Techniques for digital-microwave hybrid real-time radar simulation. G. E. Richmond, D. L. Lange, and B. C. Pierstorff (Calspan Corp., Buffalo, N.Y.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 18/3-1 to 18/3-9. Contracts No. F33615-70-C-1600; No. F33615-70-C-1373; No. F33615-68-C-1319.

An attempt is made to examine some specialized problems in high speed, real-time hybrid physical simulation in terms of the techniques involved in partitioning the problem to obtain real-time

operation with large scale problems and the various possibilities of hardware and software implementation which bear on the realization of a successful simulation. The problem treated is the development of a methodology for examining the high degree of interactions which occur when a network of air defense radars coordinated by a command-and-control system are penetrated by a significant number of aircraft, all attempting to jam or deceive the combined radar command-and-control system in order to deny it information or to confuse its operators. F.R.L.

A73-35309 **B-1 aircraft electrical multiplex system.** J. I. Ohlhaber (Harris-Intertype Corp., Melbourne, Fla.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 10/3-1 to 10/3-8. USAF-supported research.

The B-1 multiplex system performs three separate and generally independent system functions. The avionics multiplex (AMUX) is generally used to extend the avionics processor's input and output capability, and to provide a standard interface for the avionics equipment. The central integrated test system (CITS) is the smallest of these systems from a multiplexing standpoint with only approximately 1000 inputs. However, the primary role of CITS is processing these data along with the EMUX and AMUX data to determine aircraft status. The electrical multiplex (EMUX) functions outnumber those of both the AMUX and CITS. Only system elements associated with the EMUX and AMUX are mission critical and, therefore, are redundant and nuclear hardened, but the three systems all use the same standardized data and transmission word formats. F.R.L.

A73-35329 **High frequency vibration of aircraft structures.** B. L. Clarkson and D. J. Mead (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 28, June 8, 1973, p. 487-504. 53 refs.

Review of the development of research on high-frequency vibration of aircraft structures over the past twenty years, with emphasis on both fundamental and applied aspects. Topics discussed include the vibration of stiffened skin panels, the vibration of curved panels, the vibration of skin-rib structures, the damping of structures, wave propagation in periodic structures (including infinite one-dimensional structures, finite structures, and two- and three-dimensional structures), vibration design data, the dynamic properties of carbon-fiber-reinforced plastics, and acoustically induced fatigue crack propagation in centrally cracked panels with uniaxial and biaxial loading and in edge cracked panels. A.B.K.

A73-35331 **Fundamentals of aerodynamic sound theory and flow duct acoustics.** P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 28, June 8, 1973, p. 527-561. 53 refs.

Some fundamental aspects of the theory of internally generated sound (or 'sound generated aerodynamically') are reviewed and discussed. Particular stress is laid on the functional relationships between the radiated sound field and the equivalent source distribution of Lighthill's 'acoustic analogy' model, as exposed by multipole analysis. Recent theoretical and experimental progress in both turbulent mixing region noise and flow duct acoustics is cited, and discussed in the context of its fundamental implications for the future development of 'aerodynamic noise' theory. (Author)

A73-35332 **Jet noise.** M. J. Fisher, P. A. Lush, and M. H. Bourne (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 28, June 8, 1973, p. 563-585. 15 refs. Research supported by the Rolls-Royce, Ltd., National Gas Turbine Establishment, and Science Research Council.

Review of the results obtained in three major categories of jet noise studies - namely, studies of pure jet mixing noise, shock-associated noise studies, and excess or tailpipe noise studies. Jet noise mixing data obtained in an anechoic environment are presented for cold subsonic jets, showing that the Lighthill concept of a convected source model for jet noise offers a valid prediction or scaling law method only under certain conditions. In addition, the results of studies of the effects of temperature on jet mixing noise are also presented. In connection with shock-associated noise, findings regarding the dependence of overall levels and the spectral characteristics of this noise are evaluated. As for the excess noise source, it is suggested that the actual mixing noise is increased not only by this source but also by the disturbances originating from the separated flow region. A.B.K.

A73-35333 **Rotating blades and aerodynamic sound.** C. L. Morfey (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 28, June 8, 1973, p. 587-617. 180 refs.

The history of research on rotating blade noise is reviewed, from early studies of propeller radiation to current work on aircraft-engine fans. The survey is selective, with emphasis on fundamental aspects of aerodynamic sound generation by blades. The topics covered include the following: early research on propeller noise, unsteady airfoil theory, acoustic radiation and cut-off, aerodynamic sound generation, scattering by airfoils at arbitrary chord/wavelength ratios, boundary layer and vortex shedding noise from airfoils, broadband noise due to incident turbulence, high-order rotational noise from isolated rotors, rotor/tip-vortex interaction, interaction between moving blade rows, sound transmission through blade rows, the instantaneous Kutta condition, supersonic rotor noise, in-duct measurement techniques, and centrifugal flow machines. (Author)

A73-35334 **Test facilities, techniques and instrumentation.** R. G. White, M. J. Fisher, and J. F. W. Berry (Southampton, University, Southampton, England). *Journal of Sound and Vibration*, vol. 28, June 8, 1973, p. 619-630. 26 refs.

Description of some specialized test facilities for acoustic and vibration testing, and review of some recent advances in experimental test techniques. The facilities described include a subsonic boundary layer wind tunnel, acoustic fatigue ducts, and facilities for measuring the behavior and performance of acoustic duct lining materials. Also described are two adjoining reverberation rooms, which can be linked through a common opening to form a transmission suite, an anechoic chamber capable of providing measurements of pure jet noise down to velocities as low as 300 ft/sec, a fan noise laboratory, and rotor noise rigs. The experimental techniques reviewed include optical techniques for flow studies, in particular, the use of crossed-beam schlieren systems, and a transient technique for structural testing. A.B.K.

A73-35421 **Reflection coefficients for wires and cables at 10.6 microns.** C. L. Hayes and R. A. Brandewie (Rockwell International Corp., Anaheim, Calif.). *Applied Optics*, vol. 12, July 1973, p. 1564-1569. Army-supported research.

Measurements are given of the reflectivity coefficient for a variety of wires and cables at 10.6 microns. The results are presented as a function of wire incidence angle for two polarizations, parallel and perpendicular to the samples. The normal incidence reflectivity is very high, ranging from 610% for aluminum wire down to 16.8% for hemp rope in parallel polarization. The perpendicular polarization results are lower by a factor that varied from 5.9 to 2.04. Depolarization by the wires was also determined. The depolarization ratio was found to vary between 17.7% and 1%, being larger for the more irregular samples. The results indicate that a wire avoidance system could be developed for airplanes or helicopters using scanning 10.6-micron laser and coherent receiver. (Author)

A73-35442 # **Trends in flight-test strain-gage instrumentation.** R. W. Troke (Lockheed-California Co., Burbank, Calif.).

Society for Experimental Stress Analysis, Spring Meeting, Los Angeles, Calif., May 13-18, 1973, Paper. 13 p.

Airborne strain-gage systems are examined from the standpoint of optimum application to meet modern-day measurement requirements. Alternatives open to the instrumentation engineer and comparative advantages found from actual experience are presented. These are discussed for the primary areas in which strain-gage instrumentation can be improved: installation, calibration, data recording, and data reduction. The increased use of computers and computer technology is discussed, and the effect of this increased use of computers upon instrumentation is examined. Emerging techniques and present-day instrumentation trends are presented. (Author)

A73-35443 # **Test on fuselage models at reduced sizes.** R. Verny (Avions Marcel Dassault, Vaucresson, Hauts-de-Seine; Breguet Aviation, Vélizy-Villacoublay, Yvelines, France). *Society for Experimental Stress Analysis, Spring Meeting, Los Angeles, Calif., May 13-18, 1973, Paper.* 55 p.

Summary of the procedures employed and results obtained in stress analyses of aircraft structures with the aid of reduced-scale photoelastic resin models. Emphasis is placed on tests carried out to provide experimental stress distributions for window frames, emergency exit frames, and fuselage center sections at the wing/fuselage attachment of the short-haul Mercure aircraft prototype. Various tests demonstrated the reliability of results obtained by studying photoelastic models of the aircraft structure. Savings in time and costs are evaluated. T.M.

A73-35444 * # **Strain gage installation on the YF-12 aircraft.** E. J. Wilson (NASA, Flight Research Center, Edwards, Calif.). *Society for Experimental Stress Analysis, Spring Meeting, Los Angeles, Calif., May 13-18, 1973, Paper.* 16 p. 5 refs.

A flight-loads measurement program on the YF-12 aircraft required the mounting of 101 strain-gauge bridges in the fuselage, fuel tanks, control surfaces, and three stations on the left wing. The sensors were to be installed primarily on titanium and were required to operate between -70 and +600 F. Strain gauges with modified Karma filaments and backings of glass-fiber reinforced epoxy resin matrices were selected and were installed with an epoxy adhesive. Attention is given to the calibration, mounting, and performance of the sensors in flight-load measurements. T.M.

A73-35468 * # **Effect of premixing on nitric oxide formation.** D. N. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Chemical Engineers, National Meeting, 75th, Detroit, Mich., June 3-6, 1973, Paper.* 14 p. 7 refs.

Emissions from a simple 10-cm diameter tube combustor burning a premixed, gaseous propane/air mixture were measured. Inlet conditions included a temperature of 590 K, pressure of 5.5 atm, and reference velocity of 23 m/sec for a range of equivalence ratios from the lean limit to slightly richer than stoichiometric. A nitric oxide emission index of 1 g NO2/kg fuel was measured for an equivalence ratio of 0.57. (Author)

A73-35469 * # **The use of hydrogen for aircraft propulsion in view of the fuel crisis.** S. Weiss (NASA, Lewis Research Center, Aerospace Safety Research and Data Institute, Cleveland, Ohio). *NASA Research and Technology Advisory Committee on Aeronautical Operating Systems, Meeting, Ames Research Center, Moffett Field, Calif., Mar. 7, 8, 1973, Paper.* 37 p. 73 refs.

In view of projected decreases in available petroleum fuels, interest has been generated in exploiting the potential of liquid hydrogen (LH2) as an aircraft fuel. Cost studies of LH2 production show it to be more expensive than presently used fuels. Regardless of cost considerations, LH2 is viewed as an attractive aircraft fuel because of the potential performance benefits it offers. Accompanying these benefits, however, are many new problems associated with aircraft design and operations; for example, problems related to fuel system design and the handling of LH2 during ground servicing. Some of the factors influencing LH2 fuel tank design, pumping, heat exchange, and flow regulation are discussed. (Author)

A73-35477 # **Aerosat and Marsat, satellites for mobile services (Aerosat und Marsat, Satelliten für mobile Dienste).** H. C. Freiesleben and H. J. Wollak (Standard Elektrik Lorenz AG, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Nachrichtensatelliten, Stuttgart, West Germany, May 16, 17, 1973, Paper.* 10 p. In German.

Solely satellites in stationary orbits have been considered for aeronautical and maritime satellite applications. Aeronautical applications are mainly concerned with a surveillance of the transatlantic air traffic as a basis for a reduction of the distance to be kept for reasons of safety between two aircraft. Aspects of communications are principally important in the case of ships crossing the ocean because of the much longer times involved. The frequency range from 4 to 6 GHz has been considered for the transmission of messages between ground stations and satellites. G.R.

A73-35583 # **Processing of aircraft data.** A. Rodi, D. Frey, and L. A. Sherretz (National Center for Atmospheric Research, Boulder, Colo.). *Atmospheric Technology,* Mar. 1973, p. 71-74.

Description of functions performed by the NCAR Aircraft Recording Instrumentation System (ARIS) ground station in playing back, decoding, and reformatting recorded airborne measurements of atmospheric parameters for further processing by high-speed computers. The digitized airborne data which are serially recorded in bi-phase-mark format on individual tracks of half-inch magnetic tape are converted to the standard, industry-wide, seven-track gapped tape in NRZI format. The computer-compatible tapes are then processed by a computing facility using a flexible program designed to handle the peculiar input and output requirements of ARIS. The computer programming steps are functionally described, and examples of final output display options are illustrated. T.M.

A73-35625 # **Aircraft turbine engine exhaust emissions under simulated high altitude, supersonic free-stream flight conditions.** R. C. German, C. E. Robinson, M. D. High, and R. F. Lauer (ARO, Inc., Propulsion Wind Tunnel Facility, Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics and American Meteorological Society, International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, Denver, Colo., June 11-13, 1973, AIAA Paper 73-507.* 10 p. 9 refs. Members, $1.50; nonmembers, $2.00.

The exhaust emissions were measured in the exhaust plume of a J85-GE-5 turbojet engine as part of an investigation to determine the impact on the climate of flying a fleet of supersonic aircraft in the stratosphere. Measurements were made at three axial stations (0.22, 9.3, and 19.9 nozzle diameters) downstream of the nozzle exit for both military and partial afterburning power at Mach numbers and simulated altitudes of Mach 1.6/55,000 ft and Mach 2.0/65,000 ft. A continuous sampling technique was used to measure carbon dioxide, carbon monoxide, total unburned hydrocarbons, oxides of nitrogen, and particulates. The results represent the only available full-scale turbojet engine emission data to date which have been obtained at simulated high altitude with a supersonic external stream. (Author)

A73-35665 # **The possible future of air transport and the airports (Futuro posible del transporte aéreo y de los aeropuertos).** V. Cudos Samblancat. *Ingeniería Aeronáutica y Astronáutica,* vol. 25, Jan.-Feb. 1973, p. 7-21. In Spanish.

It is pointed out that within a period of less than ten years commercial aviation generally undergoes significant changes. A considerable extension and modernization of air cargo service is predicted in addition to the continuing growth in air passenger service. Whether these predictions will come true in the case of medium-range air transportation will depend to a large degree on developments affecting the competitive position between aircraft and surface transportation. Problems which have to be solved in connection with the growing air traffic include access difficulties, noise problems, traffic congestions, harmful effects of air traffic on the environment, delays, and financial problems. The changes produced in air traffic patterns by supersonic aircraft, VTOL, and STOL are also examined. New developments in airport design are considered, giving particular attention to Spanish airports. G.R.

A73-35666 # **The C-401, a STOL transport for many applications (El C-401, un transporte STOL de usos multiples).** J. L. López Ruiz and J. A. Martínez Cabeza (Construcciones Aeronáutica, S.A., Madrid, Spain). *Ingeniería Aeronáutica y Astronáutica*, vol. 25, Mar.-Apr. 1973, p. 24-32. In Spanish.

The first prototype of the C-212 made its first flight on March 26, 1971. The aircraft can carry a maximum cargo of 2000 kg. Because of the excellent qualities of the aircraft, it was decided to develop a bigger STOL for the Spanish armed forces on the basis of the experience obtained with the C-212. The new aircraft, the C-401, is to be designed as a military transport with the capability to carry a cargo of 5500 kg. At the end of a flight covering its intended range of 2500 km, the aircraft is to retain a fuel reserve for a distance of 500 km. The principal design data of the aircraft are discussed together with the performance characteristics, similar projects in other countries, and details of the development program. A number of graphs and design sketches is provided in order to illustrate versions of the aircraft for different applications. G.R.

A73-35697 **Dependence of sidelobe level on random phase error in a linear array antenna.** B. Kulke (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). *IEEE Transactions on Antennas and Propagation*, vol. AP-21, July 1973, p. 569-571. 5 refs.

The observed sidelobe level of a linear array antenna is predicted approximately by assuming a computationally simple, uniform distribution of phase error, and the effect of this phase error is shown to mask the effect of an occasional isolated element failure. The assumed level of phase error was deduced from phase measurements in the feed network. (Author)

A73-35700 **Ground and flight test results for standard VOR and double parasitic loop counterpoise antennas.** D. L. Sengupta and J. E. Ferris (Michigan, University, Ann Arbor, Mich.). *IEEE Transactions on Antennas and Propagation*, vol. AP-21, July 1973, p. 576-579. 8 refs. U.S. Department of Transportation Contract No. FA69WA-2085. FAA Project 330-001-03N.

Results of ground and flight tests carried out at 109 MHz to study the vertical plane radiation patterns of standard VOR and double parasitic loop counterpoise antennas above ground are discussed. The ground tests consist of the measurement of the fields produced in the quasi-radiation zone of the test antenna. The flight tests consist in measuring the far field with the help of an aircraft flying at a constant altitude along chosen radial paths to and from the test antenna. The reduced test results are compared with available theoretical values. (Author)

A73-35762 * # **An inexpensive technique for the fabrication of two-dimensional wind tunnel models.** D. J. Collins (California Institute of Technology, Jet Propulsion Laboratory, Physics Section, Pasadena, Calif.). *Review of Scientific Instruments*, vol. 44, July 1973, p. 855, 856. Contract No. NAS7-100.

Description of a new and inexpensive method for fabricating thin, two-dimensional, spanwise-uniform airfoil models with a high density of instrumentation for aerodynamic testing at transonic speeds. The models are produced by casting an epoxy fairing, which provides the desired aerodynamic properties, around a central spar on which all instrumentation has been mounted. T.M.

A73-35807 # **Certification program for the DC-10 slide/raft.** W. H. Shook (Douglas Aircraft Co., Long Beach, Calif.). *SAFE Engineering*, vol. 3, 1st Quarter, 1973, p. 6-8.

A73-35808 # **A new approach to aircraft exterior lighting.** J. K. Crosley (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, Ala.). *SAFE Engineering*, vol. 3, 1st Quarter, 1973, p. 14-16.

Discussion of ways and means of improving aircraft (primarily helicopter) conspicuity in daytime, particularly in CAVU weather. Providing ample visual anticollision warning during daytime operations is shown to be achievable with the aid of exterior lighting mounted on the aircraft, and/or conspicuous paint or tape schemes applied to the exterior of the aircraft. Recent studies and developments concerning aircraft conspicuity are reviewed. M.V.E.

A73-35826 **A simulation study for the design of an air terminal building.** S. Eilon and S. Mathewson (Imperial College of Science and Technology, London, England). *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC-3, July 1973, p. 308-317. 18 refs.

The use of simulation in the design of an airport passenger terminal building is considered. Results from a typical study are shown and discussed. The conclusion is drawn that whereas a conventional simulation approach offers many advantages in describing reality, the cost and complexity of analysis make it an impractical operative tool. Instead, a simpler method is suggested which may be used in conjunction with simulation or in its own right. The implications of this method are discussed in regard to (1) design and evaluation of a model; (2) reduction of variance and improved efficiency in use of simulation; and (3) integrated real-time management/computer control. (Author)

A73-35841 **Emerging aerospace materials and fabrication techniques.** A. Olevitch (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *SAMPE Quarterly*, vol. 4, July 1973, p. 24-36.

Serialized compilation of some of the findings and information generated by the materials and manufacturing technology research and development program of the Air Force Materials Laboratory. Manufacturing processes, limitations, applications, availability, and sources for additional information are outlined for a number of metal and nonmetal materials, products, and treatments. The latter include electro-slag remelting, hydraulic tube joining, samarium-cobalt magnets, gallium arsenide, and solid lubricating compacts. M.V.E.

A73-35851 **Hydraulic controls for V/STOL aircraft.** K. F. Becker and L. H. Mathis (Sperry Rand Corp., Vickers Div., Troy, Mich.). *Sperry Technology*, vol. 1, no. 3, 1973, p. 11-16.

Two decades of work on vertical and short take-off and landing (V/STOL) concepts have produced an extensive body of technology now being directed toward short-haul transportation problems. Much interest today centers on turbofan powered transports using various jet-flap configurations to provide STOL performance. In particular, attention is focused on two promising jet-flap concepts: the blown flap (internal and external) and the augmentor wing. Further study is required to determine which of these propulsive lift systems will be

the best. The question will be resolved in part by experimental STOL transport aircraft programs now in process by NASA and others. (Author)

A73-35852 **Metering and spacing.** K. P. Manning and C. A. Hall (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). *Sperry Technology*, vol. 1, no. 3, 1973, p. 17-21.

The stop-gap approach to traffic density near airports has simply provided more of the same thing that has been around for years - surveillance radar, legions of air traffic controllers, an aircraft quota system, and thousands of hours of holding time. Without question the scope of the problem is vast, encompassing enroute operations as well as the facilities and airpace near airports. But the problems related to airport congestion are more serious. The task of smoothly converting from a random to orderly flow of aircraft at runway approach is made even more complex by the speed variations (up to one hundred knots) with which different kinds of aircraft approach the runway, the varying capabilities of airborne equipment, and the interference of departing aircraft. An important answer to these problems may be the application of metering (time navigation) and spacing (vertical navigation) techniques, currently under FAA-sponsored development. (Author)

A73-35853 * **Navigation, guidance, and control systems for V/STOL aircraft.** S. S. Osder, W. E. Rouse (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.), and L. S. Young (NASA, Ames Research Center, Moffett Field, Calif.). *Sperry Technology*, vol. 1, no. 3, 1973, p. 34-41. Contract No. NAS2-6567.

The development of digital autopilots and integrated avionics systems, applicable to many classes of vehicles and missions, was undertaken by Sperry Flight Systems in the mid-sixties. The first application of the system was planned for automatic flight control in the U.S. supersonic transport; the termination of that program, however, thwarted any flight experience. The second application, which has additional navigation and energy management functions, is an airborne simulator of the space shuttle vehicle. The latter system underwent a series of successful flight tests in a CV-990 aircraft under contract with NASA. The third application, which has new electronic displays, air data computation, and time-constrained guidance (i.e., specified position and altitude at a specified time), is in the DOT/NASA STOLAND test program. The STOLAND system is described specifically in this paper. (Author)

A73-35854 **The aerodynamics of high speed ground transportation.** A. G. Hammitt. North Hollywood, Calif., Western Periodicals Co., 1973. 448 p. 37 refs. $29.50.

Aerodynamic forces are considered together with aerodynamic vehicle interactions, aspects of vehicle propulsion, air cushion aerodynamics, effects of forward speed on air cushion aerodynamics, and questions of the stability of an air cushion vehicle. Other subjects examined include blowers, ducts, vehicles in tunnels and tubes, flow about a vehicle in a tube, flow caused by vehicles in tubes, numerical solutions to tube vehicle aerodynamic problems, tube vehicle aerodynamic testing, and selected problems of the opened-end tunnel. Aspects of subway ventilation and environment are also discussed, giving attention to station environment and ventilation along with the evacuated tube environment. G.R.

A73-35870 # **The Tu-134 aircraft: Its design and operation (Samolet Tu-134: Konstruktsiia i ekspluatatsiia).** V. A. Borodenko and L. V. Kolomiets. Moscow, Izdatel'stvo Transport, 1972. 367 p. In Russian.

A detailed description of a Soviet two-engine turboprop jet airliner carrying a commercial payload up to 7700 kgf over 1970 km range, or 4000 kgf over 3380 to 3570 km, at a cruising speed from 770 to 870 km/hr. The airframe sections, landing gear, control systems, hydraulic equipment, power plant, fueling system, engine startup operation, high altitude systems, fire-fighting and anti-icing equipment, and passenger cabin of the airliner are covered. A brief description of the Tu-134 aircraft is also given. The preflight inspection procedure of the Tu-134 is appended. V.Z.

A73-35912 # **Development of methods of forecasting meteorological conditions for aviation (Razvitie metodiki prognozov meteorologicheskikh uslovii dlia aviatsii).** N. V. Petrenko (Glavnoe Upravlenie Gidrometeorologicheskoi Sluzhby SSSR, Gidrometeorologicheskii Nauchno-Issledovatel'skii Tsentr, Moscow, USSR). In: All-Union Meteorological Conference, 5th, Leningrad, USSR, June 21-25, 1971, Transactions. Volume 2. Leningrad, Gidrometeoizdat, 1972, p. 149-160. 61 refs. In Russian.

Methods developed in the USSR for forecasting the principal meteorological elements at airports and along airways are reviewed. The parameters which influence the forecasting of the lower cloud boundary are examined, and methods of forecasting over periods from 3 to 12 hours and from 1 to 3 hours on the basis of data concerning the synoptic and thermodynamic conditions of the formation and evolution of low cloudiness and the determination of its statistical characteristics are described. V.P.

A73-36063 **A contribution to the further development of pulse jet engines (Ein Beitrag zur Weiterentwicklung von Pulsationstriebwerken).** G. Heise (Dornier AG, Langenargen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 21, June 1973, p. 189-195. 13 refs. In German. Research supported by the Bundesministerium der Verteidigung.

Comparison of the characteristics of pulse jet engines and turbojet engines, and description of simulation studies carried out with an experimental pulse jet engine. It is shown that pulse jet engines in the thrust category below 500 daN have a number of advantages over turbojet engines, but, due to the interaction between the unsteady gas motion and the combustion process, the speeds attainable with these engines do not exceed 800 km/hr. Results of studies of an experimental pulse jet engine in a simulated flight Mach number range from 0 to 1.5 are presented which show that the above-mentioned speed limit in the case of pulse jet engines can be significantly exceeded. A.B.K.

A73-36066 **Alteration of a static vibration result by rigidizing some degrees of freedom (Änderung eines Standschwingungsresultats beim Erstarrenlassen einiger Freiheitsgrade).** K. Mitteilung (Saab-Scania AB, Linkoping, Sweden). *Zeitschrift für Flugwissenschaften*, vol. 21, June 1973, p. 213-215. 5 refs. In German.

Description of a procedure by means of which it is possible to calculate from measured static vibration modes of an aircraft new eigenmodes in which prescribed parts are rigidly connected to the main structure. In the first stage of this procedure, the static vibration results are altered by a calculation in such a way that the above-mentioned parts appear rigidly connected to the main structure. In the second stage, these parts are each attributed their own degrees of freedom. This procedure is shown to be useful in flutter calculations when it is necessary to vary control stiffnesses or to take into account powered controls and automatic flight control. A.B.K.

A73-36067 # **DHC-7 - The first good neighbour transport aircraft.** A. F. Toplis (de Havilland Aircraft Company of Canada, Ltd., Downsview, Ontario, Canada). *Aircraft Engineering*, vol. 45, June 1973, p. 4-10, 12, 13. 7 refs.

The DHC-7 will be the first aircraft which will not intrude on the everyday existence of communities, and will require airports of only tens of acres in size. The DHC-7 is a high wing, four-engined turboprop aircraft with a 48 seat capacity. The special qualities that make it environmentally acceptable are its quietness, cleanliness, and STOL capability. Experience has shown the benefits of increased glide path angle in reducing the dispersion of the touchdown point. Beta control, a means of controlling the propeller blade angle

directly from the power lever while the propeller rpm is maintained at high angle, is a rapid and effective means of changing gradient. Lateral control and ground deceleration systems are discussed, and the landing gear, brakes, fuselage, wing, empennage, and powerplant are described. F.R.L.

A73-36069 # Mathematical method for calculating the optical characteristics of cone-shaped cockpit windscreens. H. Kohler (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Aircraft Engineering,* vol. 45, June 1973, p. 18-21.

When designing the windscreen geometry of the VFW 614, special importance was attached to the analytical determination of light deflection by cone-shaped windscreens. In order to define the permissible amount of deflection for the pilot, it was necessary to establish which deflections occur with any given geometry. Furthermore, comparison enables the theoretical calculation to be checked against the optical quality of the manufactured windscreen and determine which deflections are caused by the curvature and which by the production process. A method of calculating light deflection is developed which, when applied to windscreens which comprise segments of slant circular cones, can determine the inner and outer contours. The result gives the light deflection for the entire windscreen area. The cone geometry parameters can be varied in such a way that a windscreen of optimum optical quality is obtained so that the light deflections are defined within a given range of values. F.R.L.

A73-36071 # Differential temperature measurements in engine fluids. L. H. Eccles and W. F. Rubart (Boeing Co., Seattle, Wash.). *Aircraft Engineering,* vol. 45, June 1973, p. 27, 29.

A method of measuring temperature differentials as low as 2.5 C with an electronic circuit utilizing platinum probes is described. Two platinum element probes are connected in series and driven by a constant current generator. An electronic circuit holds the midpoint of the probes at virtual ground, minimizing common mode voltages across the probes. A differential amplifier provides an output proportional to the differential temperature. The mismatching and nonlinearity of the platinum sensors is compensated. Voltage sensed across one probe provides an outlet proportional to the temperature of the medium. F.R.L.

A73-36075 # Satellite systems for civilian vehicle traffic control. B. P. Miller (RCA, Astro-Electronics Div., Princeton, N.J.). *AIAA, ASME, and SAE, Joint Space Mission Planning and Execution Meeting, Denver, Colo., July 10-12, 1973, AIAA Paper 73-583.* 6 p. 5 refs. Members, $1.50; nonmembers, $2.00.

During the next decade, satellite systems will be developed to provide traffic control services for nonmilitary users. These systems will eventually provide communications, navigation, and surveillance services for civilian aircraft and ships, and could be extended to certain land vehicles. The common characteristic of these systems will be the use of a synchronous satellite to transfer data between moving vehicles and fixed locations. An analysis of user requirements and the growth capabilities of existing systems leads to the conclusion that synchronous satellites will play a dominant role in the future of traffic control of ships and over-the-ocean aircraft. (Author)

A73-36158 Computation of three dimensional flows about aircraft configurations. F. Marconi and M. Salas (Grumman Aerospace Corp., Bethpage, N.Y.). *Computers and Fluids,* vol. 1, June 1973, p. 185-195. 13 refs. Navy-supported research. NR Project 61-191.

The object of this paper is to describe an accurate and efficient numerical procedure to compute the supersonic inviscid flow field about complicated three-dimensional aircraft configurations and to demonstrate how the technique works in a practical case. A two level second order marching scheme is used to integrate Euler's equations in regions where the flow is continuous. Shocks are, however, treated explicitly as discontinuities satisfying the Rankine-Hugoniot equations. Use is made of conformal mappings in order to provide proper resolution in critical areas. Results are presented for several three-dimensional flow field computations including a complete aircraft and the results are compared with experiments. (Author)

A73-36165 # Influences of international operations on aircraft-transport design /Second William Littlewood Memorial Lecture/. J. G. Borger (Pan American World Airways, Inc., New York, N.Y.). *Astronautics and Aeronautics,* vol. 11, July 1973, p. 24-34.

The extensive use of a medium of transportation underscores its operational sensitivities. Some of these are discussed in international terms, i.e., routes, power-plants, fuels, safety, noise, navigation and communications, crews, government influences, economics, and payload accomodations. 'International' is defined in geographic rather than political terms. The international operator may gain some economic advantage if he can exert the full utilization potential of his longer flights. Full utilization usually argues high density seating. The airline's customers, passengers or shippers, may be the ultimate judges of the true quality of a transport airplane. Some comments are made on future developments. F.R.L.

A73-36166 # The next careful steps in commercial aircraft structures. P. L. Sandoz (Boeing Co., Seattle, Wash.). *Astronautics and Aeronautics,* vol. 11, July 1973, p. 38-47.

In forecasting the structural design of future transports it is necessary to obtain the maximum benefit from new materials and fabrication processes, yet preserve the durability and fail-safe characteristics of contemporary transports. The value of durability shows up in low maintenance costs and airplane availability for high duty utilization rates. Service experience has demonstrated the soundness of current industry fail-safe practice. The 747 program, which illustrates an interpretation of this general requirement, is described. Bonded wing structure would pare 800 lb from the weight of an airplane. Advanced composites offer another opportunity for significantly improving the structural efficiency of commercial aircraft. Use of titanium is discussed. F.R.L.

A73-36167 # Tomorrow's structural engineering. D. S. Warren (Douglas Aircraft Co., Long Beach, Calif.). *Astronautics and Aeronautics,* vol 11, July 1973, p. 48-55. 13 refs.

Every area of structural technology can expect significant developments in the next decade. A supersonic transport and aircraft incorporating innovations such as high-lift devices and a supercritical wing will make new demands on structural design. In addition, designers will want to develop greater capabilities to take advantage of new resources, particularly continued rapid evolution in computers and operating systems. The anticipated technology escalation in five major fields of structural engineering are summarized. These are automation by computer, matrix structural technology, aeroelasticity methods that include quasi-static loads, integrated design/analysis systems, and direct structural synthesis. F.R.L.

A73-36168 * # Developing structures technology for the day after tomorrow. G. W. Brooks (NASA, Langley Research Center, Loads, Structures and Materials Div., Hampton, Va.). *Astronautics and Aeronautics,* vol. 11, July 1973, p. 56-66. 11 refs.

To prepare for new demands on aircraft structures, NASA has established a number of goals. These include automatic analysis and design, building confidence in advanced composites, improving the technology base for future supersonic and hypersonic vehicles, validating concepts for active controls, developing methods for predicting aircraft loads and aeroelasticity, and generating design methods for assuring structural integrity. Progress made in achieving these goals is discussed in detail. F.R.L.

A73-36169 # **Understanding the USAF structural integrity program.** G. P. Haviland and C. Tiffany (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics*, vol. 11, July 1973, p. 67-70.

The structural requirements of the USAF as defined by MIL-STD-1530 have taken final form and have four basic requirements. These are to produce and evaluate operational data to determine the service life of airplane systems, to acquire and evaluate operational data to maintain a continuous record of in-service integrity, to provide a basis for determining logistics and force planning requirements, and to provide a basis for improving structural criteria and methods of designing, evaluating, and substantiating future systems. Application of the requirements to various aircraft is discussed. F.R.L.

A73-36190 * # **Engine-over-the-wing noise research.** M. Reshotko, J. H. Goodykoontz, and R. G. Dorsch (NASA, Lewis Research Center, Jet Acoustics Branch, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-631.* 15 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Acoustic measurements for large model engine-over-the-wing (EOW) research configurations having both conventional and powered lift applications were taken for flap positions typical of takeoff and approach and at locations simulating flyover and sideline. The results indicate that the noise is shielded by the wing and redirected above it, making the EOW concept a prime contender for quiet aircraft. The large-scale noise data are in agreement with earlier small-model results. Below the wing, the EOW configuration is about 10 PNdB quieter than the engine-under-the-wing externally-blown-flap for powered lift, and up to 10 dB quieter than the nozzle alone at high frequencies for conventional lift applications. (Author)

A73-36192 # **Calculated leading-edge bluntness effect on transonic compressor noise.** M. R. Fink (United Aircraft Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-633.* 10 p. 18 refs. Members, $1.50; nonmembers, $2.00.

A73-36207 # **A jet-wing lifting-surface theory using elementary vortex distributions.** C. C. Shen, M. L. Lopez, and N. F. Wasson (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-652.* 13 p. 14 refs. Members, $1.50; nonmembers, $2.00. Research sponsored by the McDonnell Douglas Independent Research and Development Program; Contract No. N00014-71-C-0250.

A lifting-surface theory for jet wings based on a finite-element method - the method of elementary vortex distribution or the EVD method - is presented. The method utilizes a set of independent but overlapped elementary horseshoe vortex distributions to represent the wing and jet sheet, and satisfies a set of mixed-type boundary conditions on both the wing and jet sheet. The method is shown to be a valuable analytical tool for use in the aerodynamic analysis and design of jet wings. M.V.E.

A73-36208 # **An evaluation of hypermixing for VSTOL aircraft augmentors.** P. M. Bevilaqua (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-654.* 8 p. 6 refs. Members, $1.50; nonmembers, $2.00.

The additional thrust required for VSTOL capability may be obtained by diverting the exhaust of the cruise engine through a thrust augmenting ejector. The hypermixing nozzle has been developed to increase the rate of entrainment by the primary jet and thereby reduce the length of the augmentor. Since this is achieved at some cost in primary thrust efficiency, the conditions under which there is an overall improvement in ejector performance have been investigated. The predictions of a one dimensional analysis are compared to the results of tests performed with a single shroud and three interchangeable nozzles. It is seen that hypermixing significantly improves ejector performance by making efficient diffusion of the mixed flow possible. (Author)

A73-36209 # **A three-dimensional wing/jet interaction analysis including jet distortion influences.** C. A. Shollenberger (McDonnell Douglas Research Laboratories, St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-655.* 10 p. 19 refs. Members, $1.50; nonmembers, $2.00.

The method used in the analysis is similar in some aspects to the two-dimensional investigation of the jet/airfoil interaction conducted by Shollenberger (1973). The formulation of the wing/jet problem accounts for the nonlinear effects of jet deflection and distortion and for nonuniform jet velocity. Wings and jets are replaced by equivalent flow singularities, and appropriate boundary conditions are applied to determine the singularity strengths and the jet position. The unknown jet location makes it necessary to employ an iterative solution technique. G.R.

A73-36210 # **A conceptual study of leading-edge-vortex enhancement by blowing.** R. G. Bradley and W. O. Wray (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-656.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A conceptual wind-tunnel-test program has been conducted to verify that blowing a stream of high-pressure air over a swept-wing surface in a direction roughly parallel to the leading edge enhances the vortex system. The blowing is shown to intensify the leading-edge vortex and thus delay the deleterious effects of vortex breakdown to higher angle of attack. As a result, the vortex-lift is significantly increased and, as the blowing rate is increased, appears to approach the value predicted by the Polhamus suction-analogy for thin wings. (Author)

A73-36211 # **Transonic flow analysis using a streamline coordinate transformation procedure.** J. L. Colehour (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-657.* 8 p. 14 refs. Members, $1.50; nonmembers, $2.00.

A transonic flow analysis procedure is presented that allows transonic relaxation techniques to be applied to a wide variety of two dimensional or axisymmetric geometries. The exact potential equations for inviscid compressible flow are transformed to a plane, utilizing incompressible streamlines and potential lines as coordinates. This transformation is carried out for each case by means of an independent, incompressible, potential flow solution. This procedure has been applied, with good results, to many two-dimensional and axisymmetric flows, including lifting airfoils, closed axisymmetric bodies, and turbine engine inlets. Comparisons with data are presented. (Author)

A73-36212 # **Transonic inviscid flows over lifting airfoils with embedded shock wave using method of integral relations.** T. C. Tai (U.S. Naval Material Command, Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm*

Springs, Calif., July 16-18, 1973, Paper 73-658. 11 p. 36 refs. Members, $1.50; nonmembers, $2.00. Navy-supported research. NAVAIR Task R230,201.

A73-36213 * # **Experimental and theoretical investigations in two-dimensional transonic flow.** D. J. Collins (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and J. A. Krupp (California, University, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-659.* 16 p., 23 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS7-100.

Experimental and theoretical results are presented from a study of the flow over a family of transonically scaled circular-arc bodies mounted in a solid-wall wind tunnel. Data are presented for Reynolds numbers between 30,000 and 3,600,000, based on chord. The high Reynolds number results are compared with computations based on inviscid theory, and are used to investigate transonic similarity and the behavior of the flow near choking. The results at low Reynolds number are used to demonstrate the effect of viscosity on the overall flowfield, and comparisons are made with existing laminar viscous/inviscid interaction theory. (Author)

A73-36215 # **Turbulent boundary layer flow separation measurements using holographic interferometry.** A. G. Havener and R. J. Radley, Jr. (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-664.* 11 p. 7 refs. Members, $1.50; nonmembers, $2.00.

This paper presents unique experimental data obtained from optical measurements made of a supersonic, high Reynolds number wind tunnel test. Holographic interferometry is used to measure density in and around a recirculation region established when a turbulent boundary layer is forced to separate from a flat surface. The case presented quantitatively is separation caused by a compression turn in the flow, for which a velocity distribution is calculated by combining the density measurements with assumed total temperature and static pressure variations through the separated region. Also presented is an array of double pulsed holographic interferograms which attempt to define qualitatively the transient behavior of a separated flow. (Author)

A73-36221 * # **A kernel function method for computing steady and oscillatory supersonic aerodynamics with interference.** A. M. Cunningham, Jr. (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-670.* 15 p. 15 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-11565.

The method presented uses a collocation technique with the nonplanar kernel function to solve supersonic lifting surface problems with and without interference. A set of pressure functions are developed based on conical flow theory solutions which account for discontinuities in the supersonic pressure distributions. These functions permit faster solution convergence than is possible with conventional supersonic pressure functions. An improper integral of a 3/2 power singularity along the Mach hyperbola of the nonplanar supersonic kernel function is described and treated. The method is compared with other theories and experiment for a variety of cases. (Author)

A73-36228 # **The prediction of turbulent heat transfer and pressure on a swept leading edge near its intersection with a vehicle.** H. W. Coleman and E. C. Lemmon (Sandia Laboratories, Livermore, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-677.* 9 p. 12 refs. Members, $1.50; nonmembers, $2.00. Contract No. AT(29-1)-789.

A73-36230 # **Aircraft wake vortex transport model.** M. R. Brashears (Lockheed Missiles and Space Co., Inc., Huntsville, Ala.) and J. N. Hallock (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-679.* 13 p. 30 refs. Members, $1.50; nonmembers, $2.00. U.S. Department of Transportation Contracts No. FA72WA-2878; No. TSC-593.

A wake vortex transport model has been developed which includes the effects of wind and wind shear, buoyancy, mutual and self-induction, ground plane interaction, viscous decay, and finite core and Crow instability effects. Photographic and ground-wind vortex tracks obtained from B-747, B-707 and CV-880 aircraft flybys are compared to predicted vortex tracks computed using meteorological and aircraft data as inputs to the transport model. A parametric analysis of the effects of the aircraft, fluid mechanic, and meteorological parameters shows the relative magnitude of each transport mechanism. The study constitutes the first detailed comparison of vortex transport theory with experimental data. (Author)

A73-36231 * # **The application of a scanning laser Doppler velocimeter to trailing vortex definition and alleviation.** K. L. Orloff and G. R. Grant (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-680.* 10 p. 25 refs. Members, $1.50; nonmembers, $2.00.

A73-36232 * # **Rapid scanning, three-dimensional, hot-wire anemometer surveys for wing tip vortices in the Ames 40- by 80-foot wind tunnel.** V. R. Corsiglia (NASA, Ames Research Center, Moffett Field, Calif.), R. G. Schwind (NASA, Ames Research Center, Moffett Field; Nielsen Engineering and Research, Inc., Mountain View, Calif.), and N. A. Chigier (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-681.* 8 p. 16 refs. Members, $1.50; nonmembers, $2.00.

A73-36233 * # **Study of the far wake vortex field generated by a rectangular airfoil in a water tank.** D. K. Lezius (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-682.* 11 p. 25 refs. Members, $1.50; nonmembers, $2.00.

A73-36234 * # **Analytical investigation of compressibility and three-dimensionality on the unsteady response of an airfoil in a fluctuating flow field.** J. J. Adamczyk (United Aircraft Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-683.* 18 p. 12 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-11557.

A73-36253 * # **Laser measurement of high-altitude aircraft emissions.** P. Brockman and R. K. Seals, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-704.* 9 p. 19 refs. Members, $1.50; nonmembers, $2.00.

A73-36256 * # **Velocity decay and acoustic characteristics of various nozzle geometries with forward velocity.** U. von Glahn, D. Groesbeck, and J. Goodykoontz (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs,*

Calif., July 16-18, 1973, Paper 73-629. 44 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Utilizing a static test stand, 6- by 9-foot wind tunnel and 13-inch circular free jet, aerodynamic and acoustic data were obtained with a convergent circular nozzle, bypass nozzle, 6-tube mixer nozzle, and 6-tube mixer nozzle with an ejector. The aerodynamic data consist of velocity decay surveys with and without forward velocity. The acoustic data include total sound power, directivity and frequency spectra obtained statically and with forward velocity. The relation of aerodynamic and acoustic measurements statically and in forward flight for the various nozzle configurations are discussed. (Author)

A73-36260 # **The jet flap in three dimensions - Theory and experiment.** J. E. Hackett and V. Lyman (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-653.* 16 p. 21 refs. Members, $1.50; nonmembers, $2.00.

In the theoretical approach, the effects of the jet are simulated by a straight 'equivalent' flap whose length is obtained in closed form in two-dimensions. The solution is applied iteratively using vortex lattice methods, to determine the forces on a finite wing in potential flow. Comparisons with published theoretical results show reasonable agreement particularly for moderate jet deflection angles and higher aspect ratios. Experimental comparisons are made both with available data and with new results obtained from a slatted, unswept wing with a highly-deflected knee-blown flap. Three-dimensionally-limited lift was observed with the latter model similar in form to that reported for unpowered models. (Author)

A73-36261 # **On viscous and wind tunnel wall effects in transonic flows over airfoils.** R. E. Melnik and D. C. Ives (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-660.* 18 p. 13 refs. Members, $1.50; nonmembers, $2.00.

An extensive correlation between wind-tunnel data and finite-difference solutions of the exact potential-flow equation has been performed. Two procedures are compared, one using the Kutta condition and the other using the experimental lift coefficient to determine the circulation. The numerical calculations are used to extract viscous and wall interference effects from the data. The correlation results indicate that viscous effects on lift are greater than 30%, even for turbulent boundary layers and Reynolds numbers greater than 20,000,000. It is shown that viscous effects can be almost completely accounted for in numerical calculations by adjusting the circulation to match the experimental lift. (Author)

A73-36305 * # **Response of a rigid aircraft to nonstationary atmospheric turbulence.** J. M. Verdon (United Aircraft Research Laboratories, East Hartford, Conn.) and R. Steiner (NASA, Langley Research Center, Loads Div., Hampton, Va.). *AIAA Journal,* vol. 11, Aug. 1973, p. 1086-1092. 25 refs.

The plunging response of an aircraft to a type of nonstationary turbulent excitation is considered. The latter consists of stationary Gaussian noise modulated by a well-defined envelope function. The intent of the investigation is to model the excitation experienced by an airplane flying through turbulence of varying intensity and to examine the influence of intensity variations on exceedance frequencies of the gust velocity and the airplane's plunging velocity and acceleration. One analytical advantage of the proposed model is that the Gaussian assumption for the gust excitation is retained. The analysis described herein is developed in terms of an envelope function of arbitrary form; however, numerical calculations are limited to the case of harmonic modulation. (Author)

A73-36312 # **Investigation of the expansion side of a delta wing at supersonic speed.** W. J. Bannink and C. Nebbeling (Delft, Technische Hogeschool, Delft, Netherlands). *AIAA Journal,* vol. 11, Aug. 1973, p. 1151-1156. 11 refs.

An experimental investigation has been made of the flowfield on the expansion side of a flat delta wing with a semiapex angle of 45.3 deg and an angle of incidence of 12 deg. The measurements were performed at a Mach number of 2.94 in a 15 by 15 cm blow-down wind tunnel at a Reynolds number of 500,000 per cm. A five-hole conical-head probe, measuring pitot pressure and flow angularity, was used to explore the flowfield. The main purpose of the experiments was to determine the shape and position of the inboard shock wave and of the conical sonic line, the latter being the locus of points where the conical Mach number is equal to unity. The obtained results suggest that the conical sonic line and the inboard shock wave meet in a point well inside the central region of the flow field (in this region the influence of both the left half and the right half of the delta wing is felt). The results agree very well with numerical calculations using a shock capturing technique. (Author)

A73-36328 # **Equivalence rule and transonic flow theory involving lift.** H. K. Cheng and M. M. Hafez (Southern California, University, Los Angeles, Calif.). *AIAA Journal,* vol. 11, Aug. 1973, p. 1210-1212. Contract No. N00016-67-A-0269-0021.

The investigation conducted is mainly concerned with planar wings. It is assumed that the lift distribution vanishes sufficiently smoothly at trailing edges as well as leading edges. It is found that the equivalent source strength depends on the cross section area, the axial as well as the spanwise lift distributions. In applying the equivalence rule, the cross section area can be traded off with an alteration in the spanwise load. G.R.

A73-36340 # **Fulfilling the potential of the SRAM air conditioner.** A. E. Noreen (Boeing Aerospace Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 8th, Palm Springs, Calif., July 16-18, 1973, Paper 73-723.* 11 p. Members, $1.50; nonmembers, $2.00.

The Short Range Attack Missile (SRAM) weapons system includes an air conditioner, in the B-52 carrier airplane, to cool missiles and carrier avionics. High flight speeds at low altitude, summer temperatures and low missile and avionics temperature tolerance led to high thermal potential as a design requirement. Weight and space restrictions dictated small components. Problems with Freon refrigerant and air distribution in the heat exchangers and variability of components are discussed. Air conditioner performance trends and sensitivity to internal and external operating conditions are presented. Following intensive experimental problem solving and performance evaluation the thermal potential requirement was fully met. (Author)

A73-36393 * # **Review of current sonic boom studies.** E. J. Kane (Boeing Co., Seattle, Wash.). *Journal of Aircraft,* vol. 10, July 1973, p. 395-399. 11 refs. U.S. Department of Transportation Contract No. FA72WA-3039; Contract No. NAS1-10992.

Several aspects of the sonic boom phenomena are currently under investigation at The Boeing Co. This work, supported by the NASA and the FAA, includes an in-depth analysis of sonic boom measurements recorded at the BREN tower, a summary and evaluation of sonic boom investigations done in the last decade and a half, and configuration studies to determine practical lower bound sonic boom limits. The BREN tower test program yielded unique and valuable data because it was the first time that vertical profile measurements were made through caustics produced by maneuvers and atmospheric refraction. The objective of the second effort is to compile in a single reference an annotated abstract, including significant results, for each published sonic boom study and to provide a comprehensive review of the current state of the art to aid

future researchers. The configuration work is devoted toward determining the feasibility of supersonic transport type airplanes with a primary design goal of acceptable sonic boom characteristics. Each of these investigations is briefly reviewed and significant results are discussed. (Author)

A73-36394 # **A finite-element method for calculating aerodynamic coefficients of a subsonic airplane.** H. M. Hua (AIDC, Aeronautical Research Laboratory, Taichung, Nationalist China). *Journal of Aircraft*, vol. 10, July 1973, p. 422-426. 14 refs.

A73-36395 * # **Application of compressibility correction to calculation of flow in inlets.** J. A. Albers (NASA, Lewis Research Center, Cleveland, Ohio). *Journal of Aircraft*, vol. 10, July 1973, p. 441-442. 5 refs.

An application of the compressibility correction developed by Lieblein and Stockman (1972) to the calculation of flow in axisymmetric inlets is described. The results with experimental data from wind tunnel model tests are compared. The configuration is a conventional subsonic inlet with a NACA series one external cowl shape and a two-to-one ellipse internal lip. It is shown that the compressibility correction gives a relatively good approximation to the internal compressible flow behavior, and thus should be useful in the design and analysis of engine nacelle inlets. F.R.L.

A73-36396 # **Pumping capacity of venturi exhausts.** J. A. F. Hill and P. O. Jarvinen (Sanders Associates, Inc., Nashua, N.H.). *Journal of Aircraft*, vol. 10, July 1973, p. 444-446.

The performance of a ram air operated airborne combustion unit of aircraft heater is determined largely by the amount of air which may be forced through the combustor-duct system by the differential air pressure. Venturi exhausts may be used to provide additional pressure drop across the system, but may be required to pump gases with densities that differ from the pumping gas. Experimental data on the variation of venturi suction pressure with the pumped gas flow rate, on the optimum location of the pumping orifice in the venturi, and on the effect of varying the density of the pumped fluid by using both air and helium are discussed. F.R.L.

A73-36397 # **The dynamics of blade pitch control.** M. I. Young (Delaware, University, Newark, Del.). *Journal of Aircraft*, vol. 10, July 1973, p. 446-448. Grant No. DA-ARO(D)-31-124-71-G112.

Advanced rotorcraft such as the modern helicopter and convertible aircraft utilizing tiltable propeller-rotors frequently employ stability augmentation and gust alleviation devices which require that the pitch settings of the rotor blades be changed both collectively and cyclically in a transient manner to alter both rotor thrust magnitude and direction. Inclusion of the dynamics of blade transient pitch changes is an essential part of both the rotor subsystem and complete aircraft flight control system design and analysis. It is seen that the system, in general, is nonlinear due to the large aerodynamic inflow and pitch angles in the propeller state. F.R.L.

A73-36423 **Simulating the introduction of 747 aircraft into airport operations.** I. H. Chamberlain. In: Systems and simulation in the service of society. La Jolla, Calif., Simulation Councils, Inc. (Simulation Councils Proceedings Series. Volume 1, no. 2), 1971, p. 49-59.

The United States Department of Transportation commissioned the development of a simulation model in an effort to plan for the impact of jumbo jets on existing airport terminal facilities. The model provides for the examination of any terminal facility with any schedule of aircraft movement and any mix of aircraft types. Simulation results for several different schedules for introducing 747's into service are reported. Alterations in the staffing levels of ticket agents, baggage agents, and ramp workers were simulated to assess the impact of the different schedules on queue sizes and the quantities of missed bags and missed passengers. (Author)

A73-36427 **Modeling problems in air traffic control systems.** A. S. Jackson (Control Technology, Inc., Long Beach, Calif.). In: Mathematical models of public systems. La Jolla, Calif., Simulation Councils, Inc. (Simulation Councils Proceedings Series. Volume 1, No. 1), 1971, p. 73-86. 29 refs.

Consideration of modeling problems in the synthesis and evaluation of semiautomated air traffic control (ATC) systems. The emphasis is upon terminal-area air traffic control, with only brief mention made of modeling and simulation studies for enroute control. Some of the basic questions concerning the design of terminal-area ATC systems are presented. The methods available for answering these questions are discussed briefly with some comparisons made. A review is made of a number of analytical models which have been used successfully. Attention is then focused on computer simulation models for nonreal-time experimentation. A specific nonreal-time simulation model formulated by the author is discussed in some detail. The modeling problems and tentative solutions to them are discussed. Finally, some conclusions are drawn regarding the overall problem of modeling of ATC systems. (Author)

A73-36464 **Reinforced plastics; Conference, Karlovy Vary, Czechoslovakia, May 15-17, 1973, Lectures (Vyztuzene plasticke hmoty; Konference, Karlovy Vary, Czechoslovakia, May 15-17, 1973, Shornik Prednasek).** Plzen, Dum techniky, CVTS, 1973. 211 p. In Czech, German, Russian, and English.

Topics discussed include studies of the surface state of carbon and graphite fibers, the hardening of unsaturated polyester resins, the fabrication of fiberglass laminates, the testing of flexible epoxy prepregs for aircraft construction, electronically controlled winding of fiberglass vessels of complex shape, optimization of the working of reinforced plastic laminates, an assembly line for the fabrication of polyester glass laminates, strain gauge measurements performed by electrical resistance strain gauges, stress concentrators in fiberglass reinforced plastic laminates, the elastic and mechanical properties of reinforced plastics, the use of transparency measurements to determine stress-strain behavior, holographic interferometric testing of fiberglass reinforced plastics, the inflammability of polyester glass laminates, and the effect of a fiberglass reinforcement on the physical properties of polyamide glass laminates. A.B.K.

A73-36469 # **Development and problems of testing prepregs for the purposes of the Czechoslovakian aircraft industry (Vyvoj a problematika zkouseni prepregu pro ucely cs. leteckeho prumyslu).** J. Kobes and Z. Lachmann (Vyzkumny a Zkusebni Letecky Ustav, Prague, Czechoslovakia). In: Reinforced plastics; Conference, Karlovy Vary, Czechoslovakia, May 15-17, 1973, Lectures. (A73-36464 18-18) Plzen, Dum techniky, CVTS, 1973, p. I-A-7.1 to I-A-7.8. 11 refs. In Czech.

Review of the different types of prepreg materials, and consideration of the basic problems concerning the development of flexible epoxy prepregs. Problems involved in the testing of such prepregs are discussed, including problems connected with the determination of the amount of binder in the prepreg, the degree of conversion of the binder, the flexibility and plasticity at normal temperatures, the creep tendency, adhesion (in particular, adhesion to metals after hadening), and storability. A.B.K.

A73-36601 **Analytical design of aircraft manual control systems.** A. A. Krasovskii. *(Avtomatika i Telemekhanika*, Feb. 1973, p. 24-33.) *Automation and Remote Control*, vol. 34, no. 2, July 1, 1973, pt. 1, p. 192-200. 12 refs. Translation.

The synthesis problem of a manual control system for a flight body is defined as the task of bringing the flight body stability and

controllability close to some target values. This approximation is achieved by minimizing a functional over a set of random control actions of the pilot presented as output signals of shaping filters. The functional meets the 'generalized work' criterion. The overall structure of an optimal manual control system is defined. For illustration, the structure example of a short-period longitudinal aircraft motion control is presented. M.V.E.

A73-36682 **ATC and the offshore airport.** T. K. Vickers. *Journal of Air Traffic Control*, vol. 15, July-Aug. 1973, p. 24-29.

The principal problems involved in the design, construction, and operation of offshore airports are discussed on the basis of cost/benefit considerations. Possible solutions to access, runway, lighting, safety, and weather problems are examined. Particular attention is given to problems arising from the possible reflection of ILS localizer and glidepath signals from surface ships and to the problem of minimizing interference with ILS glideslope. V.P.

A73-36684 **New constraints of military aviation (Les nouvelles contraintes de l'aéronautique militaire).** J. Soissons (Délégation Ministérielle pour l'Armement, Direction Technique des Constructions Aéronautiques, Paris, France.) *(Congrès International Aéronautique, 11th, Paris, France, May 21-23, 1973.) L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 5-8. In French.

For several years a major constraint on military aviation has been that of cost. Before crystallizing a project a definition phase will take place where an attempt is made to calculate what costs will be for certain new requirements in relation to a known case. It is hoped that the future military fighter airplane will fly at Mach 2.5. Questions arise as to the structural material to be used, e.g., titanium or aluminum, the configuration to be adopted (variable or fixed geometry), whether to use one engine or two, and what navigational-bombardment system to use. Attention is given to questions of simplicity and ease of maintenance. F.R.L.

A73-36685 **The new frontiers of civil aviation (Les nouvelles frontières de l'aéronautique civile).** C. Abraham (Secrétariat Général à l'Aviation Civile, Direction des Transports Aériens, Paris, France.). *(Congrès International Aéronautique, 11th, Paris, France, May 21-23, 1973.) L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 9-13. In French.

The discussion is directed to aeronautics and the quality of life, and to aeronautics and the economic environment. For the former, problems of noise, the sonic boom, and smoke and toxic gases emitted by aircraft are considered. It is suggested that noise is troublesome because it is associated with an unformulated fear: that of the aircraft falling. Although aversion to noise occurs mostly among people who live close to airports, and hence actually experience the problem, aversion to the sonic boom appears to be widespread among people who have never experienced it. In many cases, aviation appears to be a scapegoat for many environmental problems. Fuel consumption by aircraft, the effects of reduction of transport time, and problems of the use of airspace and groundspace are discussed. F.R.L.

A73-36686 **Problems related to the operation of an air-ground data-link system (Problèmes liés à la mise en oeuvre d'un système data-link air-sol).** A. Michel (Service Technique de la Navigation Aérienne, Paris, France). *(Congrès International Aéronautique, 11th, Paris, France, May 21-23, 1973.) L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 15-21. In French.

The problems which arise in defining and normalizing a data-link are those relating to the definition of any system. The question is to confront the technical possibilities with the operational requirements with a view to describing the basic plan of the group and the dimensions of the parameters set to work. The air-to-ground data link will be the indispensable link connecting the automatized aspect of air traffic control to the digital management of on-board information. Such a system, which has no value except in an overall traffic system, is a tool which opens wide perspectives for the future, shackling the development of which by establishing unsuitable international standards would be inopportune. F.R.L.

A73-36687 **Determination of statistics of turbulence in clear air (Détermination des statistiques de la turbulence en ciel clair).** G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Congrès International Aéronautique, 11th, Paris, France, May 21-23, 1973.) L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 23-32. 12 refs. In French.

Knowledge of statistics of atmospheric turbulence is indispensable in the design of aircraft, both at the stage of the preliminary study or of the project itself, for the determination of critical loads and fatigue life. The determination of these statistics can only be made starting from recordings carried out on airliners, which alone are numerous enough to give an overall view. The airliner, poorly equipped, is considered as a measurement instrument, and should be calibrated. A method of calculation perfected by ONERA makes it possible to calculate the transfer function of the aircraft, starting from measurement of spectral densities of its responses and of the turbulence. An example of calibration of an airliner is given. F.R.L.

A73-36689 **Civil and military aircraft (Avions civils et militaires).** G. Bruner. *L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 59-76. In French.

Following a brief description of the Concorde and its performance, some particulars of the Lockheed L-1011 Tristar, the Hawker-Siddeley Trident 2E, the Franco-German Airbus, the BAC 111, the Fokker-VFW F.28 Fellowship, the Hawker-Siddeley Trident 3B, the VFW-614, the Europlane, and the Hawker-Siddeley HS 146 are given. These aircraft are designed for airline service on short, medium, or long routes. Various light transport, business, and touring aircraft are discussed. In the military field, attention is given to combat and training aircraft. F.R.L.

A73-36691 **Reliability of aircraft turbojet bearings (Fiabilité des roulements de turboréacteurs d'avion).** B. Devoge. *(Journées d'Etudes sur la Fiabilité des Moteurs, Paris, France, Mar. 20-22, 1972.) L'Aéronautique et l'Astronautique*, no. 41, 1973, p. 86-89. In French.

The good operation of bearings depends in large part on working conditions which are imposed on them within the engine. Their reliability is presented overall on the level of the complete engine. Viewed from this angle, the reliability appears to be statistically satisfactory. Rather than getting involved with complicated calculations of predicted reliability, SNECMA prefers from the beginning to study the detailed operation of bearings and to optimize them for each application, while taking technical precautions to limit the consequences of their failure. F.R.L.

A73-36725 # **Aspects of the finite element method as applied to aero-space structures.** J. H. Argyris (Imperial College of Science and Technology, London, England; Stuttgart, Universität, Stuttgart, West Germany), J. S. Doltsinis, K. Straub, K. J. Willam (Stuttgart, Universität, Stuttgart, West Germany), and J. F. Gloudeman (North American Rockwell Corp., Space Div., Downey, Calif.). *International Astronautical Federation, International Astronautical Congress, 23rd, Vienna, Austria, Oct. 8-15, 1972, Paper.* 50 p. 77 refs. (ISD-138)

The Space Shuttle systems are evaluated in terms of the mission requirements. The finite element method is applied to an analysis of the statics and dynamics of spacecraft components. A set of

higher-order elements is used to demonstrate the effectiveness of a finite element approach, combined with modern computer technology, in applications to aerospace structures. A mathematical model is developed to describe the physically nonlinear phenomena associated with thermoelastoplasticity and creep in aerospace structural components. V.Z.

A73-36758 # Creep in VT-14 titanium alloy under low-cycle load conditions (Polzuchest' titanovogo splava VT-14 v usloviiakh malotsiklovogo nagruzheniia). P. I. Kotov, V. M. Lebedev, and V. N. Merkulov (Moskovskii Aviatsionnyi Tekhnologicheskii Institut, Moscow, USSR). *Problemy Prochnosti*, vol. 5, May 1973, p. 54-57. 8 refs. In Russian.

A73-36774 # Experimental developments in V/STOL wind tunnel testing at the National Aeronautical Establishment. R. Wickens, P. South, R. S. Rangi, and D. Henshaw (National Aeronautical Establishment, Ottawa, Canada). *(Canadian Aeronautics and Space Institute, Annual General Meeting, Toronto, Canada, May 18, 19, 1972.) Canadian Aeronautics and Space Journal*, vol. 19, Apr. 1973, p. 145-154. 7 refs.

Review of some developments in a low-speed wind tunnel that are related to the measurement of aerodynamic characteristics of high-lift systems. This includes work on moving belt ground boards, flow breakdown, drag measurements, and a simple jet engine simulator. The phenomenon of flow breakdown has been investigated with a normal floor, as well as a moving ground, and a simple criterion has been discovered that allows the prediction of this instability for three-dimensional models. An experimental research program has been undertaken on a small scale, to determine the size of moving belt ground boards that would be suitable for use in a 30 x 30 ft wind tunnel. A jet flap model was used to simulate a powered lift system, and the effects of belt length and speed and model/tunnel configuration upon ground effect and flow breakdown limits were observed. (Author)

A73-36775 # Flight testing of the JT15D in the CF-100. C. B. Wrong and D. R. Jermyn (United Aircraft of Canada, Ltd., Montreal, Canada). *(Canadian Aeronautics and Space Institute, Annual General Meeting, Toronto, Canada, May 18, 19, 1972.) Canadian Aeronautics and Space Journal*, vol. 19, Apr. 1973, p. 155-163. 9 refs.

The market gap which led to the JT15D is discussed, and the types of aircraft envisaged as filling this role are described. The flight envelope and other considerations defining the flight test vehicle requirements are discussed, together with the choice of the CF-100. A description of the test engine installation is given in detail, as well as the requirements for the data acquisition and recording equipment including the chosen package. The use of the CF-100 in this role is discussed, and the subsequent installation and flight testing of the JT15D in the Cessna Citation and the Aerospatiale Corvette are described. (Author)

A73-36825 # Estimation of corrosion damage levels in thin-walled structural elements by the punching method (Otsenka stepeni korrozionnogo porazheniia tonkostennykh elementov konstruktsii metodom prodavlivaniia). A. M. Vorobeikov and V. A. Gorodetskii (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Fiziko-Khimicheskaia Mekhanika Materialov*, vol. 9, no. 2, 1973, p. 96-98. In Russian.

Description of an apparatus designed for the evaluation of the extent of corrosion damage in thin-walled structural elements by measuring the force required for piercing an element wall area with a punch. A corrosion damage measurement technique using this apparatus is proposed as a more practical substitute for techniques involving destruction of specimens. V.Z.

A73-36831 Real-time, three-dimensional, visual scene generation with computer generated images. W. M. Bunker (General Electric Co., Daytona Beach, Fla.). In: Summer Computer Simulation Conference, Montreal, Canada, July 17-19, 1973, Proceedings. Volume 1. La Jolla, Calif., Society for Computer Simulation, Inc., 1973, p. 205-212. 10 refs.

Discussion of visual simulation techniques with special attention to computer-generated images. The chronology of developments leading to the present state of the art is covered comprehensively. The capabilities of systems currently operational or under construction are described in detail. Problems associated with achieving desired results are discussed, along with their solutions or current status. The emphasis is on developments not previously reported in the literature. A related area also reviewed is the software simulation of hardware configurations for validation of algorithms and logic prior to fabrication. It is shown that modular sets of components, hardware, and designs are now available that can be applied to meet any of a wide variety of operational visual simulation system requirements with computer-generated images. M.V.E.

A73-36833 * A flight simulator for advanced aircraft - Servo design to realization. R. F. King (NASA, Ames Research Center, Moffett Field, Calif.). In: Summer Computer Simulation Conference, Montreal, Canada, July 17-19, 1973, Proceedings. Volume 1. La Jolla, Calif., Society for Computer Simulation, Inc., 1973, p. 248-253.

Discussion of computer-aided design results obtained for a moving-base, three-man flight simulator. From a control viewpoint, the structure is discussed in terms of disturbance torques, damping ratios, natural frequencies, load acceleration, and smoothness. The use of inertia to achieve well-behaved structural transfer functions and smooth or high fidelity load accelerations is demonstrated. Transfer functions in the complex frequency domain, as well as time-dependent solutions to the system, are derived. The relative merits of using position and/or velocity as primary feedback, for a limited travel acceleration device, are discussed. Root locus plots, which were utilized in the control-system design, Bode plots, and time-dependent plots are drawn. In addition, the theoretical ratio of velocity to commanded input Bode plot is compared to the experimental results, and the dramatic effect on the load smoothness plot caused by selecting velocity over position as primary feedback is shown. (Author)

A73-36841 Airport simulations. R. Brodsky (Brodsky, Hopf and Adler Architects and Engineers Professional Corp., New York, N.Y.). In: Summer Computer Simulation Conference, Montreal, Canada, July 17-19, 1973, Proceedings. Volume 2. La Jolla, Calif., Society for Computer Simulation, Inc., 1973, p. 885-890.

Discussion of a simulation program for a major airport aimed at providing detailed estimates of the expected load on the various airport facilities. The simulation is expected to provide meaningful measures of the expected performances of each facility in any given set of operating circumstances. This simulation was used for testing the alternate design for the new Dallas/Fort Worth Airport and was instrumental in providing solutions to roadway, parking, curb length, and other critical areas within the airport. M.V.E.

A73-36843 Computer models for air traffic control system simulation. W. C. Hoffman (Aerospace Systems, Inc., Burlington, Mass.), W. M. Hollister, and R. W. Simpson (MIT, Cambridge, Mass.). In: Summer Computer Simulation Conference, Montreal, Canada, July 17-19, 1973, Proceedings. Volume 2. La Jolla, Calif., Society for Computer Simulation, Inc., 1973, p. 1107-1120. 37 refs. U.S. Department of Transportation Contract No. TSC-212.

A functional error analysis and modeling study of the air traffic control (ATC) system is described. The dominant functional error sources in the ATC system are identified and computer simulation models are developed which will be utilized for the evaluation of advanced ATC system concepts. The models are constructed to be as realistic as possible without placing excessive computational requirements on their implementation. The models were developed in four categories: aircraft dynamics, air data system, navigation systems and surveillance systems. The performance of most of the models has been numerically verified by digital computer simulation. (Author)

A73-36845 Seminar on Accident Analysis and Prevention, Beirut, Lebanon, June 26-28, 1973, Working Documents. Seminar sponsored by the Civil Aviation Council of Arab States. Beirut, Civil Aviation Safety Centre, 1973. 315 p. In English and Arabic.

Current accident trends are discussed together with the solution of problems posed by cases of sudden incapacitation of pilots in flights, improvements in safety procedures and safety equipment, accident investigation procedures in developed countries, and the causes of accidents in agricultural aviation in Iraq. Other subjects investigated include flight recorders, relations between flight safety and maintenance, aviation safety and air traffic control, questions of atmospheric turbulence and aviation, the objectives of training in relation to accident prevention, and the effects of dust storms on aviation.

G.R.

A73-36846 # Accident prevention. R. H. Watts (International Civil Aviation Organization, Montreal, Canada). In: Seminar on Accident Analysis and Prevention, Beirut, Lebanon, June 26-28, 1973, Working Documents. Beirut, Civil Aviation Safety Centre, 1973. 24 p.

Statistical data regarding aircraft accidents are considered, giving attention to passenger fatalities, jet aircraft hull losses, estimated worldwide accident costs, and the accident record associated with the introduction of the 'third generation' turbojet aircraft, the jumbo or wide-bodied aircraft. It is significant that the 1971 and 1972 information available suggests that the fatality rate in scheduled turbojet operations was about one-tenth of the fatality rate in scheduled services operated by propeller driven aircraft. Specific proposals for further reducing accidents are made, taking into account procedures for reducing approach, landing, and takeoff accidents.

G.R.

A73-36848 # Flight recorders. W. H. Tench (Department of Trade and Industry, London, England). In: Seminar on Accident Analysis and Prevention, Beirut, Lebanon, June 26-28, 1973, Working Documents. Beirut, Civil Aviation Safety Centre, 1973. 9 p.

When the information provided by a flight recorder is properly understood, processed, and added to all the other evidence derived from the normal, orthodox methods of accident investigation it can lead to a higher degree of certainty as to the factors which led to the accident. The most common flight recorder in use today employs engraved foil. Another widely used system is the photographic type in which transducers from various aircraft systems reflect a tiny beam of light with an angular displacement that is proportional to the magnitude of the parameter being recorded. More recent developments have led to the use of EM recorders. Questions of readout are discussed together with aspects of the analysis of the recorded data.

G.R.

A73-36849 # Improvements in safety procedures and safety equipment. N. J. Gabriel (Civil Aviation Safety Centre, Beirut, Lebanon). In: Seminar on Accident Analysis and Prevention, Beirut, Lebanon, June 26-28, 1973, Working Documents. Beirut, Civil Aviation Safety Centre, 1973. 14 p. 8 refs.

Current aircraft evacuation problems are considered, giving attention to a 'negative panic' frequently shown by airline passengers in the event of an emergency. This negative panic takes the form of an inaction or immobility on the part of the persons concerned. Negative panic occurs at times also among flight crews. In some recent survivable accidents, there was considerable evidence that the fatalities were at least partially caused by this negative panic. Flight crew training in emergency evacuation procedures is of paramount importance in the effective use of escape time. Questions of human survival in aircraft crash fires are discussed together with the factors which limit the escape time. Fire safety can be improved by the use of nonflammable materials in the aircraft. Approaches for minimizing impact injury are examined along with criteria for aisle and exit design, lighting, and equipment to be used in the case of ditching.

G.R.

A73-36906 The supersonic transport and the environment (L'avion supersonique et l'environnement). R. Chevalier (Société Nationale Industrielle Aérospatiale, Paris, France). *(Académie Internationale de Médecine Aéronautique et Spatiale and Société Française de Physiologie et de Médecine Aéronautiques et Cosmonautiques, Congrès International de Médecine Aéronautique et Spatiale, 20th, Nice, France, Sept. 18-21, 1972.)* Revue de Médecine Aéronautique et Spatiale, vol. 12, 1st Quarter, 1973, p. 38-41. In French.

Consideration of a number of aspects of the problem of the impact of the SST on the environment. The aspects discussed include the fuel and oxygen consumption, noise in the vicinity of airports, the sonic boom, stratospheric pollution, and cosmic radiation. In particular, the problem of the focusing of the overpressure wave due to a sonic boom during pronounced acceleration phases and turnings is discussed and shown to be amenable to solution. In discussing stratospheric pollution, it is believed unlikely that the combustion products expelled by a fleet of Concordes would be capable of modifying the earth's climate.

A.B.K.

A73-36907 Some conclusions regarding the sonic boom following the latest French experiments (Quelques conclusions sur le bang à la suite des derniers essais français). J. C. Wanner (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Académie Internationale de Médecine Aéronautique et Spatiale and Société Française de Physiologie et de Médecine Aéronautiques et Cosmonautiques, Congrès International de Médecine Aéronautique et Spatiale, 20th, Nice, France, Sept. 18-21, 1972.)* Revue de Médecine Aéronautique et Spatiale, vol. 12, 1st Quarter, 1973, p. 42-45. In French.

Results of theoretical and experimental studies of the problem of the supersonic boom. These results concern the structure of the shock wave system generated by an aircraft traveling at supersonic speed in rectilinear flight; the changes in this structure during rectilinear acceleration, turning in the horizontal plane, and descent; and the value of the amplification coefficient due to focusing or superfocusing of the overpressure wave accompanying a sonic boom.

A.B.K.

A73-36908 Cosmic radiation and the SST (Rayonnements cosmiques et T.S.S.). R.-P. Delahaye (Hôpital d'Instruction des Armées Bégin, Saint-Mandé, Val-de-Marne, France). *(Académie Internationale de Médecine Aéronautique et Spatiale and Société Française de Physiologie et de Médecine Aéronautiques et Cosmonautiques, Congrès International de Médecine Aéronautique et Spatiale, 20th, Nice, France, Sept. 18-21, 1972.)* Revue de Médecine Aéronautique et Spatiale, vol. 12, 1st Quarter, 1973, p. 46, 47. In French.

Review of physical data obtained regarding radiobiological dangers incurred by passengers and crew of the SST during flight at cruising altitudes (16,000 to 18,000 meters) as a result of galactic and solar cosmic radiation. After a brief review of the physical composition of these two types of cosmic radiation, including the results of a study of solar flares and their repercussions at altitudes between 15,000 and 20,000 meters, the results of studies undertaken on board Concorde prototypes involving the detection of various types of particles by active and passive dosimetry are presented.
A.B.K.

A73-36949 Aviation and the environment - The point of view of the airports (L'aviation et l'environnement - Le point de vue des aéroports). J. Block (Paris, Aéroport, Paris, France). *(Académie Internationale de Médecine Aéronautique et Spatiale and Société Française de Physiologie et de Médecine Aéronautiques et Cosmonautiques, Congrès International de Médecine Aéronautique et Spatiale, 20th, Nice, France, Sept. 18-21, 1972.) Revue de Médecine Aéronautique et Spatiale*, vol. 12, 1st Quarter, 1973, p. 187-190. In French.

The problems of environment known to airports are multiple, and major attention is given to that one which is of special interest to the medical world: noise. Three means of action can be used: establishing rules for aircraft use, removing populations from aircraft, and reducing the noise of aircraft themselves. The first is already in operation, but the second is very difficult to apply to populations already living close to airports. The third means is the most effective because it attacks the cause itself directly, rather than its effects. The path leading to keeping the balance between necessary economic progress and environmental protection is necessarily a narrow one.
F.R.L.

A73-36991 Evolution of researches in the field of turbines (Evolution des recherches dans le domaine des turbomachines). M. Barrere (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and J. M. Brasseur (SNECMA, Paris, France). *Entropie*, vol. 9, May-June 1973, p. 7-17. 20 refs. In French.

Major attention is given to researches which have a triple objective: to improve the performance of actual machines, to give the possibility of developing the best compromise between different constraints imposed by the application, and to deliver new concepts. These studies bear on different parts of the machine: air inlets, turboblowers, compressors, combustion chambers, turbines, nozzles, on the integration of different parts, on the conception of mechanical parts, the dynamic control of the assembly, and noise. Attention is also given to the increase of temperature at the end of combustion, the unsteady character of flows, pollution, and noise.
F.R.L.

A73-36992 Advanced compressors: Actual state of the technique - Future developments (Les compresseurs avancés: Etat actuel de la technique - Développements futurs). J. Fabri and J. Paulon (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Entropie*, vol. 9, May-June 1973, p. 19-23. 15 refs. In French.

The principal themes of theoretical and experimental research for the development of high performance axial and centrifugal compressors are reviewed. It is shown that each of these types of compressors finds its field of application in exact conditions of use. Special attention is given to the possibilities of development of supersonic axial compressors and centrifuges. F.R.L.

A73-36993 New materials for aeronautical turbines (Matériaux nouveaux pour les turbomachines aéronautiques). M. El Gammal (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Entropie*, vol. 9, May-June 1973, p. 25-32. In French.

The tendencies manifesting themselves in the evolution of alloys which are currently used in the construction of turbines are reviewed. The techniques of powder metallurgy and oriented solidification should especially make it possible to make better use of nickel alloys. The perspectives of application of composite materials are examined. If the resistance to impacts of these materials appears insufficient in the case of moving compressor blades, their other mechanical characteristics permit a major lightening of other parts less exposed to shocks. Oriented eutectics, alloys of particular composition which take up a composite material structure by unidirectional solidification, present a set of properties which leads to expectation that some will be used for making turbine blades or vanes. F.R.L.

A73-36994 The turbojet of subsonic aircraft (Le turboréacteur des avions subsoniques). P. Alesi and J. Rossignol (SNECMA, Paris, France). *Entropie*, vol. 9, May-June 1973, p. 33-42. In French.

The evolution of subsonic aircraft turbojets, studied commencing with thermodynamic cycles, illuminates the progress achieved since the appearance of this mode of propulsion and the paths offered to manufacturers to improve the economy of air transport. The key points of this evolution are the increase of turbine entry temperatures and the improvement of basic efficiencies, i.e., deepening of the knowledge of thermal and aerodynamic phenomena, and the development of metallurgical and technological studies. The third-generation turbojet will satisfy new ecological requirements: considerable reduction of noise and pollution levels. F.R.L.

A73-36995 Transient operation of turbines (Fonctionnement transitoire des turbomachines). A. Barbot (SNECMA, Paris, France). *Entropie*, vol. 9, May-June 1973, p. 43-48. In French.

The study of the control system of a turbine is based on knowledge of the mathematical model representing its operation. The results of studies of the modeling of a twin-spool turbojet are given. Several types of models can be considered according to the phenomena to be analyzed. These are linearized models making it possible to study the stability of the system, nonlinear models representing the operation during extensive variation of the control parameters, and models established starting from laws of physics making it possible to account accurately for thermodynamic performance. F.R.L.

A73-36996 The effect of afterburning on the emission of pollutants by turbojets (L'influence de la rechauffe sur l'émission des polluants par les turboréacteurs). J. Decouflet and A. Quillevere (SNECMA, Paris, France). *Entropie*, vol. 9, May-June 1973, p. 49-54. 6 refs. In French.

Taking account of problems of pollution, turbine manufacturers are carrying out experimental and theoretical studies on combustion chambers in an attempt to reduce polluting emission by means of appropriate technological methods. The conditions for formation of toxic chemical species in combustion chambers are reviewed, and the pollution due to the afterburner system is studied in depth. Use of afterburning especially in civil supersonic engines during certain flight phases involves a considerable supplemental emission of unburnt gases from the nozzle. However, the residual pollution at a certain distance downstream of the engine remains moderate because of the oxidation of these unburnt gases within the external jet.
F.R.L.

A73-36997 Study of noise sources of hot jets (Etude de sources de bruit de jets chauds). G. Richter (SNECMA, Paris, France). *Entropie*, vol. 9, May-June 1973, p. 55-59. 14 refs. In French.

Lighthill's theory (1952, 1954) indicates that the noise emission of a gaseous jet is a function of the turbulence characteristics of the flow. Noise measurements of low speed jets (jets of bypass engines) as well as observations made in testing silencers for high speed jets have shown that temperature effects of hot jets are not negligible. The development of a method adapted to hot jets was undertaken

which consists in the determination of the space-time parameters of the turbulence by means of measurement of the infrared emission from the jet and the introduction of these data into a computer program for the calculation, based on Lighthill's theory, of the far noise field. Comparison of preliminary results of this method with acoustical measurements is encouraging. F.R.L.

A73-36998 A new turbofan formula - The Astafan (Une nouvelle formule de double flux - L'Astafan). H. C. Dabbadie (Turboméca, S.A., Mézière-sur-Seine, Yvelines, France). *Entropie,* vol. 9, May-June 1973, p. 60-63. In French.

To obtain the best cost-efficiency comprimise a new turbofan formula is proposed, using a variable pitch fan driven at constant speed through a reduction gear by various turbines of the Astazou family. This makes it possible, thanks to this reduction parameter, to adapt the dimensions and the speed of the fan to the required flight profile. The Astafan has been fitted on the Aerocommander 680 VTU for two years, and is the prototype of a formula which can be extrapolated to future STOL and business aircraft with speeds up to Mach 0.8, because the measured performances bring a substantial gain in fuel consumption, noise, and safety. F.R.L.

A73-37011 # Solution of the problem of the flow past a V-shaped wing with a strong shock wave at the leading edge (O reshenii zadachi obtekaniia V-obraznogo kryla s sil'noi udarnoi volnoi na perednei kromke). V. I. Lapygin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza,* May-June 1973, p. 114-119. 6 refs. In Russian.

A73-37021 # Analysis of the use of an auxiliary wing on a helicopter (Analiza zastosowania skrzydla pomocniczego na smigłowcu). K. Szumanski. *Technika Lotnicza i Astronautyczna,* vol. 28, June 1973, p. 9-13, 29. In Polish.

Fundamental data concerning the flight mechanics of compound helicopters are examined, together with the physical phenomena accompanying the interaction between the rotor and the wing under various flight conditions. Possible means of using the wing to improve helicopter flight performance are discussed, and helicopter wing design considerations are presented. V.P.

A73-37022 # Analysis of the aerodynamic characteristics of devices for increasing wing lift. III - Influence of ground proximity on the aerodynamic characteristics of the flaps (Analiza charakterystyk aerodynamiczych urzadzen zwiekszajacych sile nosna skrzydla. III - Wplyw bliskosci ziemi na charakterystyke aerodynamiczna klap). R. Garncarek. *Technika Lotnicza i Astronautyczna,* vol. 28, June 1973, p. 21, 22, 29. In Polish.

A73-37030 The acoustic impedance of perforates at medium and high sound pressure levels. T. H. Melling (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 29, July 8, 1973, p. 1-65. 37 refs. Research supported by the Rolls-Royce, Ltd.

A study has been made of the behavior of the acoustic impedance of a range of perforates at medium and high incident sound pressure levels. It included a detailed experimental program together with a theoretical analysis of the problem. The theoretical work yields, for the linear impedance range, an improved formula for the impedance of perforates which is based on that for a single isolated orifice modified for interaction effects. This prediction technique is substantiated by the results of the experimental program. Theoretical modeling of the nonlinear impedance is based on a quasi-steady approximation to the acoustic flow through the orifice; this approach yields a formula for the nonlinear acoustic resistance based on steady flow data for the perforate, which is readily obtainable. Further, the analysis yields a method of predicting when the nonlinear mass reactance attains its asymptotic minimum. (Author)

A73-37041 Accurate aircraft trajectory predictions applied to future en-route air traffic control. R. H. G. Martin and A. Benoit. *Ortung und Navigation,* no. 1, 1973, p. 57-82.

The current status of studies aimed at providing a planning ability from takeoff to landing, the necessary monitoring, and an effective communications medium in future air traffic control is reviewed. Processes which ensure an improved traffic management capability based on reliable forward planning in all phases of flight are outlined. Means of monitoring the evolution of the traffic situation to ensure conformity with the plan and to allow adequate time for any necessary replaning of movements are studied, together with means of providing reliable and high-speed transfer of ATC data with minimum human intervention. V.P

A73-37042 On the generation of accurate trajectory predictions for air traffic control purposes. A. Benoit and R. H. G. Martin. *Ortung und Navigation,* no. 1, 1973, p. 83-124. 13 refs.

Discussion of approaches to aircraft trajectory predictions in air traffic control applications. The quality of various trajectory prediction techniques is evaluated. Particular attention is given to the EROCOA module as a basis for aircraft trajectory prediction in air traffic control. Airborne data recordings provided by the British European Airways and the Royal Dutch Airlines are used for references in the formation of a mathematical basis for aircraft trajectory predictions. A technique is proposed for the generation of aircraft path projections accurate enough for air traffic applications. V.Z.

A73-37043 Precision of the plane conversion of coordinates for area navigation using VOR/DME (Genauigkeit der ebenen Koordinatenumformung für die Flächennavigation mit VOR/DME). K. Ramsayer (Stuttgart, Universität, Stuttgart, West Germany). *Ortung und Navigation,* no. 1, 1973, p. 125-144. In German.

The accuracy of automatic DME slant range correction is evaluated, which is necessary to compensate for the difference in distance from the aircraft to a ground station and the distance from a ground point directly below the aircraft to that same ground station. Exact and approximate expressions for calculating the approach direction in the case of changing from one VOR/DEM (Rho-Theta) station to another are proposed. V.P.

A73-37083 # Forecast of mode variation subsequent to structure modifications (Prévision de la variation des modes consécutive à la modification d'une structure). G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Congrès International de Mécanique Théorique et Appliquée, 13th, Moscow, USSR, Aug. 21-26, 1972.) La Recherche Aérospatiale,* May-June 1973, p. 173-187. In French.

The determination of the vibration modes is demonstrated that are to result from known mass and rigidity modifications applied to a structure of known vibration behavior. Also a simple formula is derived for estimating the upper limit of the error associated with the truncation of the mode expression when all the modes of the initial structure are not known. The number of the initial structure modes that must be introduced into the calculation is defined in accordance with the desired level of accuracy. M.V.E.

A73-37084 # Unsteady aerodynamic forces in transonic turbomachines (Forces aérodynamiques instationnaires dans les turbomachines transsoniques). R. Legendre and J.-P. Veuillot (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale,* May-June 1973, p. 189. In French.

A73-37086 # Laboratory for the automatic treatment of analog signals (Le laboratoire de traitement automatique des signaux analogiques). J.-P. Boisseau, G. Gori, E. Gratieux, and J. Hay

(ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale*, May-June 1973, p. 191-195. In French.

Description of a noise measuring spectral analysis system for use by interested commercial air carriers. Following a review of the operational principle and basic design features, the two-type analog-band data reduction is discussed, along with the overflight noise recording and test stand noise recording procedures. M.V.E.

A73-37090 Calculation of the natural frequencies and the principal modes of helicopter blades. F. Giordana (Milano, Politecnico, Milan, Italy). *Meccanica*, vol. 7, Dec. 1972, p. 255-262. 6 refs.

A procedure for calculating the natural frequencies and the principal modes of rotating helicopter blades based on the transfer matrix method is described. The blade is divided into a finite number of elements considered as continuous. A solution involving less laborious calculation, in which the masses are assumed to be concentrated, is also supplied. The advantage of the method developed is that it takes due account of the effective rotor-shaft constraints. Some numeric applications are given. (Author)

A73-37140 # Problems of minimum-weight turbomachine rotor designs (Problemy proektirovaniia rotorov turbomashin minimal'nogo vesa). I. V. Dem'ianushko and E. F. Koroleva. *Mashinostroenie*, no. 6, 1973, p. 19-23. 9 refs. In Russian.

Design approaches to disk weight minimization are considered as the prerequisite to the developement of turbomachine rotors of minimum weight with adequate strength. A block diagram is included to demonstrate how a multi-step designing operation should be carried out in the construction of a minimum-weight turbomachine rotor with disk weight minimization. V.Z.

STAR ENTRIES

N73-25997*# California Inst. of Tech., Pasadena.
AN INVESTIGATION OF A TWO-DIMENSIONAL PROPULSIVE LIFTING SYSTEM
Carl A. Shollenberger Washington NASA May 1973 115 p refs
(Grant NGR-05-002-161)
(NASA-CR-2250) Avail: NTIS HC $3.00 CSCL 01A

Several aspects of the nonhomogeneous flow associated with a system combining lifting and propulsive requirements of an aircraft are considered by analytical and experimental methods. The basic geometry of the problem is that of two lifting surfaces with an actuator disk located between them. The principles governing flow with energy addition are examined. Basic equations and boundary conditions are developed for the complete inviscid and incompressible analysis for the two-dimensional case. The corresponding flow singularities are discussed and the integral equations which completely specify the system are derived. The two special cases of small and large energy addition are considered in detail including solutions. A numerical procedure is developed to solve the full problem including allowance for the wake deflection. Appropriate vorticity forms are used to represent the entire system. An iterative scheme is presented which rapidly converges to a solution for the magnitude and location of the system vorticity distributions. Forces and moments are evaluated on the propulsive lift system. Author

N73-25999*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
MANEUVER AND BUFFET CHARACTERISTICS OF FIGHTER AIRCRAFT
Edward J. Ray, Linwood W. McKinney, and Julian G. Carmichael (McDonnell Douglas Corp.) Washington Jul. 1973 18 p refs (NASA-TN-D-7131; L-8554) Avail: NTIS HC $3.00 CSCL 01C

Recent research efforts in the improvement of the maneuverability of fighter aircraft in the high-subsonic and transonic speed range are reviewed with emphasis on the factors affecting aerodynamic boundaries, such as maximum obtainable lift, buffet onset, pitchup, wing rock, and nose slice. The investigations were made using a general research configuration which encompassed a systematic matrix of wing-design parameters. These results illustrated the sensitivity of section and planform geometry to a selected design point. The incorporation of variable-geometry wing devices in the form of flaps or leading-edge slats was shown to provide controlled flow over a wide range of flight conditions and substantial improvements in maneuver capabilities. Additional studies indicated that the blending of a highly swept maneuver strake with an efficient, moderately swept wing offers a promising approach for improving maneuver characteristics at high angles of attack without excessive penalties in structural weight. Author

N73-26000*# Kanner (Leo) Associates, Redwood City, Calif.
AIRFOIL PROFILES IN A CRITICAL REYNOLDS NUMBER REGION
K. Kraemer Washington NASA Jun. 1973 42 p refs Transl. into ENGLISH from Sonderdruck aus der Z. Forsch. auf dem Gebiete des Ingenieurwesens" (West Germany), v. 27, no. 2, 1961 p 33-46
(Contract NASw-2481)
(NASA-TT-F-14959) Avail: NTIS HC $4.25 CSCL 01A

On the basis of boundary layer observations of force measurements and pressure distributions on three Gottinger profiles 801, 803 and 804 at small Reynolds numbers in the range of 2 x 10,000 and 5 x 100,000, it is clear that the transition from the laminar to the turbulent form in the boundary layer flow exerts a considerable influence on the aerodynamic coefficients of airfoils. The experiments provide insight into what takes place at the point of transition and during the appearance of laminar separating streams. The meaning of the expression critical Reynolds number will be more precisely defined. Author

N73-26004* National Academy of Sciences - National Research Council, Washington, D.C.
SUPPRESSION OF FLUTTER Patent
Eliahu Nissim, inventor (to NASA) Issued 22 May 1973 11 p Filed 25 Mar. 1971 Supersedes N72-21009 (10 - 12, p 1554) Sponsored by NASA
(NASA-Case-LAR-10682-1; US-Patent-3,734,432; US-Patent-Appl-SN-127915; US-Patent-Class-244-77G; US-Patent-Class-244-75A; US-Patent-Class-244-76C; US-Patent-Class-244-77F) Avail: US Patent Office CSCL 01B

An active aerodynamic control system to control flutter over a large range of oscillatory frequencies is described. The system is not affected by mass, stiffness, elastic axis, or center of gravity location of the system, mode of vibration, or Mach number. The system consists of one or more pairs of leading edge and trailing edge hinged or deformable control surfaces, each pair operated in concert by a stability augmentation system. Torsion and bending motions are sensed and converted by the stability augmentation system into leading and trailing edge control surface deflections which produce lift forces and pitching moments to suppress flutter. P.N.F.

N73-26005* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DUAL-FUSELAGE AIRCRAFT HAVING YAWABLE WING AND HORIZONTAL STABILIZER Patent
Robert T. Jones, inventor (to NASA) Issued 5 Jun. 1973 15 p Filed 9 Dec. 1971 Supersedes N72-21010 (10 - 12, p 1554)
(NASA-Case-ARC-10470-1; US-Patent-3,737,121; US-Patent-Appl-SN-206279; US-Patent-Class-244-13; US-Patent-Class-244-46; US-Patent-Class-244-55) Avail: US Patent Office CSCL 01B

An aircraft configuration consisting of a pair of fuselages parallel to each other and connected by a main wing and a horizontal stabilizer which pivot on the fuselages is described. The pivotal attachment allows the wing to be yawed relative to the fuselages for high speed flight while at the same time spreading the weight and volume distribution of the aircraft along the direction of flight. The main wing is curved upward at the tips to compensate for any roll tendencies caused by its yawed position. Official Gazette of the U.S. Patent Office

N73-26007*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HIGH LIFT AIRCRAFT Patent Application
Willard S. Blanchard, Jr. and Joseph L. Johnson, Jr., inventors (to NASA) Filed 5 Jun. 1973 15 p
(NASA-Case-LAR-11252-1; US-Patent-Appl-SN-367268) Avail: NTIS HC $3.00 CSCL 01C

An aerodynamically balanced aircraft configuration is discussed. The design reduces the effects of large nose-down pitching moments generated by the flap high-lift forces, the loss of trim lift during high-lift flight, and the yawing moments caused by the loss of an engine without the use of large horizontal and vertical tails. Drawings of the proposed configuration are provided. Detailed descriptions of the airframe and control surfaces are included. NASA

N73-26008*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
QUIET JET TRANSPORT AIRCRAFT Patent Application
Oran W. Nicks, Richard E. Kuhn, Joseph L. Johnson, Jr., Willard S. Blanchard, Jr., and Tom F. Bonner, Jr., inventors (to NASA) Filed 5 Jun. 1973 11 p
(NASA-Case-LAR-11087-1; US-Patent-Appl-SN-367267) Avail: NTIS HC $3.00 CSCL 01C

An aircraft configuration for reducing jet aircraft noise by exhausting the engine gases over the upper surface of the wings is described. Diagrams of typical installations are provided. Advantages and disadvantages of the system are discussed.
P.N.F.

N73-26009# Royal Aircraft Establishment, Farnborough (England).
ON AN EXPRESSION FOR THE IDEAL WEIGHT OF SHELL-TYPE FUSELAGES
Guiseppe Gabrielle Dec. 1972 7 p ref
(RAE-Lib-Trans-1688; BR32894; PUBL-56) Avail: NTIS HC $3.00

An expression is derived for the ideal weight of fuselages having the form of a body of revolution with a straight axis, to which can be compared the forms adopted in modern aircraft, especially those for passenger transport. From this expression, which takes into consideration the strength-affecting loads and their distribution, together with cabin pressurization, a general formula is deduced to which the empirical formulas which give the actual weight of the fuselages, based on statistically determined data, can be conveniently reduced by adopting suitable coefficients.
Author

N73-26010# Royal Aircraft Establishment, Farnborough (England).
INVESTIGATIONS INTO THE LIFTING PROBLEM OF SLENDER WINGS IN SUPERSONIC FLOW
Arabindo Das and Hans-Holger Schroeder Dec. 1972 47 p refs Transl. into ENGLISH from Z. Flugwiss (West Germany), v. 19, no. 7, 1971 p 265-281
(RAE-Lib-Trans-1677; BR32901) Avail: NTIS HC $4.50

Linearized theories applicable to slender wings in supersonic flow are discussed. The results from the exact linear theory, the extended theory of slender bodies, and the theory of very slender bodies are compared. The following subjects are examined: (1) the nature of the transition from a subsonic to supersonic leading edge, (2) the magnitude of the suction force at the wing leasing edge, (3) the effects of viscosity on the wing flow, and (4) the nonlinear influences associated with increasing Mach number and increasing incidence.
Author

N73-26011# Royal Aircraft Establishment, Farnborough (England).
EFFECT OF SONIC BOOMS ON BUILDINGS: REPORT OF THE FINAL SYNTHESIS
A. Chaumette Jul. 1972 66 p refs Transl. into ENGLISH of Centre Sci. et Tech. du Batiment, Paris, Report. 1 Mar. 1971
(RAE-Lib-Trans-1633; BR32285) Avail: NTIS HC $5.50

A program to measure the effects of sonic booms on light building structures was conducted. The magnitude of the stresses imposed by sonic booms are compared with those caused by the environment, differential movement of materials, variations in the dimensions due to changes in temperature and humidity, and ground movements. The conditions under which the stresses are evaluated are described. Mathematical models are included to define the stresses developed.
Author

N73-26012# Royal Aircraft Establishment, Farnborough (England).
THE FATIQUE BEHAVIOUR OF AIRCRAFT STRUCTURES
W. Barrois Feb. 1973 61 p refs Transl. into ENGLISH from Rev. Franc. Mecan. (France), v. 38, 1971 p 41-65
(RAE-Lib-Trans-1678; BR34102) Avail: NTIS HC $5.25

After a review of the qualitative laws for the fatigue behavior of components in which notches are present (because of assembly requirements) and of components containing undetected cracks incurred during service, the overall problem of life prediction for service aircraft structures is discussed from a practical viewpoint. The basic reasons which make exact predictions impossible are emphasized. These lead to the use of the fail-safe concept for the design of the structure. It is also necessary to protect the quality of structures from the detail design stage right through to the service maintenance phase, keeping an eye on the true properties of the materials used, the effects of different fabrication techniques, quality control procedures and the inevitable material defects.
Author

N73-26013# Royal Aircraft Establishment, Farnborough (England).
DETERMINATION OF THE LIFE OF HELICOPTER STRUCTURAL MEMBERS
R. Prinz Jan. 1973 69 p refs Transl. into ENGLISH from West German Rept. DLR-Mitt-69-26, 1969
(RAE-Lib-Trans-1520; BR33563; DLR-Mitt-69-26) Avail: NTIS HC $5.50

Methods for determining the service life of helicopter structural members are presented. Calculated or measured stress-time functions are investigated, and analytical and experimental methods are indicated for their statistical evaluation. The use of a standard test load distribution for fatigue investigations on rotor blades is proposed, which is based on various load spectra. A number of possibilities for the fatigue test program are indicated and the necessity for statistical evaluation of the experimental results is explained.
Author

N73-26014*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF ROTOR DESIGN TIP SPEED ON NOISE OF A 1.21 PRESSURE RATIO MODEL FAN UNDER STATIC CONDITIONS
I. J. Loeffler, S. Lieblein, and N. O. Stockman 1973 21 p Proposed for presentation at 1973 Winter Ann. Meeting of the ASME, Detroit, 11-15 Nov. 1973
(NASA-TM-X-68243; E-7555) Avail: NTIS HC $3.25 CSCL 01C

Preliminary results are presented for a reverberant-field noise investigation of three fan stages designed for the same overall total pressure ratio of 1.21 at different rotor tip speeds (750, 900, and 1050 ft/sec). The stages were tested statically in a 15-inch-diameter model lift fan installed in a wing pod located in the test section of a wind tunnel. Although the fan stages produced essentially the same design pressure ratio, marked differences were observed in the variation of fan noise with fan operating speed. At design speed, the forward-radiated sound power level was approximately the same for the 750 ft/sec and 900 ft/sec stages. For the 1050 ft/sec stage, the design-speed forward-radiated power level was about 7 db higher due to the generation of multiple pure tone noise.
Author

N73-26015*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
APPLICATION OF FINITE DIFFERENCE TECHNIQUES TO NOISE PROPAGATION IN JET ENGINE DUCTS
Kenneth J. Baumeister 1973 23 p refs Proposed for presentation at Winter Ann. Meeting of the ASME, Detroit, 11-15 Nov. 1973
(NASA-TM-X-68261; E-7551) Avail: NTIS HC $3.25 CSCL 20A

A finite difference formulation is presented for wave propagation in a rectangular two-dimensional duct without steady flow. The difference technique, which should be useful in the study of acoustically treated inlet and exhausts ducts used in turbofan engines, can readily handle acoustical flow field complications such as axial variations in wall impedance and cross section area. In the numerical analysis, the continuous acoustic field is lumped into a series of grid points in which the pressure and velocity at each grid point are separated into real and imaginary terms. An example calculation is also presented for the sound attenuation in a two-dimensional straight soft-walled suppressor.
Author

N73-26016# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: NORTH CENTRAL AIRLINES, INCORPORATED, ALLISON CONVAIR 340/440 (CV-580), N90858 AND AIR WISCONSIN INCORPORATED, DHC-6, N4043B NEAR APPLETON, WISCONSIN, 29 JUNE 1972
25 Apr. 1973 33 p
(NTSB-AAR-73-9; SA-433) Avail: NTIS HC $3.75

The midair collision of a Convair 340 and a DHC-6 aircraft near Appleton, Wisconsin on 29 June 1972 is reported. All personnel aboard both aircraft were fatalities following the collision and subsequent impact with Lake Winnebago. The cause of the accident is considered to be failure of the flight crews to detect the presence of other aircraft in time to take evasive action. Hazy atmospheric conditions existing at the time contributed to the detection problem. Author

N73-26017# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: DELTA AIR LINES, INCORPORATED, MCDONNELL DOUGLAS DC-9-14, N3305L, GREATER SOUTHWEST INTERNATIONAL AIRPORT, FORT WORTH, TEXAS, 30 MAY 1972
13 Mar. 1973 38 p
(NTSB-AAR-73-3; SA-432) Avail: NTIS HC $4.00

The crash of a DC-9 aircraft at Fort Worth, Texas airport on 30 May 1972 is reported. The crash occurred during an attempted go-around following a landing approach. The landing approach was normal, but the aircraft began oscillating after passing the runway threshold and finally struck the runway in an extreme right wing low attitude. It was determined that the cause of the accident was an encounter with a trailing vortex generated by a large jet aircraft which preceded the DC-9 to the runway. Author

N73-26018# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT: MOHAWK AIRLINES, INCORPORATED, FAIRCHILD HILLER FH-227B, N7818M, ALBANY, NEW YORK, 3 MARCH 1972
11 Apr. 1973 70 p
(NTSB-AAR-73-8; SA-431) Avail: NTIS HC $5.50

An aircraft accident involving a Fairchild Hiller-227B aircraft which crashed near Albany County Airport, New York on 3 March 1972 is discussed. The flight was conducting an instrument landing approach when the crew reported trouble with the left propeller. The aircraft hit a house about three miles short of the airport. It was determined that the cause of the accident was the inability of the crew to feather the left propeller. Author

N73-26019# Federal Aviation Administration, Washington, D.C. Aviation Forecast Div.
TERMINAL AREA FORECAST, 1974-1984
Oct. 1972 387 p
Avail: NTIS $21.50

Forecasts for fiscal years 1974, 1975, 1976, and 1984 of the key measures of aviation activity at selected airports are presented. The total Terminal Area Forecast includes 1,201 airports which meet at least one of the following criteria: (1) existing tower airport, (2) candidate for a tower, (3) 50 or more based aircraft, (4) receives certificated route air carrier service, and (5) 20,000 or more general aviation itinerant operations. The forecasts are prepared to meet the needs of planning personnel in FAA offices and services with future traffic levels at these airports. The report is organized by FAA region and within each region by state. National and regional summaries are included in the introduction. The airports in each state are listed in the alphabetical order of the communities they serve. Location identifiers for all existing tower airports are shown in large bold-face type. All other known airport location identifiers are shown in standard typewriter style. Airports currently planned for new, first-time towers are identified by a planned commissioning date directly beneath their location identifier (76 airports). Author

N73-26020# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AVIATION. ISSUE NUMBER 3 OF 1972 ACCIDENTS
1 May 1973 479 p
(NTSB-BA-73-4) Avail: NTIS HC $26.00

Selected aircraft accident reports, in brief format, occurring in U.S. Civil Aviation operations during calendar year 1972 are presented. The 900 General Aviation and 29 Air Carrier Accidents contained in this publication represent a random selection. The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light pilot certificate, injuries, and causal factors. Author

N73-26021*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SIMULATOR INVESTIGATION OF THE INFLUENCE OF ENGINE RESPONSE CHARACTERISTICS ON THE APPROACH AND LANDING FOR AN EXTERNALLY BLOWN FLAP AIRCRAFT. PART 1: DESCRIPTION OF THE SIMULATION AND DISCUSSION OF RESULTS
James A. Franklin and Robert W. Koenig May 1973 79 p refs
(NASA-TM-X-62265) Avail: NTIS HC $6.00 CSCL 01C

Investigation of the influence of engine response characteristics on approach and landing operations of a powered lift aircraft were carried out in a piloted ground-based simulator. The aircraft simulated was a four engine, externally-blown jet-flap configuration having an 80 pound wing loading and .56 thrust to weight ratio. Results indicate that for ideal operating conditions and minimal pilot reaction delay, substantial reductions in engine-out wave-off altitude increment and touchdown sink rate for engine-out landings can be achieved with the fast engine compared to the slow engine response. However, delays in pilot reaction of one to two seconds diminish the advantage of rapid thrust response. A need exists for some form of automatic cueing of the pilot or automatic engine control to enable the potential of rapid thrust response to be realized in improving safety in the event of an engine failure. Author

N73-26022*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SIMULATOR INVESTIGATION OF THE INFLUENCE OF ENGINE RESPONSE CHARACTERISTICS ON THE APPROACH AND LANDING FOR AN EXTERNALLY BLOWN FLAP AIRCRAFT. PART 2: AERODYNAMIC MODEL
Donald L. Ciffone and Glenn H. Robinson May 1973 70 p
(NASA-TM-X-62265(2)) Avail: NTIS HC $5.50 CSCL 01C

An analysis of the influence of engine response characteristics on the approach and landing of an externally blown flap aircraft was conducted using flight simulator facilities. The configuration of the aerodynamic model is described. The aerodynamic characteristics as a function of angle of attack, thrust coefficient, and flap deflection are presented in tabular form and as graphs. Author

N73-26023*# McDonnell-Douglas Corp., Long Beach, Calif.
THE EFFECTS ON CRUISE DRAG OF INSTALLING LONG-DUCT REFAN-ENGINE NACELLES ON THE MCDONNELL DOUGLAS DC-8-50 AND -61
J. T. Callaghan, J. E. Donelson, and J. P. Morelli May 1973 40 p refs
(Contract NAS3-16814)
(NASA-CR-121218; MDC-J5947) Avail: NTIS HC $4.00 CSCL 01C

A high-speed wind tunnel test was conducted to determine the effect on cruise performance of installing long-duct refan-engine nacelles on the DC-8-50 and -61 models. Drag data and wing/pylon/nacelle channel pressure data are presented. At a typical cruise condition there exists a very small interference drag penalty of less than one-percent of total cruise data for the Refan installation. Pressure data indicate that some supersonic

flow is present in the inboard channel of the inboard refan nacelle installation, but it is not sufficient to cause any wave drag on boundary layer separation. One pylon modification, which takes the form of pylon bumps, was tested. It resulted in a drag penalty, because its design goal of eliminating shock-related interference drag was not required and the bump thus became a source of additional parasite drag. Author

N73-26024*# McDonnell-Douglas Corp., Long Beach, Calif.
THE EFFECTS ON CRUISE DRAG OF INSTALLING REFAN-ENGINE NACELLES ON THE MCDONNELL-DOUGLAS DC-9
J. T. Callaghan May 1973 41 p refs
(Contract NAS3-16814)
(NASA-CR-121219; MDC-J5948) Avail: NTIS HC $4.25 CSCL 01C

A high speed wind tunnel test has been conducted to determine the effect on cruise drag for installing larger JT8D Refan engine nacelles on the Douglas DC-9. Drag data and wing- and nacelle/pylon/fuselage-channel pressure data are presented. Reduced pylon spares, required to minimize effects of the nacelle installation on low-speed deep stall, were investigated. The reduce span pylons resulted in no adverse interference effects. At typical cruise Mach numbers the measured penalty for the Refan installation was less than estimated due to a favorable effect of the larger entering engine stream tube suppressing the wing upper-surface velocities with subsequent wing compressibility drag reduction. Channel pressures show no shock waves or boundary layer separations. Author

N73-26025# Battelle Columbus Labs., Ohio.
A PROGRAM DEFINITION STUDY FOR THE IMPROVEMENT OF SHORT HAUL AIR TRANSPORTATION. VOLUME 1: RECOMMENDED PROGRAM PLAN Final Report
Jan. 1973 154 p refs
(Contract DOT-FA72WA-2820)
(FAA-QS-73-1-Vol-1) Avail: NTIS HC $9.75

A recommended program plan for Federal-initiative in the Government's continued pursuit of an improved short-haul air transportation system is presented. The plan was developed in response to the broad program requirements set forth in the contract statement of work and, more specifically, was based on the system development needs, opportunities, and constraints identified in the course of performing the study. It provides the responsible Government departments and agencies with a resource they can use in the formulation and adoption of an official plan for short-haul air transportation development. Author

N73-26026# Urban Systems Research and Engineering, Inc., Cambridge, Mass.
A PLAN FOR THE IMPROVEMENT OF SHORT-HAUL AIR TRANSPORTATION Final Report
Mar. 1973 251 p
(Contract DOT-FA72WA-2816)
(FAA-QS-73-2) Avail: NTIS HC $14.75

A plan for fostering the improvement and development of the national short haul air transportation system through the year 1976 is developed. In addition, promising areas for short haul improvement are identified for the period 1972 through 1990. The plan and recommendations are based on a computer simulation comparison of alternative short haul concepts which include various combinations of vehicle types and airport configurations. Measures such as air travel demand, operating costs, revenues, noise impact, and congestion relief are utilized in making these comparisons. Author

N73-26027# Aeronautical Research Associates of Princeton, Inc., N.J.
CALCULATION OF THE WAKES OF THREE TRANSPORT AIRCRAFT IN HOLDING, TAKEOFF, AND LANDING CONFIGURATIONS AND COMPARISON WITH EXPERIMENTAL MEASUREMENTS Final Report
Coleman duPDonaldson, Richard S. Snedeker, and Roger D. Sullivan Mar. 1973 110 p refs
(Contracts DOT-FA72WAI-309; F44620-69-C-0089)
(FAA-RD-73-42; ARAP-190) Avail: NTIS HC $7.50

A method is described for the calculation of the initial form and location of the inviscid rolled-up wake vortices behind wings having both simple and complex load distributions such as those which occur when the wing is highly flapped. The method makes use of the Betz theorems of conservation of vorticity and moments of vorticity in the wake. It is found that a simple relationship exists between the radial distribution of vorticity concentrated in the wake vortices and the spanwise distribution of vorticity shed from the wing. Velocity profiles computed for the wake vortices of several aircraft in holding, takeoff, and landing configurations are shown to compare favorably with those measured at times up to one minute after fly-by during full scale experiments. Author

N73-26028# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, SUPPLEMENTAL ISSUE, 1971 ACCIDENTS
4 May 1973 103 p
(NTSB-BA-73-5) Avail: NTIS HC $7.25

Reports of aircraft accidents and incidents that occurred in 1971 and have not been included in a prior issue of briefs are presented. Included are 11 U.S. Air Carrier accidents, 53 U.S. Air Carrier indicents, 14 U.S. General Aviation accidants, and 57 U.S. General Aviation incidents. One Foreign Air Carrier accident, and 16 Foreign General Aviation accidents that were investigated by the National Transportation Safety Board are also included. This publication is the final issue of Briefs of Accidents that occurred in calendar year 1971. Author

N73-26029# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT, NORTHWEST AIRLINES, INCORPORATED, BOEING 747-151, N602US, MIAMI, FLORIDA
30 May 1973 13 p
(NTSB-AAR-73-12) Avail: NTIS HC $3.00

The aircraft accident involving a Boeing 747 aircraft which ran off the end of the runway during landing at Miami, Florida airport on 15 Dec. 1972 is reported. The aircraft had collided with a flock of gulls during takeoff and number four engine was shut down. The aircraft was cleared to return to the airport. The cause of the accident was due to ineffective braking capability of the aircraft on the wet runway and lack of reverse thrust due to shut down of number four engine and malfunction of thrust reverser on number three engine. Author

N73-26030*# Linguistic Systems, Inc., Cambridge, Mass.
NOISE CHARACTERISTICS OF A JET AUGMENTED FLAP CONFIGURATION
Alain Burrand Washington NASA Jun. 1973 20 p refs Transl. into ENGLISH from l'Aeronautique et l'Astronautique (France), no. 39, 1973 p 44-54 Presented at the 3rd Colloq. on Aeronautic Acoustics, Toulouse, 6-7 Mar. 1972
(Contract NASw-2482)
(NASA-TT-F-14951) Avail: NTIS HC $3.00 CSCL 23A

The STOL-type aircraft lift augmenting requires the use of very efficient devices which, however, are likely to be sources of noise themselves or may modify the noise generated by the jet-engines. Among these devices is the internal-flow jet augmented flap wherein a jet from auxiliary generators is directed onto the wing flap upper-surface. The noise of this device is to be added to that produced by the engines. Static tests recently performed in an anechoic chamber have made it possible to investigate the various possible configurations and to appraise the effect of numerous parameters. The application of results at full scale allows the noise level of this STOL type to be evaluated. Author

N73-26031*# Scientific Translation Service, Santa Barbara, Calif.

SLENDER DELTA WINGS FOR FUTURE SUBSONIC COMMERCIAL AIRCRAFT
Martin Lichte Washington NASA Jun. 1973 28 p Transl. into ENGLISH from Flug Rev. (West Germany), no. 2, 1973 p 27-37
(Contract NASw-2483)
(NASA-TT-F-14949) Avail: NTIS HC $3.50 CSCL 01C

The aerodynamic characteristics of slender delta wings for subsonic commercial aircraft applications are discussed. The flow distribution on the wing for various airspeed conditions is described. The characteristics of conventional wings are compared with those of the slender delta wing. Graphs of the performance of the slender delta wing for various conditions of ground effect, angle of attack, glide conditions, and aerodynamic stall are included. Author

N73-26032# Boeing Co., Seattle, Wash. Customer Support Dept.
COMMERCIAL JET MAINTENANCE AND RELIABILITY ADVANCEMENTS
R. T. Dixon Nov. 1972 29 p Presented at FAA 8th ANN. Intern Maintenance Symp., 28-30 Nov. 1972
Avail: NTIS HC $3.50

A review of the progress made in the pre-World War 2 and post-World War 2 periods with respect to the commercial aviation industry is presented. The techniques that have been developed for use during the design of an aircraft to achieve high reliability and low maintenance cost are discussed. A summary of the latest methods that have been developed for instituting aircraft maintenance programs and the actions taken to achieve maximum efficiency and lowest maintenance costs is reported. Author

N73-26033# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flugmechanik der Luftfahrzeuge.
DETERMINATION OF THE DERIVATIVES OF LONGITUDINAL MOTION OF AN AIRCRAFT FROM FLIGHT DATA BY A MODEL WITH AUTOMATIC PARAMETER ADJUSTMENT
Ruthard Koehler 5 Dec. 1972 35 p refs In GERMAN; ENGLISH summary
(DLR-FB-73-13) Avail: NTIS HC $3.75; DFVLR, Porz: 10 DM

A circuit for determining the derivatives of an aircraft from flight data and which needs relatively few computation elements at the analog computer is discussed. Since quadratic terms are also taken into account in the analysis, the polar can be determined from the ascertained coefficients in the environment of a point. The results of an evaluation of flight data are discussed.
Author (ESRO)

N73-26034# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abteilung Flugbahnen.
INVESTIGATION AND APPLICATION OF TWO METHODS FOR DETERMINING TRANSFER-FUNCTION COEFFICIENTS OF THE LONGITUDINAL MOTION OF AIRCRAFT FROM MEASURED INPUT AND OUTPUT DATA
Werner Boegel 31 Jan. 1973 81 p refs In GERMAN; ENGLISH summary
(DLR-FB-73-39) Avail: NTIS HC $6.25; DFVLR, Porz, West Ger. 17,30 DM

The basis and operation of two methods for determining transfer function coefficients are briefly described. The first may be classified as an equations of motion method and the second as a response curve fitting method. Variations of the former method are presented for special cases. A description of the digital computer programs is given. The methods were investigated using these programs and digitally simulated input-output data. The computed results provide information describing the propagation of random and non-random errors. This information aided in the design of the input function. It also facilitated the choice of methods for executing flight tests and for the reduction and evaluation of flight test data. The application of these methods to flight data is demonstrated using measurements of the short period longitudinal motion of the Piaggio P 149 D aircraft.
Author (ESRO)

N73-26035# Elliott-Automation Space and Advanced Military Systems, Ltd., Camberley (England).
A STUDY TO DEFINE AN EXPERIMENTAL AIRCRAFT FOR EARTH RESOURCE SURVEYS. VOLUME 1: SUMMARY Final Report
Jul. 1972 97 p Prepared jointly with Fairey Surveys
(Contract ESTEC-1516/71-EL)
(ESRO-CR(P)-128) Avail: NTIS HC $7.00

The results of a study of a proposed Earth Resources Aircraft Facility (ERAF) to develop a European capability in the remote sensing of earth resources are presented. The objectives are first discussed followed by a description of missions and sensors. The reasons leading to the selection of the Fokker F-27 are given together with a description of the aircraft. The support facilities are noted and ownership and organization discussed. The program for aircraft procurement, conversion and testing is outlined along with the program of operations. Finally, costs and potential problem areas are defined. ESRO

N73-26036# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORT, MACHINERY BUYERS CORPORATION, LEARJET MODEL 24, N454RN, ATLANTA, GEORGIA, 26 FEBRUARY 1973
30 May 1973 14 p
(NTSB-AAR-73-12) Avail: NTIS HC $3.00

The crash of a Learjet Model 24 following takeoff from the Atlanta, Georgia airport on 26 Feb. 1973 is reported. The cause of the accident is the loss of engine thrust during takeoff due to ingestion of birds and subsequent loss of control of the aircraft. Author

N73-26037# Rochester Applied Science Associates, Inc., N.Y.
DEVELOPMENT OF A TECHNIQUE FOR REALISTIC PREDICTION AND ELECTRONIC SYNTHESIS OF HELICOPTER ROTOR NOISE Final Report
H. Kevin Johnson Mar. 1973 133 p refs
(Contract DAAJ02-71-C-0064; DA Proj. 1F1-62208-AA-82)
(AD-759955; RASA-72-08; USAAMRDL-TR-73-8) Avail: NTIS CSCL 01/3

A helicopter rotor noise prediction program was developed so that the acoustic characteristics of new, untested rotor designs could be evaluated as well as the effects of basic rotor design changes on the acoustic signature of existing rotors. The prediction program is general enough to be able to consider future designs in hover and steady state flight for any observer location. The program output is the digital pressure time history produced by the helicopter rotors at the observer location. This pressure time history corresponds to that which would be recorded by a microphone place at the observer location. The program output can be Fourier analyzed so that the noise spectrum can be generated. The digital pressure time history can also be converted to an analog signal for subjective evaluation.
Author (GRA)

N73-26038# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
FIELD-REPLACEABLE ROTOR BLADE POCKET STUDY Final Report
Pierce A. Meck and Charles V. Galli Feb. 1973 135 p refs
(Contract DAAJ02-71-C-0022; DA Proj. 1F1-63204-DB-38)
(AD-759956; SER-50758; USAAMRDL-TR-72-69) Avail: NTIS CSCL 01/3

The present CH-54B blade consists of 28 nonstructural pockets of 14 different configurations because of spar taper. When damaged, these pockets have had to be replaced at Sikorsky because of the present heat-curing adhesive utilized for pocket attachment. The purpose of this program was to design, fabricate, and test a field-replaceable pocket which could be utilized in

any position along the blade spar and attached with ambient-temperature curing adhesives at field level to reduce cost and eliminate shipping time to CONUS. The program was conducted in three phases. Phase I consisted of design, fabrication, and test of a practical universal pocket. Phase II consisted of adhesive selection and qualification testing plus the design and fabrication of a field jigging kit. Phase III consisted of a comparison of the cost of repairing CH-54 main blades using factory support and by field-replaceable pocket kits. The study showed that the pocket design was universally adaptable to any of 27 positions on the blade and was structurally and aerodynamically adequate. The adhesive selected provided acceptable bond strength under simulated field conditions, and the field pocket jigging fixture was lightweight and capable of being utilized by Army aircraft maintenance personnel. The study showed that field repair with the universal pocket would result in a rotor blade life-cycle savings of about $300,000 per year. Author (GRA)

N73-26039# Army Electronics Command, Fort Monmouth, N.J.

OPTIMAL DESIGN OF HELICOPTER PRECISION HOVER CONTROL SYSTEMS

N. N. Purl and R. J. Niemela Apr. 1973 36 p refs
(DA Proj. 1F1-62202-A-97)
(AD-759919; ECOM-4109) Avail: NTIS CSCL 01/2

Modern Control Theory is employed to analytically determine the limit of positional precision with which a helicopter can be hovered. Approaches based on Liapunov's Second Method and a Squared Root Locus Method are formulated to this optimal control problem. Both of these methods avoid iterative solution of the Matrix Riccati Equation. The Squared Root Locus Method is developed as a computer algorithm which generates optimal control designs as a function of performance index and helicopter stability/control derivatives. Practical design constraints can readily be interpreted from the results of this formulation. Author (GRA)

N73-26040# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

LANDING APPROACH AUTOMATIC FLIGHT CONTROL SYSTEM DESIGN VIA REDUCED ORDER OPTIMAL CONTROL LAW M.S. Thesis

Jerry DeVerne Pfleeger Jun. 1973 89 p refs
(AD-760125; GGC/MA/73-3) Avail: NTIS CSCL 01/3

A set of optimal feedback gains is used as a basis for designing a practical longitudinal automatic flight control system for the landing approach task. A procedure is developed to give a good first-cut design. The procedure is systematic and straightforward. The procedure is used to design two control systems for a DC-8 aircraft. In one case it is assumed that pitch, rate, normal acceleration, and longitudinal airspeed are continuously measured on board the aircraft. The second system is similar to the first with the exception that longitudinal airspeed is deleted as one of the measured variables. These systems are compared with a high-performance automatic flight control system that was designed using classical control techniques. The procedure is also used to design two control systems for a hypothetical aircraft with direct lift control capability. Author (GRA)

N73-26041# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

STATISTICAL REVIEW OF COUNTING ACCELEROMETER DATA FOR NAVY AND MARINE FLEET AIRCRAFT FROM 1 JANUARY 1962 TO 1 JANUARY 1973 Semiannual Summary Report

Thomas A. DeFiore 1 May 1973 38 p refs
(AD-760321; NADC-13920-2) Avail: NTIS CSCL 01/3

The report is a specialized summary of normal acceleration data recorded by counting accelerometers. Data are separated by calendar time and mission category. Only data reported in the counting accelerometer program are included. Author (GRA)

N73-26042# University of Southern Calif., Los Angeles. Dept. of Aerospace Engineering.

EQUIVALENCE RULE AND TRANSONIC FLOWS INVOLVING LIFT

H. K. Cheng and Mohamed M. Hafez Apr. 1973 36 p refs
(Contract N00014-67-A-0269-0021; NR Proj. 061-192)
(AD-760349; USCAE-124) Avail: NTIS CSCL 01/3

The transonic flow around a thin and smooth configuration with swept leading edge is shown to possess an outer nonlinear structure determined principally by an equivalent line source and an equivalent line doublet. In the lift dominated and intermediate domains there is an important nonlinear lift contribution to the equivalent source, which depends on both the axial and the spanwise lift distributions. This lift contribution is not completely accounted for by the transonic small-disturbance equation. Parametric estimates based on existing transonic transport proposals indicate significant lift effect on the nonlinear outer flow. Relaxation methods based on second-order difference schemes are developed to solve the reduced lift problem in the thickness-controlled domain. (Author Modified Abstract) GRA

N73-26043# Boeing Vertol Co., Philadelphia, Pa.

EQUIVALENT ROUTE WINDS FOR HELICOPTER AIR ROUTES AT HEIGHTS OF 5,000, 10,000 AND 18,000 FEET, VOLUME 1

D. G. Brown, R. J. Cooper, and R. D. Spragg Apr. 1973 321 p refs 2 Vol.
(AD-760252; D210-10600-1-Vol-1) Avail: NTIS CSCL 01/2

Equivalent headwinds or equivalent winds are computed using Sawyer's method for approximately 4400 strategic world air routes contained in Volumes 1 and 2. The seasonal mean equivalent wind and its standard deviation and the annual 50-, 75-, and 85-percent reliability equivalent winds are tabulated. Route winds are computed for the 5,000, 10,000, and 18,000 foot levels. An IBM 360/65 program was used to compute the equivalent winds. Input data for the program consist, for each level, of a grid composed of the mean vector wind and the standard vector deviation at the intersection of each 5 degrees of latitude with each 10 degrees of longitude between 60 degrees S and 60 degrees N and at the intersection of each 5 degrees of latitude and each 20 degrees of longitude south and north of 60 degrees S and 60 degrees N respectively. In addition to the equivalent winds, great circle distances are computed and tabulated for each route. Author (GRA)

N73-26044# Boeing Vertol Co., Philadelphia, Pa.

EQUIVALENT ROUTE WINDS FOR HELICOPTER AIR ROUTES AT HEIGHTS OF 5,000, 10,000 AND 18,000 FEET, VOLUME 2

D. G. Brown, R. J. Cooper, and R. D. Spragg Apr. 1973 260 p refs 2 Vol.
(AD-760253; D210-10600-2-Vol-2) Avail: NTIS CSCL 01/2

Equivalent headwinds or equivalent winds are computed using Sawyer's method for approximately 4400 strategic world air routes contained in Volumes I and II. The seasonal mean equivalent wind and its standard deviation and the annual 50-, 75-, and 85-percent reliability equivalent winds are tabulated. Route winds are computed for the 5,000, 10,000, and 18,000 foot levels. (Author Modified Abstract) GRA

N73-26165# Hughes Aircraft Co., Culver City, Calif. Antenna Dept.

RADIATION FROM SLOT-FED DIELECTRIC SLABS

Alfred T. Villeneuve Dec. 1972 59 p refs
(Contract F19628-72-C-0145; AF Proj. 4600)
(AD-760129; HAC-Ref-C5350; Rept-2765.31/420; AFCRL-TR-73-0088) Avail: NTIS CSCL 09/5

The report contains analyses of the radiation characteristics of grounded dielectric slabs fed by slots in the groundplane. Two configurations are examined, one in which a semi-infinite slab covers the slot, a second in which a finite slab does not extend over the slot. The slots are parallel to the slab edges so that only TM mode propagation is considered. Integral equations are derived for the fields at the ends of the slabs and approximate solutions are obtained. Numerical results in the form of

radiation patterns are given for the case of the semi-infinite slab. It is found that the feed pattern is very close to the space-wave that would exist if the slab were infinite, but differs from it in the region near the horizon. The results can be applied to studies of electronic scanning of finite arrays of slots in the presence of surface wave structures. Recommendations for further study are included. Author (GRA)

N73-26239# Advisory Group for Aerospace Research and Development, Paris (France).
PROBLEMS IN WIND TUNNEL TESTING TECHNIQUES
Apr. 1973 165 p refs
(AGARD-R-601; AGARD-601) Avail: NTIS HC $10.25

The design and operation of large wind tunnels for low speed and transonic speed conditions are described. The subjects discussed include the following: (1) methods for correcting wall constraints in transonic wind tunnels, (2) interference effects of model support systems, (3) minimum required measuring times to perform instationary measurements in transonic tunnels, (4) wind tunnel requirements for helicopters, and (5) acoustic considerations for noise experiments at model scale in subsonic wind tunnels.

N73-26240 Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
REVIEW OF SOME PROBLEMS RELATED TO THE DESIGN AND OPERATION OF LOW SPEED WIND TUNNELS FOR V/STOL TESTING
Mario Carbonaro *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 24 p refs

A review is made of a number of operational problems associated with the wind tunnel testing of V/STOL aircraft including helicopters. The following subjects are discussed: (1) wall constraints, (2) use of ventilated walls, (3) testing for ground effect, and (4) flow disturbances in the tunnel circuit. Mathematical models are developed to clarify the theoretical aspects of wind tunnel operation. Author

N73-26241 Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France). Aerodynamics Dept.
SURVEY OF METHODS FOR CORRECTING WALL CONSTRAINTS IN TRANSONIC WIND TUNNELS
Jean-Ch. Vayssaire *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 48 p refs

The use of ventilated walls in transonic wind tunnels and the effect on wall interference corrections are discussed. Mathematical applications of the extreme cases of zero permeability and infinite permeability are examined. The solutions are compared and the characteristics of theoretical working sections are analyzed. Mathematical models are provided to support the theoretical considerations. Author

N73-26242 Aircraft Research Association, Ltd., Bedford (England).
INTERFERENCE EFFECTS OF MODEL SUPPORT SYSTEMS
E. C. Carter *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 10 p refs

The forms of interference occurring in subsonic and transonic wind tunnels due to model support systems are discussed. Two types of model attachment, rear sting and vertical blade sting are considered and the form and magnitude of interference terms are given for some particular examples. The buoyancy interference in the working section due to a typical sting joint and roll mechanism behind a model is considered and the effect on drag is evaluated for two typical bodies. Author

N73-26243 Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
MINIMUM REQUIRED MEASURING TIMES TO PERFORM INSTATIONARY MEASUREMENTS IN TRANSONIC WIND TUNNELS
J. W. G. VanNunen, G. Coupry (ONERA, Chatillon-sous-Bagneux, France), and H. Foersching (DFVLR, Goettingen, West Germany) *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 2 p refs

The minimum required run times for instationary measurements at transonic speeds during wind tunnel tests are analyzed. The subjects discussed are: (1) instationary pressure measurement techniques, (2) flutter tests, (3) buffet measurements, and (4) cross correlation techniques. It is concluded that present test methods require a minimum running time of ten seconds. It is suggested that new test techniques may reduce the time requirement. Author

N73-26244 Royal Aircraft Establishment, Bedford (England).
SOME CONSIDERATIONS OF TESTS UNDER DYNAMIC CONDITIONS IN LOW SPEED WIND TUNNELS
D. N. Foster *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 4 p refs

The objectives of dynamic tests conducted in low speed wind tunnels are examined. For a number of specific problems for measurements under static conditions it is possible that special techniques and new equipment will be required. The two general areas of consideration are: (1) measurement of oscillatory derivatives and (2) measurement of transient motions caused by gusts and ground effect. It is concluded that the main requirements for data relevant to dynamic effects can be met under static conditions over a wide range of variables. Author

N73-26245 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Aerodynamische Versuchsanstalt.
USE OF MODEL ENGINES (V/S/CTOL)
E. Melzer and R. Wulf *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 17 p refs

The special conditions required to conduct wind tunnel tests of jet aircraft engines are examined. The capabilities for simulation in atmospheric tunnels are discussed. The problems of testing in pressurized tunnels are analyzed. An estimation of the energy, the plants, and the test equipment required for engine simulation are listed. Author

N73-26246 Westland Helicopters, Ltd., Yeouil (England).
WIND TUNNEL REQUIREMENTS FOR HELICOPTERS
I. A. Simons and H. Derschmidt (MBB, Munich) *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 10 p refs

The sizes of model which are most suited to various aspects of wind tunnel tests of helicopters are defined. The scaling laws and associated constructional problems of small scale rotor systems are discussed. Tunnel sizes are suggested for various ranges of model size based on a consideration of interference effects. Author

N73-26247 Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
ACOUSTIC CONSIDERATIONS FOR NOISE EXPERIMENTS AT MODEL SCALE IN SUBSONIC WIND TUNNELS
T. A. Holbeche and J. Williams *In* AGARD Probl. in Wind Tunnel Testing Tech. Apr. 1973 30 p refs

Acoustic considerations for noise experiments at model scale in subsonic wind tunnels are presented. Emphasis is placed on similarity to flight test conditions, noise measurement constraints on model and tunnel sizes, the parasitic effects of background noise, and the various factors contributing to the generation of noise. The specific contributions to tunnel noise from the tunnel drive fan, the tunnel circuit, the test section mainstream flow, and the particular test section boundary conditions are discussed. Author

N73-26248# National Aviation Facilities Experimental Center, Atlantic City, N.J.
DIGITAL SIMULATION FACILITY/SYSTEM SUPPORT

FACILITY INTERFACE TESTS Final Report, Jan. - Oct. 1972
R. R. Reyers Jul. 1973 35 p
(FAA-NA-73-33; FAA-RD-73-67) Avail: NTIS HC $3.75

A series of tests was conducted to interface the Digital Simulation Facility (DSF) with the System Support Facility (SSF) at the National Aviation Facilities Experimental Center (NAFEC). Included were tests of the DSF performance, as well as tests of the hardware interface to the 9020 computer, and the software interface to the NAS Model 3dl program. This report describes these tests and the results obtained. Author

N73-26248+ Royal Aircraft Establishment, Farnborough (England).
NOISE MEASUREMENTS IN THE MODANE LARGE WIND-TUNNEL
Curt Broll 1973 14 p refs Transl. into ENGLISH from la Rech. Aerospatiale (Paris), v. 1, 1972 p 47-51
(RAE-Lib-Trans-1683; BR35413) Copyright. Avail: NTIS HC $3.00

Noise measurements made on a helicopter rotor in a wind tunnel are described. The acoustic calibration measurements made with the wind-on and wind-off in an empty tunnel are described. The helicopter noise results are corrected for reverberation and amplification effects in the acoustically untreated test section by the simple application of some comparative control measurements of the noise from a basic source at the rotor location in the tunnel wind-off and free-field conditions outside. Author

N73-26253# Federal Aviation Administration, Washington, D.C. Office of Aviation Policy and Plans.
AN EVALUATION STUDY OF THE AIRPORT DEVELOPMENT-AID PROGRAM, FY 1971 - 1972 Final Report
Raymond T. Uhl Sep. 1972 256 p
(FAA-AV-72-4) Avail: NTIS HC $15.00

This report reviews and analyzes air carrier/reliever airport grant allocations made in the first two years of the operation of the Airport Development-aid Program (Fiscal Years 1971-1972) in an attempt to determine the effectiveness of the program. In doing so, it looks at the nature of aeronautical demand, national airport system requirements, reviews ADAP program procedures, and analyzes the characteristics of airport grant allocations. Finally, the report considers the program with respect to congestion relief and suggests potential program adjustments to increase the effectiveness of the program. Author

N73-26255# Douglas Aircraft Co., Inc., Long Beach, Calif.
PROCEDURES FOR DETERMINATION OF AIRPORT CAPACITY, APPENDICES, VOLUME 2 Interim Report, Jun. 1972 - Jan. 1973
Apr. 1973 298 p Prepared in cooperation with McDonnell Douglas Automation Co., Peat, Marwick, Mitchell and Co., and Am. Airlines, Inc.
(Contract DOT-FA72WA-2897)
(FAA-RD-73-11-Vol-2) Avail: NTIS HC $17.00

Appendices are presented in support of the efforts undertaken in three major areas. These are: (1) The airport planning studies task was a user oriented effort to define the requirements for planning tools. Surveys of potential users were made which helped define the format for the planned Capacity Handbook. Definitions of airfield capacity and delay were refined. (2) Data collection involved gathering operational information relating to airfield performance at 14 U.S. airports. (3) Models for determining airfield capacity and delay were also developed. For computational efficiency it was decided to use analytical techniques for capacity determination. However, the delay model necessarily had to use Monte Carlo simulation, and the appropriate logic was developed. Author

N73-26264# Illinois Univ., Savoy.
SIMULATOR MOTION IN AVIATION SYSTEM DESIGN RESEARCH
Robert C. Williges and Stanley N. Roscoe May 1973 28 p refs Presented at the NATO seminar on Man Machine Relations, Utrecht, Netherlands, 28-30 May 1973
(Contracts N00014-67-A-0305-0014; F44620-70-C-0105)
(AD-760049; ARL-73-6/ONR-73-2/AFOSR-73-3) Avail: NTIS CSCL 01/4

In three studies, the order of merit of four flight-director/attitude-indicator displays (moving horizon, moving airplane, frequency-separated, and kinalog) was assessed under three conditions of simulator motion (no motion, normal GAT-2 simulator motion, and washout motion), and the results were compared to flight performance. Comparisons among the studies were made to determine whether or not performance on various display modes was differentially affected by simulator motion cues, and if so, what degrees and fidelity of simulator motion were required to produce results that generalized to flight performance. It was concluded that the presence or absence of motion cannot only affect absolute levels of performance, but different orders of merit among displays can occur. Specifically, inappropriate cockpit motion may be more misleading than no motion, whereas limited motion in pitch and roll that corresponds closely to the angular accelerations encountered in flight may be sufficient to produce generalizable research data on the relative merits of flight displays. (Author Modified Abstract) GRA

N73-26267# Massachusetts Inst. of Tech., Cambridge.
SIMULATOR EVALUATION OF PILOT ASSURANCE DERIVED FROM AN AIRBORNE TRAFFIC SITUATION DISPLAY Final Report, 1 Jul. 1971 - 28 Feb. 1972
Jack D. Howell Feb. 1972 170 p refs
(Contracts F19628-70-C-2301; DOT-FA71WAI-234)
(AD-749280; FAA-EM-72-3) Avail: NTIS CSCL 01/5

An extensive series of tests were run on a transport cockpit simulation facility to evaluate the pilot assurance value of airborne displays used as traffic situation monitors in high-density terminal airspace. The twenty professional pilots employed as subjects were exposed to a set of typical normal and abnormal terminal approach situations. Their level of assurance was determined from their detailed knowledge of each situation, measured by stop-action quizzes, and the ability to detect conflicts. Workload or the degree of difficulty the pilots experienced in acquiring relevant information about the situation was also regarded as a component of assurance. Specific problem areas emphasized in the test scenarios were simultaneous approaches to closely-spaced parallel runways, blunder detection and resolution, and providing a picture for the pilot when discrete address data links replace current ATC party-line communications. Author (GRA)

N73-26279# Advisory Group for Aerospace Research and Development, Paris (France). Fluid Dynamics Panel.
FLUID MOTION PROBLEMS IN WIND TUNNEL DESIGN
Apr. 1973 68 p refs
(AGARD-R-602; AGARD-602) Avail: NTIS HC $5.50

A series of research papers is presented relating to the design and operation of low speed and transonic wind tunnels with particular emphasis on the associated fluid motion problems.

N73-26280 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Inst. fuer Angewandte Gasdynamik.
THE INFLUENCE OF THE FREE-STREAM REYNOLDS NUMBER ON TRANSITION IN THE BOUNDARY LAYER ON AN INFINITE SWEPT WING
E. H. Hirschel *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 11 p refs

The three-dimensional compressible laminar boundary layer on an infinite swept wing at different sweep angles is calculated and stability and transition criteria are applied to it for free-stream Reynolds numbers ranging from values possible nowadays in transonic wind tunnels to values typically for full-scale flight.

The distribution of the inviscid flow is taken from experiments on airfoils, and exhibits for subsonic free stream Mach numbers supersonic regions terminating in shock waves at about 20 percent chord length. Results are given for four different wing sections. The techniques employed and their shortcomings are discussed. Author

N73-26281 Royal Aircraft Establishment, Farnborough (England).
SOME EXAMPLES OF THE APPLICATION OF METHODS FOR THE PREDICTION OF BOUNDARY-LAYER TRANSITION ON SHEARED WINGS
D. A. Treadgold and J. A. Beasley *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 1 p refs

The laminar boundary layer was calculated for the leading-edge region of four selected airfoils for cases where the supercritical region is terminated by a shock wave at about 20% chord. The possibility of the boundary layer becoming turbulent before the shock wave is then considered according to four different criteria: leading-edge contamination, re-laminarisation, sweep instability, and Tollmien-Schlichting instability. Many simplifying assumptions have had to be made, since the purpose of the report is to demonstrate how the problem might be treated, rather than to present difinitive results, and how the various mechanisms are seen in conjunction. It is concluded that much more needs to be known before predictions can be made confidently with any degree of precision. Author

N73-26282 Royal Aircraft Establishment, Bedford (England).
THE NEED FOR HIGH-REYNOLDS-NUMBER TRANSONIC TUNNELS
C. R. Taylor *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 13 p refs

The present generation of transonic tunnels cannot simulate full-scale flows at critical points of the flight enveloped for many current aircraft designs and there is an urgent need for new tunnels which would permit model tests to be made at much higher Reynolds numbers. New tunnels are proposed that would allow good simulations of aircraft shape to be made for a wide range of model tests; this limits the maximum tunnel total pressure to about 8 bars. A Reynolds number range which covers about half the full-scale range is advocated, demanding a working section area of about 25m squared. The tunnels would have low levels of free-stream turbulence and be capable of operation under conditions giving little heat transfer to the model. Running times of at least 10 sec are required. Author

N73-26283 Royal Aircraft Establishment, Bedford (England).
ON THE INFLUENCE OF FREE-STREAM TURBULENCE ON A TURBULENT BOUNDARY LAYER, AS IT RELATES TO WIND TUNNEL TESTING AT SUBSONIC SPEEDS
J. E. Green *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 8 p refs

Published experimental measurements are reviewed which show the turbulent boundary layer to be highly sensitive to turbulence in the free-stream. In zero pressure gradient, a small increase in the streamwise rms velocity fluctuation is found to have the same effect on the shape of the velocity profile as a fractional increase in Reynolds number roughly sixty times as great. It is concluded that this effect needs to be taken into account in planning new wind tunnels for subsonic and transonic testing at high Reynolds number. Further experimental work is needed to clarify: the importance of turbulence scale, the influence of pressure gradients, and influence of radiated pressure (as opposed to convected vorticity) fluctuations. Author

N73-26284 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin (West Germany). Inst. fuer Turbulenzforschung.
EFFECTS OF TURBULENCE AND NOISE ON WIND TUNNEL MEASUREMENTS AT TRANSONIC SPEEDS
Adalbert Timme *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 12 p refs

Current knowledge is reviewed of the effects of flow unsteadiness on steady and dynamic measurements on models in wind tunnels at transonic speeds. It is found that in most cases the influence of the pressure or velocity fluctuations on flow patterns such as boundary layers with transition or separation, bubble flow or shock interaction is quantitatively known from experiments only for particular parameter combinations. No universal information about the turbulence effect in different situations is found, nor is there a general theory including all observed effects at conditions of interest. Only in the case of a turbulent boundary layer at zero pressure gradient, a quantitative relation is known between the turbulence in the free stream and the boundary layer development. It is concluded, therefore, that new experimental work using advanced measuring techniques and a secured theoretical background is urgently needed for planning new wind tunnels for transonic testing at high Reynolds numbers. Author

N73-26285 City Univ., London (England). Dept. of Aeronautics.
DESIGN OF VENTILATED WALLS WITH SPECIAL EMPHASIS ON THE ASPECT OF NOISE GENERATION
R. N. Cox and M. M. Freestone *In* AGARD Fluid Motion Probl. in Wind Tunnel Design Apr. 1973 7 p refs

The parameters influencing the design of ventilated wind tunnel walls in current use are reviewed, and noise generation by such walls is analyzed. By drawing an analogy between results from flows past two-dimensional cavities and the discrete frequency tones generated by perforated walls, some suggestions are made about the mechanisms responsible for the tones. Finally some possible methods of reducing unwanted noise from tunnel walls are discussed. Author

N73-26288*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STUDY OF THE FAR WAKE VORTEX FIELD GENERATED BY A RECTANGULAR AIRFOIL IN A WATER TANK
Dietrick K. Lezius May 1973 10 p refs
(NASA-TM-X-62274) Avail: NTIS HC $3.00 CSCL 20D

Underwater towing experiments were carried out with a rectangular airfoil of aspect ratio 5.3 at 4 and 8 deg angles of attack and at chord-based Reynolds numbers between 2 x 100,000 and 7.5 x 100,000. Quantitative measurements by means of the hydrogen bubble technique indicated lower peak swirl velocities in the range of 100 to 1000 lengths downstream than have been measured in wind tunnel of flight tests. The maximum circumferential velocity decayed whereas the turbulent eddy viscosity increased. This behavior and other known rates of vortex decay are explained in terms of an analytical solution for the vortex problem with time varying eddy viscosity. It is shown that this case corresponds to nonequilibrium turbulent vortex flow. Author

N73-26291*# Kanner (Leo) Associates, Redwood City, Calif.
GROUND EFFECT VISUALIZATION AT LOW SPEED AROUND AIRCRAFT MODELS
Henri Werle Washington NASA Jun. 1973 27 p refs
Transl. into ENGLISH from Rech. Aerospatiale (Paris), no. 2, Mar. - Apr. 1970 p 79-93
(Contract NASw-2481)
(NASA-TT-F-14958) Avail: NTIS HC $3.75 CSCL 20D

The analysis of the ground effect on the flow around models, using visualization obtained in a hydraulic test tunnel is discussed. The ground simulation methods previously developed for fundamental research have been used for aerodynamic studies applied to actual aircraft such as Airbus-type air intake, VTOL jet aircraft, and Concorde with or without simulation of a downward vertical movement. Author

N73-26292*# Scientific Translation Service, Santa Barbara, Calif.
THE INFLUENCE OF AN INCLINED JET ON THE FLOW FIELD IN THE VICINITY OF A LIFTING SURFACE AND ON ITS AERODYNAMIC COEFFICIENTS
M. Seidel Washington NASA Jul. 1973 67 p refs Transl. into ENGLISH from the German Report DFLR-68-20
(Contract NASw-2483)
(NASA-TT-F-14956; DFLR-68-20) Avail: NTIS HC $5.50 CSCL 20D

Systematic three-component measurements were carried out on a lifting surface model (profile NACA 0010 between end discs) in order to clarify the influence of interference of an engine jet on the aerodynamics of a lifting surface. Changes in the aerodynamic force coefficients, and in particular the lift, were determined which are induced by the horizontal or vertical jet. The most important parameters are the position of the jet nozzle with respect to the lifting surface leading edge and the velocity ratio of the jet and parallel flow. The experimental installation is described in detail. Preliminary experiments are discussed which determine the properties of the jet and its propagation in the parallel flow. In addition, results for the jet which is parallel and perpendicular to the lifting surface plane are reported. Author

N73-26296# Naval Postgraduate School, Monterey, Calif.
APPLICATION OF HOLOGRAPHIC INTERFEROMETRY TO DENSITY FIELD DETERMINATION IN TRANSONIC CORNER FLOW M.S. Thesis
D. J. Collins and Robert A. Kosakoski Dec. 1972 125 p refs
(AD-759967; NPS-57C072121A) Avail: NTIS CSCL 20/4

The successful application of holographic interferometry to the study of density fields around opaque bodies in wind tunnel experiments has been reported in the literature. The present report extends this technique to the study of the asymmetric flow fields encountered near the wing-fuselage junction of an aerodynamic model in the transonic flow regime. Finite fringe interferometry has been used to investigate the three-dimensional density field about a partially transparent wing-body structure. The resulting asymmetric density field and shock wave structure are shown to be an accurate representation of the phenomena encountered in aerodynamic corner flow. Author (GRA)

N73-26304# Rochester Applied Science Associates, Inc., N.Y.
INVESTIGATION OF THE EFFECTS OF MASS INJECTION TO RESTRUCTURE A TRAILING TIP VORTEX AT TRANSONIC SPEEDS Final Technical Report, 15 Feb. 1972 - 14 Feb. 1973
John C. Balcerak and Andrew D. Zalay Feb. 1973 87 p refs
(Contract N00014-71-C-0226; NR Proj. 215-170)
(AD-760363; RASA-73-03) Avail: NTIS CSCL 20/4

The report describes the results of an experimental research program which as conducted to assess the effects of mass injection of the tip vortex on airfoil performance in transonic flow. Balance data and schlieren photographs were taken for a rectangular semispan model with a full-span aspect ratio of 7.35 in the Mach number range M = 0.553 to 0.1. The results of the investigation indicate that mass injection of the concentrated tip vortex does not generate any significant change in airfoil performance at transonic speeds for the configurations tests. Schlieren photographs of the compressible flow field showed that the near field flow characteristics of the airfoil were not influenced by mass injection or by passive nozzle characteristics at transonic speeds. The schlieren photographs showed considerable alterations to the vortex wake by the local shock structure of the airfoil as the lambda shock appeared to disrupt the trailing vortex independently of mass injection. Author (GRA)

N73-26467# IIT Research Inst., Chicago, Ill.
TRANSMISSOMETER DEVELOPMENT FOR JET ENGINE EXHAUST PLUMES Final Report, 1 Jul. 1972 - 2 Mar. 1973
H. T. Betz May 1973 39 p refs
(Contract N00140-72-C-6901)
(AD-760050) Avail: NTIS CSCL 20/6

The report describes an instrument constructed to measure the transmission of aircraft jet engine exhausts. This instrument was designed and built as an experimental breadboard system to explore the requirements and possibilities of a transmissometer in evaluating the measurement of optical transmission through an exhaust plume for characterizing the exhaust parameters. It is designed as an advanced breadboard so that all optical functions remain flexible permitting modification as experience indicates change. GRA

N73-26469# General Electric Co., Wilmington, Mass. Aerospace Instruments and Control Systems Dept.
SOLID STATE VERTICAL SCALE AIRCRAFT ENGINE PERFORMANCE INDICATOR SET Final Report, Apr. 1971 - Apr. 1973
Richard L. Skovholt, George H. Cawood, Robert E. Glusick, Norval P. Miller, and Wallace W. Thurlov Apr. 1973 93 p refs
(Contract N62269-71-C-0392)
(AD-760351; DF73AEE160) Avail: NTIS CSCL 01/4

The report is the Final Technical Report for Contract No. N62269-71-C-0392 entitled Solid State Vertical Scale Aircraft Engine Performance Indicator Set. A program is reported which involves the design, fabrication and testing of two sets of solid state engine instruments. Each set consists of three instruments which display two channels of Exhaust Gas Temperature (EGT), Percent of Engine Fan Speed (RPM) and Rate of Fuel Flow (FF). This equipment receives the appropriate sensor information from the actual sensors and transmitters for the A6A aircraft. The display media is gallium arsenide phosphide LED'S emitting a red colored light. The display presentation gives bar graph and numerical readout information. Special techniques were utilized in the fabrication of the scale plates in order to obtain sufficient contrast enhancement. (Author Modified Abstract) GRA

N73-26480*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL EVALUATION OF 150-MILLIMETER BORE BALL BEARING TO 3 MILLION DN USING EITHER SOLID OR DRILLED BALLS
Herbert W. Scibbe and Harold E. Munson 1973 27 p refs Proposed for presentation at Joint Lubrication Conf., Atlanta, 16-18 Oct. 1973; cosponsored by Am. Soc. of Lubrication Engr. and the ASME
(NASA-TM-X-68265; E7566) Avail: NTIS HC $3.50 CSCL 13I

Seven 150-mm bore ball bearings were run under 8900 Newton (2000 lb) thrust load at speeds from 6670 to 20,000 rpm (1 to 3 million DN). Four of the bearings had conventional solid balls and three bearing had drilled (cylindrically hollow) balls with 50 percent mass reduction. The bearings were under-race cooled and slot-lubricated with Type 2 ester oil at flow rates from 4.35 to 5.80 liters per minute (1.15 to 1.57 gal min). Friction torque and temperatures were measured on all bearings. No significant difference in torque was noted, between the solid and drilled ball bearings. One bearing of each type was rerun at 17,800 Newtons (4000 lb) thrust load. The solid ball bearings performed satisfactorily at 3 million DN. However, at about 2 million DN the drilled ball bearing experienced a broken ball and cracks appeared in two other balls as the result of flexure fatigue. Metallurgical examination of the cracked balls indicated a brittle structure in the bore of the drilled balls. Author

N73-26481*# United Aircraft Corp., Stratford, Conn. Sikorsky Aircarft Div.
DEVELOPMENT OF HELICOPTER TRANSMISSION SEALS, TASK 2
T. S. Hayden and C. H. Keller, Jr. Jul. 1973 78 p ref Sponsored in part by Army Air Mobility R and D Lab.
(Contract NAS3-15684)
(NASA-CR-120983; SER-50776) Avail: NTIS HC $6.00 CSCL 11A

High speed helicopter transmission seal concepts were designed, fabricated and tested. The concepts were a dual element split ring seal and a circumferential seal. The tests were performed in a rig using an actual input quill assembly. The test conditions were selected to simulate transmission operation and were 230 F oil temperature, and a sliding speed of 9400 ft/min. The split ring seal exhibited gross leakage and was considered unsatisfactory, while the circumferential seal leakage was less than 1 c.c./hour; this leakage is within acceptable limits. The circumferential seal wear was only to .0005 inches during a 100 hour run (40 starts and stops). During a 40 hour contamination test (mesh silica flour) the seal total wear was a maximum of .004 inches. This wear is considered acceptable. Author

N73-26483*# AiResearch Mfg. Co., Phoenix, Ariz.
SMALL, HIGH PRESSURE RATIO COMPRESSOR: AERODYNAMIC AND MECHANICAL DESIGN
C. A. Bryce, J. R. Erwin, G. L. Perrone, E. L. Nelson, R. K. Tu, and A. Bosco Jun. 1973 131 p refs
(Contract NAS3-14306)
(NASA-CR-120941; APS-5404-R-Vol-1) Avail: NTIS HC $8.75 CSCL 13I

The Small, High-Pressure-Ratio Compressor Program was directed toward the analysis, design, and fabrication of a centrifugal compressor providing a 6:1 pressure ratio and an airflow rate of 2.0 pounds per second. The program consists of preliminary design, detailed areodynamic design, mechanical design, and mechanical acceptance tests. The preliminary design evaluate radial- and backward-curved blades, tandem bladed impellers, impeller-and diffuser-passage boundary-layer control, and vane, pipe, and multiple-stage diffusers. Based on this evaluation, a configuration was selected for detailed aerodynamic and mechanical design. Mechanical acceptance test was performed to demonstrate that mechanical design objectives of the research package were met. Author

N73-26490# Bell Helicopter Co., Fort Worth, Tex.
LOW-TEMPERATURE TESTS OF ELASTOMERIC BEARING ROTORS ON AN OH-58 HELICOPTER IN THE CLIMATIC LABORATORY AT EGLIN AFB
C. H. Fagan Feb. 1973 50 p refs
(Contract DAAJ02-72-C-0058; DA Proj. 1F1-62205-A-119)
(AD-759957; BHC-299-099-587; USAAMRDL-TR-73-9) Avail: NTIS CSCL 13/9

The results of a program conducted to investigate the low-temperature characteristics of rotors equipped with elastomeric bearing are reported. An all-elastomeric, two-bladed main rotor and a production tail rotor, with elastomeric bearings installed in the flapping axis, were tested on an OH-58 helicopter. Tests were conducted at temperatures of 70F, 0F, -25F, -45F, -55F, and -65F. Two main rotor pitch-change bearing configurations were evaluated. The first was fabricated from natural-rubber elastomer and the other from broad-temperature-range elastomer. (Author Modified Abstract) GRA

N73-26511# Stanford Research Inst., Menlo Park, Calif.
LIDAR OBSERVATIONS OF SLANT RANGE VISIBILITY FOR AIRCRAFT LANDING OPERATIONS
William Viezee, John Oblanas, and Ronald T. H. Collis 28 Feb. 1973 47 p refs
(Contract F19628-71-C-0152; AF Proj. 6670)
(AD-760128; AFCRL-TR-73-0146; SR-1) Avail: NTIS CSCL 04/2

During July 1972, a scanning ruby lidar was operated in support of the AFCRL fog field program at Vandenberg AFB, California. In addition to observations made during thermal fog dispersal tests, backscatter data were collected during 14 separate periods of dense natural fog. Values of slant visual range computed from these data are compared with information on the visibility conditions obtained from available AFCRL instrumentation. Although no detailed quantitative evaluation of the lidar observation was feasible, the data comparison shows that the lidar provided visibility information compatible with that supplied by the more conventional measuring devices. Author (GRA)

N73-26549# Royal Aircraft Establishment, Farnborough (England).
FRACTURE TOUGHNESS OF Al-Zn-Mg-Cu-Mn ALLOYS TO DTD 5024
C. J. Peel and P. J. E. Forsyth Nov. 1972 49 p refs
(RAE-TR-72173; BR32731) Avail: NTIS HC $4.50

Five Al-Zn-Mg-Cu alloy forgings were made with different compositions within the DTD 5024 specification limits to study the effect of composition variations on fracture toughness and tensile properties. Three forgings, of dimensions 165 mm by 150 mm by 100 mm, were prepared from melts of similar compositions except for the magnesium contents of 2.2%, 2.7% and 3.1%. Two further alloys, containing 5.3% and 6.2% zinc were cast and forged by the same procedure. The 0.14% zirconium was then added to the basic ternary alloy to study its grain refinement properties and its effects on the fracture toughness. It was found that reducing the magnesium content within the specification limits increased the fracture toughness with little effect on the proof strength. Reducing the zinc content also increased the fracture toughness but reduced the proof strength. The addition of 0.14% zirconium, which was outside the DTD 5024 specification, slightly reduced the fracture toughness of the ternary alloy but was found to give good grain refinement. A relationship was found between fracture toughness and true stress-true strain tensile test data. A conclusion from earlier work, that the presence of iron reduced the fracture toughness of the alloy, was considered. Author (ESRO)

N73-26578# National Bureau of Standards, Washington, D.C.
A STUDY OF THE DECOMPOSITION PRODUCTS OF POLYURETHANE FOAM RELATED TO AIRCRAFT CABIN FLASH FIRES Final Report, Mar. 1971 - Jun. 1972
Maya Paabo and J. J. Comeford Jul. 1973 39 p refs
(FAA Order FA67-NF-AP-21)
(FAA-NA-73-69; FAA-RD-73-46) Avail: NTIS HC $4.25

A laboratory model of a flash fire cell using a high voltage arc as an ignition source was assembled and tested. The cell is designed to pyrolyze the sample in air while measuring the time of onset of a flash fire and simultaneously allowing withdrawal of gas samples for analysis. Some of the low molecular weight products produced from the pyrolysis of flexible polyether type urethane foams were identified. The flash fire cell was used to compare the flash fire potential of polymers of potential interest to the aircraft industry. Studies of the role of smoke in flash fire produced in the pyrolysis of flexible urethanes were undertaken. Flash fires in the cell were recorded on motion picture film. Author

N73-26579*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
FLIGHT-SERVICE EVALUATION OF COMPOSITE STRUCTURAL COMPONENTS
H. Benson Dexter Washington Jul. 1973 38 p refs
(NASA-TM-X-2761; L-8474) Avail: NTIS HC $3.00 CSCL 11D

A review of programs aimed at flight-service evaluation of composite materials in various applications is presented. These flight-service programs are expected to continue for up to 5 years and include selective reinforcement of an airplane center wing box a helicopter tail cone, and composite replacements for commercial aircraft spoilers and fairings. These longtime flight-service programs will help provide the necessary information required by commercial airlines to commit advanced composites to aircraft structures with confidence. Results of these programs will provide information concerning the stability of composite materials when subjected to various flight environments. Author

N73-26604# Naval Ordnance Lab., White Oak, Md.
HYDROLYTIC STABILITY OF TWO NEW POLYURETHANE POTTING COMPOUNDS
Richard D. Ezell and Joseph M. Augl 4 Apr. 1973 16 p refs
(AD-759972; NOLTR-73-42) Avail: NTIS CSCL 11/9

Two new potting compounds have been prepared in a joint effort by the Hystl Company and the Naval Ordnance Laboratory. These compounds have much greater hydrolytic stability than do some potting compounds previously used in Navy aircraft. The report summarizes work which shows the hydrolytic stability of the compounds. GRA

N73-26612 George Washington Univ., Washington, D.C.
SIMULTANEOUS EQUATION PRODUCTION FUNCTIONS (COBB-DOUGLAS TYPE) FOR DECISIONS PERTAINING TO SEA BASED TACTICAL AIR RESOURCES Ph.D. Thesis
Chantee Lewis 1972 220 p
Avail: Univ. Microfilms Order No. 72-33040

The need is discussed for improved analytical aids to assist management in making allocation decisions concerning the optimum allocation of military aircraft resources. C-D production functions in the area of sea-based tactical air resources. A simulaneous equation model posed. Five cases (F4J, A7E, A6, A4E, and E-2) are analyzed in depth and the model appears to fit and explain the variation in the data quite well (R squared ranges from .884 to .951). Predictions based upon the model merit serious consideration in view of the close fit and the analysis of the residuals indicating the main error is of the random covariance type. No significant bias in the data has been detected. The small covariance error appears to be due mainly to the noisy maintenance observations. Dissert. Abstr.

N73-26640# Environmental Technical Applications Center (Air Force), Washington, D.C.
WORLDWIDE AIRFIELD CLIMATIC DATA. EASTERN EUROPE, AND USSR. VOLUME 11, PART 1: CLIMATIC DATA SUMMARIZATION
Apr. 1973 192 p refs
(AD-759794) Avail: NTIS CSCL 04/2

The summarization is a part of a series of compilations which is worldwide in scope. It consists of climatological data pertaining to various weather-associated parameters for selected airfields and for the climatic areas in which they are located. The series itself, when complete, will include data for several thousand stations. This Part 1 of Volume XI contains information for stations located in Eastern Europe and the U.S.S.R. Author (GRA)

N73-26641# Environmental Technical Applications Center (Air Force), Washington, D.C.
WORLDWIDE AIRFIELD CLIMATIC DATA. EASTERN EUROPE, AND USSR, VOLUME 11, PART 2
Apr. 1973 486 p refs
(AD-759795) Avail: NTIS CSCL 04/2

The summarization is a part of a series of compilations which is worldwide in scope. It consists of climatological data pertaining to various weather-associated parameters for selected airfields and for the climatic areas in which they are located. The series itself, when complete, will include data for several thousand stations. This Part 1 of Volume XI contains information for stations located in Eastern Europe and the U.S.S.R. Author (GRA)

N73-26648# Air Weather Service, Scott AFB, Ill.
CATALOGUE OF LOCAL FORECAST STUDIES: INDEXES
Jan. 1973 280 p refs
(AD-760091; AWS-PAM-0-13) Avail: NTIS CSCL 04/2

Air Weather Service Pamphlet 0-13 is published to inform AWS activities of local forecast studies which are already available and where they may be obtained. It will assist AWS personnel, who are planning newer studies by furnishing reference to earlier studies of similar nature and to studies from various locations having analogous problems. Such studies can be used effectively for planning approaches to the local problem and selecting the parameters to be used. With few exceptions, studies listed in this pamphlet are included in the master file of local forecasting studies maintained at USAFETAC. Author (GRA)

N73-26663# Radio Technical Commission for Aeronautics, Washington, D.C.
RECOMMENDED BASIC CHARACTERISTICS FOR AIRBORNE RADIO HOMING AND ALERTING EQUIPMENT FOR USE WITH EMERGENCY LOCATOR TRANSMITTERS (ELT)
9 Mar. 1973 18 p refs
(RTCA-SC-124; DO-154) Avail: NTIS HC $3.00

Recommended basic characteristics for airborne radio homing and alerting equipment operating on the frequencies of 121.5 and/or 243 MHz are presented. There are three categories identified by system concept. The use of these characteristics by manufacturers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended function under all conditions. In recognition of the dependent relationships of the components of the system and the undesirability of inhibiting component design, these characteristics were developed on a system basis. This does not preclude the use of a one-channel receiver operating on 121.5 or 243 MHz which incorporates homing capability. Inasmuch as measured values of radio equipment characteristics are a function of the method of measurement, suggested means of measurement are included. Author

N73-26664# Federal Aviation Administration, Washington, D.C.
APPLICATION OF AREA NAVIGATION IN THE NATIONAL AIRSPACE SYSTEM
Feb. 1973 155 p refs
Avail: NTIS HC $9.75

The proceedings of a conference to determine the potential capabilities of area navigation and how it should be implemented in the National Airspace System in an orderly manner are presented. The principal objectives of the conference were as follows: (1) to determine the advantages of radar navigation, (2) to develop a radar navigation system design concept for implementation, (3) to develop an action plan for the definition, evaluation, and implementation of a radar navigation system, (4) to define the minimum equipment operational requirements and accuracy standards for the avionics package, and (5) to specify equipment carriage requirements for operation within a radar navigation air space. Author

N73-26665# Collins Radio Co., Cedar Rapids, Iowa.
EVALUATION OF EXISTING VOR, LOCALIZER, AND GLIDESLOPE RECEIVING EQUIPMENT: IN 50-kHz/150-kHz ENVIRONMENT, INDIVIDIAL TEST RESULTS, VOLUME 1 Final Report
Wayne Ashby Jan. 1973 146 p
(Contract DOT-FA72WA-2772)
(FAA-RD-73-1-Vol-1; Rept-523-0764695-00111M) Avail: NTIS HC $9.50

Each receiver was tested under various conditions of interference in a simulated environment with an interfering adjacent channel signal (50 kHz VOR and Localizer; 150 kHz Glideslope). Some 61 types of receivers, representing all user groups, were tested to provide data on which to base geographic facility separations. Test procedure and criteria are described and the basis for the selection of the receiver types is tested. Receiver test data for various interference situations are tabulated. Author

N73-26667# Collins Radio Co., Cedar Rapids, Iowa.
CONTROL-DISPLAY TESTING REQUIREMENTS STUDY Final Report, 24 Jan. - 24 Jul. 1972
Kenneth E. Duning, Craig W. Hickok, Kenneth C. Emerson, and

Warren F. Clement (Systems Tech., Inc.) Dec. 1972 187 p refs
(Contract F33615-72-C-1022)
(AD-759539; Rept-523-0764468-00111M; AFFDL-TR-72-122) Avail: NTIS CSCL 17/7

Control-display problems in terminal area navigation and zero visibility landing are identified along with related considerations for control laws and computations and requirements for sensors. Test and development program plans for research, development, and testing of controls and displays for full use of the capabilities of the microwave landing system are presented. Criteria and measurements for development and testing controls and displays are discussed. Procedures for evaluation of system performance, pilot performance, pilot acceptance, and safety are included. Alternative techniques for measuring pilot workload are outlined. Coordinated use of theoretical analysis, simulation, and flight test for development and testing of control-display systems is discussed. (Author Modified Abstract) GRA

N73-26687# Royal Aircraft Establishment, Farnborough (England).
ON THE REDUCTION OF THE INTRINSIC NOISE AT SOUND TRANSDUCERS IN AIR FLOW (LITERATURE SURVEY)
S. Waldschutz Dec. 1972 64 p refs Transl. into ENGLISH from Deutsche Luftund Raumfahrt report DLR-Mitt-68-31
(RAE-Lib-Trans-1660; BR33084; DLR-Mitt-68-31) Avail: NTIS HC $5.25

A survey of the accessible literature dealing with the reduction of the intrinsic noise from sound transducers was made. The cited literature refers predominantly to the intrinsic noise of sound pressure transducers in air flow at flow velocities that are smaller than the velocity of sound. Author

N73-26688*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ACOUSTIC IMPEDANCE OF CURVED MULTILAYERED DUCT LINERS
William E. Zorumski Washington Jul. 1973 12 p ref
(NASA-TN-D-7277; L-8887) Avail: NTIS HC $3.00 CSCL 20A

The effect of curvature of annular duct liners on the liner acoustic impedance is examined. Exact equations are derived for the impedance of point reacting liners which are made from an arbitrary number of thin cylindrical layers of porous material separated by small radially oriented cells. Equations are given for liners with convex curvature and for liners with concave curvature. For ducts with small curvature, it is shown that these equations reduce to the equations for a flat liner. It is shown, by analytical and numerical examples, that the effect of liner curvature is significant in practical noise reduction problems. Author

N73-26796*# General Electric Co., Cincinnati, Ohio.
PRELIMINARY DESIGN STUDY OF QUIET INTEGRAL FAN LIFT ENGINES FOR VTOL TRANSPORT APPLICATIONS IN THE 1980s Final Report
G. R. Rabone and E. Paulson Jun. 1973 280 p
(Contract NAS3-14404)
(NASA-CR-120969) Avail: NTIS HC $16.00 CSCL 21E

Preliminary designs of three integral lift fan engines suitable for commercial certification in the 80's were completed. Emphasis was placed on low cost, simplicity, low noise, low emissions, minimum weight, and design features meeting all commercial standards for fire safety and containment. Author

N73-26797*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ADVANCED TECHNOLOGY FOR REDUCING AIRCRAFT ENGINE POLLUTION
Robert E. Jones 1973 22 p refs Proposed for presentation at Winter Ann. Meeting of the ASME, Detroit, 11-15 Nov. 1973
(NASA-TM-X-68256; E-7537) Avail: NTIS HC $3.25 CSCL 21B

Combustor research programs are described whose purpose is to demonstrate significantly lower exhaust emission levels. The proposed EPA regulations covering the allowable levels of emissions will require a major technological effort if these levels are to be met by 1979. Pollution reduction technology is being pursued by NASA through a combination of in-house research, contracted programs, and university grants. In-house research with the swirl-can modular combustor and the double-annular combustor has demonstrated significant reduction in the level of NO(x) emissions. The work is continuing in an attempt to further reduce these levels by improvements in module design and in air-fuel scheduling. Research on the reduction of idle emissions has included the conversion of conventional duplex fuel nozzles to air-assisted nozzles and exploration of the potential improvements possible with fuel staging and variable combustor geometry. Author

N73-26800# Advisory Group for Aerospace Research and Development, Paris (France).
MODERN METHODS OF TESTING ROTATING COMPONENTS OF TURBOMACHINES
M. Pianko, ed. (Serv. Tech. Aeronaut., Paris) May 1973 51 p refs Partly in ENGLISH, partly in FRENCH Conf. held at Toulouse, 18-21 Sep. 1972
(AGARD-AG-167; AGARDograph-167) Avail: NTIS HC $4.75

The AGARD Propulsion and Energetics Panel conducted a survey on the methods used to test the rotating components of turbomachines. The objective was to assess the advantages and usefulness of the so-called elementary tests, compared with the tests conducted on complete turbomachines. Based on a detailed analysis of the answers received from the questionnaires, and an exchange of views among the experts appointed by the Panel, general conclusions are presented on the value and use of cascade test data; testing and measuring equipment for cascade tests; testing techniques for supersonic compressor cascade; tests on compressor or turbine stage(s), and on a complete compressor or turbine; Reynolds number effects; cold testing of turbines; and compressor stability and distortion tests. Author

N73-26802# Los Alamos Scientific Lab., N.Mex.
DART TECHNOLOGY DEVELOPMENT Final Report
K. C. Cooper and W. C. Turner Dec. 1972 40 p refs
(Contract W-7405-eng-36)
(LA-5017-MS) Avail: NTIS HC $4.00

Technology development for a Decomposed Ammonia Radioisotope Thruster (DART) of 0.01 to 0.1 lb thrust is reported. Design, materials and fabrication, and testing results are presented. Assembly of a rhenium heat exchanger, including nozzles and inlet tubes, was accomplished with electron beam welding. A useful series of molybdenum-rhenium alloys with from 20 to 46 wt % rhenium was prepared, using electron beam melting for purity. Molybdenum foam was brazed to molybdenum sheet. Diffusion couples were tested at operating conditions, and compatibility for 500 h was established between: carbon vs beryllia, carbon vs tungsten, iridium vs molybdenum-rhenium, zirconia vs tungsten, zirconia vs molybdenum, hafnia vs tungsten, and hafnia vs molybdenum. Author (NSA)

N73-26813# Stevens Inst. of Tech., Hoboken, N.J. Dept. of Mechanical Engineering.
RESEARCH ON THE FLUTTER OF AXIAL-TURBOMACHINE BLADING
Fernando Sisto and P. V. K. Perumal 2 May 1973 40 p refs
(Contract N00014-67-A-0202-0016; NR Proj. 094-363)
(AD-760354; ME-RT-73003) Avail: NTIS CSCL 21/5

An analytical method for predicting the perturbed aerodynamic reactions of a harmonically oscillating flat plate airfoil with time dependent point of separation is presented. It is shown that this method in conjunction with an empirical knowledge of the time history of the separation point can predict stall flutter. Numerical results are presented and compared with existing theoretical and experimental results. Author (GRA)

N73-26917*# Martin Marietta Corp., Orlando, Fla.
THESAURUS OF TERMS FOR INFORMATION ON MECHANICS OF STRUCTURAL FAILURE
Jr. Carpenter J. L. and Nestor Moya Jun. 1973 28 p
(Contract NAS3-16681)
(NASA-CR-121199; OR-12641) Avail: NTIS HC $3.50 CSCL 20K

A Thesaurus of approximately 700 subject terms used to describe the six problem areas in the mechanics of structural failure is presented. The initial criteria for the selection of terms are their significance and frequency of use in the literature describing the mechanics of structural failure. The purpose of the Thesaurus is to provide the Aerospace Safety Research and Data Institute a list of key works and identifiers that afford effective retrieval of information regarding failure modes and mechanisms for aerospace structures. The Thesaurus includes both a conventional listing of subject terms and a Key Words In Context (KWIC) listing. Author

N73-26918*# Martin Marietta Corp., Orlando, Fla.
REGISTER OF SPECIALIZED SOURCES FOR INFORMATION ON MECHANICS OF STRUCTURAL FAILURE
James L. Carpenter, Jr. and Frank J. Danny Jun. 1973 30 p
(Contract NAS3-16681)
(NASA-CR-121201; OR-12643) Avail: NTIS HC $3.50 CSCL 20K

Specialized information sources that generate information relative to six problem areas in aerospace mechanics of structural failure are identified. Selection for inclusion was based upon information obtained from the individual knowledge and professional contacts of Martin Marietta Aerospace staff members and the information uncovered by the staff of technical reviewers. Activities listed perform basic or applied research related to the mechanics of structural failure and publish the results of such research. The purpose of the register is to present, in easy reference form, original sources for dependable information regarding failure modes and mechanisms of aerospace structures. Author

N73-26920*# Martin Marietta Corp., Orlando, Fla.
BIBLIOGRAPHY OF INFORMATION ON MECHANICS OF STRUCTURAL FAILURE
James L. Carpenter, Jr., Nestor Moya, Richard A. Shaffer, and D. Michael Smith Jun. 1973 116 p refs
(Contract NAS3-16681)
(NASA-CR-121202; OR-12644) Avail: NTIS HC $8.00 CSCL 20K

A bibliography of approximately 1500 reference citations related to six problem areas in the mechanics of failure in aerospace structures is presented. The bibliography represents a search of the literature published in the ten year period 1962-1972 and is largely limited to documents published in the United States. Listings are subdivided into the six problem areas: (1) life prediction of structural materials; (2) fracture toughness data; (3) fracture mechanics analysis; (4) hydrogen embrittlement; (5) protective coatings; and (6) composite materials. An author index is included. Author

N73-26925*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
GENERAL CONSIDERATIONS FOR STRUCTURAL INSPECTION OF OLDER AIRCRAFT
Herbert F. Hardrath Washington Jul. 1973 11 p refs
(NASA-TM-X-2845; L-9187) Avail: NTIS HC $3.00 CSCL 01C

Generalized considerations for structural inspections needed to maintain airworthiness of older aircraft are reviewed. Recommendations are made to account for accumulated service usage by counting flights rather than flight hours, to inspect structures made of flaw-sensitive materials more frequently than those made of flaw-tolerant materials, and to inspect structures having little redundancy more frequently than those having more redundancy. Occasional destructive inspections of high-time aircraft are suggested as being useful, but expensive, sources of either continued confidence or impending problems. Author

N73-26927*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AUTOMATED PROCEDURE FOR DESIGN OF WING STRUCTURES TO SATISFY STRENGTH AND FLUTTER REQUIREMENTS
Raphael T. Haftka Washington Jul. 1973 34 p refs
(NASA-TN-D-7264; L-8592) Avail: NTIS HC $3.00 CSCL 01C

A pilot computer program was developed for the design of minimum mass wing structures under flutter, strength, and minimum gage constraints. The wing structure is idealized by finite elements, and second-order piston theory aerodynamics is used in the flutter calculation. Mathematical programing methods are used for the optimization. Computation times during the design process are reduced by three techniques. First, iterative analysis methods used to reduce significantly reanalysis times. Second, the number of design variables is kept small by not using a one-to-one correspondence between finite elements and design variables. Third, a technique for using approximate second derivatives with Newton's method for the optimization is incorporated. The program output is compared with previous published results. It is found that some flutter characteristics, such as the flutter speed, can display discontinous dependence on the design variables (which are the thicknesses of the structural elements). It is concluded that it is undesirable to use such quantities in the formulation of the flutter constraint. Author

N73-26962# National Aviation Facilities Experimental Center, Atlantic City, N.J.
THE USE OF GROUND COVER MATERIALS TO SUPPRESS FUEL SPILL FIRES Final Report, Jul. - Oct. 1972
George B. Geyer, Lawrence M. Neri, and Charles H. Urban Jul. 1973 21 p refs
(FAA Proj. 081-431-030)
(FAA-NA-73-13; FAA-RD-73-74) Avail: NTIS HC $3.25

Small-scale experiments were conducted to determine the effectiveness of crushed and graded stone aggregate in preventing or retarding the rate of flame propagation from a fixed-ignition source when it was employed as a simulated ground cover material under controlled experimental conditions, for each of three aviation fuels. Tests included the use of loosely packed aggregate and no-fines concrete made with the same material. No significant difference in the rate of flame spread was noted between the loosely packed aggregate and no-fines concrete under equivalent test conditions. The experiments showed that the effectiveness of an aggregate in retarding flame propagation was a function of its size and the flash point of the hydrocarbon fuel and of its depth below the surface of the simulated ground cover. The fire suppression and/or containment effectiveness of the ground cover materials increased as the size of the aggregate decreased and the flash point of the fuel increased and as the depth of the fuel below the surface of the stone increased. Author

N73-26970# National Research Council of Canada, Ottawa (Ontario).
QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 JANUARY - 31 MARCH 1973
31 Mar. 1973 92 p refs
(DME/NAE-1973(1)) Avail: NTIS HC $6.75

Research projects conducted by the National Aeronautical Establishment and the Divison of Engineering in Canada are discussed. The specific items presented are: (1) subspan oscillation of bundled power conductors, (2) jet fuel specifications, (3) very low frequency navigation developments, and (4) dispersion of airborne pollutants in the lower atmosphere. A listing of projects being conducted in various laboratories of the organization is included.

N73-26972 National Research Council of Canada, Ottawa (Ontario). Fuels and Lubricants Lab.

JET FUEL SPECIFICATIONS
L. Gardner and R. B. Whyte *In its* Quart. Bull. of the Div. of Mech. Eng. and the Natl. Aeronaut. Est. 31 Mar. 1973 p 21-34 refs

Various military and civil jet fuel specifications are compared and their differences noted, particularly with reference to different types of additives which are used on a mandatory or optional basis. Specification test procedures and their importance in relation to limits are discussed and the increased complexity of quality control over the years since the first jet fuel specifications is noted. Author

N73-26973 National Aeronautical Establishment, Ottawa (Ontario). Flight Research Lab.
VLF NAVIGATION DEVELOPMENT AT NAE
C. D. Hardwick *In* Natl. Res. Council of Can. Quart. Bull. of the Div. of Mech. Eng. and the Natl. Aeronaut. Est. 31 Mar. 1973 p 35-43 refs

Airborne very low frequency navigation systems in the context of both the Omega Navigation System and a system using very low frequency communications stations are discussed. An airborne mechanization of each system is presented. Results and comparison of performance tests of the two systems are provided. The potential of airborne very low frequency navigation as a no-cost alternative to line of sight navigation for remote areas is emphasized. Author

N73-26982# Air Force Avionics Lab., Wright-Patterson AFB, Ohio.
AIR FORCE AVIONICS LABORATORY TECHNICAL OBJECTIVE DOCUMENT, FISCAL YEAR 1974, PART 1
John V. Balch 1 Apr. 1973 66 p
(AD-759566; AFAL-TR-73-42-Pt-1) Avail: NTIS CSCL 05/2

Technical Objective Documents (TODs) are prepared by the Air Force Laboratories for distribution by DDC to provide industry with Air Force objectives critical to maintaining aerospace superiority. This TOD prepared by the AF Avionics Laboratory describes the technology planning objectives for meeting future Air Force avionics operational needs. Twelve (12) TPOs relating to the avionics involved in target destruction, penetration survival, information gathering, systems avionics, and avionics technology functions are subdivided into specific goals and further subdivided into technical approaches. These planning categories are taken from the laboratory's annual technology plan. (Author Modified Abstract) GRA

N73-26987# Defense Documentation Center, Alexandria, Va.
URBANIZATION AND ITS PROBLEMS Bibliography Report, Aug. 1955 - Mar. 1972
Mar. 1973 274 p refs
(AD-756500; DDC-TAS-72-82) Avail: NTIS CSCL 13/2

The reports in this bibliography consist of urban area problems particularly in the field of urban planning, noise pollution, transportation, and housing. The indexes included are corporate author-monitoring agency, and subject. Author (GRA)

N73-26989# Rohr Corp., Chula Vista, Calif.
AIRLINE ECONOMIC IMPACT COMPUTER MODEL. VOLUME 2: APPENDIX, DETAILED DATA TABLES Final Report
Gregory W. Jordan, Sydney X. Smith, William L. Metzger (Mitchell Res. Assoc.), and Ralph C. Gibson (Mitchell Res. Assoc.) Jun. 1972 181 p
(Contract DOT-FA72WA-2699)
(AD-749491; FAA-EQ-72-4-Vol-2) Avail: NTIS CSCL 01/3

The report is the Appendix to Airline Economic Impact Computer Model, Volume I - Detailed Discussion. It contains summary computer output for 12 sample cases. The purpose of the model is to provide the Federal Aviation Administration with an effective procedure to rapidly and reliably determine the economic impact on the U.S. airline industry of an aircraft sound suppression retrofit program under a wide variety of reasonable assumptions and alternatives. The model is capable of handling 20 airlines, 15 aircraft types, and 20 years. The major computational areas of the model are: airline traffic, revenue, investment base, direct operating expenses, retrofit kit cost, change in direct operating cost due to retrofit, required capital and change in investment base due to retrofit, critical route revenue loss due to retrofit, indirect operating costs, airline rate of return on investment and fare elasticity of traffic demand. Author (GRA)

N73-26992*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
GEOMETRIC FACTORS AFFECTING NOISE SUPPRESION AND THRUST LOSS OF DIVERGENT-LOBE SUPERSONIC JET NOISE SUPPRESSOR
Ronald G. Huff and Donald E. Groesbeck Washington Jul. 1973 25 p refs
(NASA-TM-X-2820; E-7393) Avail: NTIS HC $3.00 CSCL 20A

The thrust loss and noise suppression of a divergent-lobe supersonic jet noise suppressor were experimentally determined over a range of nozzle pressure ratios of 1.5 to 4.0. These small-scale cold flow tests were made to determine the effect on thrust and noise of: suppressor length, rearward facing step height, suppressor divergence angle, and ejector shroud length and location. Noise suppression was achjeved at nozzle pressure ratios of 2.5 and greater. Maximum lobe jet noise attenuation of 15 db with thrust loss differences of 1.5 percent compared to the convergent nozzle were obtained at a nozzle pressure ratio of 3.5 with an ejector shroud two nozzle diameters long. Without the ejector the attenuation was 13 db with thrust loss differences of 11 percent. Short suppressors approximately one primary nozzle throat diameter long performed as well as longer suppressors. Rearward facing step height had a significant effect on noise suppression. Ejector shrouds two nozzle diameters in length are feasible. Author

N73-26993*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
SUPERSONIC AERODYNAMIC CHARACTERISTICS OF HYPERSONIC LOW-WAVE-DRAG ELLIPTICAL BODY-TAIL COMBINATIONS AS AFFECTED BY CHANGES IN STABILIZER CONFIGURATION
Bernard Spencer, Jr. and Roger H. Fournier Washington Jul. 1973 95 p refs
(NASA-TM-X-2747; L-8640) Avail: NTIS HC $3.00 CSCL 01A

An investigation has been made at Mach numbers from 1.50 to 4.63 to determine systematically the effects of the addition and position of outboard stabilizers and vertical- and vee-tail configurations on the performance and stability characteristics of a low-wave-drag elliptical body. The basic body shape was a zero-lift hypersonic minimum-wave-drag body as determined for the geometric constraints of length and volume. The elliptical cross section had an axis ratio of 2 (major axis horizontal) and an equivalent fineness ratio of 6.14. Base-mounted outboard stabilizers were at various dihedral angles from 90 deg to minus 90 deg with and without a single center-line vertical tail or a vee-tail. The angle of attack was varied from about minus 6 to 27 deg at sideslip angles of 0 and 5 deg and a constant Reynolds number of 4.58 x one million (based on body length). Author

N73-26994# National Aerospace Lab., Tokyo (Japan).
ON THE DRAG DIVERGENCE OF TWO-DIMENSIONAL AIRFOILS AT TRANSONIC SPEEDS
Nobuhiko Kamiya Jan. 1973 112 p refs In JAPANESE, ENGLISH summary
(NAL-TR-299) Avail: NTIS HC $7.75

An experimental and theoretical investigation of the drag-divergence on two-dimensional airfoils was conducted. The data were used to design an airfoil for economical cruise at high

subsonic speeds. The pressure distributions on optimum airfoils are discussed. A predominant parameter which determines the drag-divergence characteristics improve as the thickness near the leading edge decreases. A method is proposed for developing airfoils with appropriate drag-divergence characteristics. Author

N73-26999# Naval Ordnance Lab., White Oak, Md.
STATIC AND DYNAMIC STABILITY OF FREE-FALL STORES WITH FREELY SPINNING STABILIZERS
Frank J. Regan 17 Jan. 1973 101 p refs
(AD-760677; NOLTR-73-19) Avail: NTIS CSCL 19/1

The report is the second in a two-part series of technical reports on the dynamics and aerodynamics of free-fall stores using freely spinning stabilizers. The first report presented aerodynamic data on representative free-fall store. This second report examines the dynamics of freely spinning configurations with 180-degree rotational and mirror symmetries. Specifically, it demonstrates how spin rate, restoring moment, damping moment and mass distribution are interrelated to maintain static and dynamic stability. The effect of stabilizer and forebody asymmetries on the magnitude of the rolling trim arm is also considered. Stability diagrams are developed which present these results graphically. Author (GRA)

N73-27000# Advisory Group for Aerospace Research and Development, Paris (France).
MILITARY APPLICATIONS OF V/STOL AIRCRAFT, VOLUME 1
Apr. 1973 145 p refs Partly in ENGLISH and partly in FRENCH Presented at 41st meeting of the flight Mech. Panel of AGARD, Brussels, 23-25 Oct. 1972
(AGARD-CP-126-Vol-1) Avail: NTIS HC $9.25

The proceedings of a conference on the military applications of V/STOL aircraft are presented. Past developments on experimental V/STOL aircraft as well as current military doctrine and operational experience are discussed. Ongoing and new development programs are reviewed to provide visibility to potential new capabilities. Future military applications for V/STOL aircraft in terms of currently perceived operational requirements were analyzed.

N73-27001 Massachusetts Inst. of Tech., Cambridge.
A REVIEW OF PAST AGARD/NATO ACTIONS ON V/STOL AIRCRAFT AND THEIR APPLICATIONS
R. H. Miller *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 3 p

The 1969 meeting was convened in order to review the results of an AGARD study, V/STOL Comparison Study, conducted by an ad hoc group of specialists in late 1968 and 1969 and published as AGARD Advisory Report No. 18. This study reviewed the status of existing technology, giving details of the many VTOL vehicles which had been built and the lessons learned from their flight experiences. The report then reviewed the manner in which further research could be expected to increase the effectiveness of such vehicles and the potential mission improvements which would result. The missions considered were attack, transport and rescue. Finally a research program was outlined which hopefully would ensure achieving these improvements. Author

N73-27002 Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
WIND TUNNEL FOCUSING POINT STUDY AND FLIGHT TEST OF ASSULT MIRAGE 3 5 [ETUDE ET MISE AU POINT EN SOUFFLERIE ET EN VOL DE L'AVION DASSAULT MIRAGE 3 5]
G. DeRichemont *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 15 p In FRENCH

Flight transition and control problems of the Mirage 3 (5) attack aircraft are studied during flight and in wind tunnels. Data cover flight variations caused by exhaust, longitudinal skidding effects, and lift. A comparison was made of test results. Transl. by E.H.W.

N73-27003 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio. Prototype Div.
A REVIEW OF THE US TRI-SERVICE V/STOL PROGRAMS
Bernard Lindenbaum and Daniel E. Fraga *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 17 p refs

A brief history of the U.S. Tri-Service V/STOL Programs is presented and aspects of propeller-based propulsion systems for VTOL aircraft as represented by the three distinctly different design concepts found in the XC-142A, X-19 and X-22A are examined. A comparison of the basic characteristics of these aircraft is provided in hover and vertical flight, transition and STOL flight and flight in the conventional mode. This includes a discussion of vehicle performance and efficiencies, handling qualities, and method of flight control. In addition a summary of the major accidents associated with these programs is presented as well as a brief discussion of the impact of technology improvements on future propeller driven VTOL designs. Author

N73-27004 Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
DO 31 EXPERIMENTAL PROGRAM: RESULTS AND CONCLUSIONS OBTAINED AND FUTURE OUTLOOK [PROGRAMME EXPERIMENTAL DO 31: RESULTATS OBTENUS ET CONCLUSIONS A TIRER POUR L'AVENIR]
Radoslav Draganow and Heinz Max *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 15 p refs In FRENCH

The technical aspects of the Dornier 31 V/STOL aircraft and the research project leading to production of the aircraft are discussed. The following problems of V/STOL aircraft operation are discussed: (1) control of the engine system, (2) stability and control in hover and transition, (3) jet interference effects, (4) recirculation and ground erosion effects, and (5) noise problems. Author

N73-27005 Marine Aircraft Wing (2d), Cherry Point, N.C.
AV-8A HARRIER CONCEPT AND OPERATIONAL PERFORMANCE, US MARINE CORPS
T. H. Miller, Jr. and C. M. Baker (Marine Aircraft Group 32, Beaufort, S. C.) *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 6 p

The design concept and operational performance of the AV-8a Harrier aircraft are discussed. An analysis of the U.S. Marine Corps requirements and employment of the aircraft for military purposes is presented. The use of V/STOL aircraft in various military situations is reported. Author

N73-27006 Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).
VAK 191 B EXPERIMENTAL PROGRAM FOR A V/STOL STRIKE-RECCE AIRCRAFT
Rolf Riccius and Werner Sobotta *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 18 p refs

The design, development, and flight characteristics of the VAK 191b strike/reconnaissance aircraft are presented. The subjects discussed are: (1) research and development test program, (2) control systems, (3) longitudinal response, (4) hovering and vertical flight path characteristics, (5) flight control system transition characteristics, and (6) growth potential. Author

N73-27007 Canadair, Ltd., Montreal (Quebec).
TESTING AND EVALUATION OF THE CANADAIR CL-84 TILT WING V/STOL AIRCRAFT
F. C. Phillips *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 13 p refs
Avail: NTIS

The testing and evaluation of the CL-84 tilt-wing V/STOL aircraft are discussed. The subjects presented are: (1) the CL-84 prototype program, (2) evaluation program, (3) operational experience, (4) application to specific military roles, and (5) instrument flying evaluation. Author

N73-27008 Avions Marcel Dassault, Saint-Cloud (France).
EXPERIENCE ACQUIRED DURING THE COURSE OF FLIGHT TESTS AND OPERATIONAL UTILIZATION OF BREGUET 941 STOL AIRCRAFT [EXPERIENCE ACQUISE AU COURS DES ESSAIS EN VOL ET EN UTILISATION OPERATIONNELLE DE L'AVIONS STOL BREGUET 941]
J. Czinczenheim *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 12 p refs In FRENCH

The history and performance principles of the Berguet 941 STOL aircraft are presented. Problems encountered during the course of flight tests and solutions adopted are given. Test data cover handling qualities, operational characteristics, rolling stability on the ground, and flight qualities. Transl. by E.H.W.

N73-27009* National Aeronautics and Space Administration, Washington, D.C.
NASA PROPULSIVE LIFT STOL TECHNOLOGY PROGRAM
Gerald G. Kayten and William S. Aiken *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 4 p

CSCL 01C

A NASA propulsive-lift technology program for short takeoff aircraft is discussed. In the propulsive-lift program, turbofan engine power is used to augment the lift of essentially conventional wings. Potentially important applications of the propulsive lift developments for various aircraft operating conditions are reported. It is stated that the objective of the program is to provide technical information on the design, development, operation, and regulation of propulsive-lift aircraft. Author

N73-27010* De Havilland Aircraft Co., Ltd., Downsview (Ontario).
THE BUFFALO/SPEY JET-STOL RESEARCH AIRCRAFT
D. C. Whittley *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 13 p refs Sponsored in part by NASA

CSCL 01C

The program to design and build a Buffalo/Spey Augmentor-Wing research aircraft is presented. The development of an internally blown flap system for the generation of powered lift is discussed. Modification, development, and testing of the Rolls-Royce Spey engine are reported. The ground tests and first flights of the aircraft are described and the application of the internally blown flap concept for short takeoff military transport aircraft is proposed. Author

N73-27011 British Aircraft Corp., Weybridge (England).
MILITARY ASPECTS OF CIVIL V/STOL AIRCRAFT
N. W. Boorer *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 12 p ref

The rationale of developing a military tactical short takeoff transport aircraft in an evolutionary pattern in parallel with the development of civil short takeoff aircraft is presented. The main characteristics of military and civil short takeoff aircraft are described. The military requirements and operational considerations of the short takeoff transport aircraft are defined. Author

N73-27012 Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
SELECTING A STOL TRANSPORT
Fred D. Orazio, Sr. *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 9 p refs

The procedures for identifying the proper characteristics of a short takeoff transport aircraft using current and past development efforts are discussed. The procedures include: (1) feasible designs incorporating powered/lift systems, (2) advanced systems (including composite structures), (3) high flotation landing gears, (4) vulnerability protection, (5) operating margins and criteria, (6) aircraft handling qualities, (7) operating constraints, and (8) costs. Author

N73-27013 Bundesminister fuer Verteidigung, Bonn (West Germany).
GERMAN COMMENTS ON FUTURE V/STOL REQUIREMENTS
Uwe Koester *In* AGARD Mil. Appl. of V/STOL Aircraft, Vol. 1 Apr. 1973 2 p

A survey of the V/STOL weapon system developments in Germany or with German participation is presented. The rationale for developing short takeoff rather than vertical takeoff aircraft is developed. Problems involved in the engineering of short takeoff aircraft are described. The reasons for not formulating concrete military requirements for short takeoff aircraft are enumerated. Author

N73-27014# Utah Univ., Salt Lake City.
PHYSIO-CHEMICAL STUDY OF SMOKE EMISSION BY AIRCRAFT INTERIOR MATERIALS. PART 1: PHYSIOLOGICAL AND TOXICOLOGICAL ASPECTS OF SMOKE DURING FIRE EXPOSURE *Final Report, Oct. 1969 - Jun. 1973*
I. N. Einhorn Jul. 1973 86 p refs Sponsored by FAA (FAA-RD-73-50-Pt-1; FAA-NA-73-70-Pt-1) Avail: NTIS HC $6.50

A concise review of the physiological and toxicological aspects of smoke during fire exposure has been presented. The parameters, both chemical and physical, which lead to smoke development, and subsequently, light obscuration, during their pyrolysis and combustion are discussed. Various laboratory test procedures, both small-scale and large-scale, have been summarized and a critique presented outlining their usefulness and problems encountered in interpretation of results obtained using these test procedures. A review of the physiological and toxicological parameters affecting survival of humans during fire exposure is given. Consideration is directed toward the specific hazards encountered during aircraft accidents involving fire. Recent reviews of the medical literature pertaining to fire injury is discussed in detail. Author

N73-27015# Civil Aeromedical Inst., Oklahoma City, Okla.
FREQUENCY OF ANTI-COLLISION OBSERVING RESPONSES BY SOLO PILOTS AS A FUNCTION OF TRAFFIC DENSITY, ATC TRAFFIC WARNINGS, AND COMPETING BEHAVIOR
Mark F. Lewis Apr. 1973 6 p refs
(FAA-AM-73-6) Avail: NTIS HC $3.00

Instrument-rated pilots were flown in two-hour simulated solo missions during which the frequency of traffic, ATC warnings, and ATC clearances were varied, while the visibility of the target was held constant at 100%. Each pilot was advised that his IFR mission occurred under VFR conditions and that it was his primary responsibility to maintain visual vigilance, although ATC would endeavor to warn him of possible conflicting traffic. Two values of traffic frequency were programmed independently of two values of ATC traffic warning frequency. The frequency of competing behavior was varied by independent scheduling of two values of ATC clearance frequency. The data revealed main effects from ATC clearances and from traffic warnings. Significant interactions were obtained for clearances by traffic warnings and for traffic by traffic warnings. Author

N73-27016# Federal Aviation Administration, Washington, D.C. Office of Aviation Medicine.
THE AIRCRAFT AS AN INSTRUMENT OF SELF-DESTRUCTION
Robert E. Yanowitch and Jack A. Bergin Mar. 1973 7 p refs
(FAA-AM-73-5) Avail: NTIS HC $3.00

Often the relationship between the pilot and his aircraft is such that the aircraft may be thought of as an extension of the pilot himself during the act of flight. If this pilot accumulates

stress in his life with which he can no longer adequately cope, he may engage in self-destructive acts, some of these within the context of his flying activities. The competent pilot practices and acquires skills which help him to deal with the stress of demanding flight situations. However, if this individual exceeds his piloting capabilities, or is already coping with a high stress level to his maximum capacity, the additional stress of a particular flight situation may overload his total coping ability and destruction of self, both psychologically and physically, will occur. Author

N73-27017# Boeing Co., Seattle, Wash. Commercial Airplane Group.
THE 727 NOISE RETROFIT FEASIBILITY. VOLUME 2: UPPER GOAL DESIGN, FABRICATION, AND GROUND TESTING Final Report, Jul. 1971 - Nov. 1972
J. R. Anderson, H. G. Ridley, and J. W. Smith Nov. 1972 117 p refs
(Contract DOT-FA71WA-2637)
(FAA-RD-72-40-Vol-2; D6-60175) Avail: NTIS HC $8.00

The development, design, fabrication, and ground testing of a flightworthy quiet-nacelle configuration conforming to the FAA upper noise-reduction goals for the 727 airplane are discussed. The quiet-nacelle configuration tested consists of a double-ring, acoustically treated, side engine inlet; acoustically treated engine fan duct, and a multilobe, variable-geometry ejector/suppressor in the engine exhaust system. This quiet-nacelle configuration was ground tested to obtain comparative acoustic and performance data with the production-baseline nacelle. A direct operating cost (DOC) analysis was prepared based on preliminary retrofit installation cost estimates and predicted airplane performance analyses. In addition, a retrofit kit and installation package were developed to obtain realistic retrofit kit prices, installation costs, and maintenance costs to facilitate the final update of the direct operating cost analysis. Author

N73-27018# Booz-Allen Applied Research, Inc., Bethesda, Md.
STATISTICAL PREDICTION MODEL FOR GLASS BREAKAGE FROM NOMINAL SONIC BOOM LOADS Final Report
Robert L. Hershey and Thomas H. Higgins (FAA, Washington, D. C.) 30 Jul. 1973 216 p refs
(Contract DOT-FA72WA-2823)
(FAA-RD-73-79) Avail: NTIS

A statistical model was developed which can be used to estimate the probability of glass breakage from sonic booms as a function of their nominal overpressure. Other parameters which can be taken into account in breakage probability calculations with this model include window size, aircraft vector, boom duration, and whether the glass was previously in good condition or cracked. A model window population has been devised from available data which includes the distributions of dynamic amplification factors and breaking pressures for seven window types. From computer generation of histograms from test data, the distribution of both sonic boom stresses and glass strengths were found to be lognormal. By use of the model, it was estimated that there would be 1.1 breaks per million panes in good condition boomed at a nominal overpressure of 1 psf. Author

N73-27019# Collins Radio Co., Cedar Rapids, Iowa. Avionics Div.
CURVED APPROACH PATH STUDY Final Report
K. E. Duning, N. B. Hemesath, C. W. Hickok, D. G. Lammers, and M. L. Goemaat Apr. 1973 126 p refs
(Contract DOT-FA72WA-2824)
(FAA-RD-73-143; Rept-523-0764756-00111M) Avail: NTIS HC $8.50

The application of microwave landing systems (MLS) to provide increased operational flexibility and improved capacity in the terminal area is discussed. The performance characteristics of the various classes of aircraft which influence terminal area flight path design are identified and documented. Terminal area operational concepts and flight path families for use in the MLS environment are developed, and examples of special noise abatement paths are discussed. The implications upon cockpit equipment of flying flexible paths in the MLS environment are addressed, and the performance of current flight control systems in tracking segmented paths is examined. Author

N73-27020*# Pratt and Whitney Aircraft, East Hartford, Conn.
STUDIES FOR DETERMINING RAPID THRUST RESPONSE REQUIREMENTS AND TECHNIQUES FOR USE IN A LONG RANGE TRANSPORT AIRCRAFT
D. M. Newirth and W. W. Ferguson Aug. 1973 65 p
(Contract NAS3-15550)
(NASA-CR-121243; PWA-4693) Avail: NTIS HC $5.25 CSCL 01C

Propulsion systems proposed for the next generation of long-range transport aircraft will utilize advanced technology to reduce the noise to levels that will be inoffensive to the community. Additional reductions can be realized by adopting steeper glide slopes during the landing approach. The aircraft dynamic characteristics and methods of obtaining rapid engine response during the go-around maneuver from an aborted landing approach are identified and discussed. The study concludes that the present levels of flight safety will not be compromised by the steeper approach. Author

N73-27022*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
POINT AND PATH PERFORMANCE OF LIGHT AIRCRAFT: A REVIEW AND ANALYSIS
Frederick O. Smetana, Delbert C. Summey, and W. Donald Johnson Washington NASA Jun. 1973 136 p refs
(Contract NAS1-9603)
(NASA-CR-2272) Avail: NTIS HC $3.00 CSCL 01C

The literature on methods for predicting the performance of light aircraft is reviewed. The methods discussed in the review extend from the classical instantaneous maximum or minimum technique to techniques for generating mathematically optimum flight paths. Classical point performance techniques are shown to be adequate in many cases but their accuracies are compromised by the need to use simple lift, drag, and thrust relations in order to get closed form solutions. Also the investigation of the effect of changes in weight, altitude, configuration, etc. involves many essentially repetative calculations. Accordingly, computer programs are provided which can fit arbitrary drag polars and power curves with very high precision and which can then use the resulting fits to compute the performance under the assumption that the aircraft is not accelerating. Author

N73-27023*# Dayton Univ. Research Inst., Ohio.
EFFECT OF SHEAR ON AIRCRAFT LANDING Technical Report, Jul. 1971 - Nov. 1972
James K. Luers and Jerry B. Reeves Washington NASA Jul. 1973 74 p refs
(Contract NAS8-26600)
(NASA-CR-2287) Avail: NTIS HC $3.00 CSCL 01B

A simulation study was conducted to determine the effect of wind shear on aircraft landings. The landing of various type of commercial and military aircraft was digitally simulated starting from an initial altitude of 300 feet. Assuming no pilot feedback during descent, the deviation in touchdown point due to vertical profiles of wind shear was determined. The vertical profiles of wind shear are defined in terms of surface roughness, Z sub 0, and stability, L, parameters. The effects on touchdown due to Z sub 0 and L have been calculated for the different type aircraft. Comparisons were made between the following types of aircraft: (1) C-130E, (2) C-135A, (3) C-141, (4) DC-8, (5) Boeing 747, and (6) an augmentor-wing STOL. In addition, the wind shear effect on touchdown resulting from different locations of the center of gravity and gross weights was also analyzed. Author

N73-27024# National Transportation Safety Board, Washington, D.C.
AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AVIATION
18 May 1973 486 p
(NTSB-BA-73-6) Avail: NTIS HC $26.50

Selected aircraft accident reports, in brief format, occurring in U.S. civil aviation operations during calendar year 1972 are presented. The 898 General Aviation accidents contained in the publication represent a random selection. The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light, pilot certificate, injuries, and causal factors. Author

N73-27025# Utah Univ., Salt Lake City. Coll. of Engineering.
PHYSIO-CHEMICAL STUDY OF SMOKE EMISSION BY AIRCRAFT INTERIOR MATERIALS, PART 2: RIGID AND FLEXIBLE URETHANE FOAMS Final Report
I. N. Einhorn, M. D. Kanakia, and J. D. Seader Jul. 1973 144 p refs Sponsored by FAA
(FAA-RD-73-50-Pt-2) Avail: NTIS HC $9.25

A study was conducted to determine the flammability characteristics and thermal degradation of urethane cellular plastics used in aircraft interiors. Initially, model urethane polymers, representative of systems used in aircraft interiors, were prepared, and the effect of the chemical structure of isocyanates and ployols on performance during fire exposure were studied. A series of non-fire-retarded rigid-urethane foams was synthesized and evaluated to serve as the basis for further research directed toward the synthesis of fire-retarded systems. Following this, a series of fire-retarded rigid foams was synthesized incorporating reactive and non-reactive fire retardants in various concentrations. The flammability characteristics of these cellular plastics were evaluated using test methods for the ease of ignition, flame propagation, fire endurance, smoke emission, and oxygen index as criteria. Author

N73-27026*# Boeing Co., Wichita, Kans.
STOL RIDE CONTROL FEASIBILITY STUDY
C. K. Gordon and R. O. Dodson Washington NASA Jul. 1973 103 p refs
(Contract NAS1-11683)
(NASA-CR-2276; D3-9052-1) Avail: NTIS HC $3.00 CSCL 01C

The feasibility of developing a ride-smoothing control system for a 20-passenger turboprop STOL transport was assessed. Five different ride-control system configurations with varying degrees of complexity, performance, and cost were investigated. Results indicate that a satisfactory ride-control system can be practically implemented on the aircraft with minimum flight performance degradation. Author

N73-27027*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
PRELIMINARY FLIGHT EVALUATION OF A PAINTED DIAMOND ON A RUNWAY FOR VISUAL INDICATION OF GLIDE SLOPE
Shu W. Gee and Robert C. McCracken Washington Aug. 1973 22 p refs
(NASA-TM-X-2849; H-739) Avail: NTIS HC $3.00 CSCL 05E

A diamond sized to appear equidimensional when viewed from a 3.6 deg slide slope was painted on the end of a small general aviation airport runway, and a series of flights was made to evaluate its usage as a piloting aid. The pilots could detect and fly reasonably close to the glide slope projected by the diamond. The flight path oscillations that were recorded during approaches using the diamond were not significantly different from the oscillations that were recorded without the diamond; the difference that did exist could be attributed to converging on a known projected glide slope in one case, and flying an unknown, random glide slope in the other. The results indicated that the diamond would be effective as a means of intercepting and controlling a predetermined glide slope. Other advantages of the diamond were positive runway identification and greater aim point visibility. The major disadvantage was a tendency to overconcentrate on the diamond and consequently to neglect cockpit instruments and airport traffic. Author

N73-27028*# Scientific Translation Service, Santa Barbara, Calif.
COMPARISON OF SIMULATION AND FLIGHT TEST FOR AUTOMATIC STOL LANDINGS
H. Boehret Washington NASA Jul. 1973 22 p Transl. into ENGLISH from DGLR report on the 3d Meeting of the DGLR-Symp. Flight Testing Technol. (West Germany), Oct. 1972 p 7-28 (See N73-19005 10-02)
(Contract NASw-2483)
(NASA-TT-F-14995) Avail: NTIS HC $3.25 CSCL 01C

The comparison of simulation and flight test results for automatic STOL landings is presented. The subjects discussed are: (1) description of flight control system; (2) control of flight path during approach; (3) control of aerodynamic flow conditions; (4) description of simulator; (5) influence of nonlinearity; and (6) application of radar for altitude measurement. Author

N73-27029# European Space Research and Technology Center, Noordwijk (Netherlands).
AEROSAT EXPERIMENT USING STRATOSPHERIC BALLOONS
D. L. Brown Mar. 1973 10 p refs Presented at the Intern. Conf. on Satellite Systems for Mobile Commun. and Surveillance, London, 13-15 Mar. 1973
Avail: NTIS HC $3.00

A stratospheric balloon borne transponder to relay signals from a ground station to an aircraft flying over the sea, the objective being to assess and compare techniques which could be used in an L-band aeronautical satellite communication system prior to the final definition of the system. Author (ESRO)

N73-27030# Lockheed Missiles and Space Co., Palo Alto, Calif. Palo Alto Research Lab.
STUDY OF HIGH ALTITUDE AIRCRAFT WAKE DYNAMICS. TASK 2: MODEL DEVELOPMENT Final Report
H. Hoshizaki, K. O. Redler, J. W. Meyer, R. J. Conti, and L. B. Anderson Jan. 1973 80 p refs
(Contract DOT-OS-20082)
(PB-218820/9; DOT-TST-73-5) Avail: NTIS HC $3.00 CSCL 04A

A chemically-reacting wake model computer program has been formulated. The wake model program computes the wake height and width from the jet engine nozzle to the point in time where aerodynamic perturbations are small. The program also predicts the detailed chemical reactions that occur in the jet exhaust flow field. (Author Modified Abstract) GRA

N73-27031# Boeing Commercial Airplane Co., Seattle, Wash.
AIRCRAFT HYDRAULIC SYSTEM DYNAMICS Final Report, Jun. - Dec. 1972
Alvin W. Waterman, Arun K. Trikha, and Kenneth D. Groom Feb. 1973 58 p refs
(Contract F33615-72-C-1699; AF Proj. 3145)
(AD-757537; D6-41108; AFAPL-TR-73-2) Avail: NTIS HC $3.00 CSCL 01/3

It is desirable to use computerized analysis techniques in place of costly ground testing and outmoded hand calculations as methods of analyzing aircraft hydraulic system dynamic performance. The current potential for accomplishing this objective was assessed to establish recommendations for future development. Criteria established as desirable features were the use of digital programming and building-block concepts in each of three technical areas (transient response, frequency response, and thermal analysis) needed to describe a composite of system performance. Basic development work was determined to be accomplished in all three technical areas, but in no area did these efforts meet the USAF objectives. Transient response capability needs improvement to simulate frequency-dependent friction and cavitation characteristics. Frequency response programming requires much improvement in the technique for analyzing pump/system interactions. Thermal analysis steady-state analysis programming needs to be expanded to provide transient capability. These efforts are recommended to be accomplished

in a coordinated 5-year program with continuous parallel effort being conducted in each of the three technical areas.
Author (GRA)

N73-27032# Transportation Systems Center, Cambridge, Mass.
ANALYTICAL STUDIES OF THE LIFT AND ROLL STABILITY OF A RAM AIR CUSHION VEHICLE Interim Report, Jul. 1971 - Jun. 1972
Timothy M. Barrows Dec. 1972 67 p refs
(Contract DOT-RR-307; TSC Proj. R-3316)
(PB-219820/8; DOT-TSC-FRA-72-10; FRA-RT-73-21) Avail: NTIS HC $3.00 CSCL 13F

A ram air cushion vehicle (a type of ram wing) is described schematically and compared with a conventional air cushion vehicle design. The nonlinear equations for the flow in the cushion region are derived. A review is made of the most recent literature on the subject of wings operating in a rectangular channel, and an approximate solution is developed which shows the relative effects of momentum and viscosity on the pressure distribution. Several analytic solutions are presented which show the effect of a small roll angle on the flow pattern; equations for the rolling moment coefficient are also obtained. It is recommended that future efforts be aimed at developing proper numerical techniques which can solve the nonlinear flow relations and that recent experimental efforts to obtain the lateral stability coefficients be continued and expanded. Author (GRA)

N73-27033# Grumman Aerospace Corp., Bethpage, N.Y.
TRACKED AIR CUSHION RESEARCH VEHICLE, UPDATED DYNAMIC ANALYSIS
R. Lee and R. Coppolino Oct. 1972 72 p refs
(Contract DOT-FR-10039)
(PB-218368/9; PMT-B4-R72-8; FRA-RT-73-18) Avail: NTIS HC $3.00 CSCL 13F

The TACRV Dynamics Simulation Program has been updated and specific suspension system analyses performed to reflect 'as built' vehicle dynamics. The two Phase programs which treated pitch plane and lateral dynamics separately are combined into one twenty degree of freedom model which has new models for the actuator/dampers, active suspension system, air cushions and sources of excitation. An analytical formulation of vehicle structural flexibility for future incorporation in the program is given. Sample program results for planned guideway perturbations are shown. Suspension system analyses cover the following areas: active suspension stability, nonlinear damping effects, and cushion pitch dynamics. Test results from the TACRV Ground Vibration Survey are presented. Author (GRA)

N73-27035# Army Materials and Mechanics Research Center, Watertown, Mass.
EVALUATION OF ADVANCED ULTRASONIC TESTING TECHNIQUES FOR DIFFUSION-BONDED TITANIUM ALLOY AIRCRAFT STRUCTURES
Robert H. Brockelman Apr. 1973 34 p refs
(DA Proj. 1T0-62105-A-331)
(AD-760673; AMMRC-TR-73-16) Avail: NTIS CSCL 01/3

The report describes the initial effort to develop effective nondestructive test methods for diffusion-bonded titanium aircraft components. It was demonstrated that several ultrasonic techniques have the potential for overcoming the extraneous background scattering noise normally encountered in titanium structures thereby improving the sensitivity to defect detection at the bond joint. The ultrasonic techniques examined were high resolution flaw detection, spectroscopy and compound scan. Author (GRA)

N73-27036# Calspan Corp., Buffalo, N.Y.
IN-FLIGHT SIMULATION OF MINIMUM LONGITUDINAL STABILITY FOR LARGE DELTA-WING TRANSPORTS IN LANDING APPROACH AND TOUCHDOWN. VOLUME 1: TECHNICAL RESULTS Final Report
Richard Wasserman and John F. Mitchell Washington, D. C. FAA Feb. 1973 133 p refs
(Contracts F33615-72-C-1386; DOT-FA72WAI-143; AF Proj. 920K; FAA Proj. 181-524-047)
(AD-761120; AK-5084-F-1; AFFDL-TR-72-0143; FAA-RD-73-43) Avail: NTIS CSCL 01/3

An in-flight simulation to investigate minimum longitudinal stability for large delta-wing transports in landing approach and touchdown (including ground effect) was conducted using the USAF/Calspan Total In-Flight Simulator (TIFS) airplane. Aerodynamic, inertial and control data for this class of airplane were obtained from a prototype Concorde package supplied by the FAA. The simulation program involved the examination of 20 configurations by four evaluation pilots. The configurations evaluated were based upon a systematic variation of the longitudinal stability characteristics for this class of airplane. These variations were designed to examine the influence of pitch stiffness, backsideness, pitch damping and nonlinear pitching moment effects on pilot acceptability of minimum longitudinal stability for the landing approach task. A total of 61 evaluations was performed. (Author Modified Abstract) GRA

N73-27037# Franklin Inst. Research Labs., Philadelphia, Pa.
REDUCTION OF REFLECTIONS FROM HELICOPTER WINDSHIELDS, ROTOR BLADES AND ROTOR HUB
John A. DeBenedictis and John W. Woestman Apr. 1973 74 p refs
(Contract DAAD05-71-C-0422)
(AD-761127; C3120-08; LWL-CR-06P73A) Avail: NTIS CSCL 01/3

The report addresses itself to the problem of reducing reflections from helicopters. Specific areas investigated are the windshields, rotor blades and rotor hub assembly. All feasible ideas, however remote, were solicited and considered. Recommendations are divided into general sub-categories for each area and are presented with estimates of their potential effectiveness. The body of the report is composed of a technical discussion of every potential solution as well as related precautions to heed and specific evaluations to consider. The references and bibliography provides the reader with an up-to-date comprehensive listing of studies, products and techniques related to the problem of reflected light from helicopters. Author (GRA)

N73-27038# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DESIGN OF FIXED GAIN COMPENSATOR SYSTEM FOR THE LONGITUDINAL AXIS OF THE C-141 FLY-BY-WIRE AIRCRAFT M.S. Thesis
Larry D. Kwasigroh Mar. 1973 168 p refs
(AD-760763; GGC/EE/71-12) Avail: NTIS CSCL 01/3

The report presents an attempt to design a fixed gain control system for the longitudinal axis of the C-141 fly-by-wire aircraft. Classical control theory using root locus and frequency response (Bode) techniques was used throughout the design process. It was found that a quadratic over quadratic compensator, inserted in the forward path of the C* control loop, improved the system response even with the original discrete gains. With slightly relaxed constraints on the C* performance (* envelope was originally designed for fighter aircraft), a single fixed gain in the C* loop produced acceptable C* Category 3 responses. An additional quadratic over quadratic compensator was designed for the pitch attitude control loop; however, the acceptability of the attitude response with a fixed gain is questionable. (Author Modified Abstract) GRA

N73-27039# Army Air Mobility Research and Development Lab., Fort Eustis, Va.
DYNAMIC COMPATIBILITY OF ROTARY-WING AIRCRAFT PROPULSION COMPONENTS
John M. Vance Jan. 1973 61 p refs
(DA Proj. 1G1-62207-A-A71)
(AD-761100; USAMMRDL-TR-73-10) Avail: NTIS CSCL 01/3

A study of problems related to vibration and dynamic loads in helicopter propulsion systems was made. It was found that engine vibration, shaft whirling, and dynamic instabilities seriously limit helicopter performance and reliability. It is recommended that studies be made to justify an intelligent standardization of engine vibration limit specifications for helicopters, that impedance-mobility methods be developed for optimizing engine/airframe interface design, that research and development of helicopter power transmission shafts and couplings be carried out to solve whirling problems, and that new methods and hardware be developed to eliminate torsional instabilities in helicopter drive systems with automatic fuel control.
Author (GRA)

N73-27040# Naval Air Development Center, Warminster, Pa. Crew Systems Dept.
NAVY VEHICLE DESIGN AND CONSTRUCTION: MEASUREMENT OF TRIAXIAL VIBRATION AT SIGNIFICANT HUMAN INTERFACE POINTS ON THE CH-47C AND SH-3A HELICOPTERS Final Report
Charles W. Hutchins 31 Dec. 1972 70 p refs
(AD-761199; NADC-72226-CS; JANAIR-721122) Avail: NTIS CSCL 01/3

Triaxial vibration levels were recorded on the CH-47C and SH-3A helicopters at the pilot:s seat, collective control stick, rudder pedal, instrument panel, and the pilot's head (Z-axis only). These recordings were made on two separate two-hour flights for both helicopters. The first flight was a continuous mission profile representative of the helicopters: primary mission. The second flight consisted of discrete maneuvers representative of a broad scope of mission profiles. The resulting vibration tapes were subjected to spectrum analysis and three peak frequencies found. These peaks were seen to be a function of the rotor head frequency and two harmonics of this frequency. Each of the three peak frequencies was shown to be critical in terms of human performance parameters. Author (GRA)

N73-27041# Hughes Aircraft Co., Culver City, Calif.
FLIGHT EVALUATION OF OPTIMAL COMMANDS FOR F-1 MINIMUM TIME CLIMB AND ACCELERATION Final Technical Report, Oct. 1970 - Nov. 1972
John A. Schiro and Thomas J. SHYKULA Wright-Patterson AFB, Ohio AFFDL Mar. 1973 112 p refs
(Contract F33615-71-C-1017; AF Proj. 8222)
(AD-760571; HAC-Ref-C2090; AFFDL-TR-73-32) Avai NTIS CSCL 01/3

The background and results of a flight test program to examine the comparative time advantages of an energy optimization climb and acceleration methodology, in contrast to present F-106 handbook procedures, is described. The optimum procedure was implemented in the F-106 airborne digital computer, and provided a single control error signal to indicate deviations from an optimum flight profile. Flight results indicated that time savings as great as 24 percent in climb, and 27 percent in acceleration are achievable. Operational aircraft performance variations, however, prevented consistent realization of the maximum time savings. The steering signal and display were shown to provide proper indication over some portions of the flight regime, while exhibiting erratic behavior during rapid transition flight phases. (Author Modified Abstract) GRA

N73-27042# Goodyear Aerospace Corp., Akron, Ohio.
DEVELOPMENT OF A FREE BALLOON PROPULSION SYSTEM Final Report, 22 Sep. 1971 - 22 Feb. 1973
Jerome J. Vorachek, Edward W. McGraw, and John W. Bezbatchenko 22 Feb. 1973 158 p refs
(Contract F19628-72-C-0072)
(AD-760754; GER-15871; AFCRL-TR-73-0128) Avail: NTIS CSCL 01/3

Design, fabrication, development and testing of a free balloon propulsion system for flight at 60,000 feet and 15 knot true airspeed is reported. The mission of this system was to demonstrate the feasibility of powering a natural shape balloon in the minimum wind layer. The propulsion system consists of a 35.4 foot diameter propeller driven through a gearbox by a dc electric motor. The electric motor is powered by a group of silver zinc batteries. Steering of the gondola and balloon system is accomplished with a rudder in the propeller slipstream. A command control and telemetry system is used to control the balloon and propulsion payload. The propulsion system (less propeller) was tested in an altitude chamber to verify proper functioning under high altitude, low temperature conditions. (Author Modified Abstract) GRA

N73-27043# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTRICAL MODELING OF ELASTIC VIBRATIONS OF A WING
T. V. Pavelko 21 May 1973 16 p refs Transl. into ENGLISH from Vopr. Ekspluatatsionnoi Prochnost. i Nadezhnosti Aviats. Konstruktsii (Riga), v. 6, no. 191, 1971 p 93-102
(AD-760965; FTD-HT-23-260-73) Avail: NTIS CSCL 01/3

The report describes electromodeling of the motion of a wing in flight under the action of a distributed load with consideration of displacement of the center of gravity of the aircraft and its rotation as a solid body. GRA

N73-27044# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTRICAL MODEL OF A DELTA WING
E. R. Suvorova 17 May 1973 12 p refs Transl. into ENGLISH from Vop. Electromodelirovaniya Aviakonstruktsiy (USSR), v. 196, no. 1, 1971 p 30-35
(AD-760948; FTD-HT-23-0263-73) Avail: NTIS CSCL 01/3

The report describes the development of an electrical circuitry for studying the stress-deformation state of a model of a delta wing on the basis of a discrete design diagram. GRA

N73-27045# Aerophysics Research Corp., Bellevue, Wash.
OPTIMAL DESIGN INTEGRATIONS OF MILITARY FLIGHT VEHICLES (ODIN/MFV) Final Report, May 1971 - Sep. 1972
D. S. Hague and C. R. Glatt Dec. 1972 592 p refs
(Contract F33615-71-C-1480; AF Proj. 1431)
(AD-760568; AFFDL-TR-72-132) Avail: NTIS CSCL 01/3

ODIN/MFV is a digital computing system for the synthesis and optimization of military flight vehicle preliminary designs. The system consists of a library of technology modules in the form of independent computer programs and an executive program, DIALOG, which operates on the technology modules. The technology module library contains programs for estimating military flight vehicle characteristics, for example, aerodynamics, trajectory and geometry. In addition a generalized optimization module, plotting module, and a program precompiler are available in the technology module library. The initial program library was limited to only a few programs due to the limited scope of the study; however, other programs may readily be introduced into the library by a minor program modification. (Author Modified Abstract) GRA

N73-27046# Army Combat Developments Command Supply Agency, Fort Lee, Va.
AIRCRAFT REFUELING AND REARMING IN FORWARD AREAS (FARR). VOLUME 1: MAIN REPORT AND APPENDIXES A-F Final Study
Nov. 1972 114 p refs
(AD-760524) Avail: NTIS; paper copy also available from NTIS $4.75/set of 2 reports as AD-760524 - set CSCL 01/3

The report identifies and examines the organizations, doctrine, and equipment utilized in refueling and rearming Army aircraft in forward areas. The time frame addressed is current (up to 1975). Both qualitative and quantitative types of analyses are made. The study determines the personnel and equipment required by specific nondivisional, separate brigade/regiment, and divisional aviation units for accomplishing forward area refueling and rearming (FARR) operations. In addition, a supplementary FARR capability is proposed for attachment or assignment to supporting headquarters, as required. Revisions also are indicated which

should be made to field manuals and tables of organization and equipment by proponent agencies, upon approval of this study.
Author (GRA)

N73-27047# Army Combat Developments Command Supply Agency, Fort Lee, Va.
AIRCRAFT REFUELING AND REARMING IN FORWARD AREAS (FARR). VOLUME 2: APPENDIXES G-P Final Study
Nov. 1972 238 p refs
(AD-760525) Avail: NTIS; paper copy also available from NTIS $4.75/set of 2 reports as AD-760524 - set CSCL 01/3

The report identifies, examines and analyzes questionnaires sent to overseas commands; current doctrine, MOS capabilities, armament subsystems and refueling equipment. A composite service organization is structured. A statistical analysis is performed to determine organizational level of assignment, the number of personnel and amount of equipment required to support the operation. Author (GRA)

N73-27048# Boeing Co., Seattle, Wash. Commercial Airplane Group.
THE 727 NOISE RETROFIT FEASIBILITY. VOLUME 1: LOWER GOAL DESIGN, FABRICATION, GROUND AND FLIGHT TESTING Final Report, Jul. 1971 - Mar. 1972
R. B. Tate, H. G. Ripley, and J. A. Lambert Mar. 1972 62 p refs
(Contract DOT-FA71WA-2637)
(AD-756040; FAA-RD-72-40-Vol-1) Avail: NTIS CSCL 21/5

The work performed in Phase 1 of the contract was design, fabrication, and ground testing of a treated nacelle configuration conforming to the FAA lower noise reduction goals for the 727 airplane. The nacelle configuration tested consists of acoustically treated side engine inlet, fan duct and tailpipe. This nacelle configuration was developed by the Boeing Company, flight tested and certificated in July 1971. The same nacelle was then used to conduct the contract Phase 1 ground tests to obtain comparative acoustic and performance data with the basic, or tare, nacelle. In addition, a cost analysis was prepared showing the retrofit kit installation and direct operating cost (DOC) charged to the 727 airplane with a Phase 1 quiet nacelle. The results of the flight testing, not a part of this contract, are included in this report. Author (GRA)

N73-27098 Ohio State Univ., Columbus.
ANALYSIS OF ON-AIRCRAFT ANTENNA PATTERNS Ph.D. Thesis
Walter Dennis Burnside 1972 217 p
Avail: Univ. Microfilms Order No. 73-1957

The radiation patterns of on-aircraft antennas are analyzed using high frequency solutions. This is a basic study of aircraft-antenna pattern performance in which the analytic aircraft is modelled in its most basic form. The fuselage is assumed to be a perfectly conducting convex surface. The wings are simulated by arbitrarily many sided flat plates and the jet engines are treated as finite circular cylinders. The three principal plane patterns are analyzed in great detail with measured results taken to verify each solution. A volumetric pattern study is initiated with the fuselage modelled by an arbitrary convex surface of revolution. Dissert. Abstr.

N73-27104# Federal Aviation Administration, Washington, D.C. Office of Systems Engineering Management.
ENGINEERING AND DEVELOPMENT PROGRAM PLAN: SATELLITE EXPERIMENTATION
Mar. 1973 52 p refs
(FAA-ED-17-1) Avail: NTIS HC $4.75 CSCL 17B

The application of space technology to air traffic control is considered. The planning, development, engineering, experimentation, and evaluation of an aeronautical satellite communication capability over the Atlantic Ocean is outlined and the development and design data and techniques through analysis and experimentation is described. Author

N73-27110*# Ohio State Univ., Columbus. ElectroScience Lab.
THE RADIATION FROM APERTURES IN CURVED SURFACES
P. H. Pathak and R. G. Kouyoumjian Washington NASA Jul. 1973 79 p refs
(Grant NGR-36-008-144)
(NASA-CR-2263) Avail: NTIS HC $3.00 CSCL 17B

The geometrical theory of diffraction is extended to treat the radiation from apertures or slots in convex, perfectly-conducting surfaces. It is assumed that the tangential electric field in the aperture is known so that an equivalent, infinitesimal source can be defined at each point in the aperture. Surface rays emanate from this source which is a caustic of the ray system. A launching coefficient is introduced to describe the excitation of the surface ray modes. If the field radiated from the surface is desired, the ordinary diffraction coefficients are used to determine the field of the rays shed tangentially from the surface rays. The field of the surface ray modes is not the field on the surface; hence if the mutual coupling between slots is of interest, a second coefficient related to the launching coefficient must be employed. In the region adjacent to the shadow boundary, the component of the field directly radiated from the source is presented by Fock-type functions. In the illuminated region the incident radiation from the source (this does not include the diffracted field components) is treated by geometrical optics. This extension of the geometrical theory of diffraction is applied to calculate the radiation from slots on elliptic cylinders, spheres and spheroids. Author

N73-27114# Institute for Telecommunication Sciences, Boulder, Colo. Office of Telecommunication Sciences.
ELECTROSPACE PLANNING AND ENGINEERING FOR THE TRAFFIC ENVIRONMENT Final report
G. D. Gierhart, R. W. Hubbard, and D. V. Glen Dec. 1970 304 p refs
(Contract DOT-FA67WAI-134)
(FAA-RD-70-71) Avail: NTIS HC $17.25

Service limitations imposed upon VHF/UHF/SHF radio communication links by cochannel and adjacent-channel interference is the primary subject, but limitations imposed by intermodulation and noise are also discussed. Methods for predicting available desired-to-undesired signal ratios (protection ratio) and determining the required protection ratio are summarized. Appendices on frequency sharing with air traffic control satellite, modulation characteristics, and system performance measurements are included. Author

N73-27131# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
ERROR REDUCTION IN A TWO-GIMBAL, AIRBORNE, ANGLE TRACK SYSTEM M.S. Thesis
George L. Wright Mar. 1973 78 p refs
(AD-760551; GE/EE/73-25) Avail: NTIS CSCL 17/9

Angle measurement in a two-gimbal, airborne, tracking system is complicated by the motion of the aircraft. The two-gimbal system is characterized by the azimuth and elevation channel control systems. Rolling motions introduce error-causing disturbance inputs into each channel. One method of reducing the error investigated in this report is a linear transformation method which treats both channels simultaneously by considering a cross-coupled multivariable system. Another method, the invariance method, utilizes a feed forward branch whose input is the unwanted disturbance to reduce the error due to aircraft roll rate for each channel separately. (Author Modified Abstract)
GRA

N73-27141# Office of Telecommunications, Boulder, Colo. Inst. for Telecommunication Sciences.
MICROWAVE LINK PERFORMANCE MEASUREMENTS AT 8 AND 14 GHz Final Report
R. E. Skerjanec and C. A. Samson Oct. 1972 55 p refs
(Contract DOT-FA65WAI-86)
(AD-756605; FAA-RD-72-115) Avail: NTIS CSCL 17/2

Received signal level recordings were made at 8 and 14 GHz for one year on a 31-mile microwave relay link in southeastern Colorado. Data were processed with a switch-combiner simulator to determine the effect of dual diversity with selection combining. This study indicated improved performance for frequency, space, and crossband diversity configurations. Meteorological effects on link performance were also investigated. Author (GRA)

N73-27142# Lincoln Lab., Mass. Inst. of Tech., Lexington.
A HIGH PERFORMANCE, LOW COST AIR TRAFFIC CONTROL RADAR
Charles E. Mueche, Jr. and Lincoln Cartledge 15 Feb. 1973 45 p refs
(Contract F19628-73-C-0002; AF Proj. 649L)
(AD-759179; TN-1973-12; ESD-TR-73-62) Avail: NTIS CSCL 17/9

Recent improvements in the technology of electronically switched antennas and digital signal processing make possible a relatively high performance, low cost, surveillance radar. The radar described employs an electronically step-scanned, cylindrical antenna together with an advanced digital signal processor to give superior MTI performance at an estimated cost of less than half the present S-band ASRs. The radar output consists of narrow band, digital target reports free of false alarms, suitable for transmission over telephone lines. Remote radar operation using digital, bright, scan-history displays becomes practical as does easy incorporation of beacon and direction finder outputs along with digitally generated video maps. The complete absence of moving parts, the low power transmitter and the largely solid-state construction will provide high reliability and low maintenance costs. (Author Modified Abstract) GRA

N73-27158# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
PASSIVE DETECTION AND RANGING OF A GROUND RADAR FROM AN AIRCRAFT USING AN EXTENDED KALMAN FILTER M.S. Thesis
David Henry Watjen Mar. 1973 116 p refs
(AD-760764; GGC/EE/73-20) Avail: NTIS CSCL 15/3

The dynamic equations between a moving aircraft and a stationary ground based radar transmitter are used to design an extended Kalman filter for determining the location of the transmitter with respect to the aircraft. Emphasis is placed on obtaining the range of the transmitter from the aircraft. The only inputs available to the filter are the velocity and attitude of the aircraft and the bearing and elevation angles which the transmitters radar beam makes with the aircraft. The filter is implemented on a digital computer and its performance is observed for various flight paths of the aircraft. The time for the error in the estimate in range to decrease to specified values is tabulated for comparison. Author (GRA)

N73-27161# Army Electronics Command, Fort Monmouth, N.J.
VSWR MEASUREMENTS OF ANTENNA SYSTEM INSTALLATIONS ON ARMY AIRCRAFT.
James T. Maguire, Edmund T. Tognola, and Joseph H. Huggins May 1973 35 p refs
(DA Proj. 1F2-64201-DC-97)
(AD-761031; ECOM-4114) Avail: NTIS CSCL 09/5

The report describes a new antenna sweeping method which gives a rapid, accurate measurement of VSWR over a designated frequency spectrum. This new method offers technical and procedural advantages over alternate methods and it is compared with regard to cost and time consumption with two other methods presently being used. Theory of operation, test setup, and test procedures are given for each of the three methods. Test results using the new method on various antenna systems are tabulated and its potential applications are summarized. Author (GRA)

N73-27175*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
WIND TUNNEL FLOW GENERATION SECTION Patent Application
Norman E. Sorensen, inventor (to NASA) Filed 13 Jul. 1973 16 p
(NASA-Case-ARC-10710-1; US-Patent-Appl-SN-379019) Avail: NTIS HC $3.00 CSCL 14B

An apparatus for generating acceptably uniform flow for the test section of a wind tunnel over a range of different flow velocities. More particularly, it has been found that by appropriately adjusting the length of the porous wall surfaces in the flow generation section of the wind tunnel to which a negative pressure is applied and by applying appropriate negative pressures, the flow through the test section of the wind tunnel can be made uniform. In its basic aspects, therefore, the apparatus comprises a pair of generally opposed, porous wall surfaces defining the flow generation section, means for selectively applying appropriate negative pressures to the exterior sides of such porous wall surfaces, and means for selectively varying the length of such wall surfaces to which the negative pressure is applied. NASA

N73-27178*# Scientific Translation Service, Santa Barbara, Calif.
ON THE ACCURACY OF AERODYNAMIC PARAMETERS FOR SIMULATION
B. Haftmann Washington NASA Jul. 1973 18 p refs Transl. into ENGLISH from DGLR report on the 3d Meeting of the DGLR-Symp., Flight Testing Technol., Oct. 1972 p 53-66
(Contract NASw-2483)
(NASA-TT-F-14994) Avail: NTIS HC $3.00 CSCL 14B

The procedure for developing the aerodynamic parameters for use in flight simulator research projects is described. Emphasis is placed on wind tunnel measurements to determine aerodynamic coefficients. Sources of error in wind tunnel measurements are analyzed. Procedures for compensating for errors arising during wind tunnel tests are explained. Results of a typical investigation are presented as graphs. Author

N73-27179# Parsons, Brinckerhoff, Quade and Douglas, New York.
ELEVATED STOL PORT TEST FACILITY CONCEPTUAL DEVELOPMENT AND COST STUDY Technical Report, 30 Jun. 1972 - 31 Jan. 1973
S. Rottenberg and A. H. Degraw Apr. 1973 56 p
(Contract DOT-FA72WA-3114)
(FAA-RD-73-15) Avail: NTIS HC $5.00

A cost analysis was conducted on construction of an elevated short takeoff and landing test facility. A suitable structural scheme was selected, cost estimates were prepared, and the location at the National Aviation Facilities Experimental Center was recommended. A similar analysis was conducted for a test facility located in a hypothetical metropolitan environment. The facility was conceptualized with the added consideration of future expansion to a passenger carrying facility. A comparision of the two test facilities was made based on structural, cost, and einvironmental considerations. Author

N73-27180# Douglas Aircraft Co., Inc., Long Beach, Calif.
PROCEDURES FOR DETERMINATION OF AIRPORT CAPACITY, VOLUME 1 Interim Report, Jun. 1972 - Jan. 1973
Apr. 1973 197 p refs Prepared in cooperation with McDonnell Douglas Automation Co., Am. Airlines, Inc., and Peat, Marwick, Mitchell and Co.
(Contract DOT-FA72WA-2897)
(FAA-RD-73-11-Vol-1) Avail: NTIS HC $12.00

Procedures for determining airfield capacity are discussed. Three major areas were investigated as follows: (1) definition of requirements for planning tools, (2) gathering of operational information relating to airport performance, and (3) development

of models for analyzing airport capacity and causes for delays. A Monte Carlo simulation method and appropriate logic for the analysis are discussed. For volume 2 see ats 08622. Author

N73-27185# North Central Alabama Regional Council of Governments, Decatur.
HARTSELLE, ALABAMA, AIRPORT ZONING PROVISIONS: ROUNTREE FIELD
1972 44 p Sponsored by HUD
(PB-220087/1; ALA-NCA-0860-1009-01) Avail: NTIS HC $4.25 CSCL 13B

Proposed regulations are listed whose primary purpose is to promote safety in air navigation in utilizing the municipal airport of Hartselle, Alabama (Rountree Field). These proposed regulations are prepared in legal form, along with appropriate maps, for adoption and administration by the city as an addition to the existing Zoning Ordinance. Author (GRA)

N73-27186# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
EVALUATION OF KAISER MX19-B AND MX19-C ALUMINUM HONEYCOMB LANDING MAT
Gordon L. Carr and Dave A. Ellison Mar. 1973 57 p refs
(DA Proj. 1T0-62103-A-046)
(AD-758840; AEWES-Misc-Paper-S-73-11) Avail: NTIS CSCL 01/5

The report describes an investigation conducted to evaluate the MX19 aluminum honeycomb-core landing mat with modified male and female hinge-type connectors. The MX19 mat was a sandwich-type structure composed of an aluminum honeycomb core bonded by an adhesive to top and bottom aluminum sheets. The extruded aluminum edge connectors were welded to the sheets and bonded with adhesive to the core. The panels were joined along two edges by a hinge-type male/female connection. The adjacent edges were joined by an overlap/underlap connection secured by a locking bar. (Author Modified Abstract) GRA

N73-27187# CLM/Systems, Inc., Cambridge, Mass.
AIRPORTS AND THEIR ENVIRONMENT: A GUIDE TO ENVIRONMENTAL PLANNING Final Report, Oct. 1970 - Sep. 1972
Sep. 1972 524 p refs
(Contract DOT-OS-00059)
PB-219957/8; DDT-P-5600.1) Avail: NTIS HC $12.50 CSCL 13B

The report is designed to assist and guide airport planners, regional planners, and all other interested parties in identifying and resolving environmental problems associated with airport planning and development. It treats airport environmental planning as an integral part of the comprehensive regional planning process as this process is affected by the National Environmental Policy Act of 1969 and other relevant Federal legislation. It contains major chapters in the following: environmental planning process; aircraft noise; impacts on land use; air pollution; water pollution; hydrologic impacts; and ecologic impacts. GRA

N73-27189# Metcalf and Eddy, Inc., Boston, Mass.
ANALYSIS OF AIRPORT SOLID WASTES AND COLLECTION SYSTEMS: SAN FRANCISCO INTERNATIONAL AIRPORT Final Report
1973 149 p Prepared for San Francisco City and county Airports Comm., Calif.
(Grant EC-00294)
(PB-219372/0; EPA-SW-48D-73) Avail: NTIS HC $5.45 CSCL 13B

The study develops basic information on solid wastes generated at San Francisco International Airport and alternative collection, transfer, and transportation systems that might demonstrate engineering feasibility and economic benefit. The weight and composition of solid wastes were derived from field data gathered from passenger terminals, air freight areas, including mail service facilities, aircraft service centers, and aircraft maintenance bases. Questionnaires were sent to national airports to determine their operating levels and the levels were then compared to those at San Francisco to ascertain whether the data derived there would be applicable on a nationwide basis. The report describes two collection systems of potential economic benefit to the airport complex that were selected from various alternatives evaluated. GRA

N73-27190# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
EVALUATION OF REDESIGNED XW18 MEMBRANE AND ACCESSORIES Final Report, Mar. 1969 - Jan. 1970
Frank M. Palmer May 1973 127 p refs
(DA Proj. 1G6-64717-D-556)
(AD-761089; AEWES-TR-S-73-3) Avail: NTIS CSCL 01/5

Tests were conducted at the U. S. Army Engineer Waterways Experiment Station to determine the suitability of the redesigned XW18 membrane and accessories as expedient surfacing for waterproofing and dustproofing hastily prepared airfields for operations of C-130 aircraft. The objectives of the tests were as follows: to compare the redesigned XW18 membrane with the WX18 membrane, which was considered unsuitable as an expedient surfacing for C-130 operations as a result of integrated engineering and service tests conducted at Ft. Campbell, Kentucky, during 11 May to 15 November 1966, and to determine whether the XW18 membrane met the requirements of the Department of the Army approved Qualitative Materiel Requirement (QMR) for Prefabricated Airfield Surfacings. GRA

N73-27191# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONSTRUCTION AND MAINTENANCE OF AIRFIELDS
G. I. Glushkov and B. S. Raev-Bogoslovskii 22 Dec. 1972 468 p refs Transl. into ENGLISH of the book "Ustroystvo i Soderzhaniye Aerodromov" Moscow, 1970 p 1-318
(AD-759243; FTD-MT-24-544-72) Avail: NTIS CSCL 01/5

The manual contains the general requirements for airfields, information about their elements, and about the methods of operational maintenance and repair of flying field and basic airport installations. Special attention is given to the unsurfaced flying strips. The book examines contemporary constructions of hard and soft coverings, including concrete, reinforced, prestressed - monolithic and composite, asphalt-concrete and rough coverings made of crushed stone and gravel mixtures, and also sectional coverings. Snow and ice coverings on airfields are described. (Author Modified Abstract) GRA

N73-27192# Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.
IOWA STATE AIRPORT SYSTEM PLAN. VOLUME 1: SUMMARY REPORT Final Report, 1971 - 1972
R. L. Carstens Nov. 1972 53 p Sponsored in part by FAA
(PB-217531/3; ISU-EIR-AMES-72249-1) Avail: NTIS HC $3.00 CSCL 13B

The report sets forth a State Airport System Plan (SASP) for Iowa and suggests means for implementing those actions necessary to develop such a system. The recommended system includes 117 airports. An appropriate expectation is that the designated system should better satisfy the economic and social goals of the State of Iowa than any alternative system, whether that alternative consists of the same number, a lessor number, or a greater number of airports. Author (GRA)

N73-27193# Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.
IOWA STATE AIRCRAFT SYSTEM PLAN. VOLUME 2: TECHNICAL SUPPLEMENT Final Report, 1971 - 1972
R. L. Carstens Nov. 1972 424 p refs Sponsored in part by FAA
(PB-217532/1; ISU-ERI-AMES-72249-2) Avail: NTIS HC $6.00 CSCL 13B

A variety of electroacoustic instruments and devices have evolved in attempts to improve the perception and discrimination of aural signals and messages. The report describes

instrumentation that delivers binaurally time-delayed signals that tend to enhance the intelligibility of speech signals delivered to subjects. The electroacoustic device can be used to improve the intelligibility of desired signals when immersed in masking (interfering) noise. The device used to achieve binaural time delays encompasses completely variable delays ranging from 0 (in phase) to 1500 msec. This device has proved of considerable value in situations where desired speech signals coexist with masking or other interfering noises, such as voice recordings obtained within cockpits of aircraft. Details of the device and practical applications of binaural time-delay phenomenon are discussed. Author (GRA)

N73-27206# Aeronautical Research Inst. of Sweden, Stockholm.
PRESSURE DISTRIBUTION ON A PLANE GROUND SURFACE CAUSED BY A SUBSONIC AIRCRAFT
Bo Johansson Dec. 1970 43 p ref
(FFA-AU-634-Pt-2) Avail: NTIS HC $4.25

An analytic investigation has been made of the pressure distribution on a plane ground surface under an aircraft flying at low altitude with subsonic velocity. The effects of the volume and the lift of the aircraft on the pressure distribution have been considered. The aircraft volume has been represented by an ovoid and the lift by a vortex of constant strength and two trailing tip vortices. The volume and lift components of this pressure distribution have furthermore been expanded in power series in the ratios of the aircraft dimensions to the flight altitude. As a numerical example, a fighter aircraft, flying at the Mach numbers 0.8, 0.9 and 0.97 and at the altitudes 25, 50, 100 and 200 meters, has been considered. Author

N73-27207*# Hamilton Standard, Windsor Locks, Conn.
NOISE AND WAKE STRUCTURE MEASUREMENTS IN A SUBSONIC TIP SPEED FAN: TABULATION AND PLOTS OF TEST DATA
B. Magliozzi, B. V. Johnson, D. B. Hanson, and F. B. Metzger 23 Jul. 1973 284 p
(Contract NAS1-11670)
(NASA-CR-132259) Avail: NTIS HC $16.25 CSCL 20D

Noise and wake structure measurements in a ducted fan were conducted. The tip speed was kept at subsonic levels. The anechoic platform used during the test is described. The following conditions are reported: (1) one third octave band analyses of the fan noise data, (2) narrow band analyses of the fan noise for selected test conditions, (3) narrow band sound power level data for all fan test conditions, and (4) velocity and air angle evaluation of blade wake data. Author

N73-27209*# Kanner (Leo) Associates, Redwood City, Calif.
CALCULATION OF POTENTIAL FLOW AROUND PROFILES WITH SUCTION AND BLOWING
K. Jacob Washington NASA Jul. 1973 34 p refs Transl. into ENGLISH from Ing.-Arch. (Berlin), v. 32, no. 1, 1963 p 51-65
(Contract NASw-2481)
(NASA-TT-F-14962) Avail: NTIS HC $3.75 CSCL 20D

A method of computation was developed for computing plane incompressible potential flows around arbitrary thick, cambered profiles with continuous or discontinuous blowing or suction. It works with source and vortex distributions on the contour and in the interior of the profile. An integral equation for the vortex distribution on the contour of the profile is arrived at, the solution of which is reduced to a linear set of equations. Finally, the method yields the velocity and pressure distribution on the contour of the profile and the flow stream function for plotting the flow pattern. The practicability of the method was established for the circular cylinder by comparing the velocity distribution with the exact solution, and on some thick, cambered profiles by comparison of the theoretical pressure distribution with measurements. Author

N73-27212# National Aerospace Lab., Tokyo (Japan).
A NUMERICAL CALCULATION OF A TWO-DIMENSIONAL INCOMPRESSIBLE POTENTIAL FLOW AROUND A SET OF AIRFOILS APPLYING THE RELAXATION METHOD
Masayoshi Nakamura Jan. 1973 14 p refs In JAPANESE; ENGLISH summary
(NAL-TR-309) Avail: NTIS HC $3.00

An application of the relaxation method to the two-dimensional incompressible potential flow around a system of arbitrary airfoils is described. The governing equation is the Laplace's (two-dimensional partial differential) equation of the stream function. This equation is solved in a boundary value problem of the Dirichlet-Neumann type. For numerical solution, some difference equations of the square meshes are used instead of the differential equation. The stream function is calculated numerically by solving those difference equations. The values of boundary condition are given on a certain finite distance from the airfoils. And the boundary value on each surface of the airfoils is varied to satisfy the Joukowski's condition. For example, a flow around an airfoil with a leading-edge slat and a slotted flap is calculated. The result is compared with other numerical solutions and experimental data. Author

N73-27214*# McDonnell-Douglas Corp., Long Beach, Calif.
SOME PROBLEMS OF THE CALCULATION OF THREE-DIMENSIONAL BOUNDARY LAYER FLOWS ON GENERAL CONFIGURATIONS
Tuncer Cebeci, Kalle Kaups, G. J. Mosinskis, and J. A. Rehn Washington NASA Jul. 1973 57 p refs
(Contract NAS1-11623)
(NASA-CR-2285) Avail: NTIS HC $3.00 CSCL 20D

An accurate solution of the three-dimensional boundary layer equations over general configurations such as those encountered in aircraft and space shuttle design requires a very efficient, fast, and accurate numerical method with suitable turbulence models for the Reynolds stresses. The efficiency, speed, and accuracy of a three-dimensional numerical method together with the turbulence models for the Reynolds stresses are examined. The numerical method is the implicit two-point finite difference approach (Box Method) developed by Keller and applied to the boundary layer equations by Keller and Cebeci. In addition, a study of some of the problems that may arise in the solution of these equations for three-dimensional boundary layer flows over general configurations. Author

N73-27217*# Kanner (Leo) Associates, Redwood City, Calif.
EXPERIMENTAL DETERMINATION OF BOUND VORTEX LINES AND FLOW IN THE VICINITY OF THE TRAILING EDGE OF A SLENDER DELTA WING
D. Hummel and G. Redeker Washington NASA Aug. 1973 24 p refs Transl. into ENGLISH of "Experimentelle Bestimmung der gebundenen Wirbellinien sowie des Stroemungsverlaufs in der Umgebung der Hinterkante eines schlanken Deltafluegels", Braunschweigische Wissenschaftlich Gesellschaft, Abhandungen, 1972 p 273-290
(Contract NASw-2481)
(NASA-TT-F-15012) Avail: NTIS HC $3.25 CSCL 20D

Boundary layer measurements were carried out on a sharp-edged delta wing (Aspect ratio = 1.0, angle of incidence = 20.5) with turbulent boundary layers. From the velocities at the outer edge of the boundary layer on the upper and the lower side of the wing the bound vortex lines in the lifting surface were determined. A comparison with former investigations concerning laminar boundary layers shows the influence of the status of the boundary layer on vortex formation. Studies on the flow downstream from the wing trailing-edge indicate that the trailing vortex sheet rolls up into a vortex, the rotation of which is opposite to that of the leading-edge vortex. The axis of this so-called trailing edge vortex forms a spiral within the leading-edge vortex. Author

N73-27426# Franklin Inst. Research Labs., Philadelphia, Pa.
DUAL DIAMETER ROLLER BEARING - 3.5 MILLION

DN-600 F Final Report, 23 Jun. 1971 - 31 Dec. 1972
John Rumberger, James Dunfee, Edmund Filetti, and David Gubernick Wright-Patterson AFB, Ohio AFAPL May 1973 190 p refs
(Contract F33615-71-C-1883; AF Proj. 3048)
(AD-760563; FIRL-F-C3132; AFAPL-TR-73-23) Avail: NTIS CSCL 13/9

Five gas turbine engine mainshaft roller bearing configurations were investigated for capability of sustained performance at DN values (Bore in mm x Speed in rpm) from 2 million to 3.5 million and normal operating temperatures to 600F. A unique Dual Diameter Roller was selected for the final analysis of stress and lubrication parameters, design and fabrication. A 140 mm Bore Dual Diameter Roller Bearing operated successfully for 30 min. continuous operation at 25,000 rpm (3.5 million DN) with stabilized outer race temperatures above 525F. Lubrication was with Polyphenyl Ether 5P4E in an air environment. Author (GRA)

N73-27456# Rolls-Royce, Ltd., Leavesden (England). Small Engine Div.
PROPERTIES OF ELECTRON BEAM WELDMENTS IN 2 1/2 PERCENT Ni-Cr-Mo STEEL AND 18 PERCENT Ni-Co-Mo MARAGING STEEL
A. E. Longley Orpington, Engl. Defence Res. Inform. Centre [1971] 28 p
(Contract KS/1/0496/C.B.43(A)2)
(S/T-Memo-9-71; BR25369) Avail: NTIS HC $3.50

Tensile and axial loading fatigue tests were carried out in order to evaluate the static and fatigue properties of electron beam weldments in two aircraft steels: 2 1/2 Ni-Cr-Mo-S.98 and a double vacuum melted 18% Ni-Co-Mo maraging steel. After welding, a further tempering was effected as soon as possible. The properties of the welds were compared with those of unwelded samples in the same material. No deterioration in static mechanical properties was observed but fatigue tests indicated a drop of about 6% in fatigue strength at 100 million cycles due to welding. Electron beam welding of 18% Ni-Co-Mo maraging steel in the form of 1/4 in. plate was carried out on the material with a variety of pre and post weld heat treatments. The properties of the welds were compared with those of unwelded fully heat treated samples in the same material. Without post weld heat treatment drastic reductions in static and fatigue properties occurred due to welding. ESRO

N73-27474# Advisory Group for Aerospace Research and Development, Paris (France).
IMPACT OF COMPOSITE MATERIALS ON AEROSPACE VEHICLES AND PROPULSION SYSTEMS
May 1973 288 p refs In ENGLISH and partly in FRENCH Presented at Joint Symp. of the AGARD Structures and Mater. Panel, and Propulsion and Energetics Panel, Toulouse, 20-22 Sep. 1972
(AGARD-CP-112) Avail: NTIS HC $16.50

The proceedings of a conference on the use of composite materials in the construction of aerospace vehicles and propulsion systems are presented. The subjects discussed include the following: (1) mechanical properties of high performance plastic composites, (2) design concepts using composites in airframes, (3) design and manufacturing aspects of composite materials with organic matrices, (4) application of advanced fibrous composites to aeronautical gas turbine engines, and (5) failure analysis of fiber reinforced composite motor case.

N73-27476 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Bauweisen- und Konstruktionsforschung.
FIBER REINFORCED MATERIALS FOR APPLICATION IN THE COLD PART OF TURBINE ENGINES
Gerhard Grueninger and Richard Kochendoerfer *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 13 p refs

The strength to density ratio property of fiber reinforced materials with plastic and metallic matrix is discussed. The properties of fibrous materials used in structures which are submitted to uniaxial loads are analyzed. The use of composite materials for blades and discs of turbine engines for operation at elevated temperatures is analyzed. Author

N73-27479 British Aircraft Corp., Preston (England). Military Aircraft Div.
DESIGN CONCEPTS FOR THE USE OF COMPOSITES IN AIRFRAMES
I. C. Taig *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 18 p refs

A philosophy for design of filamentary composite components, emphasising integrity and cost-effectiveness, is outlined. This involves intensive development of a limited number of basic structural concepts. Several such concepts, applicable to airframe structures, are reviewed, starting with a simplified assessment of their structural efficiency (measured in terms of mass saving) and including a brief discussion of features relating to integrity and fabrication. The review includes composite reinforcement of metal structures, solid rods, tubes and beams, sandwich skin panels and sandwich box structures, stiffened skins and wound tubes and lattices. Particular attention is given to attachments and load introduction and a brief section deals with bonded and mechanical joints. The paper concludes with illustrations of structures embodying some of the concepts described. Author

N73-27480 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
DESIGN AND FAILURE CRITERIA OF ADVANCED COMPOSITE PRIMARY STRUCTURE
Larry G. Kelly *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion systems May 1973 8 p

The design, fabrication, and flight test of a boron/epoxy F-111 stabilizer are discussed. The applicability of this composite material to airframe construction and the ability to achieve significant weight savings are reported. The material allowables and design philosophy utilized in the evolution of this structure are employed as an example of an approach to establishing logical failure criteria from which efficient designs can be developed with continuous aligned high modulus-high strength composite materials. One of the outstanding features of filamentary composite materials is their directional properties which provides the ability through crossplying of lamina to tailor a structure which meets specific loads and/or stiffness requirements with a minimum amount to material and weight. Thus a more efficient and reliable method of establishing design allowables for all laminates of interest was developed. The approach selected was to experimentally determine the stress-strain response to simple unidirectional laminae at the required design temperature and with the aid of a mathematical model establish a failure envelope to serve as the designers tool for selection of a suitable laminate thickness and ply orientation for a given set of load conditions. Author

N73-27482 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
APPLICATION OF COMPOSITE MATERIALS FOR AEROSPACE STRUCTURES
F. Och and W. Jonda *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 10 p refs

The use of reinforced composite materials for aerospace

structures is discussed. Component developments for the application of various composites, such as glass, carbon, and PRD, as well as combinations of glass and carbon are reviewed. An example of an all-glass composite used in a third stage of a rocket launcher is presented. The application of all-carbon composites for helicopter rotor blades is reported. The mechanical and physical properties of PRD-49 organic fiber are analyzed. Author

N73-27483 *Westland Helicopters* Ltd., Hayes (England).
USE OF COMPOSITES IN HELICOPTERS: ADVANTAGES AND DISADVANTAGES
H. F. Winny *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 9 p refs

A survey is given of the use of glass and carbon fiber composite materials for helicopter structures. It is reported that glass reinforced plastics should be used on rotorheads of the semi-rigid types and on rotor blades where fatigue strength and low stiffness and density are required to save weight. Carbon fiber reinforced plastics are recommended for the main helicopter structures. A summary of the strength and stiffness properties of both types of composites is presented. Methods of overall fabrication for cost effective materials are proposed. Author

N73-27484 Societe Nationale Industrielle Aerospatiale, Courbevoie (France). Dept. Structures Nouvelles.
COMPOSITES IN ENGINE STRUCTURES AND THEIR ADAPTATION TO AERONAUTICAL NEEDS [LES COMPOSITES DANS LES STRUCTURES D'ENGINS ET LEUR ADAPTATION AUX BESOINS AERONAUTIQUES]
G. Jube *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 10 p In FRENCH

The use of highly rigid composite materials in aircraft structures, particularly engine structures is examined. A detailed review was made of the use of reinforced boron and carbon filaments. A comparison was also made of the fatigue life of the two materials. Transl. by E.H.W.

N73-27485* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
APPLICATION OF COMPOSITES TO THE SELECTIVE REINFORCEMENT OF METALLIC AEROSPACE STRUCTURES
W. A. Brooks, Jr., E. E. Mathauser, and R. A. Pride *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 15 p refs

CSCL 11D

The use of composite materials to selectively reinforce metallic structures provides a low-cost way to reduce weight and a means of minimizing the risks usually associated with the introduction of new materials. An overview is presented of the NASA Langley Research Center programs to identify the advantages and to develop the potential of the selective reinforcement approach to the use of composites. These programs have shown that selective reinforcement provides excellent strength and stiffness improvements to metallic structures. Significant weight savings can be obtained in a cost effective manner. Flight service programs which have been initiated to validate further the merits of selective reinforcement are described. Author

N73-27486 Technische Universitaet, Brunswick (West Germany). Inst. fuer Flugzeugbau und Leichtbau.
EXPERIENCE WITH COMPOSITES AS OBTAINED FROM GLIDERS
W. F. Thielemann *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 7 p

A survey is given of the design and manufacture of gliders using glass fiber and carbon fiber reinforced plastic composites for primary structures. The two main advantages cited are: (1) the possibility of getting very smooth surfaces of high aerodynamic quality and (2) the possibility of reducing the fabrication costs by producing large integral structures instead of assembling many prefabricated metallic structural details. The design problems, structural problems, and performance test data for reinforced plastic construction are reported. Author

N73-27487 Army Air Mobility Research and Development Lab., Fort Eustis, Va. Structures Div.
ADVANCES IN BALLISTICALLY TOLERANT FLIGHT CONTROLS
I. E. Figge, Sr. *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 8 p refs

Combat data indicate that helicopter flight control components are exceptionally vulnerable to catastrophic failure upon ballistic impact. The ballistic tolerance approach, which is to design the critical components to function after ballistic penetration, offers a solution to reduce vulnerability. Studies have shown that this approach can virtually eliminate catastrophic failure while achieving substantial weight saving and reduced production costs. Limited data indicate the approach is also adaptable to flight control bearings and attachments. Venting was found to reduce the damage on the exit side of sandwich structures and preslotting was found to prevent delamination of the exit face in the area of impact. Author

N73-27489 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost.
DESIGN AND MANUFACTURING ASPECTS OF COMPOSITE MATERIALS WITH ORGANIC MATRICES FOR APPLICATION AT HIGH TEMPERATURES
J. J. Cools *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 15 p refs

Some design and manufacturing aspects are presented of the mixed-structure concept which was developed for application in aerospace structures subjected to high temperatures. In this concept a HM-composite material with an organic matrix is laminated between metallic faces to combine simultaneously the favorable features of both types of materials. The HM-composite material is the main load carrying component. The metallic faces protect the organic matrix against oxidation by air at high temperatures, provide an electrically conductive surface of the structure and contribute to stabilization against buckling. The mixed-structure concept can also be applied to aerospace structures, subjected to normal operating temperatures. Author

N73-27490 National Gas Turbine Establishment, Pyestock (England).
A LIMITED REVIEW OF THE APPLICATION OF ADVANCED FIBROUS COMPOSITES TO AERO GAS TURBINE ENGINES
A. W. H. Morris *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 16 p refs
CSCL 11D

A review of fiber reinforced composite material relevant to aero gas turbine engine application is presented for systems both commercially available and projected. Emphasis has been placed on those mechanical property requirements and fabrication problems which are peculiar to gas stream components. Although high strength and high elastic modulus composites are available in organic and inorganic matrices for low temperature application, these materials exhibit extremely poor impact and erosion characteristics which may limit use where foreign object damage is prevalent. Several engineering solutions to the problem are discussed. The application of composites in the high temperature turbine stage has difficulties such as fiber stability and thermal fatigue and is considered to be very impractical.

The development of directionally solidified eutectics, which can loosely be described as composites, offers more encouragement as the next generation turbine material. Author

N73-27491* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MATERIAL AND STRUCTURAL STUDIES OF METAL AND POLYMER MATRIX COMPOSITES
Robert A. Signorelli, Tito T. Serafini, and Robert H. Johns *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 16 p refs

Fiber-reinforced composites and design analysis methods for these materials are being developed because of the vast potential of composites for decreasing weight and/or increasing use temperature capability in aerospace systems. These composites have potential for use in airbreathing engine components as well as aeronautical and space vehicle structures. Refractory wire-superalloy composites for use up to 2200 F or more and metal-matrix composites for lower temperature applications such as aerospace structures and turbojet fan and compressor blades are under investigation and are discussed. The development of a number of resin systems, including the polyimides and polyphenylquinoxalines, is described and their potential for use at temperatures approaching 315 C (600 F) is indicated. Various molecular modifications that improve processability and/or increase thermal and oxidative resistance of the resins are also described. Structural analysis methods are discussed for determining the stresses and deformations in complex composite systems. Consideration is also given to residual stresses resulting from the curing process and to the foreign object damage problem in fan blade applications. Author

N73-27494 Motoren- und Turbinen-Union Muenchen G.m.b.H. (West Germany).
EUTECTIC ALLOYS WITH UNI-DIRECTIONAL SOLIDIFICATION: STUDY ON THEIR USE FOR TURBINE BLADES

H. Huff and W. Betz *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 6 p refs

The principle of directional solidification of eutectic alloys is briefly shown and the influence of temperature gradient, solidification rate and impurities is described. Using a list of the most important demands on turbine blade materials the merits and demerits of directionally solidified eutectics for this purpose are discussed. It seems that there are good chances for utilizing this compound material for gas turbines. There will be, however, a lot of further investigations necessary especially with respect to casting technology. Author

N73-27499 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France). Dept. Resistance des Materiaux.
STUDY OF DISK BINDING OF COMPRESSORS BY BASE COMPOSITES OF BORON WIRE [ETUDE DU FRETTAGE DES DISQUES DE COMPRESSEUR PAR DES COMPOSITES A BASE DE FIL DE BORE]
Claude Stoltz *In* AGARD Impact of Composite Mater. on Aerospace Vehicles and Propulsion Systems May 1973 8 p In FRENCH

A theoretical study was made of the general principles of binding compressor disks with boron composites. Data cover possible weight reductions and peripheral speed augmentation. Crack and endurance tests are also made. The results are compared with predictions. Transl. by E.H.W.

N73-27568# National Aviation Facilities Experimental Center, Atlantic City, N.J.
VISUAL APPROACH SLOPE INDICATOR (VASI) IMPROVEMENTS Final Report, Jun. 1968 - Jan. 1973
Thomas H. Paprocki Jul. 1973 8 p refs
(FAA Proj. 071-312-000)
(FAA-NA-73-64; FAA-RD-73-96) Avail: NTIS HC $3.00 CSCL 17G

The major work to improve and update Visual Approach Slope Indicator (VASI) equipment and systems being utilized at various category airports within the United States is discussed. Results and conclusions arrived at through a number of of VASI evaluation projects are cited in so far as they pertain to the following areas of VASI development and investigation: (1) suitability of VASI for long-bodied aircraft use; (2) techniques for reducing VASI lateral beam coverage; (3) visual approach multiple slope indicator (VAMSI) concept development; and (4) VASI signal transition zone and color modifications. Reference to previous and interim reports providing detailed information about each of the subject areas is provided. Author

N73-27573# Army War Coll., Carlisle Barracks, Pa.
AIRSPACE COORDINATION - WHO NEEDS IT?
James A. Kilgore 14 Feb. 1973 28 p refs
(AD-761034) Avail: NTIS CSCL 01/2

The theme is based upon the Army's need to coordinate airspace. Data were gathered using a literature search. The airspace above the combat zone is used by all services and by all combat branches within the Army. History indicates control of the airspace became a problem during World War I. Between World War I and World War II new concepts for integration of air into the land battle scheme were developed. Korea brought new innovations and produced combat experience in the helicopter for the Army. The Vietnam War produced the concept of airmobility that further increased airspace control problems. There is no current agreement on joint use of the airspace. Doctrine provides for an Airspace Coordination Element (ACE) that, currently, is not authorized on most TOEs. The ACE, although a workable solution, is restricted by being only a planning and management facility with limited capability. Air Defense Artillery has recommended consolidation of selected equipment with aviation to help solve the airspace problem. (Author Modified Abstract) GRA

N73-27574# Transportation Systems Center, Cambridge, Mass.
SIGNAL ANALYSIS FOR AEROSAT Final Report, Jan. Jun. 1972
L. A. Frasco Aug. 1972 79 p refs
(AD-758407; DOT-TSC-FAA-72-29; FAA-RD-73-34) Avail: NTIS CSCL 17/7

The report addresses signal design for the AEROSAT system. Candidate data and surveillance modems are analyzed for L-Band avionics. Detailed theoretical analyses are presented of the effects of the oceanic satellite-aircraft channel on data modem performance. In addition, an L-Band avionics transceiver is proposed to meet the requirements of the Experimentation and Evaluation Phase of AEROSAT. The proposed avionics are flexible and easily adaptable to a variety of operational and access control concepts. A task plan outline is presented for an improved modem task for the following year. Author (GRA)

N73-27701*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF A 1.20 PRESSURE RATIO STOL FAN STAGE AT THREE ROTOR BLADE SETTING ANGLES
George W. Lewis, Jr., Royce D. Moore, and George Kovich Washington Jul. 1973 32 p refs
(NASA-TM-X-2837; E-7434) Avail: NTIS HC $3.00 CSCL 21E

A model of a short takeoff and landing (STOL) fan stage was tested in a single-stage compressor research facility. Surveys of the airflow conditions ahead of the rotor, between the rotor and stator, and behind the stator were made over the stable operating range of the stage. At the design speed of 213.3 meters per second and a weight flow of 31.2 kilograms per

second, the stage pressure ratio of 1.15 was less than the design value of 1.2. The stage was tested with the rotor blades reset for more flow. Design pressure ratio was achieved and surpassed with the minus 5 deg and minus 7 deg resets, respectively. The stage efficiency was 0.88 for the minus 5 deg reset and 0.85 for the minus 7 deg reset. Author

N73-27704*# Pratt and Whitney Aircraft, East Hartford, Conn.
STUDY OF UNCONVENTIONAL PROPULSION SYSTEM CONCEPTS FOR USE IN A LONG RANGE TRANSPORT
George A. Champagne Aug. 1973 104 p ref
(Contract NAS3-15550)
(NASA-CR-121242; PWA-4692) Avail: NTIS HC $7.25 CSCL 21E

The noise level of an uncoventional propulsion system for the next generation of subsonic, long-range transport aircraft is discussed. The desired noise level may be achieved by: (1) a fixed geometry, high bypass ratio turbofan with a geared two-stage fan and advanced acoustic treatment or (2) a moderate bypass ratio turbofan with a variable pitch two-stage fan, variable primary and duct nozzles, and advanced acoustic treatment. The geared fan system meets the noise goal with minimum economic penalty. Comparison of the noise levels at takeoff and landing in combination with the economic penalties required to achieve the lower noise levels at specific noise measuring stations, indicate that both area reduction and current certification procedures should be used to ascertain the point of diminishing returns in establishing future noise goals. Author

N73-27707*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
EXPERIMENTAL QUIET ENGINE PROGRAM. PREDICTED ENGINE PERFORMANCE
Feb. 1973 148 p Revised
(Contract NAS3-12430)
(NASA-CR-121258) Avail: NTIS HC $9.50 CSCL 21E

Three turbofan configurations, each incorporating alternative noise reduction features, were tested under the Quiet Engine Program. Performance data for these engines are shown over a range of flight conditions. The data are presented in tabular form for standard day flight inlet conditions. Procedures for estimating nonstandard day performance are shown. Tabular data and calculation procedures to allow determination of ram recovery, customer bleed, and customer shaft power extraction effects on engine performance can be found in the original Performance Brochure titled, Experimental Quiet Engine Program, Predicted Engine Performance, dated April 8, 1970. Predicted engine noise levels for representative take-off and approach conditions are provided. Author

N73-27709*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DYNAMIC RESPONSE OF MACH 2.5 AXISYMMETRIC INLET WITH 40 PERCENT SUPERSONIC INTERNAL AREA CONTRACTION
Robert J. Baumbick, Robert E. Wallhagen, George H. Neiner, and Peter G. Batterton Washington Jul. 1973 20 p refs
(NASA-TM-X-2833; E-7426) Avail: NTIS HC $3.00 CSCL 21E

Results of experimental tests conducted on a supersonic, mixed compression, axisymmetric inlet are presented. The inlet is designed for operation at Mach 2.5 with a turbofan engine (TF-30). The inlet was terminated with either a choked-orifice plate or a long pipe with variable area choked exit plug. Frequency responses were obtained for selected static pressures in the diffuser. These pressures were selected as potential control signals for terminal shock control. Frequency responses were obtained for the Mach 2 and 2.5 conditions for different terminations. Responses also were obtained with and without cowl bleed. Internal disturbances were produced by sinusoidally varying the inlet overboard bypass doors at frequencies out to 100 hertz. Author

N73-27711# Cincinnati Univ., Ohio. Dept. of Aerospace Engineering.
AN EXPERIMENTAL STUDY OF THE EROSION REBOUND CHARACTERISTICS OF HIGH SPEED PARTICLES IMPACTING A STATIONARY SPECIMEN
G. Grant, R. Ball, and W. Tabakoff May 1973 46 p refs
(Grant DA-ARO(D)-31-124-71-G154)
(AD-760578; Rept-73-36; AROD-10223.4-E) Avail: NTIS CSCL 21/5

The impact and rebound characteristics of high speed solid particles have been experimentally determined. This study was limited to a system where the particle material is much harder than the target material and thus erosion takes place at impact. The impact parameters were found to be statistical in nature and thus the statistical distributions were obtained. The effect of the particle velocity and impact angle was also investigated. In additon, the rebound data was related to the erosion damage. Author (GRA)

N73-27712# ARO, Inc., Arnold Air Force Station, Tenn.
ANALYSIS AND COMPUTER PROGRAM FOR EVALUATION OF AIRBREATHING PROPULSION EXHAUST NOZZLE PERFORMANCE Final Report, Jun. 1970 - Nov. 1972
S. Wehofer and W. C. Moger AEDC May 1973 306 p refs
(AD-760541; ARO-ETF-TR-72-190) Avail: NTIS CSCL 21/5

An analytical technique based on the time-dependent flow equations has been developed to predict the inviscid transonic flow field in axisymmetric propulsion nozzles. The analysis includes the treatment of axisymmetric nonuniform nozzle inlet profiles of total pressure, total temperature, specific heat, and molecular weight. The analysis is also capable of considering convergent-divergent, convergent, and shrouded or unshrouded plug nozzle geometries. A computer listing and three sample calculations are presented to illustrate some of the capabilities of the program. Author (GRA)

N73-27714# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TESTING JET ENGINES (SELECTED ARTICLES)
L. S. Skulbachevskii 23 Apr. 1973 124 p Transl. into ENGLISH from the publ. "Ispytaniya Vozdushno-Reaktivnykh Dvigateley" Moscow, 1972 75 p
(AD-760963; FTD-MT-24-96-73) Avail: NTIS CSCL 21/5

The report is a compilation of articles that briefly describe the salient test parameters of jet engines and test methods used in the Soviet Union. GRA

N73-27722# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.
EFFECT OF STRATOSPHERIC OZONE DEPLETION ON THE SOLAR ULTRAVIOLET RADIATION INCIDENT ON THE SURFACE OF THE EARTH
Pythagoras Cutchis Mar. 1973 47 p refs
(Contract DAHC15-73-C-0200)
(AD-761179; P-922; IDA/HQ-72-14697) Avail: NTIS CSCL 06/18

Recent theoretical work indicates that the oxides of nitrogen that would be injected into the stratosphere by a fleet of supersonic transport aircraft could result in a significant depletion of natural stratospheric ozone. Since the stratospheric ozone layer shields the biosphere from harmful ultraviolet (UV) radiation, there is concern about the biological effects of the increase in UV radiation that would attend a reduction in the present amount of natural ozone. The paper estimates the factor by which UV radiation would be increased as a function of percentage ozone depletion and wavelength. To illustrate a potentially significant biological effect of increased UV radiation, the attendant increase in erythemal (sunburn-producing) UV radiation dosage is calculated for several conditions of ozone depletion, radiation wavelength, and solar zenith angle. Author (GRA)

N73-27789# Army Engineer Waterways Experiment Station, Vicksburg, Miss.

STRENGTHENING OF KEYED LONGITUDINAL CONSTRUCTION JOINTS IN RIGID PAVEMENTS Technical Report, Jan. 1971 - Jul. 1972
R. W. Grau Mar. 1973 129 p refs Sponsored in part by FAA
(Contract F30602-70-X-0010; AF Proj. 683M)
(AD-759570; AFWL-TR-72-174) Avail: NTIS CSCL 13/2

The rigid pavement test section was constructed of portland cement concrete (PCC) and trafficked with a 360-kip 12-wheel assembly and a 166-kip twin-tandem assembly to evaluate the performance of keyed and doweled longitudinal construction joints in rigid airfield pavements under multiple-wheel heavy gear loadings (MWHGL) and to investigate the feasibility of strengthening existing keyed longitudinal construction joints. (Author Modified Abstract) GRA

N73-27798*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPARISON OF TEMPERATURE DATA FROM AN ENGINE INVESTIGATION FOR FILM-COOLED AND NON-FILM-COOLED, PANWISE-FINNED VANES INCORPORATING IMPINGEMENT COOLING
Daniel J. Gauntner Washington Jul. 1973 28 p refs
(NASA-TM-X-2819; E-7386) Avail: NTIS HC $3.00 CSCL 20M

The experimental temperature characteristics of two spanwise-finned, impingement-cooled vanes, one with film cooling and one without film cooling, were investigated in a modified J-75 research turbojet engine. Values of maximum temperature, average temperature, and maximum chordwise temperature difference were compared for the two vanes at the midspan. An analytical redesign of the two vane configurations indicated that the maximum and average temperatures and the maximum chordwise temperature difference could be significantly lowered. The experimental tests indicated that suction-surface film cooling may cause increased heat transfer near the trailing edge of the vane. Author

N73-27804*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TURBOJET EMISSIONS, HYDROGEN VERSUS JP
Jack Grobman, Carl Norgren, and David Anderson 1973 22 p refs Presented at Working Symp. on Liquid-HydrogenFueled Aircraft, Langley, Va., 15-16 May 1973
(NASA-TM-X-68258; E-7539) Avail: NTIS HC $3.25 CSCL 21B

Preliminary data from an experimental combustor show that the NOx emission index, g(NO2)/Kg fuel, is about three times greater for hydrogen than for JP at simulated cruise conditions. However, if these results are applied to aircraft designed for a given mission, hydrogen's higher heating value enables the aircraft to have a lower gross weight and a lower fuel flow rate so that the NOx emission rate, Kg (NO2)/hr may be reduced about 30 percent compared to JP. Theoretical kinetics calculations indicate that combustors may be designed for hydrogen that could further decrease NOx emissions by taking advantage of hydrogen's wide flammable limits and high burning velocity. Author

N73-27807*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
HANDBOOK OF INFRARED RADIATION FROM COMBUSTION GASES
C. B. Ludwig, W. Malkmus, J. E. Reardon, J. A. L. Thomson, and R. Goulard, ed. 1973 497 p refs
(NASA-SP-3080) Avail: NTIS HC $6.00 CSCL 20M

The treatment of radiant emission and absorption by combustion gases are discussed. Typical applications include: (1) rocket combustion chambers and exhausts, (2) turbojet engines and exhausts, and (3) industrial furnaces. Some mention is made of radiant heat transfer problems in planetary atmospheres, in stellar atmospheres, and in reentry plasmas. Particular consideration is given to the temperature range from 500K to 3000K and the pressure range from 0.001 atmosphere to 30 atmospheres. Strong emphasis is given to the combustion products of hydrocarbon fuels with oxygen, specifically to carbon dioxide, water vapor, and carbon monoxide. In addition, species such as HF, HCl, CN, OH, and NO are treated. Author

N73-27835* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MULTISPECTRAL IMAGE DISSECTOR CAMERA FLIGHT TEST c14
Bernard L. Johnson *In its* Significant Accomplishments in Technol., 1972 1973 p 74-76
CSCL 14E

It was demonstrated that the multispectral image dissector camera is able to provide composite pictures of the earth surface from high altitude overflights. An electronic deflection feature was used to inject the gyro error signal into the camera for correction of aircraft motion. G.G.

N73-27869# Battelle Columbus Labs., Ohio.
A PROGRAM DEFINITION STUDY FOR THE IMPROVEMENT OF SHORT-HAUL AIR TRANSPORTATION. VOLUME 2: WORKING PAPERS Final Report
Jan. 1973 527 p refs
(Contract DOT-FA72WA-2820)
(FAA-QS-73-1-Vol-2) Avail: NTIS HC $28.50

A program definition study for the improvement of short haul air transportation is presented. The subjects discussed are: (1) patterns of future short haul demand, (2) airport development requirements, (3) private sector constraints, and (4) local community constraints. The study was performed to provide a background for the formulation of a program plan and to define and extend the understanding of the short haul air transportation development plan. For Volume 1 see ATS 08502. Author

N73-27877# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
INVESTMENT STRATEGIES FOR DEVELOPING AREAS: MODELS OF TRANSPORT
Richard De Neufville, John Hoffmeister, and David Shpilberg Jan. 1973 93 p refs
(Contract DOT-OS-00096)
(PB-219292/0; DOT-P-5200.7) Avail: NTIS HC $3.00 CSCL 13B

The basic objective of the present study is to support Department of Transportation activities in advising developing countries on transport infrastructure improvements. Models of air, river and highway transportation are developed for use in the comparison of alternative investment strategies in transportation for developing areas. The work performed under this contract was executed simultaneously with a parallel contract DOT-OS-00080). The results, however, are presented here. For a full exposition, both reports would be considered jointly. (Author Modified Abstract) GRA

N73-27879# George Washington Univ., Washington, D.C. School of Engineering and Applied Science.
DULLES AIRPORT RAPID TRANSIT STUDY
B. A. Claveloux 1973 271 p refs
(Grant NSF GZ-2605)
(PB-220074/9; ME-251-252-B) Avail: NTIS HC $3.00 CSCL 13B

Various aspects are examined of the feasibility of a high-speed transit service between downtown Washington, D.C. and Dulles Airport. The route selected is one that utilizes, for the most part, existing rights of way, and the calculated velocity schedule provides a 10-minute total travel time. (Author Modified Abstract) GRA

N73-27880# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.

ROLE OF AIR TRANSPORTATION IN SPARSELY DEVELOPED AREAS

Richard DeNeufville, Ulpiano Ayala, Jorge Acevedo, and Luis Mira Jan. 1973 174 p refs

(Contract DOT-OS-00080)

(PB-219293/8; R72-49; DOT-P-6000.1) Avail: NTIS HC $3.00 CSCL 01B

The basic objective of the study, was to support Department of Transportation activities in advising developing countries on transport infrastructure improvements. A theoretical base for evaluating the effect of transport investments in a developing area is presented. A model is developed to estimate the optimal modes of transportation for areas with differing levels of traffic. The model shows that under certain circumstances air transportation has significant cost and service advantages over alternative modes. This guideline is substantited by an extensive case study of the experience of SATENA, a government-operated airline in Colombia. (Author Modified Abstract) GRA

N73-27881# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

ARCTIC ENVIRONMENTAL CONSIDERATIONS

28 Jun. 1972 47 p refs

(AD-761105; TOP-1-1-001) Avail: NTIS CSCL 15/5

The report is intended to assist TECOM agencies and item developers evaluating potential or actual test items by providing basic information on the effects of cold. The information provided is limited to the most common types of material and materiel. GRA

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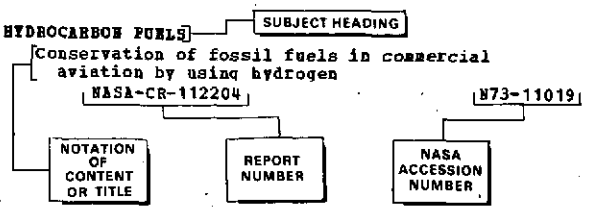

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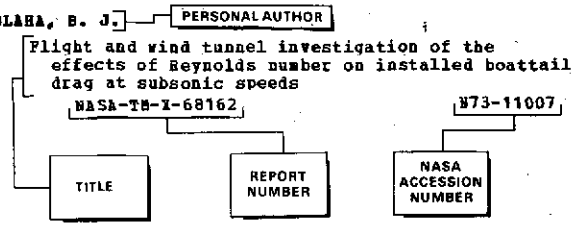

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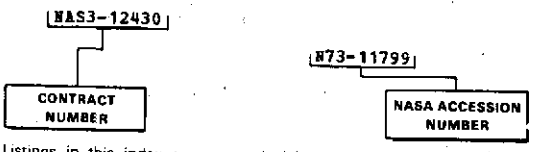

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