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AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 114

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 1979 in

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

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 Continuing Bibliography* (NASA SP-7037) lists 394 reports, journal articles, and other documents originally announced in September 1979 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* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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

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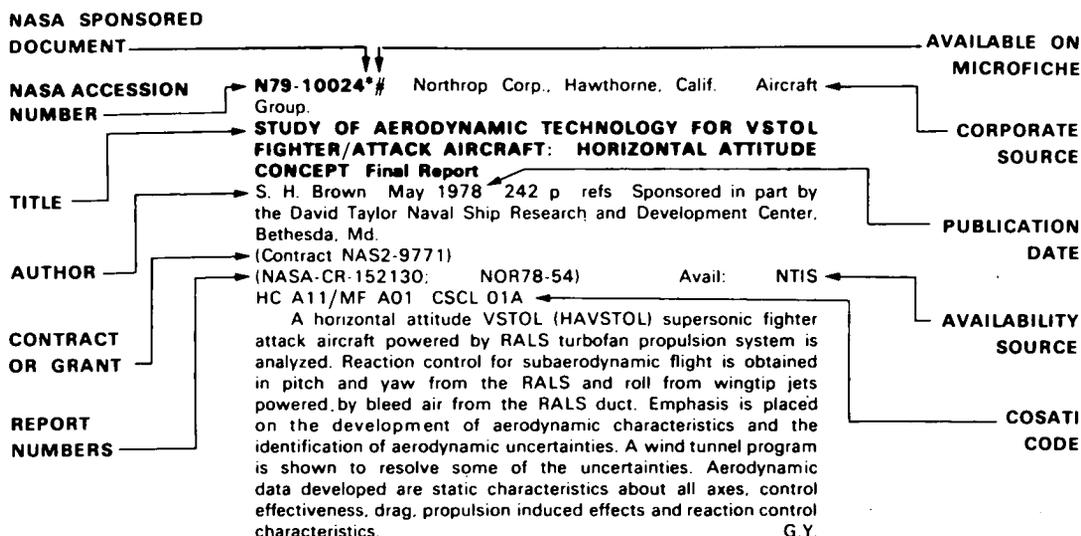
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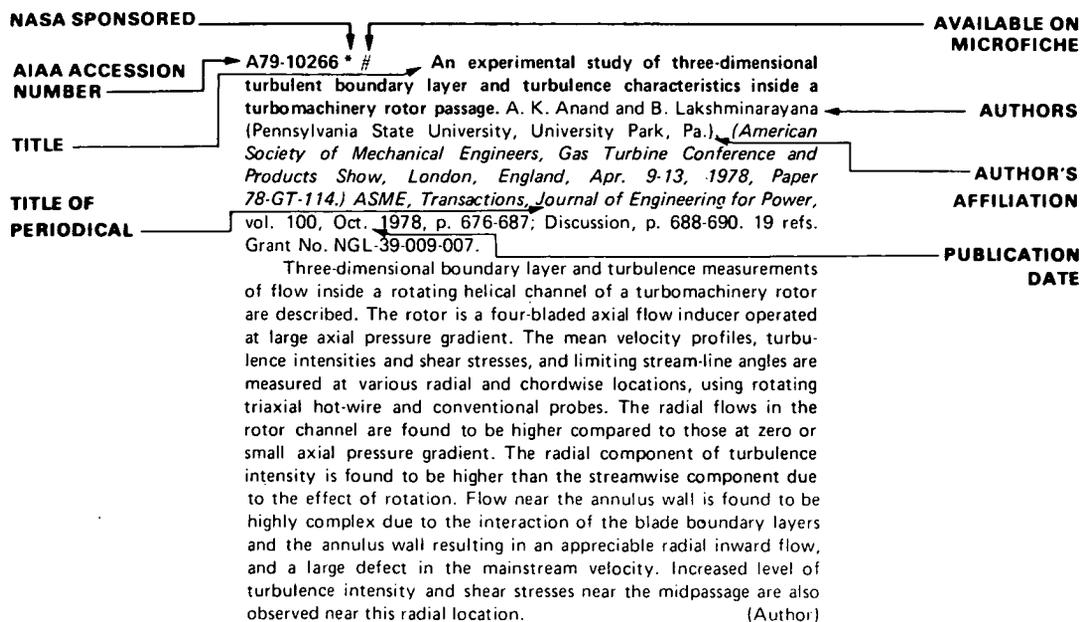
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TYPICAL CITATION AND ABSTRACT FROM IAA



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 114)

OCTOBER 1979

IAA ENTRIES

A79-40139 Airport engineering. N. Ashford (Loughborough University of Technology, Loughborough, Leics., England) and P. H. Wright (Georgia Institute of Technology, Atlanta, Ga.). New York, Wiley-Interscience, 1979. 458 p. 203 refs. \$24.95.

Fundamental aspects of airport engineering are presented. The various international, national and local organizations associated with air transportation are discussed, together with the means by which airports are financed. Principles of airport master planning and systems planning are examined, including airport capacity and configuration and aspects of airport layout and design such as geometric design, airport drainage, pavement design, and passenger terminal lay-outs. Chapters on forecasting air traffic demand, air cargo facilities, airport access, requirements of V/STOL aircraft, and environmental effects of airports are provided. C.K.D.

A79-40155 Flight control. II - Control system design (Flugregelung. II - Entwurf von Regelsystemen). R. Brockhaus (Braunschweig, Technische Universität, Braunschweig, West Germany). Munich, R. Oldenbourg Verlag GmbH, 1979. 332 p. 101 refs. In German. \$25.12.

General principles of flight control are reviewed and attention is given to the development of flight measurement methods and instrumentation. Particular consideration is given to the design of fully or partly automatic flight control systems; the structure and design of integrated flight control systems are examined. B.J.

A79-40172 New air service and deregulation - A study in transition. M. S. Cohen (Civil Aeronautics Board, Washington, D.C.). (Annual Air Law Symposium, 13th, Dallas, Tex., Mar. 22, 1979.) *Journal of Air Law and Commerce*, vol. 44, no. 4, 1979, p. 695-703.

An overview of the changes in service patterns since the airline deregulation and the implications of these changes for small and medium sized communities are discussed. Types of air carriers and their control by CAB is described, noting that the Airline Deregulation Act of 1978 enabled all airlines to place equipment in the markets that have the greatest demand consistent with the most efficient operation of their system, produced profitable expansion, and reduced fares. Although some cutbacks in service occurred, currently 98% of the traveling public have the same or more service available than one year ago. Determining the essential level of air service for 500 communities by October 1979, protecting the public from carriers exercising monopoly power, and abolishing anti-competitive agreements are some of the current CAB problems. A.T.

A79-40200 # Simplified calculation method for subsonic airloads on wing-body combinations. S. Chu and P.-J. Lu (National Taiwan University, Taipei, Nationalist China). *National Science Council, Proceedings*, vol. 3, Apr. 1, 1979, p. 212-221. 19 refs. National Science Council of Nationalist China Contract No. 66E-0401-02(01).

A simplified method for the calculation of airloads on combinations of planar and/or non-planar wings and a slender body in steady or unsteady subsonic flow is presented. In this method, the linearized

boundary-value problem is transformed to an integral equation and it is then solved numerically through the finite-element approach. With wings represented by oscillatory doublets, major emphasis of the method is placed on the formulation of an improved body scheme with internal source/sink/doublet distributions and wing image systems. By taking full advantage of symmetric/antisymmetric characteristics of the vehicle configuration and loading conditions, the calculation scheme is significantly simplified. The solution enables the evaluation of net airload distributions on the body and wings; and of static and dynamic aerodynamic coefficients. Application of the method is demonstrated through examples of wing-body combinations with the planar wing and wrap-around wings. Calculated results have been compared with experimental measurements. The agreement is excellent. (Author)

A79-40313 # Canadair Challenger. R. D. Neal and E. Aubrey (Canadair, Ltd., St. Laurent, Quebec, Canada). *Aircraft Engineering*, vol. 51, June 1979, p. 7-13.

A new Canadian, high speed, wide body business jet, the Challenger, is discussed. Powered by two high by-pass ratio (5:1) turbofan engines of 7500 lb take-off thrust, the aircraft features advanced aerodynamics allowing for low fuel consumption and high performance. The powerplant system, designed with overall aircraft serviceability in mind, features a quick release 1-piece engine nacelle. Attention is given to the APU, the air driven emergency generator, fuel system, electrical system, and hydraulic system. Flight controls comply with FAR 25.671 and have features such as appropriate redundancy in the control signal mechanical and electrical circuits, disposition of control surface actuators among the various multiple power sources (hydraulic and electric), and location of the various system components outside of the rotor burst zone. Also discussed are the oxygen system, landing gear, structural design including empennage bird impact testing. In addition, Canadian DOT Type Approval includes compliance with parts of FAR 25, FAR 36, and FAA Special Conditions. M.E.P.

A79-40314 # New techniques in jet engine balancing. W.-D. Reutlinger and H. Boxberger (Dr. Reutlinger und Söhne, Darmstadt, West Germany). *Aircraft Engineering*, vol. 51, June 1979, p. 14-17.

A method, which uses specially adapted force measuring balancing machines for jet engine balancing is discussed. Consideration is given to special demands that jet engine parts make on balancing machines, such as the need for minimum spinning time to reduce the risk of scoring the journal surface. The system uses a motionless force measuring support system, which eliminates the need for nulling or calibration runs and a formula utilized by the computer-based system to reduce the measured forces to a function of two parameters is given. With these preliminary runs eliminated, total spinning time - including starting and stopping the piece - is 20-30 sec, whereas a displacement measuring machine needs about ten times as long for the same operation. Since motion free measuring does not require frames to connect vibration bridges, an additional source of balancing error is eliminated. M.E.P.

A79-40315 # Display monitoring problems. R. A. Chorley (Smith's Industries, Ltd., Aviation Div., London, England). *Aircraft Engineering*, vol. 51, June 1979, p. 20-23.

Consideration is given to methods of making the aircraft pilot's monitoring tasks easier. The problem of lowering system malfunction

probability which results in greater system complexity is discussed. Eventually complexity reaches a point where the pilot can no longer cope with the monitoring tasks, which again increases the malfunction probability. Simple monitoring aids such as warning flags to draw attention to a fact that may not have been observed by direct monitoring are covered. Also covered are more advanced monitoring aids including electronic checks on altimeters and Mach/airspeed indicators, which measure the servo motor voltage signaling when this does not remain zero, indicating an error. Attention is also given to CRT displays which will allow monitoring of more data with less complexity. Since this allows the pilot to suppress information not of current interest, a capability to monitor this data and signal potential hazards must be incorporated. M.E.P.

A79-40326 # Preparing for the TKF 90. G. Kannamüller. *Dornier-Post* (English Edition), no. 3, 1979, p. 8-10.

The German Air Force plans to adopt a new tactical combat aircraft (TKF 90) in the early nineties is discussed, noting preliminary concept related studies and basic layout. Design philosophy developed from military mission resulting from threat, technical feasibilities and available resources, is presented. Technological features of the basic design include CCV to improve L/D ratio also during maneuvers, carbon fiber composite materials to reduce structural weight, and multipurpose displays. Attention is also given to trade off studies including thrust/mass ratio, options such as night visibility through FLIR, and alternatives such as different engines, wing configurations, etc. Carbon fiber structures being tested on an Alpha Jet flying test bed are airbrake, rudder, horizontal tail surface and wing. It is concluded that German work in this field will improve their negotiating position in their efforts to arrive at a European cooperative program. M.E.P.

A79-40327 # First flight imminent for new technology wing. W. Haberland. *Dornier-Post* (English Edition), no. 3, 1979, p. 20-25.

The new technology wing program is intended to develop a wing for twin-engine general aviation aircraft that will result in: a substantial reduction in drag, particularly in the design-critical situation of an engine failure during a climb; a substantial increase in the maximum lift coefficient for an acceptably complex flap system; a reduction in manufacturing costs and in wing weight due to a new integral construction. A Dornier Skyservant has been modified for use as a flying test bed for the new wing which also utilizes single-slotted Fowler flaps. The program phases and details of the design studies embraced, are detailed. Attention is given to the test aircraft wing construction which is of a cantilever design with a rectangular trapezoidal planform. Also surveyed are fuselage, tail unit, landing gear, power plant fuel system, etc. Results of the testing will be available by mid 1980. M.E.P.

A79-40476 # Analytical modeling of ramjet combustor heat transfer modes. P. F. Melia (United Technologies Corp., Chemical Systems Div., Sunnyvale, Calif.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1124*, 7 p. 8 refs. Contract No. F33615-74-C-2059.

An analytical model of charring heat transfer in an ablatively lined ramjet combustor correlated well with firings using either virgin linings or fully charred linings. Pyrolysis gas reactions were shown to be a significant heat transfer mechanism in certain regions. The model showed the existence of two qualitatively different heat transfer zones with similar total heat fluxes. An aft zone existed, characterized by a heat flux that was reactive and convective for actively charring linings. Linings in this zone, when fully charred, experienced only the convective flux. A forward recirculation zone also existed, in which the heat transfer was convective and radiative in nature. In this zone, total flux was comparable to the total flux experienced in the aft zone for actively charring linings. However, this forward flux remained essentially the same for either charring of fully charred linings. (Author)

A79-40480 * # Evaluation of turbo-propulsion simulators as a testing technique for fighter aircraft. R. O. Bailey, M. Harper (NASA, Ames Research Center, Moffett Field, Calif.), and T. Jannetta (NASA, Ames Research Center, Moffett Field, Calif; McDonnell Aircraft Co., St. Louis, Mo.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1149*, 17 p. 13 refs.

Ames Research Center has under way a program to develop the technology for using turbine-powered jet engine simulators as a test technique for simulating installed jet engine characteristics in small-scale wind-tunnel models of complete VSTOL fighter configurations. The program consists of three key elements: (1) static testing SN003 prototype turbine engine simulator (MAPS), (2) the development of the Propulsion Simulator Calibration Laboratory at Ames, and (3) the design, fabrication, and testing of a twin-engine 'closely coupled' VSTOL fighter wind-tunnel model. The model will use the Compact Multi-mission Propulsion Simulator (CMAPS) and will also be tested in flow-through and jet-effects modes to assess the effect of simultaneous inlet and nozzle flow simulation. This paper includes a description of the planned effort and anticipated future tasks. (Author)

A79-40481 # Effects of Reynolds number and other parameters on the throttle-dependent, nozzle/afterbody drag of an 0.11 scale single-engine aircraft model. R. J. Glidewell (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), H. L. Stevens (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.), and W. M. Presz (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1167*, 11 p. 12 refs.

A series of wind tunnel, nozzle/afterbody tests was carried out on a 0.11 scale F-16 model. Results are presented for three basic support systems (the small sting support, large sting support and wing tip support) tested at Mach numbers of 0.6, 0.9 and 1.2. Sufficient data were obtained to define the effects of the support system, Reynolds number, angle-of-attack and horizontal tail incidence on variations in the throttle-dependent drag characteristics of the nozzle/afterbody. The drag and pressure measurements were compared with results obtained with state-of-the-art flow prediction procedures, including three-dimensional paneling procedures applied to the exact F-16 wind tunnel model with and without support systems, and two axisymmetric flow calculations (a potential flow calculation and a finite difference transonic procedure) applied to the F-16 equivalent bodies of revolution. Predicted drag trends were found to provide the minimum support system interference. C.K.D.

A79-40483 * # Causes of high pressure compressor deterioration in service. J. H. Richardson, G. P. Sallee, and F. K. Smakula (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1234*, 8 p. Contract No. NAS3-20632.

The high mechanical reliability and low deterioration rate of the JT9D high-pressure compressor results in long utilization without exceeding engine operational limits. The increasing cost and decreasing supply of fuel have focused attention on the fuel burned implications of such high time use without refurbishment. The paper presents the results of JT9D high pressure compressor studies. The mechanical deterioration of the JT9D high-pressure compressor gaspath parts versus increasing service usage, documented from inspection of service parts, is presented and discussed including changes in airfoil roughness, blade length, airfoil contour and outer air seal trench characteristics. An estimate of the performance loss versus usage is related to each type of damage. The combined estimated high-pressure compressor performance loss for all mechanisms determined from part inspection is compared to historical engine test data to establish the validity of the predicted loss levels. The effect of cold section refurbishment on engine fuel consumption recovery and the results of an optimization study to determine the

appropriate interval for high pressure compressor refurbishment are also reported. (Author)

A79-40486 # Parts tracking and engine history recording for on-condition maintenance. G. I. Walker and R. M. Donovan (General Electric Co., Aircraft Engine Business Group, Lynn, Mass.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1280*. 12 p. USAF-supported research.

The Parts Life Tracking System (PLTS) used to manage on-condition maintenance of the TF34-100 engine in USAF/A10 aircraft is described. The PLTS includes a parts-tracking system (PTS) and an engine time-temperature recorder (ETTR) system. The central data base includes a parts master file encompassing all designated parts entered into the system either as spares or as part of an engine, and an engine master file section containing a record of the engine data and data for all designated parts in that engine. The PLTS requires data from the mechanic responsible for changing parts (engine serial number, part serial number, location of part and date) and periodic reading and recording of information taken from the signal to the aircraft cockpit Inter-Turbine Temperature and stored in the ETTR system. The ETTR parameters used in logistic analysis include events at 550 C, events at 790 C, events at 810 C, time at or above 790 C, time at or above 810 C, and engine operating hours. The PLTS provides repair facilities with an accurate listing of the estimated life remaining on all designated parts in the engine and also of the spare parts available for installation. C.K.D.

A79-40487 # V/STOL performance comparisons with variable pitch and variable inlet guide vane fans - A report on experimental data. H. Healy (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1286*. 13 p.

Two twenty inch fan models tested in a compressor test rig were designed with the pressure ratio and flow rate for the V/STOL Type A aircraft. Fan maps showing pressure ratios, stall lines, and efficiencies as functions of speed, flow rate, and variable geometry angles are drawn, and when related to a V/STOL operation including take-off and approach to landing with control showed that variable pitch fan did a better job of covering the required thrust range than the variable inlet guide vane fan. Blade element data including loading, loss, Mach number, and incidence were compared, and the fans were tested with a clean inlet, and radial and circumferential inlet distortion screens. The variable pitch fan efficiency was up to 3.5% higher than that for the variable inlet guide vane fan, and the only area where the latter was better than the variable pitch fan was in stall margin at high thrust. A.T.

A79-40488 * # A summary of NASA/Air Force Full Scale Engine Research programs using the F100 engine. W. J. Deskin (United Technologies Corp., Government Products Div., West Palm Beach, Fla.) and H. G. Hurrell (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1308*. 14 p. 20 refs.

This paper summarizes a joint NASA/Air Force Full Scale Engine Research (FSER) program conducted with the F100 engine during the period 1974 through 1979. The program mechanism is described and the F100 test vehicles utilized are illustrated. Technology items which have been addressed in the areas of swirl augmentation, flutter phenomenon, advanced electronic control logic theory, strain gage technology, and distortion sensitivity are identified and the associated test programs conducted at the NASA-Lewis Research Center are described. Results presented show that the FSER approach, which utilizes existing state-of-the-art engine hardware to evaluate advanced technology concepts and problem areas, can contribute a significant data base for future system applications. Aerodynamic phenomenon previously not considered by current design systems have been identified and incorporated into current industry design tools. (Author)

A79-40647 # The distribution pattern of Omega observations. E. R. Swanson (U.S. Naval Ocean Systems Center, San Diego, Calif.). *Journal of Navigation*, vol. 32, May 1979, p. 276-278. 6 refs.

The distribution pattern of errors in observations of the Omega navigation system is discussed. Large deviations of Omega observations from nominal are almost entirely due to the perturbation of the ionosphere by sudden ionospheric disturbances and polar cap absorptions, which are associated with solar activity cycles. It is pointed out that the data used by Hiraiwa (1978) to compile the basic distribution of Omega errors were obtained near a solar minimum, possibly making safety estimates based on his findings overly optimistic. The distribution of Omega measurements over a propagation path is also known to exhibit both positive kurtosis and negative skewness, however the skewness can be eliminated by pairing propagation paths to obtain lines of position. A.L.W.

A79-40664 * Simulation of distributed microprocessor-based flight control systems. P. S. Lee and H. F. VanLandingham (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: *International Symposium on Simulation Software and Numerical Methods for Differential Equations*, Blacksburg, Va., March 9-11, 1977. Amsterdam, North-Holland Publishing Co., 1978, p. 131-134. Grant No. NsG-1239.

The aim of the present paper is to demonstrate, within the framework of a digital flight control system, the method of simulating the information exchange between a microcomputer and a supervisory computer, and between microcomputers working on separate control tasks. A gradient technique is described that considers the trade-off between the objectives of the control system and the information exchange requirements. V.P.

A79-40676 Materials problems in gas turbine engine technology; Colloquium, Munich, West Germany, October 27, 28, 1977, Report (Werkstofftechnische Probleme bei Gasturbinentriebwerken; Kolloquium, Munich, West Germany, October 27, 28, 1977, Bericht). Colloquium sponsored by the Motoren- und Turbinen-Union München GmbH. Edited by W. Hansen and P. Esslinger (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). Karlsruhe, Werkstofftechnische Verlagsgesellschaft mbH, 1978. 262 p. In German.

In this examination of gas turbine materials, attention is given to materials technology research and development, service life determination (using turbine blades as an example), and considerations of failure analysis and quality assurance (using turbine disks as an example). Papers are presented on such topics as service life prediction for heat-resistant materials, high-integrity casting of turbine blades of high thermal stability and long service life, determination of safety factors, and materials quality assurance for turbine disks. B.J.

A79-40677 Advances in materials technology through the BMVg - Goals, problems and main points of interest (Förderung der Werkstofftechnik durch das BMVg - Ziele, Probleme, Schwerpunkte). W. Simmler (Bundesministerium der Verteidigung, Bonn, West Germany). In: *Materials problems in gas turbine engine technology; Colloquium, Munich, West Germany, October 27, 28, 1977, Report*. Karlsruhe, Werkstofftechnische Verlagsgesellschaft mbH, 1978, p. 9-19. In German.

Certain aspects of military-related materials technology in Germany are discussed with special reference to aviation materials. Particular consideration is given to research and development on processing techniques for engine materials. B.J.

A79-40680 Development of materials and processes for engine components - Current and future points of interest (Werkstoff- und Verfahrensentwicklung für Triebwerk-Bauteile Schwerpunkte heute und morgen). P. Esslinger (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). In:

Materials problems in gas turbine engine technology; Colloquium, Munich, West Germany, October 27, 28, 1977, Report.

Karlsruhe, Werkstofftechnische Verlagsgesellschaft mbH, 1978, p. 59-74. In German.

The goals of materials technology for gas turbine engines are outlined. These include elevated gas temperature, weight reduction, increased reliability, and cost reduction. The current status of gas turbine development is reviewed and attention is given to possible directions of realizing the future goals of gas-turbine R&D, namely higher temperature and lower weight. B.J.

A79-40684 Service life parameters of turbine blades (Lebensdauerbestimmende Parameter bei Turbinenschaufeln). W. Betz (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). In: Materials problems in gas turbine engine technology; Colloquium, Munich, West Germany, October 27, 28, 1977, Report. Karlsruhe, Werkstofftechnische Verlagsgesellschaft mbH, 1978, p. 127-134. In German.

Parameters characterizing the service life of turbine blades are defined in terms of blade load and strength characteristics. Several examples are considered including the effects of hot-gas corrosion on blade service life. B.J.

A79-40687 Methodological considerations on the service life design of turbine disks (Methodische Betrachtungen zur Lebensdauerdimensionierung von Triebwerkscheiben). K. H. Nasita (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). In: Materials problems in gas turbine engine technology; Colloquium, Munich, West Germany, October 27, 28, 1977, Report. Karlsruhe, Werkstofftechnische Verlagsgesellschaft mbH, 1978, p. 183-201. 20 refs. In German.

The paper considers the development of methods of low cycle fatigue testing of turbine blade specimens; emphasis is placed on the choice of crack conditions. The use of test specimens to simulate the actual turbine components is discussed in some detail and attention is given to analytical concepts of low cycle fatigue. B.J.

A79-40752 # Further test results with the airjet distortion generator - A new tool for aircraft turbine engine testing. M. W. McIlveen (ARO, Inc., Arnold Air Force Station, Tenn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1185*. 10 p. 6 refs.

An airjet distortion generator system has been developed to produce steady-state total pressure distortion at the inlet of turbine engines. The system employs a method of injecting controlled amounts of high-velocity secondary air counter to the primary airstream to produce a local total pressure decay. Digital computer control provides an on-demand distortion pattern capability. Results of the latest development effort of the ADG are discussed and compared to previous test results in terms of steady-state distortion pattern fidelity, time-variant flow-field characteristics, and engine stability assessment. (Author)

A79-40755 # Type A V/STOL propulsion system development. E. R. Glasgow and R. E. Skarshaug (Lockheed-California Co., Burbank, Calif.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1287*. 11 p. 6 refs.

Design and performance considerations associated with the development of a unique Type A V/STOL four-turbopropulsion system concept are described. This propulsion system uses fixed horizontal nacelles with thrust vectoring nozzles installed for achieving lift, a coaxial fan flow reaction control system for pitch control and trim, and an engine compressor bleed reaction control system for roll and yaw control and engine-out roll trim. Critical propulsion system sizing conditions are identified, and the sensitivity of aircraft takeoff gross weight to changes in control criteria requirements, engine cycle parameters, and engine rating schemes are

discussed. The use of wing tip ejectors, a cruise cross shaft, and water injection are also evaluated. In addition to having competitive performance characteristics, the propulsion system concept described herein has zero single point failures, low development cost and risk, and good reliability/maintainability. (Author)

A79-40758 # General Electric Company variable cycle engine technology demonstrator programs. R. D. Allan (General Electric Co., Aircraft Engine Group, Evendale, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1311*. 7 p.

The variable cycle engine (VCE) technology demonstration program aimed to improve mixed mission (supersonic/subsonic) propulsion systems installed performance is reviewed. The VCE is expected to reduce or eliminate the propulsion drag associated with the mixed mission aircraft and to contribute to reduction of the noise pollution problem. The single bypass and double bypass VCE concepts are discussed, and features which contribute to the performance and acoustic advantages of the double bypass VCE, aft variable area bypass injector, variable area low pressure turbine stator, split fan, forward variable area bypass injector, and co-annular acoustic plug exhaust nozzle are described. All of the VCE testing used YJ101 dual rotor, low bypass ratio turbojet hardware and it is providing demonstration of the feasibility of VCE features in a sea level static test program. A final step in the current test series scheduled for 1980 is the NASA Test Bed VCE which will duplicate the Supersonic Cruise Research study VCE configuration in YJ101 size except for the temperature levels in the engine hot section. A.T.

A79-40759 * # Progress on Variable Cycle Engines. J. S. Westmoreland, R. A. Howlett, and R. P. Lohmann (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1312*. 11 p. 9 refs. Contracts No. NAS3-20061; No. NAS3-20602; No. NAS3-20048.

Progress in the development and future requirements of the Variable Stream Control Engine (VSCE) are presented. The two most critical components of this advanced system for future supersonic transports, the high performance duct burner for thrust augmentation, and the low jet coannular nozzle were studied. Nozzle model tests substantiated the jet noise benefit associated with the unique velocity profile possible with a coannular nozzle system on a VSCE. Additional nozzle model performance tests have established high thrust efficiency levels only at takeoff and supersonic cruise for this nozzle system. An experimental program involving both isolated component and complete engine tests has been conducted for the high performance, low emissions duct burner with good results and large scale testing of these two components is being conducted using a F100 engine as the testbed for simulating the VSCE. Future work includes application of computer programs for supersonic flow fields to coannular nozzle geometries, further experimental testing with the duct burner segment rig, and the use of the Variable Cycle Engine (VCE) Testbed Program for evaluating the VSCE duct burner and coannular nozzle technologies. A.T.

A79-40760 * # Design and performance of the propulsion system for the quiet short-haul research aircraft /QSRA/. M. D. Shovlin (NASA, Ames Research Center, Moffett Field, Calif.), H. Skavdahl, and D. L. Harkonen (Boeing Commercial Airplane Co., Seattle, Wash.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1313*. 10 p. 6 refs.

This paper describes the design and performance of the Quiet Short-Haul Research Aircraft (QSRA) propulsion system. A discussion of the mixed-flow boundary layer control (BLC) system, which uses high and low pressure engine bleed air, is included. This system seriously affected propulsion system performance, particularly engine acceleration characteristics, requiring an integration of BLC system and powerplant controls. Funding limitations for the QSRA Project prevented extensive full-scale testing and systems mockups, resulting in a high reliance on small-scale tests and analytical

techniques. Ground tests of the actual aircraft systems showed that the extrapolation of small-scale tests and analytical techniques were in good agreement with measured full-scale results. (Author)

A79-40761 # Some recent developments in solid propellant gas generator technology. G. B. Pogue and E. J. Pacanowsky (Talley Industries of Arizona, Inc., Mesa, Ariz.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1327*. 6 p.

A gas generator propellant incorporating a proprietary 'phase-stabilized' modified ammonium nitrate (AN) which can be temperature-cycled indefinitely without the detrimental effects of grain growth has been demonstrated and released for use. A new low-cost moldable rubber/AN propellant with an exhaust gas cleanliness approaching N-28 has been developed for use in hot gas missile servo applications. A new castable AN propellant has been demonstrated with a burn rate approaching 0.025 inch/second at 1000 psi for use in long burn time gas generators within reasonable envelop constraints. A series of sodium azide based propellants which yield nontoxic nitrogen have been developed and utilized in applications such as the automobile air bag and aircraft emergency inflation systems. (Author)

A79-40764 # Contribution of the engine R & D community to reduced cost of ownership of Army helicopters. D. B. Cale (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1360*. 7 p. 8 refs.

The three basic categories of helicopter ownership cost and the contributions of the engine R&D community to cost reductions are examined. Development cost covers the aircraft engineering development through the fabrication and testing of prototypes and the government pays the cost directly. Acquisition cost includes production budgets, and operational costs are for fuel, lubricants, repair and maintenance parts, and personnel. The Army engine R&D programs aimed at improvements in component performance, reliability, and maintenance, new specification requirements, new manufacturing methods and technology, and design-to-unit production cost (DTUPC) efforts are discussed, with their impact on the T700 engine development. The experience acquired during the T700 program was applied to the Army 800 hp Advanced Technology Demonstrator Engine (ATDE) program to reduce its ownership cost, and it provided inputs in areas of technology level, instrumentation, hardware, testing, specifications, and reliability and maintainability. During the course of the ATDE evaluation, the Material Index Factor (MIF) method was used as a tool for estimating the production cost and it is concluded that the MIF method can be used to track the DTUPC effort during the development phase. A.T.

A79-40770 # Indirect measurement of turbulent skin friction. G. M. Elfstrom (National Aeronautical Establishment, High Speed Aerodynamics Laboratory, Ottawa, Canada). (*Hydrodynamics Colloquium, Bethesda, Md., Feb. 2, 1979.*) *Canada, National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment, Quarterly Bulletin*, no. 1, 1979, p. 21-51. 17 refs.

The indirect techniques reviewed in the present paper are based, respectively, on the use of the logarithmic portion of the velocity profile to estimate skin friction in turbulent boundary layers; the use of the analogy between local skin friction coefficient and heat transfer from heated strips imbedded in a surface; and surface flow visualization. Particular attention is given to devices which exploit the wall-similarity of the flow in a turbulent boundary layer. These devices include the razor blade technique, the sublayer fence device (which, like the razor blade senses the flow very close to the wall), the Preston tube - a device which senses part of the logarithmic portion of the velocity profile; and the obstacle block. The principles of obstacle block operation are outlined. V.P.

A79-41113 Multivariable control design principles applied to a variable cycle turbofan engine. R. L. De Hoff and S. M. Rock (Systems Control, Inc., Palo Alto, Calif.). In: *Annual Asilomar Conference on Circuits, Systems, and Computers, 12th, Pacific Grove, Calif., November 6-8, 1978, Conference Record*.

New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 122-131. 11 refs. Contract No. F33615-77-C-2096.

Described is a preliminary design of a controller for an advanced turbine engine concept, the variable cycle engine. This controller provides transient and steady-state regulation, fault detection and accommodation, and supervisory engine protection logic. It is designed for engine-mounted microprocessor implementation. Emphasis is on regulator design and trajectory generation. New techniques are described which have been developed to satisfy the requirements imposed by the variable cycle engine technology. The regulator is based on output feedback. It incorporates dc gain considerations and fixed structure gain matrices in its design. The trajectory generator mimics optimal trajectories for both large and small transients without the need for solving a two-point boundary value problem. (Author)

A79-41167 # Theoretical principles of long range navigation systems. I (Theoretische Grundlagen von Langstrecken- Navigationsanlagen. I). P. Korrell (Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Information der zivilen Luftfahrt*, vol. 14, no. 6, 1978, p. 306-322. In German.

The fundamentals of aircraft navigation systems are reviewed. Attention is given to inertia navigation systems, including compound navigation, noting its inaccuracies in the higher latitudes. Formulas relating to gyroscopic theory, such as those for moment of inertia and angular momentum, are studied and basics of inertial navigation, including forces exerted by acceleration, are analyzed. Platform stabilization, covering position, vertical, and turning gyroscopes, and including methods of orientation such as geographic, free, and azimuth, is surveyed. Attention is also given to the force vectors acting on gyroscopes, the effect of platform attitude on speed and position error, and the coriolis effect. Further consideration is given to acceleration signals and position finding, with the Soviet I-11 system highlighted. M.E.P.

A79-41168 # Problems of increasing the efficiency of Malev. II (Aufgaben zur Erhöhung der Effektivität der Malev. II). E. Vilmos (Magyar Legikozlekedesi Vallalat, Budapest, Hungary). *Technisch-ökonomische Information der zivilen Luftfahrt*, vol. 14, no. 6, 1978, p. 323-336. In German.

Further problems associated with increasing the productivity of Malev Air Tours are surveyed. Topics covered are: (1) making full use of aircraft capacity including seat load factors and useful load factors, (2) market considerations, (3) the degree of compliance between supply and demand (4) organization of the commercial service, and (5) airline image. Also studied are the economic effects of increased capacity utilization. Consideration is given to factors in the reduction of operating costs such as flight speed, which affects fuel consumption, crew salaries, and depreciation. Other possibilities for fuel savings are purchasing fuel where it is cheapest and selection of the proper flight profile, an area which will see more research during the present five-year plan. M.E.P.

A79-41174 * # Performance characteristics of a wedge nozzle installed on an F-18 propulsion wind tunnel model. J. E. Petit (Boeing Aerospace Co., Seattle, Wash.) and F. J. Capone (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1164*. 19 p. 11 refs.

The results of two-dimensional wedge non-axisymmetric nozzle (2D-AIN) tests to determine its performance relative to the baseline

axisymmetric nozzle using an F-18 jet effects wind tunnel model are presented. Configurations and test conditions simulated forward thrust-minus drag, thrust vectoring/induced lift, and thrust reversing flight conditions from Mach .6 to 1.20 and attack angles up to 10 degrees. Results of the model test program indicate that non-axisymmetric nozzles can be installed on a twin engine fighter aircraft model with equivalent thrust minus drag performance as the baseline axisymmetric nozzles. Thrust vectoring capability of the non-axisymmetric nozzles provided significant jet-induced lift on the nozzle/aftbody and horizontal tail surfaces. Thrust reversing panels deployed from the 2D-AIN centerbody wedge were very effective for static and inflight operation. A.T.

A79-41175 # CF6 jet engine performance deterioration. R. H. Wulf (General Electric Co., Cincinnati, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1233.* 7 p.

The results of performance deterioration studies of CF6 engines are presented. The program was aimed at identifying and quantifying engine hardware degradation, and it included in-depth reviews of hardware conditions to analyze detrimental sources, documented observed deterioration trends, and assigned performance degradation to specific part conditions. The Engine Diagnostics program was utilized to accumulate engine life cycle trends and fuel burn degradation data to construct performance and hardware deterioration models for each step in the engine life cycle. The program verified that performance deterioration is due to damaged clearances, airfoil quality and leakages. The effects of hardware conditions on performance data analyses and of shop practices on hardware conditions are discussed. The program was applied during the routine overhaul of three CF6-50 engines and demonstrated that fuel burn could be reduced by at least one percent. A.T.

A79-41176 Manoeuvre handling in a multiradar, a.t.c. system. H. W. Thomas (Manchester, Victoria University, Manchester, England). *Institution of Electrical Engineers, Proceedings*, vol. 126, June 1979, p. 469-475.

Results are presented for a study of maneuver detection in multiradar environments. A tracking scheme, essentially based on the Kalman filter but using a probability approach to detecting maneuvers, is proposed and described. An interesting result is the definition of an effective plant-noise term for the filter in terms of maneuver probabilities. Some comparisons are made between the proposed tracker and a more conventional approach to maneuver detection, and improvements are observed, particularly in difficult track situations. A further advantage is that the approach described is suitable for incorporating additional information (e.g. flight-plan data) into the tracking process. S.D.

A79-41207 CFM56 - Franco-American ten-tonne turbofan production launch. J. M. Ramsden. *Flight International*, vol. 115, June 9, 1979, p. 2025-2028, 2045.

A method for extending the longevity of the DC-8 aircraft, by using ten-ton turbofan engines, is presented. The redesigning of the DC-8 engines is expected to increase total flying hours by at least 50,000 or 13 years. United is the first airline to begin converting its present 31 DC-8-61 aircraft to the ten-ton turbofan CFM56 engine. The expected cost of \$3 billion, to refit the entire world fleet of 243 DC-8's, which would require 1,250 new engines, is weighed against noise levels and fuel consumption. FAA guidelines are discussed, and emphasis is given to their implementation over the next 6 years. A point is made that the upgraded DC-8 will be the quietest four-engined transport in service, not only meeting FAA regulations, but offering protection against more stringent future regulations. Data are presented about various cyclic endurance tests, which consist of takeoff, engine heating and cooling as well as bird impact tests. Special detail is given to the study of extensive engine abuse and its results. C.F.W.

A79-41209 Can Europe choose a common fighter. *Flight International*, vol. 115, June 9, 1979, p. 2075-2077.

A proposal by Great Britain, France and West Germany to collaborate on a new tactical combat aircraft for the 1990's, is discussed noting the difficult problem of the appointment of a design leader. Design necessities such as digital flight control, direct lift control, gust alleviations and radar systems are analyzed. In addition, various missile technologies and their capabilities are described. It is concluded, that if a common design cannot be developed, the RAF will import the U.S. F-18L and employ it as a future combat aircraft. C.F.W.

A79-41233 Military-technology-related flight testing in the framework of DFVLR/BWB cooperation - Status and perspectives (Wehrtechnische Flugerprobung im Rahmen des Kooperationsvertrags DFVLR/BWB - Bilanz und Perspektiven). P. Hamel, H. Galleithner, and R. Koehler (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *DFVLR-Nachrichten*, June 1979, p. 32-35. In German.

DFVLR/BWB flight test cooperation encompasses such tasks as (1) improvement and further development of test methodology, (2) development of standardized evaluation procedures, (3) development of appropriate software, (4) organization of flight-mechanics research flights, and (5) radar and telemetry developments. Planning and organization of the cooperative program are described and consideration is given to some particular examples of flight testing, including the testing of MRCA Tornado aircraft. B.J.

A79-41234 The DFVLR-F4 transonic wing as European test model (Transsonischer Tragflügel DFVLR-F4 als europäisches Testmodell). G. Redeker and N. Schmidt (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Entwurfs-Aerodynamik, Braunschweig, West Germany). *DFVLR-Nachrichten*, June 1979, p. 36-39. In German.

The 'Supercritical Wings' group of the Group for Aeronautical Research and Technology in Europe has selected the DFVLR-F4 transonic wing as a model to be tested in European wind tunnels. This paper outlines the technology of transonic wings and gives results on the aerodynamic design and analysis of the DFVLR-F4 wing; experimentally determined pressure distributions on the wing are compared with calculated ones. B.J.

A79-41237 Experimental studies of axial and radial compressors by means of new measurement techniques (Experimentelle Untersuchungen an Axial- und Radialverdichtern mit neuen Messtechniken). H. B. Weyer (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Antriebstechnik, Cologne, West Germany). *DFVLR-Nachrichten*, June 1979, p. 50-53. In German.

A two-focus laser procedure has been developed for measuring flow velocity in axial and radial compressors. Some sample results are presented on flow profiles in transonic axial compressors. The measurement of fluctuating pressures in turbocompressors is also considered. B.J.

A79-41238 Sound absorption through flow separation - A new possibility for acoustic attenuation of engines (Schallabsorption durch Strömungsablösung - Eine neue Möglichkeit zur Schalldämpfung von Triebwerken). D. Bechert, U. Michel, and E. Pfizenmaier (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für experimentelle Strömungsmechanik, Göttingen, West Germany). *DFVLR-Nachrichten*, June 1979, p. 54-56. In German.

Experimental studies of internal engine noise have shown that a separated-flow effect in the exhaust jet can lead to attenuation of low-frequency noise. This attenuation principle appears to hold generally for free jets separating from rigid walls. Experimental data on this type of attenuation are presented and compared with current theory. B.J.

A79-41304 # Application of a laminar lighting device to the smoke visualization of aerodynamic flows in wind tunnels (Application d'un dispositif d'éclairage laminaire à la visualisation des écoulements aérodynamiques en soufflerie par émission de fumée). M. Philbert, R. Beaupoil, and J.-P. Faleni (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aéronautique*, May-June 1979, p. 173-179. 22 refs. In French.

The paper deals with the application of a 1-W argon ion laser to the three-dimensional smoke visualization of wind tunnel flows. Photographs of turbulent flows past delta- and swept-wing models are presented and discussed. V.P.

A79-41407 The transonic integral equation method with curved shock waves. D. Nixon. *Acta Mechanica*, vol. 32, no. 1-3, 1979, p. 141-151.

Nixon (1975) calculated the pressure distribution about a parabolic arc airfoil using the extended integral equation method and compared the results to computations by the accurate 'conservative' finite difference method of Murman (1974). In this comparison the basic potential equation and the boundary conditions were identical in both methods, but in the integral equation method the simplifying assumption of a normal (to the freestream) shock wave was made; a further simplification was that the velocity ahead of and behind the airfoil could be neglected in the computation. The present study investigates the possibility of removing the two simplifying assumptions made by Nixon (1975), particularly the assumption of a normal shock wave. B.J.

A79-41414 Helical instabilities of slowly divergent jets. P. Plaschko (Berlin, Technische Universität, Berlin, West Germany). *Journal of Fluid Mechanics*, vol. 92, May 28, 1979, p. 209-215. 8 refs.

The inviscid spatial growth of spiral modes of circular, slowly diverging jets is analyzed. A multiple-scales expansion is used to develop a linear stability study for nonaxisymmetric disturbances of arbitrary helicity. The numerical evaluation is restricted to axisymmetric modes and to the first two helical modes. It is shown that in the case of comparatively high values of the Strouhal number the modes exhibit a very rapid growth and reach their maximal amplification after a short distance, the axisymmetric instabilities being excited more strongly than their spiral counterparts. Contrary to this, the modes grow comparatively slowly in the case of smaller values of the Strouhal number and exhibit their maximal amplification further downstream. In the latter case the first spiral mode is more unstable than the axisymmetric one. A comparison with experiments seems to support these results. (Author)

A79-41418 Autorotating flat-plate wings - The effect of the moment of inertia, geometry and Reynolds number. J. D. Iversen (Iowa State University of Science and Technology, Ames, Iowa). *Journal of Fluid Mechanics*, vol. 92, May 28, 1979, p. 327-348. 35 refs.

Free-flight and wind-tunnel measurements by previous investigators of the flat-plate autorotation phenomenon have been analyzed. The variation of the autorotation characteristics with changes in the Reynolds number and the aspect ratio, thickness ratio and moment of inertia of the flat plate have been correlated. The interpretation of the role of the Reynolds number made in a previous investigation is shown to be incorrect. The tip-speed ratio, for the ranges of the dimensionless parameters investigated, is shown to be a function of only the plate aspect ratio, thickness ratio, and also the moment of inertia if the latter is sufficiently small. The lift and drag coefficients, and therefore the free-flight glide angle, are shown to be functions of the tip-speed ratio, the aspect ratio and the Reynolds numbers based on the chord and plate thickness. (Author)

A79-41494 # Unsteady aerodynamic pressure measurements on rotating lifting systems. K. Kienappel (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aeroelastik, Göttingen, West Germany). (*Biennial Fluid Dynamics Symposium, 13th, Poland, Sept. 5-10, 1977.*) *Archivum Mechaniki Stosowanej*, vol. 31, no. 1, 1979, p. 107-114.

An experiment designed to measure the local pressure distribution of a ship propeller is described in which a pressure pipe and a pressure transducer near the propeller hub were used. The method of measurement involves an analog Fourier analysis system to measure the real and imaginary parts of the first six harmonic components of a periodic signal. Experimental results are reported which indicate that a periodic signal can be measured by measuring its harmonics. F.G.M.

A79-41567 Unsteady hypersonic gas flow past a thin finite-span wing. V. I. Bogatko, A. A. Grib, and G. A. Kolton (Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR). (*Akademiia Nauk SSSR, Doklady*, vol. 240, June 11, 1978, p. 1040, 1041.) *Soviet Physics - Doklady*, vol. 23, June 1978, p. 355. Translation.

The problem of the unsteady uniform hypersonic flow of an ideal gas past the windward side of a finite-span thin wing at constant angle of attack is examined. It is assumed that the shape of the wing surface depends on time. The thin-shock-layer method is used to find a solution. B.J.

A79-41568 On a property of the linearized boundary layer equations with self-induced pressure. V. I. Zhuk and O. S. Ryzhov (Akademiia Nauk SSSR, Vychislitel'nyi Tsentr, Moscow, USSR). (*Akademiia Nauk SSSR, Doklady*, vol. 240, June 11, 1978, p. 1042-1045.) *Soviet Physics - Doklady*, vol. 23, June 1978, p. 356-358. 15 refs. Translation.

Consideration is given to the theory of perturbations of a boundary layer with self-induced pressure on a heat-insulated flat plate for the case when the free-stream Mach number of the incoming flow is greater than unity. A system of asymptotic equations is presented for the viscous sublayer. It is found that the theory gives a good description of the slow propagation of small-scale perturbations. These disturbances are concentrated not inside the boundary layer, but at its base near the plate surface. B.J.

A79-41573 Nonlinear mathematical simulation of unsteady flow past a helicopter rotor. S. M. Belotserkovskii, V. A. Vasin, and B. E. Loktev. (*Akademiia Nauk SSSR, Doklady*, vol. 240, June 21, 1978, p. 1320-1323.) *Soviet Physics - Doklady*, vol. 23, June 1978, p. 393, 394. 6 refs. Translation.

The problem of modeling unsteady flow past a helicopter propeller is solved in a nonlinear framework. Each blade is simulated by an infinitely thin midsurface; it is assumed that attached and free vortices are located on each blade; and free vortices are shed from the blade as it moves. Only the aerodynamic part of the problem is considered; the problem of determining deformations and Mach motions of blades is neglected. Some digital simulation results are presented. B.J.

A79-41727 What makes a plane crash. L. Torrey. *New Scientist*, vol. 82, June 28, 1979, p. 1074-1077.

The procedures used in investigating the causes of the May 25, 1979 crash of an American Airlines DC-10 are discussed. The approach included analysis of the injuries received by the victims, reassembly of the engine pylon, analysis of data logs for the flight, electron scanning microscope studies of failed components, and simulation studies. Numerous examples of techniques used to determine the causes of other crashes are given. C.K.D.

A79-41751 # Rotor blade stability in turbulent flows. II. Y. Fujimori, Y. K. Lin (Illinois, University, Urbana, Ill.), and S. T. Ariaratnam. *AIAA Journal*, vol. 17, July 1979, p. 673-678. 8 refs. Grant No. DAAG29-78-G-0039.

This paper is directed towards the effects of turbulence in the atmosphere on rotor blade stability during a forward flight. Two types of motion are considered; uncoupled flapping, and coupled flapping and torsion. Assuming that the turbulence velocities which appear as parametric excitations can be approximated by white noise processes, the method of Markov processes is applied in the formulation of the problem. The results are presented as stability boundaries for the first- and second-order stochastic moments

corresponding to different spectral levels of the excitations. The stability boundaries for the nonturbulence case, previously obtained from deterministic analyses, are also included for comparison. It is shown that the uncoupled flapping motion remains quite stable under the turbulence intensities and operating conditions which may be reasonably expected in the service life of a helicopter, but the stability region for the coupled flapping and torsional motion is significantly reduced due to normal turbulence. (Author)

A79-41752 # Finite-element approach to compressor blade-to-blade cascade analysis. W. G. Habashi (Concordia University, Montreal, Canada), E. G. Dueck, and D. P. Kenny (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). *AIAA Journal*, vol. 17, July 1979, p. 693-698. 17 refs. Natural Sciences and Engineering Research Council of Canada Grants No. A-3662; No. P-7901.

A study of the application of the finite-element method to compressible potential flows in the context of axial turbomachinery is undertaken. Some novel finite-element approaches relating to the analysis as well as to the mesh generation are presented. The solutions use a pseudovariational integral, applicable to shockless transonic flows and possessing a physical basis for the iteration. Appropriate grids are generated automatically for all cascades at any solidity. The scheme is based upon an approximate mapping of a blade into a near circle around which a suitable grid, with layers reproducing the airfoil shape, is constructed. Such mapping homogenizes the gradients by geometrically condensing regions of low gradients on the main part of the blade while magnifying regions of steep gradients near the leading and trailing edges. The analysis, however, is carried out in the original physical plane. Successful comparisons are made with other results for incompressible flows. (Author)

A79-41763 # On the transonic-dip mechanism of flutter of a sweptback wing. K. Isogai (National Aerospace Laboratory, Tokyo, Japan). *AIAA Journal*, vol. 17, July 1979, p. 793-795. 11 refs.

The mechanism for the sharp drop of the flutter boundary observed for sweptback wings in transonic flight (transonic dip) is investigated. The calculated deepening of the drop with increasing mass ratio, the decrease of the flutter frequency with increasing Mach number, and the rapid decrease of the phase difference between vertical and pitching displacements with increasing Mach number and mass ratio indicates that the flutter mode is basically a pitching oscillation with the pivotal point very close to the first natural mode. It is concluded that the mechanism of single-degree-of-freedom flutter dominates the flutter, at the bottom of the transonic dip and that the large time lag between aerodynamic pressures and airfoil motion in the transonic region, due to compressibility effects, is the main cause of transonic dip. A.L.W.

A79-41766 Slender wings for civil and military aircraft /Eighth Theodore von Kármán Memorial Lecture/. P. Poisson-Quinton (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Israel Journal of Technology*, vol. 16, no. 3, 1978, p. 97-131. 73 refs.

The effect of wing shape and the various ways to control or enhance the vortex flow are reviewed along with stability and control problems. The slender wing at incidence is discussed relative to vortex lift and its control. Vortex lift enhancement is examined on the basis of the wing-plus-strake concept, spanwise blowing, and canard configurations. The transonic and supersonic performances of delta shapes are analyzed, with particular reference to transonic highly maneuverable fighters and to optimized configurations for supersonic transportation. Finally, highly swept configurations suitable for hypervelocities are illustrated by hypersonic-cruise projects and by the Space Shuttle Orbiter. S.D.

A79-41767 A new analytic method for the study of classic helicopter ground resonance. H. L. Price (Leeds University, Leeds, England). *Israel Journal of Technology*, vol. 16, no. 3, 1978, p. 142-153. 9 refs.

A simple analytical method of determining neutral stability boundaries is developed for a single main rotor helicopter when the rotor has three or four articulated blades and the helicopter stands on an undercarriage that is either isotropic or possesses only lateral freedom. The discussion concerns the stability determinant and its treatment, neutral stability boundaries, and extension of the theory to exponential oscillations. Curves of constant modal damping are studied, and their geometry is discussed in some detail. The classical Coleman criterion for stability is shown to be false, and the growth rate of the unstable oscillations is found for cases where the criterion is satisfied. The Coleman criterion can be nearly true over a range of values for the undercarriage viscous damping parameter, but in other cases is drastically wrong. S.D.

A79-41768 A dynamic analysis of landing impact. A. Brot (Israel Aircraft Industries, Ltd., Lod, Israel). *Israel Journal of Technology*, vol. 16, no. 3, 1978, p. 154-158.

The paper summarizes the methods used at the Israel Aircraft Industries to compute the dynamic loads during landing impact. A schematic representation of the landing impact model as applied to a cantilever-type landing gear is presented. Equations defining the dynamics of landing impact are given. Solution of the equations of motion by numerical integration is discussed, along with the results of a landing-impact simulation (typical time-history of landing impact). Very good agreement is observed between the analytical and test results on both the vertical load and the shock-absorber closure. S.D.

A79-41771 * Numerical solution for supersonic flow near the trailing edge of a flat plate. D. Degani (Technion - Israel Institute of Technology, Haifa, Israel), M. Y. Hussaini, and B. S. Baldwin (NASA, Ames Research Center, Moffett Field, Calif.; Technion - Israel Institute of Technology, Haifa, Israel). (*Israel Conference on Mechanical Engineering, 12th, Technion - Israel Institute of Technology, Haifa, Israel, July 11, 12, 1978.*) *Israel Journal of Technology*, vol. 16, no. 5-6, 1978, p. 208-215. 9 refs.

In the present study, problems of laminar and turbulent two-dimensional flow of a viscous compressible fluid near the trailing edge of a thin flat plate are considered. The complete set of Navier-Stokes equations is solved by the finite-difference method of McCormack (McCormack and Baldwin, 1975). It is an explicit, predictor-corrector, time-splitting method of second order accuracy. The computational mesh employed has sufficient resolution for all the characteristic lengths suggested by theory. In the laminar case, the present results are compared with the triple deck solution of Daniels (1974). This comparison indicates that the asymptotic triple deck theory for supersonic trailing edge flow is accurate within five percent for Reynolds numbers greater than 1000. In the turbulent case, the Prandtl-Van Driest-Clauser algebraic eddy viscosity model is used. The numerical results show that the region of upstream influence is approximately of the order of the boundary layer thickness. The solutions for skin-friction, pressure and wake center-line velocity are presented. (Author)

A79-41772 Advanced instrumentation and data evaluation techniques for flight tests. B. Stieler and H. Winter (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). *Ortung und Navigation*, no. 1, 1979, p. 55-100. 12 refs.

The use of advanced hardware and software techniques for flight testing at the DFVLR is reviewed. The flight test sensors include both ground-based (i.e., tracking radar and/or cinetheodolites) and onboard (i.e., INS, Doppler radar, and barometric altimeter) sensors. All data recorded during flight are evaluated off-line using optimal filtering and smoothing algorithms. Testing experience is demonstrated with three examples: testing of the German MLS, a Doppler radar, and an INS. B.J.

A79-41773 Increasing the accuracy of integrated Doppler/TACAN navigation through frequent change of TACAN stations (Steigerung der Genauigkeit der integrierten Doppler/TACAN

Navigation durch häufigen Wechsel der TACAN-Stationen). M. Reich and W. Schöller (Stuttgart, Universität, Stuttgart, West Germany). *Ortung und Navigation*, no. 1, 1979, p. 117-132. 6 refs. In German.

The range and direction errors of individual stations (so-called station-specific errors) in an integrated Doppler/TACAN system have a great influence on total system error. This paper shows that the overall system error can be reduced by frequent changes of TACAN stations utilized in a narrow time interval. Simulated TACAN data demonstrate that total navigation accuracy can be increased substantially by computer-controlled alternation of network stations. B.J.

A79-41827 # Error localization in turbojet engines through determination of the characteristics of structural members (Fehlerlokalisierung an Turbinen-Luftstrahl-Triebwerken durch Bestimmung der Bauteilkenngrößen). G. Dahl. Braunschweig, Technische Universität, Fakultät für Maschinenbau und Elektrotechnik, Dr.-Ing. Dissertation, 1977. 172 p. 57 refs. In German.

In the present thesis, a conventional continuous-process calculation, where the flow parameters are determined from the given component characteristics is inverted in such a way that component characteristics can be determined from the given flow parameters. The ambient pressure and temperature and the pressures and temperatures at the input and output of the compressor and at the turbine output plane, as well as the fuel flow rate, were taken as the flow parameters. The adaptation of this approach to the localization of engine malfunctions is described. V.P.

A79-41849 CKS - Taiwan's 21st century airport. J. Wang. *Journal of Air Traffic Control*, vol. 21, Apr.-June 1979, p. 8-11.

Taiwan's 532,000 sq. ft. Chiang Kai-Shek International airport outside Taipei, is described in this paper in full detail. The automated Airport Management System, which consists of computer connected sensors, displays, monitors, closed circuit TV and discreetly located cameras and communications equipment, directs all airport operations. All systems ranging from flight information to watering systems are encompassed; preventive maintenance is one of AMS' major roles resulting in a safer and more economical monitoring system. The terminal radar system is equipped with underground cables which relay information to the control tower. Along with basic radar signals, the computer complex adds aircraft identification, speed and altitude data to the control display. An independent category II ILS provides horizontal, vertical and distance information on either of the two runways, helping pilots in landing. The radio and interphone systems in the control tower as well as high-powered long-range air ground communications instruments, and a highly sensitive security system are discussed. The possibility of using the airport also as an air-defense airbase in time of war is stressed. C.F.W.

A79-41850 Geneva, Zurich get fine-grain 3-D color weather radar. T. K. Vickers. *Journal of Air Traffic Control*, vol. 21, Apr.-June 1979, p. 12-16.

The Airways Environmental Radar Information System (AERIS) installed in Geneva, Switzerland, to cope with the problem of storms in the Swiss Alps is analyzed. It includes C-band weather radar connected to a minicomputer which extracts and processes radar data creating a 3-D color display of the location and intensity of the precipitation in the area. A set of 19 scans, known as a volume scan, constructs a complete picture that is updated every 10 minutes with the volume scan made at incremented elevation angles from 1/2 to 40 degrees. The average precipitation intensity in a 2 by 2 by 1 km block is displayed on a color TV by using six different colors which correspond to six different levels of precipitation. The display concept is discussed in detail with emphasis on the dimensional capabilities. Unnecessary aircraft detours are eliminated by the 'consistent altitude mode' which enables the controller to view individual 'slices' of the plan to measure the precipitation intensity of any selected altitude band. Specific emphasis is given to the feature that distinguishes between ground clutter and heavy precipitation. C.F.W.

A79-41913 # Nuclear aircraft innovations and applications. J. C. Muehlbauer (Lockheed-Georgia Co., Marietta, Ga.) and R. E. Thompson (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa.). *American Institute of Aeronautics and Astronautics, Very Large Vehicle Conference, Arlington, Va., Apr. 26, 27, 1979, Paper 79-0846*. 15 p. 18 refs.

Determination of the minimum weight nuclear propulsion cycle and aircraft configuration, identification of technologies and innovations for enhancing mission accomplishment, and evaluation of alternate mission applications in the framework of the Innovative Aircraft Design Study (IADS) program are discussed. Parametric studies of four aircraft configurations showed the minimum weight configuration to be one which carries the payload and reactor in the fuselage and uses a canard surface for horizontal control. A Bi-Brayton propulsion cycle with a gas cooled reactor and dual mode engines offers the potential for the lightest weight nuclear aircraft. While sea control, cruise missile carrier, tanker, and airborne command post are prospective alternate mission applications, the nuclear powered cruise missile carrier aircraft (NuCMCA) concept provides unique strategic capabilities. V.T.

A79-41945 Lift and drag of sail aerofoil. J. Robert and B. G. Newman (McGill University, Montreal, Canada). *Wind Engineering*, vol. 3, no. 1, 1979, p. 1-22. 12 refs.

A two-dimensional sail aerofoil formed by wrapping fabric round a circular leading edge and bringing the two sides together to form a sharp trailing edge was tested. Lift, drag, and trailing force were measured for the full range of angles of attack, using a nylon fabric, and more limited tests were made on a less porous but stiffer dacron fabric. The aerofoils were stable and showed no tendency to flap. It was found that due to the increase of camber with angle of attack they have a life-curve slope and a higher lift than comparable conventional aerofoils; nevertheless their drag is usually higher. The maximum lift coefficient and drag coefficient both increase with looseness of the sail. The trailing edge force coefficients are 5 or less in the chordwise direction and 1 or less in the normal direction. This information is useful for designing a sail wing, since it determines the force on the wire or rope which is required to tension the trailing edge. V.T.

A79-42007 Mathematical model of the oscillatory cycle associated with nonsteady interaction of a supersonic jet with a barrier. V. G. Dulov. (PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki, Nov.-Dec. 1978, p. 48-58.) *Journal of Applied Mechanics and Technical Physics*, vol. 19, no. 6, May 1979, p. 747-754. 5 refs. Translation.

A supersonic jet impinging on a wall can give rise to intense self-sustaining vibrational processes at the wall. In the present paper, an attempt is made to substantiate a physical hypothesis, according to which a dominant part in the mechanism of this phenomenon is played by an internal, periodically arising and vanishing wake behind the bifurcation line of shock fronts. The system as a whole acts to amplify the relatively weak disturbances associated with the periodic behavior of the wake. It is shown that this hypothesis is capable of interpreting some experimentally observed phenomena. V.P.

A79-42029 * Split-film anemometer measurements on an airfoil with turbulent separated flow. W. H. Wentz, Jr. (Wichita State University, Wichita, Kan.) and H. C. Seetharam (Boeing Co., Renton, Wash.). In: *Biennial Symposium on Turbulence, 5th, Rolla, Mo., October 3-5, 1977, Proceedings*. Princeton, N.J., Science Press, 1979, p. 31-38; Discussion, p. 39. 5 refs. Grants No. NGR-17-003-021; No. NsG-2134.

Experimental studies of turbulent separation on airfoils have been conducted to aid in improving theoretical models of post-stall airfoil behavior. The studies utilize a variety of pressure and hot-film probes. The split-film anemometer has proved particularly valuable for measurement of highly turbulent reversing flows. Suggested

techniques for on-line digital computer processing of the data are discussed. (Author)

A79-42053 Dilational model of noise from a moving jet in terms of arbitrary jet structure and observer motion. R. J. Adrian and B. G. Jones (Illinois, University, Urbana, Ill.). In: Biennial Symposium on Turbulence, 5th, Rolla, Mo., October 3-5, 1977, Proceedings. Princeton, N.J., Science Press, 1979, p. 303-311. 17 refs.

The dilatational model of noise generated by turbulent motions is extended to include subsonic motion of the reference frame with respect to a uniform acoustic medium and arbitrary motion of the observer. The application of particular interest is the fly-by of a noise producing jet over a stationary observer. The model neglects refraction by mean shear, but it allows the space-time covariance of the hydrodynamic pressure fluctuations in the jet to have arbitrary structure, thus permitting the use of realistic fits to experimental space-time covariances. A non-singular result is also derived for the case of noise emitted along the eddy convection Mach cone of supersonic jets. The application of these results to the prediction of the far field noise generated by stationary and non-stationary jets is discussed. (Author)

A79-42061 Laser velocimetry measurements on high temperature round and rectangular twin-jet flows. J. C. F. Wang (General Electric Co., Schenectady, N.Y.). In: Biennial Symposium on Turbulence, 5th, Rolla, Mo., October 3-5, 1977, Proceedings. Princeton, N.J., Science Press, 1979, p. 435-443. Department of Transportation Contract No. OS-30034.

Mean and turbulent velocity measurements of high temperature twin-round and twin-rectangular jet flows were obtained at the Corporate Research and Development Center of the General Electric Company. These experimental results were obtained in connection with basic jet engine noise and suppressor studies. Evidence of a turbulence intensity reduction at the interface between the two jets was found. The experimental setup, laser velocimeter system and results will be discussed in this paper. (Author)

A79-42062 The European Airbus has definitively penetrated the world market (L'Airbus Européen a définitivement percé sur le marché mondial). J. Morisset. *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 5-9, 11-13. In French.

In the first five months of 1979, the number of European Airbus A300 aircraft firmly sold or under option to 28 companies increased from 176 to 239, and orders for the A310 Airbus increased from 60 to 107, representing a total of over 100 aircraft sold. Factors precipitating and means of meeting the rapid increase of Airbus orders are discussed. The necessary quadrupling of the rate of aircraft production to about eight aircraft per month could be supported by the aeronautical industries of the present Airbus Industries consortium, consisting of Belgium, France, Germany, Great Britain, the Netherlands and Spain. Factors considered responsible for the dramatic increase in orders include the high performance and reliability of Airbus already in service, the second wave of fuel price increases, the freight capacity of the Airbus, postponements of orders by other companies and the initiation of the A310 program. Airbus Industries has thus become one of the four largest producers of transport aircraft in the world. A.L.W.

A79-42063 Alpha Jet - The Franco-German training and tactical support aircraft (L'avion Franco-Allemand d'entraînement et d'appui tactique Alpha Jet). G. Bruner (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 15-33. In French.

The history, design, performance and production of the Alpha Jet Franco-German training and tactical support aircraft are discussed. Specifications for a twin jet subsonic training aircraft were drawn up jointly by France and the Federal Republic of Germany in

1969 and a tactical air support variant was later designed for German use exclusively. The first prototype was tested in October, 1973, and the first flight versions were flown in November 1977 and April, 1978. The design of the aircraft is detailed, including the airfoil, fuselage, empennage, landing gear, propulsion system, flight control and hydraulic, electric, compressed air and weapons systems, and performance criteria of the two versions are illustrated for high and low altitude flight regimes. Delivery of the 200 aircraft contracted by each country is expected to continue through 1980, and 246 more aircraft have been ordered by other nations. Fabrication of the airframe and the Larzac 04 engines and the final assembly are outlined. A.L.W.

A79-42064 The European helicopter industry and cooperation (L'industrie Européenne de l'hélicoptère et la coopération). F. Legrand (Société Nationale Industrielle Aéronautique, Division Hélicoptères, Marignane, Bouches-Du-Rhône, France). *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 35-45. In French.

The condition of the helicopter industry in Europe is examined, with special attention given to cooperation between European manufacturers. The development of helicopter technology since the end of the second world war is outlined and the current status of European manufactures as a group is shown to be comparable to that of American manufacturers, with European products attaining a significant fraction of the world market. Factors influencing the success of European helicopters include both novel designs, marketing procedures, the development of appropriate products and cooperation in the development of such products as the Franco-British Puma, Gazelle and Lynx helicopters. Problems to be resolved in the future are discussed, and it is argued that continued attention to the development of advanced technology, the requirements of the world market and cooperation between governments and industries will ensure the future competitiveness of the European helicopter industry. A.L.W.

A79-42065 CFM56 - An act of cooperation, a new class of engine, a path towards the aeronautics of tomorrow (Le CFM56 - Une coopération, une nouvelle famille de moteurs, une voie vers l'aéronautique de demain). J.-C. Malroux (CFM International, S.A., Paris, France). *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 51-61. In French.

The CFM56 aircraft engine is discussed from the viewpoints of its design and development and the cooperation between SNECMA and General Electric which led to the introduction of this new class of engine of from nine to 12 tons of thrust for 100- to 150-seat civil or 50- to 180-ton military transport aircraft. The CFM56 is a twin spool dual flow turbojet engine with high aspect ratio and a variable high pressure compressor stator, designed for subsonic flight and derived from the F101 engine. Engine components are detailed and the division of fabrication, development and testing responsibilities between the two manufacturers is outlined. The engine development program is discussed, noting that the testing program has so far progressed very satisfactorily. Principles guiding the collaboration, the success of which is demonstrated by the ordering of 150 CFM56 engines by a major airline, consist of considerations of mutual long-term interest, a careful allocation of tasks and revenues, program management by a body distinct from both participants, and efforts towards clarity and simplicity. A.L.W.

A79-42066 The new European subsonic aerodynamic testing facilities (Les nouveaux moyens d'essais aérodynamiques Européens en subsonique). P. Poisson-Quinton (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 62-69. 8 refs. In French.

Four high performance subsonic wind tunnels developed by the laboratories of the principle European investigating nations are discussed. The facilities considered are the German-Dutch atmospheric tunnel in the Dutch northeast polders, the RAE pressurized

tunnel at Farnborough, the ONERA F-1 pressurized tunnel at Fauga and the ONERA S-1 subsonic and transonic atmospheric tunnel at Modane, which are intended to serve as complementary facilities. The design and performance characteristics of the four wind tunnels are presented, noting the use of interchangeable airflow chambers and the Reynolds numbers attainable. Specific characteristics of each of the facilities are noted, with particular attention given to model support systems. A.L.W.

A79-42067 Euromissile - An example of cooperation with respect to missiles (Euromissile - Exemple de coopération en matière de missiles). J. P. Meyer. *L'Aéronautique et l'Astronautique*, no. 76, 1979, p. 71-78. In French.

The origin and functions of the Euromissile group are described as an example of industrial and government cooperation in the field of tactical missiles. The creation of the Euromissile group by the Office of Franco-German Programs as a governmental directing agency for the already existing collaboration between Nord-Aviation and Bölkow for the development of missiles is detailed. The organization of the group is outlined, and the major products of the collaboration, the Milan light antitank missile for infantry use, the Hot long-range antitank missile and the Roland ground-to-air missile systems, are described. It is concluded that the organization of Euromissile offers a solution to the problem of bilateral cooperation. A.L.W.

A79-42207 # Theoretical approach to spray combustion in gas turbine combustor. M. Katsuki, Y. Mizutani, and M. Ohta (Osaka University, Osaka, Japan). *Osaka University, Technology Reports*, vol. 29, Mar. 1979, p. 205-213. 8 refs.

An analytical model was developed for the process of spray combustion in a gas turbine combustor of can-type. Droplets of liquid fuel were introduced into the combustor premixed with the primary air (premixed spray). The droplets were classified into several size-groups, and the law of mass conservation was applied to each size-group considering the evaporation and diffusion of droplets. The emission of nitric oxide was estimated assuming the Zeldovich mechanism and the finite-rate, one-step combustion reaction of fuel vapor. Significant effects of the mean droplet diameter on the combustion efficiency and nitric oxide emission were predicted. (Author)

A79-42245 Practical considerations for manufacturing high-strength Ti-10V-2Fe-3Al alloy forgings. C. C. Chen (Wyman-Gordon Co., Worcester, Mass.) and R. R. Boyer (Boeing Commercial Airplane Co., Seattle, Wash.). *Journal of Metals*, vol. 31, July 1979, p. 33-39. 13 refs.

The manufacturing method for producing high-strength Ti-10V-2Fe-3Al alloy forgings with suitable ductility/toughness combinations has been established. The achievable property combinations at high strengths depend critically on the billet chemistry-homogeneity, the forge heat-treat variables, and the section thickness of the forgings. The manufacturing capability developed in this program has made this alloy an attractive potential for high-strength forging applications on Boeing's future aircraft. (Author)

A79-42275 # The chemical stability of kerosene fractions (Khimicheskaya stabil'nost' kerosinovykh fraktsii). A. Ivanov, K. Kovacheva, Z. Kutsarova, and S. Vylkova. *Khimiia i Tekhnologiiia Topliv i Masel*, no. 6, 1979, p. 6-9. In Russian.

The compositions of the adsorbed resin components of the kerosene fractions of jet fuels which are desorbed by methanol or acetic acid are investigated and the effects of the resins on fuel stability are assessed. Infrared spectroscopy in the region 650 to 4000 kaysers indicates that the major components of the methanol fraction are alcohols, while predominantly organic acids and other carbonyl compounds are observed in the acetic acid fraction. Resins desorbed by methanol are found to inhibit fuel oxidation to a greater degree than resins desorbed by acetic acid, when added in various

concentrations to kerosene from which resins and sulfur have been removed. A.L.W.

A79-42348 # Possibilities and limits of the application of estimation methods for development costs and equipment unit prices of flight systems in preliminary design, planning, and evaluation tasks (Möglichkeiten und Grenzen der Anwendung von Schätzverfahren für Entwicklungskosten und Gerätestückpreise fliegender Systeme bei Vorentwurfs-, Planungs- und Bewertungsaufgaben). H. Hansen, P. Ebeling, and W. Lohkamp (Industrieanlagen-Betriebsgesellschaft mbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kostenprognosen bei fliegenden Systemen, Cologne, West Germany, May 17, 1979, Paper 79-052*. 51 p. In German.

General principles of cost estimation in early design stages of military aircraft are discussed. The features of the RCA system PRICE are discussed and illustrated. P.T.H.

A79-42349 # Survey of the cost estimation process used during the transporter design stage (Abriss der bei der Transporter-konzeptfindung angewendeten Kostenverfahren). H. Lanckenau (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kostenprognosen bei fliegenden Systemen, Cologne, West Germany, May 17, 1979, Paper 79-054*. 43 p. In German.

During the development phases it is necessary to make cost estimates in order to determine the project's chances for realization, and in order to optimize, compare, and evaluate several projects. A VFW-Fokker developed cost prognosis procedure is detailed, and various aspects such as cost prognosis models, their structure, method of operation and possible applications, are examined. In addition, an operating costs procedure is being reworked and expanded. M.E.P.

A79-42351 # Possibilities and limitations of air traffic control (Möglichkeiten und Grenzen der Flugsicherung). H. Voss (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-023*. 29 p. In German.

Consideration is given to various aspects of air traffic control. Freedom of mobility is discussed, noting the reluctance of amateur pilots to follow a strict flight plan. Economics and environmental concerns are studied, as is safety. In addition, the fluidity of air traffic is investigated noting the dependence on adequate system capacity. Finally, air traffic regularity, resulting from reduced sensitivity to poor weather due to all weather instrumentation, is covered. M.E.P.

A79-42352 # The influence of the Terminal Control Area on airline operations (Der Einfluss des Flughafen-Nahbereichs auf den Betrieb einer Luftverkehrsgesellschaft). J. Voigt (Deutsche Lufthansa AG, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-024*. 19 p. In German.

The problems of airport operations, including all aspects of air travel ranging from pre-taxiing conditions and navigational check systems to the landing approach, are examined. Methods to alleviate time-lags between announced and actual departure times, including shorter holding times, as well as air traffic, and landing difficulties induced by wind shear are discussed, and the use of an air-traffic-flow-management system to ease airflow at peak travel times, for all European countries, is suggested. The possibility of a communication network between individual countries, through a centralized system, enabling instant rerouting and alternate flight paths, are considered. It is suggested that solutions to problems of air traffic are to be found not only in air traffic control, but also in the availability of basic knowledge and research directed developments as well as combined efforts by all parties involved. C.F.W.

A79-42353 # Air traffic control requirements from the viewpoint of the airport (Die Anforderungen an die Flugsicherung aus der Sicht des Flughafens). B. Rietdorf. *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-025.* 13 p. In German.

The main air traffic control requirements as seen from the viewpoint of the airport are discussed. Attention is given to airport noise, choice of approach procedure, and maintenance of the approach path. P.T.H.

A79-42354 # Aircraft guidance in the ATC sector - Problems and perspectives (Flugführung im Flughafennahbereich - Aufgaben und Perspektiven). M. Fricke (Berlin, Technische Universität, Berlin, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-026.* 41 p. 25 refs. In German.

Increasing demands on aircraft guidance with respect to safety, economics, and environmental concerns, are discussed. Attention is given to current developments in the following areas: (1) aircraft noise, all-weather flight, windshear, and wake vortices; (2) flight control, including structure and technology of aircraft guidance systems, digital guidance systems, and the interaction of the pilot and the flight control system; and (3) navigation and flight safety, noting future navigation systems such as TRSB, new approach techniques involving MLS, automation of flight and traffic safety. The current status of West German aviation development is detailed, and areas of future research are proposed. M.E.P.

A79-42355 # Missed approach of commercial aircraft regarding wind shear in the ground boundary layer (Fehlflug von Verkehrsflugzeugen unter Berücksichtigung von Windscherung in der Bodengrenzschicht). R. König (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-028.* 27 p. In German.

Factors affecting aircraft climbing ability after missed approach are examined. Head and tail winds and wind shear occurring in the clearway can cause hazardous conditions for low performance aircraft in spite of their complying with FAR part 25. Other factors studied are engine power reduction due to high temperatures and the use of air conditioning. Attention is given to results from simulations at Stuttgart airport, where it was found that unfavorable wind and temperature conditions could lead to penetration of the clearway at the end of the flight path. Uneven terrain can cause hitherto unencountered forms of wind shear due to wind/surface interaction in the ground boundary layer. It is concluded that such factors should be addressed in clearway regulations and the FAR. M.E.P.

A79-42356 # Influence of delay time and dead time on wind shear landings (Verzögerungs- und Totzeiteinflüsse bei Scherwindlandungen). P. Krauspe (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-029.* 31 p. 10 refs. In German.

The reaction time of jet engines and pilots during wind shear conditions is studied. Topics examined include causes and effects of jet engine lag time, a mathematical jet engine model, and the thrust corrections required while under wind shear influence. In addition consideration is given to the causes of pilot delay time, and related simulator results are analyzed. It is found that engine lag time is of minimal influence but that pilot delay time (5-10 seconds) can lead to a hazardous situation. Since delay time occurs with the use of conventional instruments, some precautionary techniques to be observed until on board wind shear detectors become available, are given. M.E.P.

A79-42357 # Factors influencing runway capacity as typified by the Munich-Riem airport (Die Startbahnkapazität und ihre Einflussfaktoren, dargestellt am Beispiel des Flughafens München-Riem). G. Och (Messerschmitt-Bölkow-Blöhm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-030.* 27 p. 18 refs. In German.

Runway capacity determination based on measurements of the time required for arrivals, runway clearance, and departures, is described. Depending on traffic conditions, the Munich airport has a capacity of 20 to 40 movements per hour. The quantitative influence of the following factors is studied: (1) visibility conditions (VFR to category II); (2) wind with wet runway; (3) staggering, and other air traffic control regulations (including wake vortex problems); and (4) traffic composition consisting of (a) arrivals and departures and (b) widebody jets and medium size aircraft. Finally, technical possibilities for increasing capacity, such as high speed taxi lanes and MLS, are analyzed. M.E.P.

A79-42358 # Introduction of Category IIIA at Deutsche Lufthansa AG (Einführung der Betriebsstufe IIIA bei der Deutschen Lufthansa AG). K. Menninger (Deutsche Lufthansa AG, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-031.* 9 p. In German.

Cat IIIA deals, by definition, with operation down to the runway surface with visibility during last phase of landing of around 200 m. The paper discusses some of the questions posed by this category for a commercial airline. The main questions are (1) who will need the new flight rule, and (2) what are the costs of implementation. In the case of Lufthansa, it was decided to introduce Cat IIIA with the A300 as first model. Estimated cost over six years is 415,000 DM, with seven airports under consideration. P.T.H.

A79-42359 # Air traffic control strategies for handling air traffic in the terminal area (Strategien der Flugsicherung zur Abwicklung des Luftverkehrs im Flughafennahbereich). W. P. Schwarzott (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-032.* 11 p. In German.

The paper reviews the present-day capabilities of terminal area air traffic control, with emphasis on the exchange of control between the terminal area authority and the route segment authority. It is pointed out that in the area from about 40 nautical miles from the airport to the glide path there exists at present no automatic course guidance. All instructions must be given by radio among the crew, and there are no automatic aids to support the pilot in the 'balancing act' of high-capacity/maintenance of stagger. P.T.H.

A79-42360 # Aspects of traffic flow control in the approach region (Aspekte zur Verkehrsflusssteuerung im Anflugbereich). M. Schubert, U. Völkens (Braunschweig, Technische Universität, Braunschweig, West Germany), and A. Seyfried (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR-Paper 79-033.* 20 p. In German.

The general problem of traffic control in the approach area is discussed. The basic techniques employed in this traffic control are reviewed, and their effects on the arrival distribution and on the traffic flow are evaluated. Possibilities for a coordinated computer-supported operation are considered. P.T.H.

A79-42361 # Development of specifications for taxiing guidance and control systems (Rollfeldnavigation und Rollführung -

Teilaspekte einer Verkehrsfluss-Steuerung des Flugplatzverkehrs). C. Wöltge (Hannover, Technische Universität, Hannover, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-034*. 13 p. 8 refs. In German and English.

The taxiing and control guidance requirements of a pilot, including steering and distance information as well as warnings of directional changes and system failures are discussed, while other guidelines for control unit personnel, ground vehicle operators and those of a general nature are presented in outline form. Requirements for a system to provide safe and expeditious movement under extremely low visibility conditions are described and three sets of conditions for taxiing purposes are developed, where visibility is sufficient for both the pilot and the ground crew, sufficient for the pilot and not for the ground crew, and where visibility is insufficient for both. C.F.W.

A79-42362 # Technical calculation methods for automatic collision recognition and avoidance in air traffic (Rechentechische Verfahren zur automatischen Konflikterkennung und -lösung im Nahverkehrsbereich). D. Brunner (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-035*. 21 p. 5 refs. In German.

A FAA problem of deciding among the constant flow of cheaper and more efficient systems to equip the over 130,000 aircraft in the U.S., is one of the reasons for not implementing a collision avoidance system (CAS). Methods for determining the distance between aircraft are discussed and particular attention is given to the formula developed by Morrel (1956), that calculates the time it takes two aircraft to come within sounding distance of each other. Guidelines for a CAS are presented, including instantaneous speed, distance and azimuth measurements, thus enabling quick and accurate rerouting. A Eurocontrol filtering system that can determine the exact coordinates of 150 planes in only 80 ms and also calculate the advanced positions for the next 9 to 128 seconds is examined. Emphasis is also given to three CAS, (airborne, beacon-based and ground-based), suggesting that the ground-based system may be the best way of preventing collisions. C.F.W.

A79-42363 # Experience in the analysis of real and simulated collisions and dangerous encounters in German airspace (Erfahrungen bei der Analyse echter und simulierter Zusammenstöße und gefährlicher Begegnungen im deutschen Luftraum). O. Weber (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 Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-036*. 31 p. 36 refs. In German.

The paper discusses general principles of collision avoidance in the airport region under visual flight conditions, and examines those parameters which are of interest for design of automatic conflict detection and resolution systems for two- and three-dimensional curved flights. Real and simulated conflict situations are studied, in order to determine which factors are present in possible collisions. Simulations were carried out to determine if certain types of equipment for conflict detection and resolution could have been useful in real situations. P.T.H.

A79-42364 # The DME-based Azimuth System /DAS/ as a commercial navigation aid (Das DME-gestützte Azimut-System DAS als wirtschaftliche Navigationshilfe). G. Blaschke (Standard Elektrik Lorenz AG, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-038*. 46 p. 6 refs. In German.

DAS, a high accuracy polar coordinate navigation system with an azimuth error of less than 0.05 deg and a distance error of less than 20 m is described. DAS is based on and fully compatible with the ICAO-standardized 'Distance Measuring Equipment', (DME). Functioning principles of the precision-DME-transponder are detailed as are the angle measurement principles and the DAS data format for angle and broadcast data transmissions. Attention is given to possible DAS applications especially in conjunction with TRSB landing systems and as a navigation aid in the terminal control area. Possible economic advantages through the use of DAS are noted. M.E.P.

A79-42365 # Investigation of different system configurations for a TMA navigation system taking special account of traffic load and channel requirements (Untersuchung verschiedener Systemkonfigurationen für ein TMA-Navigationssystem unter besonderer Berücksichtigung von Verkehrsbelastung und Kanalbedarf). A. Becker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung Braunschweig, West Germany) and W. Skupin (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-039*. 27 p. In German.

The paper reports on a comparison of three alternative terminal maneuvering area (TMA) navigation system configurations with the current system. The new systems make use of VOR/DME, TRSB (approach azimuth, approach elevation, and missed approach azimuth), and PDME. The procedures used in these systems are discussed in terms of four flight phases. One variant uses a TRSB-360-deg element in place of VOR/DME, and another one substitutes DAS for VOR/DME. The systems are briefly discussed in terms of operational considerations, implementation, integrity, performance, cost, and growth potential. P.T.H.

A79-42366 # Possibilities for increasing distance measuring accuracy of DME (DME, Möglichkeiten zur Erhöhung der Entfernungsmessgenauigkeit). H. Vogel (Standard Elektrik Lorenz AG, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-040*. 28 p. 5 refs. In German.

The paper presents some results of a study of the errors in DME systems with the purpose of finding means of increasing the distance measuring accuracy of DME while retaining the standard DME signal format. The errors are divided into instrumental errors and radio field errors. Special attention is given to reflection errors, arising from multipath propagation by the superposition of the direct signal onto later arriving reflected signals. A number of current methods being investigated for reducing these errors are reviewed. P.T.H.

A79-42367 # A simple integrated navigation system based on multiple DME (Ein einfaches integriertes Navigationssystem basierend auf Mehrfach-DME). U. Brokof and K. Hurrass (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 Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-041*. 19 p. 5 refs. In German.

A simple integrated navigation system is described, consisting of a dead reckoning system using the intrinsic velocity and the compass heading. The system is supported by range measurements to various DME ground stations by means of a Kalman filter. The state vector contains, besides the elements for dead reckoning, the systematic errors of the ground stations. The operation of the system is discussed in the light of test flight results with an HFB 320. P.T.H.

A79-42368 # Application oriented simulation as a tool for the planning of radio beacon systems (Praxisorientierte Simulation als Instrument der Planung von Funksystemen). H. Ecklund (Braunschweig, Technische Universität, Braunschweig, West

Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-042.* 16 p. In German.

Attention is given to the various factors to be considered when planning a radio beacon system. Such factors are: development of new systems, choice of versions, system installation, and planning of the surrounding area. An MLS is used as an example for organization of the simulation, noting the necessity for three models: (1) an aircraft motion model, (2) an electromagnetic wave propagation model with the formation of an interference field, and (3) the system model which, when using DLS, must consider signal generation, ground measurement, and on-board signal processing. Finally, problems with duplicating complex phenomena such as diffraction and wave propagation are surveyed. M.E.P.

A79-42369 # Increasing guidance accuracy through use of an integrated digital piloting system (Erhöhung der Führungsgenauigkeit durch den Einsatz eines integrierten digitalen Flugführungssystems). V. Adam (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 Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-043.* 28 p. In German.

The paper presents the control system, sensor system, and software structure of an integrated digital piloting system. The system has a hierarchical structure corresponding to different degrees of automatization running through the groups denoted as advance control, automatic operating modes, and functions. The control system is a coupled multiparameter system. The computational functions are clearly separated from one another in the modular software structure. Some flight test results are presented. P.T.H.

A79-42370 # The influence of the amount of automation in a flight path guidance system on flight path deviation and pilot work load (Der Einfluss des Automatisierungsgrades eines Bahnführungssystems auf Bahnablagen und Pilotenbelastung). P. Sundermeyer and W. Alles (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-044.* 39 p. 17 refs. In German.

Attention is given to simulations carried out to investigate the delegation of duties between the pilot and autopilot by determining the effect of the amount of automation on flight path accuracy and pilot work load. Three steps of automation are studied: (1) flight path guidance with autopilot control, (2) flight path guidance with information relay to the control elements, and (3) fully automatic flight path guidance. It was found that flight path accuracy improved through a vertical speed error reduction of 20% for step 2, and 25% for step 3. In addition, course error was reduced 10 and 25%, respectively. M.E.P.

A79-42371 # Decelerated approach - Comparison of different procedures (Decelerated approach - Vergleich verschiedener Verfahren). W. Wellern and P. Wüst (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-045.* 17 p. 5 refs. In German.

The paper compares the operational and computational aspects of several different procedures for decelerated approach, by which a reduction in engine power is achieved during approach. Emphasis is on those methods in which the flaps are extended later than usual. P.T.H.

A79-42372 # Increasing effectiveness of piloting systems by modern methods of digital signal processing (Effektivitätssteigerung

von Flugführungssystemen durch moderne Methoden digitaler Signalverarbeitung). V. Krebs (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-046.* 14 p. 5 refs. In German.

Some signal processing techniques are discussed that offer possibilities for improved piloting systems. After a brief discussion of possible structures of parallel-redundant systems, the concept of analytic redundancy is introduced, through which it is possible to replace one of the three radar altitude measurements needed for an automatic landing system by the drop velocity calculated by the air data computer. Two practical applications implemented in the GCU 70 D digital piloting system for the microwave landing system are presented: implementation of a mathematical model for the MLS signals received on board and comparison of model outputs and measurement signals, enabling design of an adaptive Kalman filter for signal filtering with error control, and a sensor concept for relating barometric altitude measurement to the MLS-derived altitude by Kalman filtering. P.T.H.

A79-42373 # Onboard methods for increasing landing approach capacity upon introduction of MLS (Bordseitige Massnahmen zur Erhöhung der Anflugkapazität mit Einführung des MLS). R. Seifert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-047.* 28 p. 8 refs. In German.

Attention is given to onboard equipment necessary to take full advantage of MLS. It includes: (1) precise flight autopilot and data display, and (2) inclusion of time handicap for landing and a data display that allows an exact adherence to the prescribed landing time + or - 10 s. Present development trends in the USA are surveyed, noting the NASA Langley modified B-737 used for testing. The results of this testing, which has demonstrated the development degree of Time Referenced Scanning Beam (TRSB), are studied. M.E.P.

A79-42374 # Problems of onboard determination of wind relationships with optimal filters (Probleme bei der bordseitigen Bestimmung der Windverhältnisse mit Optimalfiltern). H. J. Hotop, W. Lechner, and B. Stieler (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 Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-048.* 50 p. 8 refs. In German.

The paper reports on studies aimed at determining the errors in the inertial navigation system (INS) and air data sensors used in the air traffic control operations in the airport region. The experiments were conducted on an HFB 320 equipped with a Litton LN-3A INS, various flight data sensors, and flight log. The paper describes the procedure for onboard wind-measurement and the regression technique for separating the wind part from the sensor error. The regression technique is valid even for small wind velocity, but cannot be used in flight where the azimuth angle does not change. The results of the experiments are suitable for developing a method to prepare optimal measurement signals for obtaining wind relationships in flight. P.T.H.

A79-42375 # New onboard structure of display and control system for piloting and air traffic control (Neue bordseitige Struktur des Anzeige- und Bediensystems für Flugführung und Flugsicherung). R. Beyer (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany) and F. V. Schick (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation,*

Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-049. 19 p. In German.

Electronic image tube displays and control devices can form the basic element of future aircraft display and control systems in which the same devices are used for different functions by the use of different control programs. Advantages of such electronic display and control systems are discussed, and some development trends in this area are noted. P.T.H.

A79-42376 # Investigation concerning an Airborne Terminal /AT/ for pilot/controller communication over a ground/board/ground data link (Untersuchungen zu einem Airborne Terminal /AT/ für die Kommunikation Pilot/Lotse über eine Datenverbindung Boden/Bord/Boden). 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 Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-050.* 21 p. 5 refs. In German.

As opposed to the usual tactical executive air traffic control procedures, strategic air traffic planning over a two-way radio link between pilot and controller is proposed, whose purpose is to ensure conflict-free flight for all aircraft operating in a given airspace for the whole flight of an individual aircraft, including movements on the ground. Three components of the system are the electronic display of flight control data along with function keys for communication with ATC points, hardcopy printer for output of long-term valid data, and interface of display and printer with the data link. Some of the desired features of the display are discussed. P.T.H.

A79-42377 # Fundamentals of navigation in the terminal maneuvering area (Elemente der Navigation im Flughafen-nahbereich). P. Form (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper.* 21 p. In German.

The paper discusses some of the principles of traffic management in the terminal maneuvering areas. The discussion covers standardized approach paths, procedures followed as an aircraft flies over these paths, the need sometimes to deviate from standard paths, and special problems in an area near mountains, such as Salzburg. Illustration are provided for the discussion of the standard terminal arrival routes of Frankfurt, Bremen, London, and Salzburg. P.T.H.

A79-42378 Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1979. 221 p. Members, \$27.50; nonmembers, \$35.

Papers are presented on the productivity of airships in long-range transportation, analysis of Coast Guard missions for maritime patrol airships, thruster control for airships and the structural loads due to gusts on semibuoyant airships. British civil airworthiness requirements for airships, Japanese lighter-than-air mission studies and Canadian interest in modern LTA mission studies are also among the papers discussed. Attention is given to airship dynamic stability, unmanned miniblimp systems, and tethered communications and monitoring systems. C.F.W.

A79-42379 # Analysis of Coast Guard missions for a maritime patrol airship. H. K. Rappoport (Summit Research Corp., Gaithersburg, Md.). In: *Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 1-5. (AIAA 79-1571)

A review of the U.S. Coast Guard's operation, has led to the selection of eight airship participation programs that, compared to the current operating platforms of ships and aircraft, were found to

be cost effective. 30 potential airship missions, for the eight programs, were described and 263 mission profiles were compiled, including ice patrol, surveillance and inshore undersea warfare. Special attention was given to the point design analysis of these programs and the annual requirements for capable airships, as a function of flight duration. Emphasis was placed on statistical data and calculations of crew size and mission duration. 120,000 hours of operations of less than 40 hours were analyzed and it was concluded that 50 maritime patrol ships, at a cost of \$10 million, could be utilized. The hourly cost of operating an airship was found to lie between \$700 and \$1200, depending on the mission requirements and flight duration. C.F.W.

A79-42380 # Tri-rotor Coast Guard airship. N. D. Brown (Goodyear Aerospace Corp., Akron, Ohio). In: *Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 6-14. 7 refs. (AIAA 79-1573)

Development of the tri-rotor Coast Guard airship (ZP-3G) is discussed and the vehicle characteristics for the eight missions (including search and rescue operations, port safety, and ice operations), examined by Rappoport (1979), are tabulated. Emphasis is given to speed control and acceleration, propeller performance, fuel consumption, power setting, envelope sizing and the inboard profile. The design of the three-engine, 800 hp airship, with an envelope volume of 875,000 cu ft and a top speed of 97 knots, is examined. A vertical takeoff and landing system is incorporated as well as conventional operations. The maximum ferry range is noted at 3407 n mi, with a 4420 lb fixed-on-board payload, a crew of 6, provisions for 5 days, 10% fuel reserve and a minimum flight speed of 40 knots. Further detail is given to various major characteristics, including beta factors, gross weights, dynamic lift capabilities, varying speed ranges and other performance statistics. It is concluded that the technical risk associated with the ZP-3G is low and an operational prototype could be flying within three years after the finalized design. C.F.W.

A79-42381 # The potential role of airships for oceanography. R. E. Stevenson (U.S. Navy, Office of Naval Research; California, University, La Jolla, Calif.). In: *Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 15-24. (AIAA 79-1574)

The use of an oceanographic airship to collect data of temperature discontinuities at sea surfaces, extending through the upper ocean, is proposed. A scenario of an oceanographic experiment is outlined, implementing an airship equipped with a complete satellite receiving system, expendable bathythermographs, salinity probes, sound velocimeters, plus a collection of remote sensors. Several photographs, mostly taken from orbiting satellites, are attached depicting ocean swells, large internal waves, eddies, whip wakes and sea surface slicks. C.F.W.

A79-42382 # Modern rigid airships as sea control escort platforms. D. G. Kinney (U.S. Naval Weapons Center, China Lake, Calif.). In: *Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.* New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 25-33. (AIAA 79-1575)

A preliminary analysis of the potential of modern airships to meet the U.S. Navy's sea control escort needs, is presented. The use of airborne stations (rigid airships), operating at high altitudes with reduced empty weight, is suggested and the modern rigid airship, an updated version of the 1930's design, with improved materials and components and equipped with modern surveillance systems, is described. Airship size, performance and endurance are studied together with payload capabilities (up to 60,000 lb) and gas volumes of up to 6 million cu ft. Special emphasis is given to the airship's radar detection performance, and anti-air and antisubmarine warfare

capabilities of the airship are investigated, showing cost-comparisons to present airborne defense systems. It is concluded that the cost of a 15-year life cycle for 5 airships would be \$600 to \$900 million, only 8 to 12% of present defense systems. Finally, results show that the limitations of modern rigid airships, including low operating ability in severe storm conditions, and high detectability and survivability, do not outweigh its potentially valuable contribution. C.F.W.

A79-42383 * # Weight and cost estimating relationships for heavy lift airships. D. W. Gray (Goodyear Aerospace Corp., Akron, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 34-42. NASA-supported research. (AIAA 79-1577)

Weight and cost estimating relationships, including additional parameters that influence the cost and performance of heavy-lift airships (HLA), are discussed. Inputs to a closed loop computer program, consisting of useful load, forward speed, lift module positive or negative thrust, and rotors and propellers, are examined. Detail is given to the HLA cost and weight program (HLACW), which computes component weights, vehicle size, buoyancy lift, rotor and propeller thrust, and engine horse power. This program solves the problem of interrelating the different aerostat, rotors, engines and propeller sizes. Six sets of 'default parameters' are left for the operator to change during each computer run enabling slight data manipulation without altering the program. C.F.W.

A79-42384 # Structural loads due to gusts on semibuoyant airships. A. D. Topping (Bell Aerospace Textron, New Orleans, La.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 43-46. 7 refs. (AIAA 79-1581)

The semiempirical preliminary design equations often used for the estimation of the structural weight of airship envelopes implicitly assume neutral buoyancy. Many proposed new airships are semi-buoyant, and the heavy-lift airship (HLA) is a case in point. In this paper, translational accelerations in the vertical plane are calculated for a gust loading based on existing experimental data. Virtual mass effects are included. Results indicate envelope weights for heavy airships may be much higher than for neutrally buoyant airships, while car and related structure may be lighter than would be expected in a conventional airship with the same gross weight. (Author)

A79-42385 # British lighter-than-air activity - A review. A. W. L. Naylor (Royal Aeronautical Society, London, England). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 47-56. 18 refs. (AIAA 79-1583)

The progress of British lighter-than-air activity and its state-of-the-art is discussed and a brief historical background is presented. The possible uses of airships to provide convenient lift devices for freight and heavy indivisible loads are examined. A current project, has made use of advanced materials and technologies to develop the AD-500 nonrigid airship, using helium, and an envelope of thin single-ply polyester, coated with polyurethane and loaded with titanium dioxide. The design of a nonrigid helium airship, carrying an array of solar cells that generate electrical power and feeds it to dc motors, that drive its propellers, is suggested. It is concluded that the airship could be a fuel-economic load carrier and the comparatively small versions being built today could be the forerunners of tomorrow's freight airship fleets. C.F.W.

A79-42386 # Canadian interest in modern LTA transport. R. G. E. Browning (Alberta Transportation, Edmonton, Canada). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 57-66. (AIAA 79-1585)

A market study to assess the applicability of LTA in the Canadian North-West to satisfy particular transportation demands has been completed. The study identifies possible vehicle configurations and assigns them to specific tasks that were identified by potential users. An economic analysis of some of the missions is provided. Results indicate that the market has sufficient economic significance to warrant LTA operations in this region. (Author)

A79-42387 # Japanese lighter-than-air mission studies. K. Iinuma (Japan Buoyant Flight Association, Tokyo, Japan). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 67-72. (AIAA 79-1587)

The transportation of people and heavy cargo, using express trains, aircraft and possibly lighter-than-air (LTA) ships, among the islands of Japan is examined. The conceptual design of a 120 seat LTA craft, with a cruising speed of 150 km/h and a range of 700 km is discussed. A two phase plane, one for heavy cargo (up to 100 tons) transportation and the other for the transportation of people, is presented. It is concluded that insufficient evidence is available to decide what type of LTA craft is most suitable for these purposes. C.F.W.

A79-42388 # Flight dynamics analyses and simulation of Heavy Lift Airship. B. L. Nagabhushan and N. P. Tomlinson (Goodyear Aerospace Corp., Akron, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 73-81. 8 refs. (AIAA 79-1593)

Performance, stability, and control characteristics of a quad-rotor Heavy Lift Airship concept with a simply suspended payload are determined by using an analytical model of such a configuration. Nonlinear equations of motion are derived and used to construct a hybrid computer simulation of the system as well as to derive a linear system model of the configuration dynamics. Results are presented that show (1) the performance of the vehicle in typical missions, such as off-loading container ships and logging; (2) possible instabilities of the configuration dynamics; and (3) controllability of the vehicle-payload system in the flight envelope of operational interest. (Author)

A79-42389 # 'Thruster control for airships'. V. H. Pavlecka (Airships International, Inc., Tustin, Calif.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 82-87. 18 refs. (AIAA 79-1595)

The use of thruster control to alleviate the task of controlling airships at low speeds and standstill, is presented. Historical background, including the Forlani solution (1920) of using momentum of cold air jets valved off in the bow and stern to move an airship horizontally or vertically is given. Four possible systems of thruster control are examined: (1) the use of control blowers with pressurized air ducting to valve manifolds, (2) the use of local blowers in the bow and stern plenum chambers activating valves for cold air jets, (3) tapping internal pressure of the hull with blowers supercharging it, and (4) the deployment of individual electrically driven thrusters, using external air driven intermittently from the central airship electrical power plant. A NASA directed study found the last system to be much lighter than the fins and movable control surfaces that it will replace, and is the most desirable solution. Evaluation of results confirmed that airships will become independent of ground crews and fully controllable at zero and low flight speeds as well as lower in cost due to the lower fuel weight of control thruster installation. C.F.W.

A79-42390 # The productivity of airships in long-range transportation. W. N. Brewer (Goodyear Aerospace Corp., Akron, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 88-98. (AIAA 79-1596)

Closed-form solutions are developed for the transportation productivity (payload ton/nautical miles per hour) for airships in long-range transportation. Both fully air-buoyant (FAB) and semi-air-buoyant (SAB) concepts are treated. It is shown that FAB vehicles develop maximum productivity when the useful load is split into two-thirds payload and one-third fuel at all ranges. A cruise speed is selected so that this amount of fuel will last the full range of a particular mission. The SAB airships are treated for flying at constant speed or at constant L/D with or without buoyancy control. The fundamental relationships between productivity and airship parameters are shown for each case. (Author)

A79-42391 # Lighter-than-air craft for strategic mobility. G. A. Pasquet (USAF, Military Airlift Command, Scott AFB, Ill.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 99-104. 9 refs. (AIAA 79-1597)

The possibility of using lighter-than-air craft (LTAC), as a viable means of improving U.S. strategic mobility, is suggested. Four tasks and their relationships to intertheater or strategic airlift are presented with the most critical airlift task found to be the deployment of personnel and equipment to overseas theaters in order to balance force ratios. Another important 'retrograde' task is the shipping home of noncombatants, wounded and damaged equipment. Other tasks consist of providing material, which allow the sustaining of combat capabilities, as well as 'employment', involving direct delivery of combat forces to the area of operations. Special attention is given to mission flexibility, defined as a combination of ranges, payloads, self-sufficiency, off runway and adverse weather capabilities. It is estimated that a LTAC should have an unrefueled range of 7,100 nautical miles and payloads between 600 and 1,500 tons. Results show that survivability, in terms of its large size and slow speed, eliminate the LTAC from consideration as a combat vehicle, but advantages of complementing present air and sea lift capabilities provide enough data to give serious thought to using LTAC for strategic mobility. C.F.W.

A79-42392 # Airship potential in strategic airlift operations. J. E. Glod (Goodyear Aerospace Corp., Akron, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 105-112. 11 refs. (AIAA 79-1598)

The use of fully-air buoyant (FAB) and semi-air-buoyant (SAB) airships, as potential strategic transport airships (STA), is described. The scope of the airlift requirement is found to be in an approximate range of 4,600 n mi with a varying payload from 300,000 to 780,000 tons. In order to develop a suitable airship, four technological areas are studied: structure, propulsion, aerodynamics, and operational requirements. It was determined that missions of non-stop flights from the continental U.S. to Europe and the Mid-East, would require a rigid type of structure, with VTOL thrusts loads and the classical wire braced frame and upper limits of 50 million cu ft and speeds of 75 to 100 knots. The most suitable all-round STA was determined to be a SAB, cruising at 115 knots with a 363 ton payload. Finally, the most critical limitation associated with a SAB vehicle is that it is a totally new and unique vehicle compared with any prior LTA or HTA craft. C.F.W.

A79-42393 # Further advancements in the concept of delta-winged hybrid-airships. P.-A. Mackrodt (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Experimentelle Strömungsmechanik, Göttingen, West Germany). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13,

1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 113-122. 35 refs. (AIAA 79-1599)

During the last years several concepts arose for hybrid-airships. One of these concepts combines a slender delta-wing with a rigid airship, called hybrid-Zeppelin. In the present paper, the aerodynamic performance of such a vehicle has been calculated starting from the technical state of the art of the prewar LZ 129 and based on the slender body theory. The results show that the optimum hybrid-Zeppelin at the given conditions lifts roughly one half of its take-off weight by aerodynamic lift at a cruise speed in the closed interval 125-225 km/hr. If fueled with liquid hydrogen or Blaugas and driven by gas-turbines its payload and fuel consumption figures are much superior to those of existing aircraft. (Author)

A79-42394 # British civil airworthiness requirements for airships. E. J. Niedermayer (Civil Aviation Authority, Airworthiness Div., Redhill, Surrey, England). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 123-130. (AIAA 79-1600)

The historic background of airship airworthiness requirements in the UK are reviewed and the philosophy which has led to the development of the British Civil Airworthiness Requirements for nonrigid airships is discussed. Restrictions apply to nonrigid airships with an envelope volume of not more than 0.5 million cu ft and equipped with two, or more, piston engines. The philosophy which has led to the formulation of specific airship requirements includes flight handling and performance, structural, design, and construction aspects, engine and equipment installations, and levels of safety. The framework of these requirements can be expanded to cover rigid airship structures, turbine engines and control systems. V.T.

A79-42395 # High strength fibers for lighter-than-air craft. M. H. Horn and J. J. Pigliacampi (Du Pont de Nemours and Co., Textile Fibers Dept., Wilmington, Del.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 131-139. 19 refs. (AIAA 79-1601)

High performance fibers that combine mechanical properties comparable to metals with the light weight and handleability of conventional textiles are needed in any new lighter-than-air craft. Kevlar aramid, graphite, and glass fibers are prime candidates to meet the demanding performance criteria of this evolving concept. Specifically, the performance of these materials are compared in the configurations envisioned for lighter-than-air craft, i.e., composites, coated fabrics, ropes, and industrial hose. (Author)

A79-42396 * # Potential applications of a high altitude powered platform in the ocean/coastal zone community. D. Escoc, P. Riegerink (Computer Sciences Corp., Silver Spring, Md.), and J. D. Oberholtzer (NASA, Wallops Flight Center, Wallops Island, Va.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 140-145. (AIAA 79-1602)

The results of a survey of the ocean/coastal zone community conducted for the NASA Wallops Flight Center to identify potential applications of a high altitude powered platform (HAPP) are presented. Such a platform would stationkeep at 70,000 feet for up to a year over a given location and make frequent high resolution observations, or serve as a regional communications link. The survey results indicate user interest among scientific researchers, operational agencies and private industry. It is felt that such a platform would combine the desirable characteristics of both geostationary satellites (wide area, frequent observation) and aircraft (high resolution). As a result a concept for an operational HAPP system in the form of a 'mesoscale geostationary satellite' system evolved. Such a system could employ many of the same technologies used in current NASA

and NOAA geostationary satellite programs. A set of generalized instrument requirements for HAPP borne sensors is also presented.

(Author)

A79-42397 * # Applications of a high-altitude powered platform /HAPP/. M. B. Kuhner (Battelle Columbus Laboratories, Columbus, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 146-154. 9 refs. Contract No. NASw-2800. NASA Task 19. (AIAA 79-1603)

The high-altitude powered platform (HAPP) is a conceptual unmanned vehicle which could be either an airship or airplane. It would keep station at an altitude of 70,000 ft above a fixed point on the ground. A microwave power transmission system would beam energy from the ground up to the HAPP to power an electric motor-driven propeller and the payload. A study of the HAPP has shown that it could potentially be a cost-competitive platform for such remote sensing applications as forest fire detection, Great Lakes ice monitoring and Coast Guard law enforcement. It also has significant potential as a communications relay platform for (among other things) direct broadcast to home TVs over a large region.

(Author)

A79-42398 * # Wind study for high altitude platform design. T. W. Strganac (NASA, Wallops Flight Center, Wallops Island, Va.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 155-161. 6 refs. (AIAA 79-1607)

An analysis of upper air winds was performed to define the wind environment at potential operating altitudes for high-altitude powered platform concepts. Expected wind conditions of the contiguous United States, Pacific area (Alaska to Sea of Japan), and European area (Norwegian and Mediterranean Seas) were obtained using a representative network of sites selected based upon adequate high-altitude sampling, geographic dispersion, and observed upper wind patterns. A data base of twenty plus years of rawinsonde gathered wind information was used in the analysis. Annual variations from surface to 10 mb (approximately 31 km) pressure altitude were investigated to encompass the practical operating range for the platform concepts. Parametric analysis for the United States and foreign areas was performed to provide a basis for vehicle system design tradeoffs. This analysis of wind magnitudes indicates the feasibility of annual operation at a majority of sites and more selective seasonal operation for the extreme conditions between the pressure altitudes of 100 to 25 mb based upon the assumed design speeds.

(Author)

A79-42399 # The ATMOSAT Program 1975-78. T. F. Heinshemer (Aerospace Corp., El Segundo, Calif.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 162-172. (AIAA 79-1608)

The first manned superpressure balloon has been developed to provide means for accurately following a parcel of air, making physical and chemical measurement en route, and collecting atmospheric data: ozone, NO_x, SO₂, temperature gradients and turbulence. The aim of the first prototype ATMOSAT flight was to measure the superpressure induced by supertemperature at the 100 mb level, while the performance of materials (Kevlar composite fabrics), balloon, launch and flight techniques were evaluated during the 10-meter ATMOSAT flights. The history and results of the pollution monitoring flights 4-9 conducted in 1976-1978 are presented. It is proposed to use ATMOSAT-type balloons rolling about on the surface of Mars for exploring the planet in the late 1980s.

V.T.

A79-42400 # Tethered telecommunications, broadcast, and monitoring systems. J. P. Hirl (TCOM Corp., Columbia, Md.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 173-180. (AIAA 79-1609)

This paper reviews the TCOM aerostat technology of a stationary platform 3 km high whose operation and, specifically, onstation time is not encumbered by energy-supporting considerations. Operating from this platform, modern electronic equipment gains a substantial advantage in cost-effective area coverage. As applied to telecommunications, a system configured to the telephone requirements of a specific area can be fulfilled on a short term, wide application basis with the flexibility of expansion as the real growth of the area demands. A full range of direct broadcast-to-user services (TV, AM/FM, mobile radio, etc.) can be provided from the platform, blanketing an area in excess of 125,000 sq km. Further, the aerostat system can accommodate active or passive monitoring devices that have unique application to such difficult problems as control and protection of coastal areas. This paper concludes that the tethered aerostat is a unique system whose platform capability significantly enhances the use of modern electronic equipment to provide a broad range of cost-effective services with a very short time from conception to achievement of full system utilization.

(Author)

A79-42401 # Unmanned mini-blimp system. G. R. Seemann, G. J. Brown, and G. L. Harris (Development Sciences, Inc., City of Industry, Calif.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 181-186. (AIAA 79-1610)

Technology development of an unmanned (remotely piloted) mini-blimp (RPMB) during the past four years are discussed including aerodynamics, propulsion, flight control, envelope and car construction. Flight test results of two prototype systems are presented. Applications are numerous for both civil and military. This paper deals primarily with civil applications such as law enforcement, customs and immigration, pollution monitoring, and surveillance and patrol. A law-enforcement RPMB system is presented in detail including technical and operational data. Funding is required for a full scale demonstration in a civilian application before implementation in an urban area.

(Author)

A79-42402 # Determination of the natural frequency of an airship model. S. G. Sampath (Batelle Columbus Laboratories, Columbus, Ohio), G. H. Workman (Applied Mechanics, Inc., Columbus, Ohio), and W. N. Brewer (Goodyear Aerospace Corp., Akron, Ohio). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 187-191. 6 refs. (AIAA 79-1582)

In this effort the determination of the natural frequency of a lighter-than-air (LTA) vehicle design with an internal catenary system is described. The Rayleigh method, coupled with the finite-element method to obtain the assumed model shape about the large displacement static 'rigged' condition, was utilized for the frequency determination. To obtain the response of a LTA vehicle to both the initial static loadings and the analyzed displacement pattern due to the assumed dynamic loads, a finite element digital computer program was utilized. The natural frequency as calculated by the above methodology agreed well with that based on limited experimental data on LTA vehicles of this type.

(Author)

A79-42403 # Coast guard missions for lighter-than-air vehicles. K. E. Williams and J. T. Milton (U.S. Coast Guard, Conservation and Advanced Technology Branch, Washington, D.C.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 192-197. 7 refs. (AIAA 79-1570)

The Coast Guard Office of Research and Development is examining the potential of modern lighter-than-air vehicles for coastal patrol and other missions. This paper describes Coast Guard missions and responsibilities. LTA vehicles appear to fill a gap between ships and aircraft regarding speed, payload and endurance capabilities. Energy savings for certain missions may be significant. Heavy weather operations and the economic viability for LTA vehicles which would satisfy performance and environmental needs are the major areas of uncertainty. (Author)

A79-42404 # Airship dynamic stability. J. DeLaurier and D. Schenck (Toronto, University, Toronto, Canada). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 198-211. 22 refs. Research supported by the Transport Canada and National Research Council of Canada. (AIAA 79-1591)

An analysis has been developed for predicting the lateral and longitudinal dynamic stability of airships in which non-neutral net buoyancy and non-coincident mass and volumetric centers are accounted for. Also, control forces and moments act on the vehicle through static gains of its pitch and heading angles. This analysis has been applied to three example airships, including two historic designs (U.S. Navy Airships ZR-1 and ZR-4) for which comprehensive values of their geometric, inertial, and aerodynamic properties have been obtained and derived. The results from this work show that: (1) specific types of airship dynamic modes are readily identifiable for a general range of configurations; (2) the two historic airships were controls-fixed unstable in certain operational conditions. (Author)

A79-42405 # High altitude powered platform - A microwave powered airship. J. W. Sinko (SRI International, Menlo Park, Calif.). In: Lighter-Than-Air Systems Technology Conference, Palo Alto, Calif., July 11-13, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 212-218. (AIAA 79-1606)

A concept for providing a platform for communications and earth observations at an altitude of about 20 km over a station transmitting a microwave beam to power the platform's electric motors, is described. Since fuel does not have to be physically supplied to the airship, the flight duration is limited only by the need to perform maintenance on the airship and its payload. Cost estimates and environmental effects are evaluated and it is noted that in the design presented costs were minimized by balancing the costs of larger antenna sizes with the increased power costs associated with operating at a lower efficiency. Samarium-cobalt electric motors would be used for the airship while the baseline design uses ballonets (airbags in the hull). The advantages are listed particularly noting the possibility of building a direct television broadcast network. V.T.

A79-42410 Optimization of the weight of a wing with constraints on the static aeroelasticity. A. P. Seiranian. (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela*, vol. 13, July-Aug. 1978, p. 34-42.) *Mechanics of Solids*, vol. 13, no. 4, 1978, p. 29-36. 16 refs. Translation.

The paper examines the problem of minimizing the weight of an unswept wing of a flight vehicle with constraints imposed on the critical divergence and reversal velocities of the aileron. An unswept wing with a large span-chord ratio and an aileron in a gas flow is considered. The way in which the optimal solution and minimum weight depend on the parameters of the problem is analyzed. Some numerical results are reported. S.D.

A79-42423 Ilyushin 'Candid'. Air International vol. 17, July 1979, p. 42-44.

The Ilyushin Il-76 Candid is the key element in the current Soviet military air mobility enhancement program and a more

effective logistic support aircraft than the An 12 Cub, affording twice the payload and twice the range. Essentially of similar concept to the Lockheed C-141B StarLifter, with which it compares closely in size and weight, the Il-76 is 20% more powerful and capable of utilizing relatively primitive airstrips. With nominal task of transporting 40 tons of freight over 3100 miles in less than six hours, the Il-76 combines full-span slats, double-slotted trailing-edge flaps and high-liftation 20-wheel undercarriage with ample power to permit operation from short, unprepared strips. The four Soloviev D-30KP two-shaft turbofans are each rated at 26,455 lb for take-off and are fitted with clamshell-type thrust reversers. The aircraft is expected to enter service with both the long-range Aviation and the Naval Air Force as a flight refuelling tanker compatible with the Backfire, and it is serving as the basis of the new AWACS aircraft. V.T.

A79-42546 # Calculation of the working process in a piston-type 'slow' compression wind tunnel (Raschet rabocheho protsessa v aerodinamicheskoi porshnevoi trube 'medlennogo' szhatiia). A. B. Berezovskii and V. B. Panfilovich. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 3-10. In Russian.

The thermodynamic processes during the compression phase of the cycle of a piston-type slow compression wind tunnel are analyzed on the following assumptions: (1) the process is quasi-steady-state; (2) the gas is ideal; (3) the piston is massless; (4) heat exchange between the gas and the external medium is neglected; and (5) friction between the piston and wall is absent. The fundamental equations are the work equation of Leuchter (1965) and a given relation between the pressure of the working gas and the instantaneous volume. The resulting equations were numerically integrated to obtain plots of temperature and barotropic index as a function of time during compression and of the temperature of the compressed gas as a function of the pressure rise during passage of the gas through the nozzle. P.T.H.

A79-42547 # Gas curtain in gas turbine engines (Gazovaia zavesa v gazoturbinnnykh dvigateliakh). I. S. Varganov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 11-16. 13 refs. In Russian.

The use of a gas curtain in the bypass circuit of a turbofan engine permitting variation of the flow rate ratio according to flight conditions is analyzed. To achieve a ratio of pressure behind turbine to pressure behind the fan of at least 2 during thrust reversal at constant rotational speed of the high pressure rotor, it is proposed to change the operating condition of the fan by reducing the slot area relative to the area of the exit nozzle of the main circuit. A method for establishing the energetic foundation for such a process is developed. P.T.H.

A79-42549 # Study of the nonuniformity of the temperature field of a homogeneous combustion chamber as the parameters of the primary zone vary (Issledovanie neravnomernosti polia temperatur gomogennoi kamery sgoraniia pri izmeneni parametrov pervichnoi zony). O. A. Evin, V. M. Iankovskii, and I. N. Diatlov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 24-29. In Russian.

A79-42550 # Measuring the moment imparted by a liquid pump in startup regime (Izmerenie momenta peredavaemogo nasosom zhidkosti, na rezhime zapuska). N. S. Ershov, V. V. Ramodina, and V. V. Chervakov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 30-35. In Russian.

An experimental method was developed for determining the moment required by a high-speed bladed pump during transient regimes that makes use of coaxial input and output multipliers. A method for calculating the moments acting in the multipliers during startup with allowance for the friction in the supports and the inertia of the rotating masses is given. Experiments on empty and flooded pumps were performed to determine coefficients in the relationships. P.T.H.

A79-42551 # Computer calculations of steady-state temperature fields in air-cooled turbine rotor blades (Raschet na ETsVM stacionarnykh temperaturnykh polei v rabochikh lopatkakh turbin s vozdushnym okhlazhdeniem). V. I. Lokai, Iu. N. Ivan'shin, and Sh. Sh. Abdrakhmanov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 36-40. 6 refs. In Russian.

A simple engineering method using a digital computer is proposed for calculating the steady-state temperature fields in the blades of turbines with longitudinal cooling channels under variable boundary conditions pertaining to the gas and coolant with allowance for the change in cross-sectional area of the blade and the dependence of the heat conduction coefficient on temperature. The blade is divided into sections, to each of which is applied the solution of the one-dimensional heat conduction problem with matched solutions at the section divisions. P.T.H.

A79-42552 # Choice of optimal parameters for a heat exchanger with heat pipes for a gas turbine engine (Vybor optimal'nykh parametrov teploobmennika s teplovymi trubami, prednaznachennogo dlia GTD). N. V. Lokai and I. I. Mosin. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 41-46. 5 refs. In Russian.

Some means of achieving maximum degree of regeneration in a heat exchanger with heat pipes are investigated by extending some previous analysis methods for heat exchangers with intermediate heat carrier. Two conditions are found which must be satisfied in order to achieve maximum degree of regeneration: (1) the heat transmitting power of the heat pipes must exceed the heat release intensity from both the gas and air directions; and (2) two dimensionless parameters for the gas and air sides must be equal. P.T.H.

A79-42553 # Computer calculation of steady-state temperature fields in cooled turbine disks (Raschet na ETsVM stacionarnykh temperaturnykh polei v okhlazhdaemykh diskakh turbin). V. I. Lokai, V. V. Zhuikov, and R. D. Fakhrutdinov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 47-50. In Russian.

The calculation of the steady-state temperature field in a cooled turbine disk of arbitrary shape is based on the solution of the Bessel equation for a disk of constant thickness. The variable-thickness disk is divided into a series of concentric rings such that at the edges of each ring the relevant parameters can be regarded as constant, and the Bessel equation solution is worked out for each ring. An algorithm for the method is given, and some computer calculation results are presented and compared with temperature field measurements in a real disk. P.T.H.

A79-42555 # Systematization of simple structural elements of a regulated gas turbine engine nozzle (Sistematzatsiia prostykh ob'ektov konstruktsii reguliruemogo sopla GTD). I. E. Sapozhkov and E. D. Sten'kin. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 57-63. In Russian.

A systematic approach to the classification of gas turbine engine nozzle parts is based on function of the part in its module, its connection modes, surface types, type of initial forming, type of finishing, type of strength calculation, and basic shape. Such a subsystem approach reveals that in a regulated nozzle 30-70% of the parts are not subjected to strength analysis and that their shape and dimensions are determined from structural considerations, and also enables establishing the most common type of connection and the most massive shape. P.T.H.

A79-42558 # Study of mass transfer between the primary zone and secondary air jets in gas turbine engine combustion chambers (Issledovanie massoobmena mezhdyy pervichnoi zonoii i struiami vtorichnogo vozdukha v kamerakh sgoraniia GTD). V. G. Chumachenko, V. M. Iankovskii, and A. V. Talantov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 81-85. In Russian.

The oxygen excess coefficient in the primary zone of a combustion chamber depends on the amount of air reaching the primary zone from jets of secondary air. This paper is concerned with determining this amount by a combined experimental-theoretical technique for combustion chambers in which the flow pattern in the primary zone is formed by secondary flow jets of the first belt of openings. P.T.H.

A79-42559 # An approximate method for calculating a laminar boundary layer in micronozzles (Ob odnom priblizhennom metode rascheta laminarnogo pogranichnogo sloia v mikrosoplakh). F. A. Akhmed'ianova, A. A. Vaindiner, P. G. Danilaev, and N. F. Salikhov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 86-88. In Russian.

The results of a calculation of a laminar boundary layer arising during the motion of an ideal gas in microchannels by the simple method of Natalevich (1973) are compared with a finite difference solution of the transformed laminar boundary layer equations for flow in a flat Laval microchannel with thermally insulated wall and Prandtl number of unity. The Natalevich method gave good agreement with the finite difference results with regard to integral characteristics, especially the boundary layer displacement thickness, but the deviation for the velocity profile could attain 20%. P.T.H.

A79-42560 # Aerodynamic improvement of the inlet pipe of a gas turbine (Aerodinamicheskoe sovershenstvovanie vkhodnogo patrubka gazovoi turbiny). I. G. Gogolev, P. V. Korolev, Iu. D. Kudashov, V. A. Magala, and B. A. Shifrin. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 88-91. In Russian.

The velocity field, mass flow rate distribution, and stream line shapes were measured in several variants of a turbine engine with tangentially situated combustion chambers and spiral inlet. Different ways of controlling the flow were evaluated, and simple methods of obtaining flow uniformity were found. P.T.H.

A79-42562 # An analysis of air intakes in the boundary layer (Raschet vozdukhozabornykh ustroystv v pogranichnom sloe). V. T. Kalugin, T. V. Klebanova, Iu. I. Kozlov, and V. N. Koshevoi. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 93-96. 6 refs. In Russian.

A method for analyzing the parameters of air intakes operating at an altitude corresponding to the thickness of the boundary layer is presented. The distribution of the pressure at the inlet and outlet of the air intake device is analyzed as a function of the degree of throttling. The analysis shows that in the absence of air intake, a separated stagnation zone develops in front of the inlet. The size of the separated flow zone decreases with an increase in the outlet cross-section. The theoretical results have been confirmed by experimental measurements. C.K.D.

A79-42564 # Unloading the drive of gas distributor valves operating at high pressures (K voprosu o razgruzke privoda klapnov gazoraspredeleitelei, rabotaiushchikh pri vysokikh davleniakh). I. A. Krivosheev, A. M. Rusak, I. M. Urakaev, and Z. G. Shaikhutdinov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 100-102. In Russian.

By using simple gasdynamic relations it is shown possible to use the reaction of an issuing gas to unload valves whose working forces are rather large at high inlet pressure. Three valve designs are studied with respect to their static force characteristics. One valve with a spring element is shown to be best in terms of reduction of drive power. P.T.H.

A79-42565 # The amplification factor in the two-dimensional interaction between a transverse sonic jet and a supersonic flow (Koeffitsient usileniia pri dvumernom vzaimodeistvii poperechnoi zvukovoi strui so sverkhzvukovym potokom). V. I. Krishtal'. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 102-105. 9 refs. In Russian.

A79-42569 # Twisting of the blades of an axial turbine stage during tangential inclination of the nozzle blades (O zakrutke rabochikh lopatok osevoi turbinoi stupeni pri tangentsial'nom naklone soplovykh lopatok). Iu. I. Mitiushkin, A. V. Perevoznikov, and V. P. Iakovlev. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 112-115. 5 refs. In Russian.

Tangential inclination of nozzle blades in an axial turbine is an effective way to reduce the reactivity gradient along the turbine blades. This paper presents experimental results on the influence of turbine blade twist on the efficiency of axial turbines in the case of tangential inclination of nozzle blades; investigations were conducted at nozzle outlet velocities of $M = 0.48-0.5$ and nozzle outlet Reynolds numbers of 500,000 to 570,000. B.J.

A79-42570 # Through-heating of chambers with regenerative cooling (O progreve kamer s regenerativnym okhlazhdeniem). V. V. Orlov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 115-117. In Russian.

A one-dimensional heat propagation model was used to investigate the through-heating of engine combustion chambers with regenerative cooling during the process of engine startup. Chambers of different design were analyzed and the results identified some characteristics of thermal loading which affect the stress-strain state of chamber structural elements. It is shown that pressure changes in the chamber have a substantial effect on the intensity of through-heating of the most thermally stressed structural elements. B.J.

A79-42571 # Study of the dispersity of oil droplets which form in the oil-system mains of gas-turbine engines (Issledovanie dispersnosti kapel' masla, obrazuiushchikhsia v magistraliakh maslianykh sistem GTD). P. G. Petrov and O. A. Povarov. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 117-119. In Russian.

A79-42572 # Nonstationarity of heat transfer in the blade cascade of an axial-flow turbine during engine start-up (O nestatsionarnosti teploobmena v turbinoi osevoi lopatochnoi reshetke pri zapuske dvigatelja). A. M. Poliakov, V. S. Petrovskii, and V. I. Krichakin. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 119-123. In Russian.

In the thermal design of gas-turbine elements, it is conventionally assumed that the heat transfer coefficients are independent of the nonstationarity of the heat transfer process. In the present paper, the time dependence of the coefficient of local heat transfer at the surface of the rotor blades of an axial-flow gas-turbine is determined on the basis of temperature measurement during start-up of the engine. V.P.

A79-42574 # A pneumatic distributor for the control system of a turbojet engine (Pnevmozaspreditel' sistemy upravleniia TRD). M. G. Khabibullin. *Aviatsionnaia Tekhnika*, vol. 22, no. 1, 1979, p. 126, 127. In Russian.

A pneumatic distributor developed for the thrust reverser control system of the NK-8-2U turbojet engine used in the TU-154 is described. The load bearing rings are made of metallographite which acts as a lubricant for the contact surfaces. The distributor partition is significantly thinner than the load bearing rings, a design feature which reduces the driving stroke of the sleeve valve and the overall dimensions of the distributor. C.K.D.

A79-42624 Estimation of fatigue life of Al-alloy used for compressor disc of jet engine. H. Minata and H. Nakamura (Kawasaki Heavy Industries, Ltd., Technical Research Laboratory, Akashi, Japan). *Japan Society of Materials Science, Journal*, vol. 28, Apr. 1979, p. 272-277. 21 refs. In Japanese, with abstract in English.

The life of gas turbine engine compressor and turbine disks made of Al alloy 2014-T6 at 120 C and combined stress of 21-22 kg/sq mm was estimated on the basis of creep rupture data at 212, 400, and 600 F. The creep rupture curves were obtained from the Larson-Miller curves. Time-strength diagrams were plotted including static creep, intermittent creep, and push-pull wave with hold time. P.T.H.

A79-42799 # Calculation of rotor impedance for articulated-rotor helicopters in forward flight. K. Kato (Tokyo, University, Tokyo, Japan) and T. Yamane. *Journal of Aircraft*, vol. 16, July 1979, p. 470-476. 5 refs.

A procedure is presented to calculate the loads transferred from an articulated flexible rotor to the fuselage when the hub is forced to oscillate sinusoidally. Blade motions are determined from a set of linear algebraic equations derived from equations of motion with periodic coefficients. The aerodynamic loads are based on two-dimensional quasisteady strip theory and the effect of preceding and returning wakes as well as the reversed frequency flow are neglected. Sample calculations indicate that: 1) the major components of impedances with hub-forcing frequency predominate over those with interharmonic coupling frequencies; 2) the former impedances do not depend on the blade azimuth angle relative to the hub excitation phase; and 3) the former impedances are similar to those obtained in hovering flight. (Author)

A79-42800 * # Simulation study of the operational effects of fuel-conservative approaches. L. Tobias, E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.), and P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.). *Journal of Aircraft*, vol. 16, July 1979, p. 498-505. 5 refs.

Fuel-conservative procedures have been investigated using real-time air traffic control simulations linked to two piloted simulators. The fuel-conservative procedures studied were profile descents and two types of landing approaches, delayed flap and IATA. The investigation determined the effect of these procedures on the ATC system operation. It examined the mixing of aircraft executing fuel-conservative approaches with those executing conventional approaches. The most difficult approach type mix of traffic was found to be 50% conventional and 50% delayed flap. However, for the test scenario chosen, arrival rates of at least 30 aircraft per hour were feasible and resulted in a net average fuel saving, even for the most difficult mix. Also, there is a fuel savings and reduced controller workload for the profile descent procedures. (Author)

A79-42806 Modeling of turbulent wakes in ideal fluids. S. M. Belotserkovskii and M. I. Nisht. *Fluid Mechanics - Soviet Research*, vol. 7, Jan.-Feb. 1978, p. 102-115. 15 refs. Translation.

A model of turbulent wakes, produced in separated flow of an ideal fluid over bluff bodies (airfoils), is described. The final pattern of the flow with separation is defined from an analysis of the entire process leading to its formation. It is assumed that tangential discontinuity surfaces that move together with the perturbed flow are shed from the sharp edges and inflections of the airfoil surface. It is also assumed that the Chaplygin-Zhukovskii finite-velocity hypothesis is satisfied on these edges and inflections, while the impermeability condition is satisfied over the entire airfoil surface. The problem is solved by the method of discrete vortices. Fields of average and fluctuating velocities and pressures, as well as the principal statistical properties of the turbulent flow are calculated from the computed intensity and location of vortices in the wake. The structure and principal characteristics of flat, axisymmetric and three-dimensional wakes are described. The effectiveness of the approach herein described is proved by comparison with experimental data. Certain examples of computed statistical properties of the flow are also given. (Author)

A79-42891 Measurement of heat transfer rate to turbine blades and nozzle guide vanes in a transient cascade. T. V. Jones, D. L. Schultz, M. L. G. Oldfield, and L. C. Daniels (Oxford University, Oxford, England). In: *International Heat Transfer Conference*, 6th, Toronto, Canada, August 7-11, 1978, General Papers. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1978, p. 73-78. 7 refs. Research supported by the Science Research Council, Ministry of Defence (Procurement Executive), and Rolls-Royce Ltd.

A heat transfer measurement technique is described which enables complete heat transfer distributions to be determined on turbine blades at representative full-scale engine conditions. A new form of short-duration wind tunnel is used for these tests, and the instrumentation for this transient experiment is described. Typical heat transfer distributions are presented and discussed. The transient method shows advantages over other techniques in terms of tunnel power requirements, model construction and accuracy of measurement of heat transfer rates. S.D.

A79-42892 **The influence of longitudinal pressure gradient and turbulence of the flow upon heat transfer in turbine blades.** L. M. Zysina-McClozhen, M. A. Medvedeva, and E. G. Rohst. In: International Heat Transfer Conference, 6th, Toronto, Canada, August 7-11, 1978, General Papers. Volume 2. Washington, D.C., Hemisphere Publishing Corp., 1979, p. 79-84. 10 refs.

Results are presented for an experimental study on the local values of heat transfer coefficients outside an airfoil profile in the presence of a transonic flow with different degrees of turbulence in an airfoil cascade inlet. The discussion covers heat transfer at the leading edge of a blade, heat transfer of convex profile surfaces, heat transfer of concave profile surfaces, and relaminarization of the turbulent boundary layer. Empirical equations for heat transfer calculations are presented. S.D.

A79-42971 **Numerical methods for solution of radiative-convective heat transfer problems - Radiative boundary layer.** M. V. Brykin (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). In: International Heat Transfer Conference, 6th, Toronto, Canada, August 7-11, 1978, General Papers. Volume 3. Washington, D.C., Hemisphere Publishing Corp., 1978, p. 397-401.

New rapid iterative methods are proposed for solving the problem of radiative-convective heat transfer in the vicinity of the stagnation point of a blunt body traveling at hypersonic speed through dense atmosphere. The proposed methods allow problem solving for any optical thickness of a radiating volume. It is shown that the radiant thermal conductivity approximation enables one to describe correctly the flow structure and to determine the radiation flux with an error no more than 10%. Simple relations for radiation flux on the surface are established. Flow regimes are shown to exist when the radiation mean free path exceeds the boundary-layer thickness, in which case the thermal conductivity approximation is no more valid. S.D.

A79-42981 **Regenerator matrices for automotive gas turbines.** C. W. Rapley (Sunderland Polytechnic, Sunderland, England). In: International Heat Transfer Conference, 6th, Toronto, Canada, August 7-11, 1978, General Papers. Volume 4. Washington, D.C., Hemisphere Publishing Corp., 1978, p. 201-206. 21 refs.

A recently developed compact passage-type regenerator matrix is described and the heat transfer and pressure-drop performance reported. The heat transfer performance was obtained with the single blow technique using a new test rig, the features of which are discussed. A brief review is made of the evolution of the single blow technique and the various evaluation procedures that can be used. An attempt is made to compare the performance of different types of regenerator matrix using the available published data in a way that is particularly applicable to automotive gas turbine regenerators. This comparison indicates the range of overall matrix parameters that should lead to effective automotive gas turbine regenerator matrix design. (Author)

A79-42989 **Radiating laminar boundary layer flow over a flat plate at a large free-stream Mach number.** S. P. Venkateshan and K. Krishna Prasad (Indian Institute of Science, Bangalore, India). In: International Heat Transfer Conference, 6th, Toronto, Canada,

August 7-11, 1978, General Papers. Volume 5. Washington, D.C., Hemisphere Publishing Corp., 1978, p. 203-208. 16 refs.

The basic theory of flow over a flat plate in the presence of both radiation and large freestream Mach numbers is formulated. It is shown that radiation Knudsen numbers, Boltzmann numbers, and Mach numbers are the three parameters that characterize the radiating flow and that the Boltzmann number is important for determining the effects and regimes of radiation interaction. Consideration is given to the case of equal wall and freestream temperatures and the dominant radiation interaction in a weak shock limit. No radiation heat flux is observed at the wall. It is noted that the larger the Eckert number the larger is the effect of interaction and that the interaction results in a general reduction of the temperature throughout the boundary layer which itself is optically thin. V.T.

A79-43135 # **Obtaining solutions of the lifting-surface equation (K nakhozhdeniiu resheniia uravneniia nesushchei poverkhnosti).** V. V. Dykhata. *Prikladnaia Matematika i Mekhanika*, vol. 43, May-June 1979, p. 475-479. In Russian.

In the present paper, the basic two-dimensional singular integral equation of the linear theory of thin airfoils of arbitrary aspect ratio and planform is reduced, by means of a number of artificial devices, to certain homogeneous Riemann boundary value problems that are amenable to solution in terms of Cauchy integrals. The results are analyzed for a lifting surface moving at a constant velocity along a straight line in an unbounded medium. V.P.

A79-43136 # **Region of a plane pointed profile in supersonic flow (Okrestnost' ploskogo zaostreniia pri sverkhzvukovom obtekanii).** Iu. B. Radvogin. *Prikladnaia Matematika i Mekhanika*, vol. 43, May-June 1979, p. 480-488. 6 refs. In Russian.

The present analysis deals with the local structure of the supersonic flow of an inviscid nonheat-conducting gas past a pointed profile. It is assumed that the shock wave is attached to the leading edge. The problem is linearized with respect to the flow past an infinite wedge. This leads to a boundary value problem 'in a corner'. A solution is obtained in explicit form, and its properties are studied. V.P.

A79-43153 # **Fast-acting valves for use in shock tubes. II - Formation of shock waves.** T. Ikui, K. Matsuo, and Y. Yamamoto (Kyushu University, Fukuoka, Japan). *JSME, Bulletin*, vol. 22, May 1979, p. 693-699. 10 refs.

In the previous paper (1977), two types of quick-response valves (type-V and type-H) were developed and their characteristics discussed. In the present paper, the type-H valve is used in a shock tube and investigated experimentally in order to assess the intensity of shock waves generated by the opening of the valve, along with the correlation between shock formation distance and the opening time of the valve. Also, experiments with a cellophane diaphragm are carried out, with all operating conditions remaining unchanged. It is shown that when the initial pressure ratio is relatively small, the valve produces as strong a plane shock wave as the conventional diaphragm shock tubes, although the shock Mach numbers are less than those produced by the breaking of diaphragm at a larger initial pressure ratio. The shock formation distance is nearly proportional to the product of the maximum shock Mach number along the tube axis and the opening time of the valve or the diaphragm. S.D.

A79-43166 # **Theoretical and experimental investigation of the aerodynamic characteristics of three-dimensional bodies (Teoreticheskoe i eksperimental'noe issledovanie aerodinamicheskikh kharakteristik prostranstvennykh tel).** A. A. Gusarov, V. M. Dvoretiskii, M. Ia. Ivanov, V. A. Levin, and G. G. Chernyi. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1979, p. 97-102. 11 refs. In Russian.

The present analysis deals with the problem of designing the aerodynamic configuration of flight vehicles in accordance with their

intended operational conditions. The analysis is centered on the aerodynamic configuration of nose cones smoothly fitted to midsections of arbitrary shape, and on the determination of the type of surfaces capable of meeting this requirement. The drag characteristics of ruled surfaces of special shape are studied. V.P.

A79-43172 # Experimental investigation of the aerodynamic drag of simple bodies in two-phase flow (Eksperimental'noe issledovanie aerodinamicheskogo soprotivleniia prostykh tel v dvukhfaznom potoke). B. A. Balanin and V. V. Zlobin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1979, p. 159-162. In Russian.

In the present study, the drag of steel models in the form of plates, spheres, cylinders, cones, and wedges was studied in a wind tunnel at flow velocities of up to 200 m/sec. All measurements were made at zero incidence. The medium employed was air with suspended particles of abrasive powder. Plots of the drag coefficient versus powder concentration are given and discussed. V.P.

A79-43174 # Deformation of a shell under the influence of a supersonic gas flow (Deformatsiia obolochki pod vozdeistviem sverkhzvukovogo potoka gaza). N. M. Beliaev and V. K. Khrushch. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1979, p. 165-168. 6 refs. In Russian.

The effect of static deformation of a conical or wedge-shaped shell on its aerodynamic resistance in a supersonic gas flow is analyzed. The shape of the deformed surface is initially unknown but is obtained simultaneously with the numerical solution of the gas dynamics equations. The influence of the thickness of the shell and of the dimensions of its midship cross-section on the increase in wave resistance caused by the deformed surface is examined. It is shown that deformation of a shell can significantly increase its wave resistance. For an aircraft flying at Mach 4 at an altitude of 10 km incorporating a conical shell 1 m long and 5.3 mm thick with a mid-ship cross section of 0.488 m, made of a material with a Young's modulus of 20×10 to the 10th N/sq m, the wave pressure is increased by 30%. C.K.D.

A79-43223 Experiments on an aerofoil at high angle of incidence in longitudinal oscillations. C. Maresca, D. Favier, and J. Rebont (Aix-Marseille I, Université, Marseille, France). *Journal of Fluid Mechanics*, vol. 92, June 27, 1979, p. 671-690. 12 refs. Direction Technique des Constructions Aéronautiques Contract No. 76/98214-00481-7586.

An investigation into unsteady flow phenomena associated with a wing in motion parallel to a uniform subsonic airstream at fixed incidences involved torsion dynamometric measurements, smoke-filament visualization, pressure and skin friction measurements, and hot-wire anemometer measurements. For large incidences, the mechanism of dynamic reattachment of the boundary layer over part of the period, followed by a vortex shedding process, is observed and analyzed. Unsteady effect on the time histories of pressure and skin friction distributions, aerodynamic forces, and pitching moment are also studied. An empirical formula concerning the averaged lift over a period is obtained as a function of the reduced amplitude and frequency for a wide range of angles of incidence below and above the angle of static stall. Optimization of the favorable unsteadiness effect on the mean lift coefficient is also discussed. P.T.H.

A79-43241 YC-14 thermoplastic/graphite elevator. E. E. House (Boeing Aerospace Co., Seattle, Wash.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 201-216.

Interest in thermoplastic matrix composites is on the upswing because of their cost-reduction potential over more commonly used

high-performance composites, such as the graphite/epoxies. To demonstrate the advantages and manufacturing capabilities of the thermoplastic matrix composites, full-size elevator boxes for the YC-14 AMST aircraft were fabricated. These parts have a span of 19 feet and a maximum chord of 18 inches. Two resin systems were used: P-1700 polysulfone and PKXA. The latter is an end-capped polysulfone. Graphite fabric was selected as the reinforcement because of its superior handling characteristics compared with unidirectional graphite. The molding processes evaluated included autoclave consolidation of prepreg into sheet stock, forming and fusing of prepreg plies to preconsolidated sheet stock, autoclave forming and consolidation, and matched die molding. (Author)

A79-43243 * Fabrication research for supersonic cruise aircraft. E. L. Hoffman, T. T. Bales (NASA, Langley Research Center, Materials Div., Hampton, Va.), and L. Payne (Lockheed-California Co., Sunland, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 232-241.

Advanced fabrication and joining processes for titanium and composite materials are being investigated by NASA to develop technology for the Supersonic Cruise Research (SCR) Program. Full-scale structural panels are being designed and fabricated to meet the criteria of an existing integrally stiffened shear panel on the upper wing surface of the NASA YF-12 aircraft. The program consists of laboratory testing and Mach 3 flight service of full-scale structural panels and laboratory testing of representative structural element specimens. Borsic/aluminum honeycomb-core, titanium clad Borsic/aluminum skin-stringer, graphite/PMR-15 polyimide honeycomb-core, and titanium superplastically formed/diffusion bonded panels have been designed, fabricated, and tested. Graphite/LARC-160 polyimide skin-stringer panels have been designed, and fabrication methods are being developed. (Author)

A79-43244 C-141 hybrid composite leading edge. C. W. Schneider (Lockheed-Georgia Co., Marietta, Ga.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 242-251. USAF-sponsored research.

A program to demonstrate the production readiness of a hybrid composite for the C-141 leading edge and provide flightworthy structure for service evaluation is described. Cost comparisons with aluminum honeycomb structures showed that significant life cycle cost reductions are possible. The composite leading edge was designed to meet the same criteria as the honeycomb component, and is fabricated from unidirectional tape graphite/epoxy and fiberglass/epoxy fabric. Design and manufacturing details are described, noting that the rib mandrels were made of the Dapco No. 1 'Blue' castable rubber to overcome the shrinkage effects on the rib longitudinal direction when using black tool rubber mandrels. The composite leading edge weight is 10 lbs higher than that of the honeycomb due to the conservative design restricting edge deflection, but the relaxation of this criteria can yield significant weight reduction since each fiberglass skin ply accounts for 9 lbs. A.T.

A79-43245 Fabrication of thick graphite/epoxy wing surface structure. L. E. Meade (Lockheed-Georgia Co., Marietta, Ga.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 252-259. 8 refs.

The fabrication of thick structural laminates from Narmco 5208/T300 graphite/epoxy prepreg has presented problems of dimensional and void content control. This paper describes the fabrication process development conducted on Laminar Flow Con-

trol wing surfaces for passenger transport applications to achieve thick laminates of high quality. The steps addressed include prebleeding, layup, tooling aids, and curing to achieve the required laminate quality. (Author)

A79-43253 **Overage indicators for prepreg products.** Z. N. Sanjana (Westinghouse Research Laboratories, Pittsburgh, Pa.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 330-341. Contract No. N00019-77-C-0247.

Prepreg products consist of a partially reacted mixture of monomers which have been impregnated into the reinforcement. During shipping and storage, prior to use, the reactions will continue. The amount of reaction or 'age' of the prepreg will depend on the conditions (principally, temperature and time) that it has been exposed to. These conditions are often unknown. At a point in the age of the prepreg, some critical property or properties will deteriorate. This would then represent the end of the useful life of the prepreg. The critical property will often depend upon the material and the end use intended for the prepreg. The overage indicator is a measurement which monitors the age of the prepreg and correlates well with the loss of the critical property. This paper presents data and results of aging studies performed on Hercules 3501-6/AS graphite epoxy prepreg. During the aging, the following methods were used successfully to track the age of the prepreg: (1) dielectric analysis, (2) dynamic mechanical analysis, and (3) a time-temperature integrating device which is carried with the prepreg and provides a visual observation of the time and temperature exposure of the prepreg. (Author)

A79-43257 **Non destructive evaluation /NDE/ of impact damage in thick graphite composite aircraft structures.** W. H. Sheldon (Northrop Corp., Aircraft Div., Hawthorne, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 372-376.

Graphite composites are vulnerable to damage resulting from impact by hard objects with low velocity. The effect of this impact causes severe internal damage to the structure with little or no visual surface indications. Various impact damaged panels were nondestructively tested to assess damage. A field test was developed using a portable ultrasonic thickness tester. (Author)

A79-43261 **The structural effects and detection of variations in Hercules 3501-5A and Avco 5505 resin systems.** H. Borstell (Grumman Aerospace Corp., Bethpage, N.Y.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 422-445. USAF-supported research.

The effects of resin variations on the structural properties of Hercules 3501-5A graphite-epoxy and Avco 5505-4 boron/epoxy resin systems were analyzed. Prepreg tapes containing resin with known variations were prepared with production processes, tension and compression tested after saturation at 150 F and 82% relative humidity, and constant amplitude fatigue tested with the laminate oriented to emphasize matrix dominated properties. The resin and prepreg samples were analyzed with infrared spectroscopy, liquid chromatography, differential scanning calorimetry, and dynamic dielectric analysis. The laminate and analytical data were correlated, showing that the structurally unacceptable variations can be detected by chemical analysis, and that the majority of the variations are prevented by resin suppliers quality controls. Thus, it is feasible to prepare matrix specifications with chemical analytical requirements to screen out structurally undesirable resin variations. A.T.

A79-43264 **Chemical analysis of advanced composite prepreps and resins.** A. A. Wickham, D. D. Rice, and R. J. DuBois (Hercules, Inc., Aerospace Div., Magna, Utah). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 506-521.

A rapid and precise chemical analysis system is described for amine-cured, epoxy-based advanced composite prepreps and resins. Infrared, liquid chromatographic and other analytical methods are proposed for determination of the 'as built' and 'free' components of the resin as well as for the degree of resin advancement in Hercules composite systems. Typical recovery data and the relative precision of the analytical methods is presented. (Author)

A79-43269 **Recent advances in fire resistant materials in aircraft construction.** H. M. Deutsch (Aircraft Products Co., Anaheim, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 575-589. 5 refs.

Silicone polymers, their fire resistance, low by-product toxicity, and usefulness for aircraft construction materials are reviewed. Silicone structure and behavior during heating, decomposition, and ignition are discussed, noting that they produce nonflammable silicone dioxide, high thermal insulation carbonaceous chars, and condensed silica which drastically reduce flame spread. Silicone polymer applications include seals, acoustic curtains, firewall sealants, and wire insulation, and their mechanical properties as a function of temperature are compared with organic elastomers. The test methods related to aircraft materials are classified, noting that the Steiner tunnel method performs burning tests reliably and simply, and also measures smoke emission, dripping, and after burning characteristics. A.T.

A79-43270 **Special sandwich constructions for the interior of commercial aircraft.** J. Kummer and H. Schellstede (VFW-Fokker GmbH, Bremen, West Germany). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 590-598.

Fiberglass reinforced phenolic resin skin and a polymethacrylimide rigid-foam core sandwich was tested for suitability for the interior of commercial aircraft. Tests showed that fire safety requirements, flammability, smoke density and toxicity are met by the composite, which also provides good heat insulation with sound insulation equal to that of a comparable honeycomb sandwich. The strength is adequate for several components, and the core filling material can be eliminated to produce weight and labor savings. The technique is of rigid foam sandwich construction was demonstrated by the manufacture of a window panel. A.T.

A79-43271 **Aircraft passenger seat material development for airline fire safety.** E. L. Trabold (Douglas Aircraft Co., Long Beach, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 599-610.

A program to establish a basic data base for selection of improved fire-resistant aircraft passenger seat materials is described. The individual material screening program is briefly outlined. The functional layers of future seat designs are identified and related key

requirements suggested. The main focus is on heat-release-rate determinations for multilayer specimens. Selected materials for multilayer tests are described and test results reported herein.

(Author)

A79-43272 * **Effects of boron and glass hybrid epoxy-composites on graphite-fiber release in an aircraft fire.** S. S. Tompkins and W. D. Brewer (NASA, Langley Research Center, Hampton, Va.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 620-630.

Recent studies have shown that the benefits gained by using graphite-epoxy composite structures may not be realized without some risk. The graphite fibers are very good electrical conductors and fibers released into the environment during a fire create a possible hazard to electrical equipment. Several graphite-epoxy hybrids were exposed to a fire and simulated explosion and their graphite fiber retention characteristics were examined. Several low melting-temperature glasses which wet and clump graphite-fibers and a glass/graphite fabric which reduced impact damage were identified as promising hybridizing components to minimize graphite fiber release.

(Author)

A79-43273 **Elimination of friction induced thermal cracks in landing gear components.** H. E. Fewtrell (Lockheed-California Co., Structures Div., Burbank, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 631-637.

Tests indicating that the thermal properties of bearing materials are more significant in controlling transient temperature spikes than mechanical properties in inducing thermal cracks in landing gear components are reported. High and low strength aluminum bronzes and a beryllium copper alloy were subjected to bearing pressures and velocities of the landing gear of a wide bodied commercial transport in a test rig. Test considerations are discussed with respect to size effects, thermal time constants, and metallurgical features required to simulate operational conditions which initiate thermally induced cracks in chrome-plated high strength steel landing gear components. It was concluded that the interfacial temperature was substantially lower with beryllium copper, and it prevented hot-spotting and thermal cracking of the bearing surface. It was also shown that an epoxy-phenolic bonded solid lubricant coating on the chromium plated surface prevented the triggering of cumulative damage and high interfacial temperature spikes.

A.T.

A79-43276 **Demonstration of an improved method for repair of bonded aircraft structure.** R. E. Horton (Boeing Co., Seattle, Wash.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p.659-668. 13 refs.

This paper describes work that was done to demonstrate the practical application of bonded repair procedures that provided significantly improved environmental durability. Results of the work led to the recommendation of the phosphoric acid nontank anodize process for surface preparation of aluminum for bonded repairs. The repairs were accomplished under both on-the-aircraft and off-the-aircraft conditions. The repairs were nondestructively and destructively evaluated, including examination of the bond surfaces with a scanning electron microscope.

(Author)

A79-43277 **Material developments for airline safety - Impact on the safety of ground maintenance employees.** W. C. Applegate, J. J. Brenneman, and D. Rush (United Airlines Maintenance Operations Center, San Francisco, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the

Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 1. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 669-674.

Health, safety, and fire protection of personnel and equipment from chemicals used in aircraft maintenance are discussed. Control of potential hazards including education on the adverse effects of chemicals on the body, protective devices such as respirators and safety glasses, ventilation, and substitution of less hazardous materials are considered. Industrial hygiene aspects covering exposure to hazardous solder fumes, carcinogens, talc and asbestos packed inflatable rafts, and poisonous organic solvents are described. Finally, fire protection and control documentation are outlined, and it is concluded that material suppliers and specification writers should provide for the safety aspects of raw materials as they affect the user.

A.T.

A79-43314 **Structural adhesive bond repair of aircraft flight control surfaces.** M. H. Kuperman (United Airlines Maintenance Operations Center, San Francisco, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1126-1139. 5 refs.

The repair techniques for aircraft metal-honeycomb adhesive bonded structures are reported. Adhesives and surface preparation are discussed, noting that most honeycomb bonded flight control surfaces consist of 2024T3 or 7075T6 clad aluminum skins joined with 250-350 F adhesives. Failure modes are described, with almost all of the deteriorated structures delaminated and corroded, necessitating the adoption of phosphoric acid anodizing of the aluminum surfaces. Repair techniques are classified into six categories, from the partial repairs with a heating blanket and a vacuum bag, an autoclave when time constraints do not allow anodizing and corrosion inhibiting priming, to full reconditioning with acid etching, anodizing, and priming. The rebuilding of a structure is illustrated by a description of all steps in the repair of a delaminated and corroded spoiler, noting that the same steps are used for other parts such as flaps and aileron tabs.

(Author)

A79-43315 **The repair of adhesively bonded aircraft structures using vacuum pressure.** K. B. Armstrong (British Airways, Heathrow Airport, Middx., England). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1140-1187. 16 refs.

The use of vacuum pressure for repair of adhesively bonded metal/metal and metal/honeycomb structures is reported. The test program covered the effects of vacuum pressures on lap shear tests to determine the minimum acceptable pressure, the effects of cure cycles on adhesives, and the properties of the fabric interlayer between the adhesive and the honeycomb which allows extraction of air from the honeycomb to ensure a positive bonding pressure. Metal/metal bonding of doublers to skins was done with a 120 C curing film adhesive at vacuum pressures from zero to 11 psi, showing that it could be cured 4 times. Metal/honeycomb bonding with a 120 C film under the 10 psi vacuum pressure showed that with a fabric interlayer this method can be used to bond thin, flat, or single curvature aluminum, steel, or titanium skin/honeycombs. Finally, the effects of nylon, acrylic, and Terylene, woven and non-woven, mono and multifilament fabrics, and their percentage open space and yarn surface areas are discussed.

A.T.

A79-43317 **Aircraft service experience of bonded assemblies prepared with phosphoric acid anodized prebond surface treatment.** D. B. Arnold and J. C. McMillan (Boeing Co., Seattle, Wash.). In: The enigma of the eighties: Environment, economics,

energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1200-1210. 7 refs.

Tests of prebond phosphoric acid anodized (PAA) aluminum aircraft structures are reported. PAA and its advantages which led to the three test programs undertaken prior to its production use are discussed. Various PAA treated panels, including fin closure, body skin, trailing edge, and stringer were installed on the 727 and 737 models and served over 4 years without degradation. The empennage primary structure of the prototype YC-14 aircraft used PAA treated aluminum sandwich panels for 2 years without bond failures, and PAA treated aluminum spars and fittings bonded to graphite reinforced composites to produce model 737 spoilers were tested without premature bond failures. A.T.

A79-43320 Applications of metal-matrix composites, the emerging structural materials. L. Rubin (Aerospace Corp., Materials Sciences Laboratory, El Segundo, Calif.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1236-1249. 11 refs.

Applications, development, benefits, and costs of metal-matrix composites (MMC) are reviewed. The properties of the MMCs, including high temperature strength, structural rigidity, dimensional stability, high thermal conductivity, low thermal expansion in the fiber direction, and the high specific stiffness are discussed. Characteristics of reinforcing fibers including boron, boric, graphite, alumina, and silicon carbide are described, noting that materials with the tensile modulus greater than 50 million psi prove most useful. Boron-aluminum composites are used in the Space Shuttle airframe, the aft pylon skin in the DC-10, and the wing rib of the B-1 bomber. Graphite fibers are the most widely used reinforcement materials in MMCs, and graphite-aluminum composites are studied for the Army helicopters, tanks, and assault bridges and Navy foils, skins, ducts, and fuel tanks for tactical missiles. Finally, the mechanical properties and costs of the MMC materials fabricated as representative structures are summarized. A.T.

A79-43331 Hybrid Wing Box structure. G. L. Bailey and G. E. Kuhn (Vought Corp., Dallas, Tex.). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1372-1381.

This paper presents the results of the recently completed Laminated Hybrid Wing Box program. The study, sponsored by the Air Force Flight Dynamics Laboratory, involved the development of preliminary designs, and fabrication and test of structural segments of a hybrid (composite/metallic) wingbox for the F-16 Air Combat Fighter. It resulted in a structurally acceptable design with projected weight and cost savings of 7% and 12% as compared to the baseline F-16 configuration. The hybrid design utilized a graphite/epoxy lower skin with integral spar caps and bonded laminated aluminum spars and upper skin. (Author)

A79-43332 High tip speed/FOD resistant boron-aluminum fan blades. R. T. Debski (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) and D. R. Beeler (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: The enigma of the eighties: Environment, economics, energy; Proceedings of the Twenty-fourth National Symposium and Exhibition, San Francisco, Calif., May 8-10, 1979. Book 2. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1979, p. 1382-1404.

Results are presented on the development of a composite blade for the F100 engine first stage fan. The design of the all composite, shroudless blade features an all radial boron fiber construction in an aluminum matrix with a titanium outer sheath and a curved root attachment. Six blades each were fabricated by two different methods representative of an all composite blade along with six blades to the APSI spar-shell concept. Screening tests will subject the three blade types to single blade structural and foreign object damage tests. (Author)

A79-43436 Analysis of plume rise from jet aircraft. R. Yamartino, J. Lee, S. Bremer (Argonne National Laboratory, Argonne, Ill.), D. Smith, and J. Calman (Environmental Research and Technology, Inc., Lexington, Mass.). In: Symposium on Turbulence, Diffusion, and Air Pollution, 4th, Reno, Nev., January 15-18, 1979, Preprints. Boston, Mass., American Meteorological Society, 1978, p. 630-635. 11 refs. FAA-USAF-supported research.

The ensemble-fit method was used to analyze measurements of the CO exhaust plume from taxiing B707 and B727 aircraft obtained in the monitoring program at Dulles International Airport. Results suggest that the rise of these horizontally injected, buoyant plumes is not consistent with the 2/3 power relation obtained by Slawson and Csanady (1967) over the distance range of 65 to 165 m; however, large event by event deviations from this average behavior give rather poor correlations between predicted and observed pollutant concentrations. The average ensemble value of h determined in the present study is about one-half the value found from the relation $1.6 F$ to the $1/3$, where the total buoyancy flux (F) of the taxiing aircraft is approximately 150 m to the 4th/sec to the 3rd. (Goldberg, 1978). The plume rise delay time is found to be significant. C.K.D.

A79-43456 The hydrofoil sea-plane as high-speed naval craft. K. H. Harbaugh. *Hovering Craft and Hydrofoil*, vol. 18, May 1979, p. 8-10. 5 refs.

A vehicle, (basically a seaplane) that is not dependent on continued operation at or in close proximity to the air water interface of the sea which incorporates a single hydrofoil for performing landing and takeoffs in high sea states is described. The performance of seaplanes in waves is found to be drastically improved through the employment of a heavily loaded element such as a hydrofoil or a hydroski, achieving localization of large hydrodynamic forces while providing an energy absorbing stroke over the length of its strut. Design considerations and performance in overload conditions are discussed, and it is found that the use of a hydrofoil produces a reduction in landing load 'g' factors of up to 70%. The possible use of the combined system of a hydrofoil and a seaplane as a high speed naval vehicle is considered concluding that such a system offers the best solution for a vehicle suitable for ASW and search and rescue missions. C.F.W.

A79-43457 Winglets are no drag. *Aviation Engineering and Maintenance*, vol. 3, June 1979, p. 6, 8, 9.

The first application of winglets in the production of commercial aircraft is analyzed, noting reduced drag and a correspondingly reduced fuel flow as the most significant gains. It is determined that a winglet equipped aircraft can climb to 50,000 ft in approximately 12 minutes and due to a long wingspan, exhibit superior takeoff performance and a reduced takeoff distance of 26%. The key effect of winglets is that an increase in aspect ratio and reduced drag is produced. Stability and control as well as drag polar comparisons are analyzed in detail and one of the most beneficial effects of winglets is its sideslip maneuverability. At sideslips beyond 8 degrees though the forward wing stalls and causes a large stabilization moment, which slows the forward wing, swinging the aircraft back in line with the direction indicated by its nose. C.F.W.

A79-43458 Fly-by-light. R. Cotta. *Aviation Engineering and Maintenance*, vol. 3, June 1979, p. 30-32.

The Hydra-Optic Servo System, (developed by Bertea Corp.) and also known as fly-by-light, is an aircraft control system that transmits signals over optical fiber guides using light impulses. The uniqueness of the system consists in the fact that the electrical power to receive and process the signals is generated hydraulically at the control surface actuators, allowing servo loop closure and control electronics to be housed completely within the actuator. The conductively sealed actuator eliminates problems caused by electromagnetic interference, radio frequency interference and lightning strikes. Attention is given to the flowcharts of the hydra-optic system and the remote control system and hydraulics. The latter is examined in detail, dealing mainly with its application on a conventional aircraft. C.F.W.

A79-43469 Garrett ATF 3. M. Hirst. *Flight International*, vol. 115, July 14, 1979, p. 108-112.

The Garrett ATF 3, a turbofan for business jets, is examined. The engine layout is described, which places engine accessories at the rear, and uses eight diffuser boxes to spill core gases into the fan flow. In addition, the engine is a three shaft design in which the fan is driven by the intermediate-pressure turbine. Thus, the engine is believed to be highly efficient in spite of an internal gas path of twice the engine length. Overall losses are considered negligible because the 180 deg bends in the core exhaust only affect 25% of the total mass flow. While the diffuser boxes probably cause backpressure it is noted that they are effective silencers. In the HU-25A Guardian the engine will be rated at 5,050 lb thrust at takeoff. Finally, simplified maintenance is claimed as a result of the unusual layout. M.E.P.

A79-43499 Hovering impulsive noise - Some measured and calculated results. D. A. Boxwell, Y. H. Yu, and F. H. Schmitz (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *Vertica*, vol. 3, no. 1, 1979, p. 35-45. 12 refs.

In-plane impulsive noise, radiating from a hovering model rotor has been measured in an anechoic environment. The hover acoustic signature was compared with existing theoretical prediction models and with previous forward flight experiments using the same model rotor. These hover tests showed good experimental consistency with forward flight measurements, both in pressure level and waveform character over the range of Mach numbers tested (0.8-1.0). Generally poor correlation, however, was confirmed with current linear theory prediction efforts. Failure to predict both the peak pressure levels and shape was reported, especially with increasing tip Mach number. (Author)

A79-43500 An experimental study of high frequency noise from model rotors - Prediction and reduction. K. S. Aravamudan, A. Lee, and W. L. Harris (MIT, Cambridge, Mass.). *Vertica*, vol. 3, no. 1, 1979, p. 47-63. 15 refs.

Experimental results pertaining to prediction and reduction of high frequency noise radiation from a 1.27 m model rotor operating in a 1.52 x 2.29m open jet anechoic facility are discussed. The effects of rotor mean thrust, advance ratio and number of blades on the intensity and spectrum of high frequency broadband noise (HFBN) have been investigated. The effects of each parameter were determined by maintaining the other two constant. Based on the experimental evidence, a scaling law is proposed to predict the frequency and amplitude of HFBN. The effects of free stream turbulence on the high frequency noise is discussed. Influence of leading edge, pressure side and suction side serrations in reducing the radiation of HFBN and their consequent effects on the performance of the rotor are described. (Author)

A79-43501 # New paths for the development of aircraft equipment opened up by the use of modern computer technology (Nektere nove smery vyvoje vybaveni letadel umoznene vyuzitim moderni pocitacove techniky). M. Lnenicka. *Zpravodaj VZLU*, no. 1, 1979, p. 11-15. 6 refs. In Czech.

Possibilities for employing modern digital computer technology for transport aircraft equipment are discussed. A system for spatial navigation is briefly presented, and a review of new methods of flight indication in the cockpit is given. The prospects for further penetration of digital computer technology in airborne systems are evaluated. P.T.H.

A79-43502 # Prospects for airborne computer systems (Perspektivy palubnich pocitacovych soustav). M. Knezovic. *Zpravodaj VZLU*, no. 1, 1979, p. 17-20. 5 refs. In Czech.

The paper discusses the structure of a prospective onboard computer system and its operating system. The system includes a sequential multiprocessor, full processor, matrix processor containing a fast Fourier processor, permanent memory, operational memory, main control block, and power supply. P.T.H.

A79-43503 # Sources and magnitude of radio compass instrumental errors (Zdroje a velikost pristrojove chyby radio-kompasu). V. Hoffner. *Zpravodaj VZLU*, no. 1, 1979, p. 21-23. In Czech.

Sources of instrumental errors in radio compasses are identified and the magnitudes of certain kinds of errors are estimated. Special attention is given to errors arising during encoding and decoding of directional information. P.T.H.

A79-43504 # Omega navigation system (Navigacni system Omega). F. Vejrazka, J. Fiker, and B. Stavovcik. *Zpravodaj VZLU*, no. 1, 1979, p. 25-30. 18 refs. In Czech.

The paper describes briefly some of the more important signal processing methods used in the Omega navigational system. Three basic synchronization techniques are mentioned, and their errors are briefly analyzed. Cost, weight, and size questions of the Omega system are discussed. P.T.H.

A79-43505 # Quasi-autonomous navigation system (Kvaziautonomni navigacni system). P. Bakos. *Zpravodaj VZLU*, no. 1, 1979, p. 31-36. In Czech.

A quasi-autonomous navigation system that calculates the instantaneous position of an aircraft is described. The input data are the data from the azimuth-range measuring system; the relative bearings of a transmitter on two radio beacons and the aircraft heading; and the true airspeed, heading, and probable wind vector attitude of the aircraft. The calculation supplies the geographical coordinates of the instantaneous aircraft position. The calculation formulas are presented and the accuracy of position determination is analyzed. P.T.H.

A79-43506 # Solution of navigation problems in aircraft onboard systems equipped with digital computer (Realizace navigacni ulohy v leteckych palubnich systemech vybavenych cislicovym pocitacem). J. Kotas. *Zpravodaj VZLU*, no. 1, 1979, p. 37-40. 5 refs. In Czech.

A general concept of an onboard computer system as a multiprocessor system based on microprocessors is proposed. A variant of the operating system of an onboard computer system for a light aircraft is considered, and the navigation tasks performed by the system are examined. The nature of the particular navigation tasks is reflected in the structure of the operating system control programs and in the overall structure of the system. P.T.H.

A79-43507 # The basic geodetic shapes and position lines (Zakladni geodeticke utvary a polohove cary). Z. Pech. *Zpravodaj VZLU*, no. 1, 1979, p. 41-45. 5 refs. In Czech.

The paper reviews some of the main concepts and reference surfaces of higher geodesy. The discussion covers the geoid, the reference ellipsoid, the reference sphere, and other concepts.

Formulas of the fundamental problem of geodesy are given. A method of calculating the characteristics of the great circle and rhumb line is set forth. P.T.H.

A79-43508 # Some possibilities for the navigation of small passenger aircraft (Některé z možností navigace maleho dopravního letadla). S. Vosecky. *Zpravodaj VZLU*, no. 2, 1979, p. 59-62. In Czech.

The use of angle measuring or angle-and-range measuring navigation systems for small passenger aircraft is considered. Some applications of such systems are discussed including landing approach. B.J.

A79-43509 # Navigation instruments for small passenger aircraft of the 1980s (Navigační přístroje pro malá dopravní letadla v osmdesátých letech). V. Vek. *Zpravodaj VZLU*, no. 2, 1979, p. 63-66. In Czech.

A brief description is given of an airborne system for horizontal navigation designed for small passenger aircraft of the 1980s. The system includes RSBN, VOR, and Omega and a computer for automation of navigation and displays. B.J.

A79-43510 # Compass system for small aircraft (Kursova soustava pro malá letadla). V. Jirsa. *Zpravodaj VZLU*, no. 2, 1979, p. 67-69. In Czech.

A brief description is given of a gyrocompass system for small aircraft. The technical requirements of this system are discussed along with effects of systematic and random disturbances experienced by the system in flight. The feasibility of using this system for navigation in controlled air traffic is discussed. B.J.

A79-43511 # Use of a gyroscope with adjustable torsion suspension in precise gyroscopic sensors (Použití setrvačnicku s laděným torzním závěsem v přesných gyroskopických snímacích). V. Silhanek. *Zpravodaj VZLU*, no. 2, 1979, p. 71-74. 5 refs. In Czech.

The characteristics of a new gyroscopic sensor with adjustable torsion suspension for use in inertial navigation systems is described. Consideration is given to the design, principles of operation, and applications of the sensor. B.J.

A79-43513 # Technical means for automation of air navigation (Technické prostředky pro automatizaci letecké navigace). A. Vanek. *Zpravodaj VZLU*, no. 2, 1979, p. 79-83. 17 refs. In Czech.

The use of microprocessors to automate aircraft control and navigation functions is discussed. The characteristics of different classes of microprocessor component sets are examined and compared from the point of view of requirements on navigation computers. The impact of microprocessor technology on air navigation is reviewed in light of recent developments in digital flight control technology. B.J.

A79-43514 # Navigation at high latitudes (Navigace v extrémních zeměpisných šířkách). J. Cernohorsky. *Zpravodaj VZLU*, no. 2, 1979, p. 85-88. In Czech.

Some aspects of air navigation at high latitudes are considered with special reference to medium-haul passenger aircraft. Particular consideration is given to problems associated with the utilization of VOR and strapdown inertial systems. B.J.

A79-43515 # Allowable notch effectivity criterion for aircraft structures. J. Drexler and V. Nejedlý. *Zprava VZLU*, no. Z-32, 1978, p. 1-11. 5 refs.

A procedure for evaluation of fatigue quality of a new aircraft design by an allowable notch effect criterion is presented. The criterion is constructed by comparing the fatigue behavior of a new structure with model specimens of area critical from fatigue standpoint. The allowable notch effect criterion of a new aircraft

design, criteria for model specimens with unknown fatigue notch factor, and derivation of input data for allowable notch effect criterion are discussed. The deduced criteria are based on previous service and fatigue testing, comparing the fatigue notch effect of new structures with test specimens considered to be a good model of the critical part or with the fatigue tests of an analogous structure proven successful by experiment and service experience. Statistical analysis of allowable notch effectivity criterion for a light aircraft transport wing structure is given as an example. A.T.

A79-43597 Wave propagation associated with wings (Wellenausbreitung an Flügeln). K. Oswatitsch (Wien, Technische Universität, Vienna, Austria). *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 3, May-June 1979, p. 149-156. In German.

This lecture reviews wave phenomena associated with wings, including wave processes associated with local supersonic regions, sonic booms generated by supersonic aircraft, and three-dimensional steady and unsteady flows. The wave propagation problem is discussed in relation to Mach lines and Mach angles, shock-free supercritical flows, principal types of transonic flows, and shock wave propagation in unsteady flow. B.J.

A79-43600 LCF life prediction for a flight-by-flight load sequence of a turbine disc (Lebensdauer vorherhersage im LCF-Bereich am Beispiel eines Einzelflugablaufs für Triebwerksscheiben). H. Zenner (Industrieanlagen-Betriebsgesellschaft mbH, Ottobrunn, West Germany). (*Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Ermüdungsfestigkeit von Flugzeugen und Modernen Bauweisen, Darmstadt, West Germany, Sept. 22, 1978.*) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 3, May-June 1979, p. 182-187. 10 refs. In German.

Two concepts of LCF life prediction are presented: the nominal stress concept and the notch stress-strain concept. The methods are described for one flight-by-flight load sequence of a turbine disc. A comparison between calculated and experimentally tested lifetime (the tests were carried out with notched specimens taken from an Inconel 718 turbine disc) results in a similar unconservative prediction for the two concepts. The scatter of the damage sum for different stress levels and temperatures is relatively small. At present, too few experimental results for realistic load sequences at high temperatures are available. So these results should not be generalized. (Author)

A79-43607 # Problems associated with flows in aerodynamic wakes of blade cascades (Problematyka przepływu w śladach aerodynamicznych palisady profili). J. W. Elsner and J. Wilczynski (Czestochowa, Politechnika, Czestochowa, Poland). *Politechnika Czestochowska, Zeszyty Naukowe, Nauki Techniczne - Mechanika*, no. 14, 1978, p. 5-35. 23 refs. In Polish.

In the work described, the evolution of velocity fields in turbulent wakes with a longitudinal pressure gradient was studied theoretically and experimentally. Existing similarity hypotheses are examined, and the concept of a flow region where the mean and fluctuating motions may be described by means of two different velocity scales is proposed and discussed. The experiments indicate that the degree of nonuniformity of the mean flow and the turbulent stress tensor components are potential functions of the distance from the cascade, whose exponents depend both on the longitudinal pressure gradient and the initial turbulence level. V.P.

A79-43620 # New methods for ground-testing aeronautical structures (Nouvelles méthodes d'essai au sol de structures aéronautiques). G. Piazzoli. (*Conférence sur les Problèmes d'Aéroélasticité et la Conception des Avions, Rhode-Saint-Genève, Belgium, May 7-11, 1979.*) *ONERA, TP* no. 1979-47, 1979. 23 p. In French.

The classical method for dynamical identification of structures, which entailed the 'appropriation' of excitational forces and successive isolation of each degree of freedom, can lead to large errors

when applied to complex systems such as aeronautical structures. Two new methods which give the modal characteristics of a system with greater accuracy and rapidity are presented. The identification procedures are based on independent and 'non-appropriate' excitations. The first method requires the resolution of the eigenvalue equations of a complex power matrix. The second approach is based on finding a set of forces which isolate one mode and cancel all others.
C.K.D.

A79-43621 # Aerospace applications of oscillators (Application aérospatiales des oscillateurs). R. Moreau. (*Séminaire sur les Etalons de Fréquence, leur Caractérisation et leur Utilisation, Besançon, France, Apr. 24-27, 1979.*) ONERA, TP no. 1979-48, 1979. 43 p. 18 refs. In French.

Aerospace applications of oscillators are discussed, with attention to four broad areas: location and navigation (radars, radio telescopes, phased arrays), detection (surveillance radar, echo analysis, radio holography, selective radiometry); telecommunications (multiplexing, telecommunications satellites, data transmission); instrumentation (time-frequency hybrid systems, very long base interferometers, manometers, thermometers, accelerometers). The state-of-the-art of oscillator technology in these areas is examined, and problems in the application of oscillators are considered. It is concluded that progress must be made in two directions: improvement of long-term stability and development of more accurate expressions for modeling drift.
C.K.D.

A79-43622 # Wind tunnel simulation of the firing of missiles carried under aircraft (Simulation en soufflerie de tirs de missiles sous avion). J. Coste (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Symposium on Missile System Flight Mechanics, London, England, May 21-24, 1979.*) ONERA, TP no. 1979-65, 1979. 9 p. In French.

Methods used in studying separation trajectories of missiles carried under aircraft by means of wind tunnel simulations are discussed on the basis of experience gained at ONERA. The ONERA S2 (cross section: 1.85 x 1.75 m) continuous flow wind tunnel at Modane-Avrieux is equipped with a computer controlled stand with six degrees of freedom. The missile/aircraft interaction for the entire flight envelope can be evaluated by either the 'grid' method, in which the forces exerted on the missile in the aerodynamic field of the aircraft are measured and used to calculate its trajectory, or the 'captive trajectory' method, in which the trajectory is determined by computer as the test takes place. In addition, the trajectories of mockups dynamically similar to those of the missile in question can be investigated by cinematographic techniques. The advantages and limitations of these approaches are discussed, and some test results are presented.
C.K.D.

A79-43678 # Particle trajectories near an airfoil with a film-cooled leading edge. M. Suo, W. P. Patrick, and B. V. Johnson (United Technologies Research Center, East Hartford, Conn.). *Journal of Energy*, vol. 3, May-June 1979, p. 156-160. 5 refs.

Flow visualization techniques were developed and used to study particle trajectories near an airfoil with a film-cooled leading edge. The study was conducted to determine the size of particles which could be deflected by the cooling air jets. This is an important problem relevant to the development of high-temperature gas turbines which burn fuels which produce ash particles (e.g., coal). Experiments were performed on a large-scale airfoil in a low-speed wind tunnel utilizing uniformly sized DOP (Di-octyl phthalate) droplets and chopped streak photography to visualize particle trajectories. The results have been related to the flow in an engine through the use of Stokes parameter scaling. The results indicate that turbine airfoil leading-edge film cooling in a gas turbine engine may deflect particles up to at least 5.8-microns in diameter when the cooling air velocity is at least 0.67 times the approach velocity.
(Author)

A79-43679 # Particle trajectories in turbine cascades. R. P. Dring, J. R. Caspar, and M. Suo (United Technologies Research

Center, East Hartford, Conn.). *Journal of Energy*, vol. 3, May-June 1979, p. 161-166. 11 refs.

An analytical investigation into the nature of particle trajectories in cascades of airfoils has been carried out in order to predict the location, velocity, and angle of particle impact on the airfoils of turbines. As a result of this analysis it has been shown that for any given inviscid flow, particle trajectories are uniquely determined by the specification of only two dimensionless parameters, the most important of which is the Stokes number. In addition, computed results have indicated that particle trajectories are virtually invariant with cascade Mach number. Finally, a comparison of analytically and experimentally determined trajectories for the flow around the circular leading edge of a blunt body has shown excellent agreement over a wide range of Stokes number.
(Author)

A79-43710 Aerodynamics of airfoils with porous trailing edges. C. S. Ventres (Bolt Beranek and Newman Inc., Cambridge, Mass.) and R. Barakat (Harvard University; Bolt Beranek and Newman, Inc., Cambridge, Mass.). *Aeronautical Quarterly*, vol. 30, May 1979, p. 387-399. 7 refs.

The aerodynamics of a thin airfoil of arbitrary camber having a porous trailing edge in steady, subsonic, compressible potential flow is investigated. In the special case of a flat plate airfoil with a porous trailing edge, an exact, closed form solution is obtained using complex variable theory. The pressure loading on the airfoil, the lift and pitching moments are exhibited explicitly along with typical numerical results. The corresponding situation in supersonic flow is also considered.
(Author)

A79-43711 Effect of base cavities on the aerodynamic drag of an axisymmetric cylinder. T. Morel (GM Research Laboratories, Warren, Mich.). *Aeronautical Quarterly*, vol. 30, May 1979, p. 400-412. 11 refs.

Experiments were performed using three different types of base cavities, one solid walled and two ventilated, each with six different depths ranging from 0.1 to 0.9 body diameters. All three types of cavities reduced the body drag for small cavity depth: the reductions are an order of magnitude lower than those reported for two-dimensional bodies, but are achieved with a much shorter cavity depth. Hotwire investigations revealed that base cavities suppress wake periodicity. For cavities of small depth this correlated with a reduction in drag, but for large cavity depths the trends of the intensity of the periodic motion and of drag are not always the same.
V.T.

A79-43712 The fibre composite helicopter blade. E. H. Mansfield and A. J. Sobey (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Quarterly*, vol. 30, May 1979, p. 413-449.

Expressions are derived for the coupled torsional, extensional and flexural stiffnesses of a fibre composite tube, such as a helicopter blade, which is subject to torsion, longitudinal tension, chordwise, and flapping bending moments and shear. Particular attention is given to the coupling effects in which an asymmetric fibre lay-up results in a twisting of the tube under bending and/or tension. Consideration is also given to the influence on the stiffness characteristics of an initial twist in the tube. The amount of twist induced by bending and/or tension is determined for certain glass-fiber-reinforced plastic tubes with varying degrees of asymmetry in the fibre lay-up. An analysis, simplified by the omission of end effects, of the vibrational behavior of such tubes is also presented.
V.T.

A79-43724 Fundamentals of design. II - VTO for combat aircraft. B. R. A. Burns. *Air International*, vol. 16, Apr. 1979, p. 177-181.

The design models of various prototype aircraft, including the British Harrier and the Dassault Mirage IIIV, specializing in vertical take-offs (VTO) and/or vector thrust operations are examined. In

determining which method is best suitable for combat, acceleration and maneuver, as well as jet induced lift losses, hot gas reingestion and reaction control bleed are analyzed. Attention is given to the study of directed airflows which, depending on the position of the engine mounting, will reduce thrust loss to a minimum. It was determined, that if thrust margin is insufficient for a VTO, then rolling to a speed of 60 kt will produce enough engine and wing lift for a safe lift-off. The advantages and disadvantages of separate lift engines and vectored thrust are analyzed noting that a logistical disadvantage in using two types of engines in the same aircraft exists. For true VTO, the use of specialized lift engines is found to offer the lightest solution for a single mission design, but vectored thrust uses optimum combinations of lift and propulsive thrust for best airfield performance. C.F.W.

A79-43725 **Fundamentals of design. III - V-G for combat aircraft.** B. R. A. Burns. *Air International*, vol. 17, Aug. 1979, p. 72-75.

The characteristics of a variable-sweep and a fixed-wing design, sized to meet the same requirements, are compared with respect to lift, drag, and gust response. It was determined that sweep-wings increase maximum lift at takeoff and subsonic speeds at least 30% and that a much higher lift/drag ratio, which is beneficial to aerial combat, exists. The benefits of a smaller variable-sweep aircraft, yielding lower drag and reduced fuel requirements, are offset by: (1) increased structural weight, (2) 'dead' volume in the fuselage and, (3) overall increased systems weight. Attention is also given to stability and control and it was found that the rearward shift of the center of lift, is reduced by one of the following options: (1) outbound location of the wing pivot, (2) rearward location of the pivot on the chord or, (3) an increased wing taper. It is concluded that variable-sweep offers a more versatile aircraft, efficient over a wider range of operating conditions, possibly not foreseen at the time the operational requirement is specified. C.F.W.

A79-43732 **Sharjah - An airport out of Arabian Nights.** A. F. Meldrum and J. Ries. *Airport Forum*, vol. 9, June 1979, p. 29-32, 34, 36-42. In English and German.

The facilities of the Sharjah airport in the United Arab Emirates are detailed. The airport is part of the Sharjahport complex which seeks to capitalize on Sharjah's geographical location on the Arabian Gulf. Other factors cited in the emirate's favor are: Liberal governmental attitude towards business and individual freedom, potential of natural resources (oil), and the nearness of other developing localities, particularly Dubai and Abu Dhabi, which will ensure a transport market. Future prospects include transiting and tourist traffic. In addition the airport's single runway can accept the Concorde while the boarding area can accommodate four wide body jets at a time. M.E.P.

A79-43733 **Mombasa - Welcome to a new airport.** V. Davies. *Airport Forum*, vol. 9, June 1979, p. 45, 47, 48, 51-54. In English and German.

Features and specifications of the new airport in Mombasa, Kenya are presented. The modified airport includes a new 3350-m runway that permits 747's to land, thus allowing lower cost direct flights. The scope of works, planning, financing, and construction are discussed. Attention is given to the tight schedule under which work was completed, noting that the runway was lengthened in time for 707/DC 8 use in December 1975 and completed in October 1976 for 747 use. M.E.P.

A79-43734 **Preventing fires in aviation fuel storage and transport systems. II.** L. Scheichl. *Airport Forum*, vol. 9, June 1979, p. 61, 62, 64-66. In English and German.

Technical precautions for preventing fires in tanks and tank farms are examined. Attention is given to the proper venting of fixed roof tanks, and some other necessary design safety features are discussed including: flame arresters, anti-static grounding, use of light color reflecting paints on tanks, tank sprinkler systems, a fuel spillage catch trough around each tank, and safety zones around tank farms.

Formulas for determining the maximum permissible rate of filling or draining are presented. Fuel transport by rail and by road are also covered. M.E.P.

A79-43779 **Near field problems in three-dimensional panel methods.** J. A. H. Petrie (British Aerospace, Aircraft Group, Kingston-on-Thames, Surrey; Leeds University, Leeds, England). *Aeronautical Journal*, vol. 83, May 1979, p. 194-197.

The paper addresses the disadvantages of using a lattice of vortex rings to model a surface of vorticity, namely that points close to the lattice surface may see large 'holes' in what from a greater distance appears as smooth distribution. The obvious way to overcome this problem is to improve the accuracy of the vorticity model whenever a point draws critically near to the vortex lattice. A method based on Maskew's two dimensional technique, and extended to three dimensions is presented, and results for the program's test on a flat plate and a thick swept wing are given. M.E.P.

STAR ENTRIES

N79-26009*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

FUEL-CONSERVATIVE GUIDANCE SYSTEM FOR POWERED-LIFT AIRCRAFT

Heinz Erzberger and John D. McLean Jun. 1979 18 p refs To be presented at the AIAA Guidance and Control Conf., Boulder, Colo., 6-7 Aug. 1979

(NASA-TM-78595; A-7860) Avail: NTIS HC A02/MF A01 CSCL 01C

A concept for automatic terminal area guidance, comprising two modes of operation, was developed and evaluated in flight tests. In the predictive mode, fuel efficient approach trajectories are synthesized in fast time. In the tracking mode, the synthesized trajectories are reconstructed and tracked automatically. An energy rate performance model derived from the lift, drag, and propulsion system characteristics of the aircraft is used in the synthesis algorithm. The method optimizes the trajectory for the initial aircraft position and wind and temperature profiles encountered during each landing approach. The design theory and the results of simulations and flight tests using the Augmentor Wing Jet STOL Research Aircraft are described. S.E.S.

N79-26010# Loughborough Univ. of Technology (England), Dept. of Transport Technology.

A CONSIDERATION OF GENERAL AVIATION IN THE UK

R. E. Caves May 1979 73 p refs

(TT-7902; ISSN-0140-9751) Avail: NTIS HC A04/MF A01 Performance and cost data for the operation of a range of general aviation aircraft in the U.K. were established. Two potentially attractive routes were examined from a conventional, theoretical stand point to demonstrate the marginal nature of Third Level operations. Some attention is given to airport access, to non-scheduled general aviation, and to the relevance of the results within present U.K. transport planning choices. J.A.M.

N79-26013*# Maryland Univ., College Park. Dept. of Aerospace Engineering.

A STUDY OF THE DROOPED LEADING EDGE AIRFOIL

John D. Anderson, Jr. and Jewel B. Barlow Apr. 1979 41 p refs

(Grant NsG-1570) (NASA-CR-158717; SR-1) Avail: NTIS HC A03/MF A01 CSCL 01A

Wind tunnel tests were conducted to examine various aspects of the drooped-leading edge airfoil which reduces the tendency for an airplane to enter a spin after stall occurs. Three baseline models were used for tests of two dimensional models: NACA 0015, 0014.6, and 0014.2. The 14.6% and 14.2% models were derived from NACA 0015 sections by increasing the chord and matching the profiles aft section. Force, balance data (lift, drag, pitching moment) were obtained for each model at a free-stream Reynolds number of 2.66×10^6 to the 6th power/m. In addition, oil flow visualization tests were performed at various angles of attack. An existing NACA 64 sub 1 A211 airfoil was used in a second series of tests. The leading edge flap was segmented in three parts which allowed various baseline/drooped leading edge configurations to be tested. Force balance and flow visualization tests were completed at chord Reynolds numbers of 0.44×10^6 to the 6th power, 1.4×10^6 to the 6th power, and 2.11×10^6 to the 6th power. Test results are included. A.R.H.

N79-26015*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

FUSELAGE SURFACE PRESSURE MEASUREMENTS OF A HELICOPTER WIND-TUNNEL MODEL WITH A 3.15-METER DIAMETER SINGLE ROTOR

Carl E. Freeman and Raymond E. Mineck Mar. 1979 170 p refs

(NASA-TM-80051) Avail: NTIS HC A08/MF A01 CSCL 01A

A wind-tunnel investigation was conducted to measure the time averaged fuselage surface pressures of a helicopter model with a 3.15 meter diameter, four-bladed articulated rotor. Measurements were made at hover and advance ratios of 0.05, 0.15, and 0.20 for a range of thrusts. Data are presented with no analysis. Author

N79-26016*# National Aeronautics and Space Administration, Hugh L. Dryden Flight Research Center, Edwards, Calif.

GROUND-BASED MEASUREMENTS OF THE WAKE VORTEX CHARACTERISTICS OF A B-747 AIRCRAFT IN VARIOUS CONFIGURATIONS Final Report, Dec. 1975 - Jul. 1978

D. C. Burnham (Transportation Systems Center), J. N. Hallock (Transportation Systems Center), I. H. Tombach (AeroVironment, Inc.), M. R. Brashears (Lockheed Missiles and Space Co., Huntsville, Ala.), and M. R. Barber Dec. 1978 545 p refs (NASA-TM-80474; AD-A067588; FAA-RD-78-146; DOT-TSC-FAA-78-28) Avail: NTIS HC A23/MF A01 CSCL 01/2

A Boeing 747 aircraft flew 54 passes at low altitude over ground based sensors. Vortex velocities were measured by a laser Doppler velocimeter, an array of monostatic acoustic sounders, and an array of propeller anemometers. Flow visualization of the wake was achieved using smoke and balloon tracers and was recorded photographically. Data were obtained on vortex velocity fields, vortex decay, and the effects of spoilers and differential flap settings on the dissipation and structure of the vortices. Author

N79-26017*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

WIND-TUNNEL INVESTIGATION OF HIGHLY MANEUVERABLE SUPERSONIC V/STOL FIGHTER

Michael Falarski Jun. 1979 24 p refs Presented at V/STOL Aerodyn. Workshop, Monterey, Calif., May 1979

(NASA-TM-78599; A-7876) Avail: NTIS HC A02/MF A01 CSCL 01A

Results from the initial wind-tunnel test of a large-scale, highly maneuverable supersonic V/STOL fighter model in the Ames 40- by 80-foot wind tunnel are summarized. The STOL configuration which was tested combined upper surface blowing and spanwise blowing to improve the lift characteristics over a wide angle-of-attack range. A close-coupled canard was added to this configuration to create a highly maneuverable STOL aircraft. The 7.28 m (24 ft) span model was powered by two J-97 turbojet engines, each producing 9340 N (2200 lb) thrust at a pressure ratio of 2. With the nozzle flap and aileron set at 30 deg, the model produced lift coefficients greater than 4. The model was longitudinally unstable because of the forward canard position and because of the large body area of fuselage, strake, and nacelles forward of the center of gravity. J.A.M.

N79-26018*# Kansas Univ. Center for Research, Inc., Lawrence.

COMPARISON OF THEORETICAL PREDICTED LONGITUDINAL AERODYNAMIC CHARACTERISTICS WITH FULL-SCALE WIND TUNNEL DATA ON THE ATLIT AIRPLANE

Cornelis P. G. vanDam, Michael Griswold, and J. Roskam Jul. 1979 365 p

(Grant NsG-1574) (NASA-CR-158753; KU-FRL-399-1) Avail: NTIS HC A16/MF A01 CSCL 01A

An analytical method is presented for predicting the lift coefficient, the pitching moment coefficient, and the drag coefficient of light, twin-engine, propeller-driven airplanes. The method was applied to the Advanced Technology Light Twin-

Engine airplane. The calculated characteristics were then correlated against full scale wind tunnel data. The analytical method was found to predict the drag and pitching moment fairly well. However, the lift prediction was extremely poor. R.E.S.

N79-26020*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECTS OF WING LEADING-EDGE DEFLECTION ON LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A LOW-ASPECT-RATIO HIGHLY SWEEPED ARROW-WING CONFIGURATION

Paul L. Coe, Jr. and Robert P. Weston 1979 73 p refs (NASA-TP-1434; L-12784) Avail: NTIS HC A04/MF A01 CSCL 01A

Static force tests were conducted in the Langley V/STOL tunnel at a Reynolds number (based on the mean aerodynamic chord) of about 2.0×10^6 to the 6th power for an angle-of-attack range from about -10 deg to 17 deg and angles of sideslip of 0 and + or - 5 deg. Limited flow visualization studies were also conducted in order to provide a qualitative assessment of leading-edge upwash characteristics. A.R.H.

N79-26021*# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

BUMBLEBEE PROGRAM AERODYNAMIC DATA. PART 3: PRESSURE FIELDS AT MACH NUMBERS 1.5 TO 2.0

G. A. Barnes and L. L. Cronvich Apr. 1979 169 p (NASA Order L-600036-A) Avail: NTIS HC A08/MF A01 CSCL 01A

Additional data are provided for use in defining the Mach number effect ($M = 1.5$ and 2.0) on flow field characteristics around a missile body at relatively high angles of attack (to $\alpha = 23$ deg). The Mach number effect is described by means of pressure fields only, at a mid-body station where a wing might be located. A.R.H.

N79-26022*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECT OF SEVERAL GEOMETRIC PARAMETERS ON THE STATIC INTERNAL PERFORMANCE OF THREE NONAXI-SYMMETRIC NOZZLE CONCEPTS

Bobby L. Berrier and Richard J. Re Jul. 1979 136 p refs (NASA-TP-1468; L-12810) Avail: NTIS HC A07/MF A01 CSCL 01A

Effects of several geometric parameters on the internal performance of nonaxisymmetric convergent-divergent, single-ramp expansion, and wedge nozzles were investigated at nozzle pressure ratios up to approximately 10. In addition, two different thrust-vectoring schemes were investigated with the wedge nozzle. The results indicated that as with conventional round nozzles, peak nonaxisymmetric nozzle, internal performance occurred near the nozzle pressure ratio required for fully expanded exhaust flow. Nozzle sidewall length or area generally had little effect on the internal performance of the nozzles investigated. J.A.M.

N79-26023*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECT OF NOSE BLUNTNES AND AFTERBODY SHAPE ON AERODYNAMIC CHARACTERISTICS OF A MONOPLANAR MISSILE CONCEPT WITH BODIES OF CIRCULAR AND ELLIPTICAL CROSS SECTIONS AT A MACH NUMBER OF 2.50

Ernald B. Graves and Roger H. Fournier Washington 1979 88 p refs (NASA-TM-80055; L-12632) Avail: NTIS HC A05/MF A01 CSCL 01A

The tests were performed at a Mach number of 2.50 and at angles of attack from about -4 deg to 32 deg. The results indicate that increasing nose bluntness increases zero lift drag and decreases both the maximum lift-drag ratio and the level of directional stability. The center of pressure generally moves forward with increasing nose size; however, small nose radii on the modified elliptical configurations move the center of pressure rearward. The circular bodied configurations exhibit the greatest longitudinal stability and the least directional stability. Concepts

with the variable geometry afterbody contour display the most directional stability and the greatest zero lift drag. S.E.S.

N79-26024*# Low Energy Transport Systems, Capistrano Beach, Calif.

SUMMARY OF PAST EXPERIENCE IN NATURAL LAMINAR FLOW AND EXPERIMENTAL PROGRAM FOR RESILIENT LEADING EDGE

B. H. Carmichael May 1979 50 p refs (Contract NAS2-10113) (NASA-CR-152276) Avail: NTIS HC A03/MF A01 CSCL 01A

The potential of natural laminar flow for significant drag reduction and improved efficiency for aircraft is assessed. Past experience with natural laminar flow as reported in published and unpublished data and personal observations of various researchers is summarized. Aspects discussed include surface contour, waviness, and smoothness requirements; noise and vibration effects on boundary layer transition, boundary layer stability criteria; flight experience with natural laminar flow and suction stabilized boundary layers; and propeller slipstream, rain, frost, ice and insect contamination effects on boundary layer transition. The resilient leading edge appears to be a very promising method to prevent leading edge insect contamination. A.R.H.

N79-26025# Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept.

AERODYNAMIC CHARACTERISTICS OF THE CLOSE-COUPLED CANARD AS APPLIED TO LOW-TO-MODERATE SWEEP WINGS. VOLUME 2: SUBSONIC SPEED REGIME Final Report, 1970 - 1974

David W. Lacey Jan. 1979 116 p refs (WF14142109) (AD-A067122; AERO-1257-Vol-2; DTNSRDC-79/002) Avail: NTIS HC A06/MF A01 CSCL 01/3

An analysis of the effects of canard size, shape, position and deflection on the aerodynamic characteristics of two general research models having leading edge sweep angles of 25 and 50 degrees is presented. The analysis summarizes the findings of four experimental subsonic wind-tunnel programs conducted at the David W. Taylor Naval Ship Research and Development Center between 1970 and 1974. The analysis is based on four canard geometries varying in planform from a 60-degree delta to a 25-degree swept wing high aspect ratio canard. The canards were located at seven different positions and deflected from -10 to 25 degrees. Significant findings include: the excellent correlation between canard exposed area ratio and changes in lift, drag, and pitching moment; the detrimental effect of positive canard deflection; and the optimum longitudinal position for each canard shape for maximum improvements in lift and drag. It is further concluded that the favorable aerodynamic changes caused by interference of the close-coupled canard are not significantly dependent on wing leading edge sweep or wing leading edge modifications. Author (GRA)

N79-26027# Oklahoma Univ., Norman. School of Aerospace, Mechanical and Nuclear Engineering.

SUPERSONIC FLOW PAST CONICAL BODIES WITH NEARLY CIRCULAR CROSS SECTIONS Final Report

Martin C. Jischke Oct. 1978 65 p refs (Grant AF-AFOSR-3468-77) (AD-A068004; OU-AMNE-78-10; AFOSR-79-0475TR) Avail: NTIS HC A04/MF A01 CSCL 20/4

Inviscid, supersonic conical flows past bodies whose cross-section deviates slightly from that of a right circular cone are studied by means of a perturbation technique. The effects of small angles of attack and yaw are included. Using the hypersonic small disturbances theory approximations, we have developed explicit results for the flow field velocity components, pressure, entropy, and shock shape for cases $n, m = 1, 2, 3, 4$. Comparisons of theory with experiment for $n = 1, 2$ are favorable. The stream surfaces of the velocity field are calculated and possible waverider geometries that can be developed therefrom are discussed. GRA

N79-26029# Louisiana State Univ., Baton Rouge. Dept. of Mechanical Engineering.

DEVELOPMENT OF A RESEARCH PLAN FOR THE IMPROVEMENT OF AERODYNAMIC MODELS FOR ANALYSIS OF BALLISTIC RANGE DATA Final Report, 1 Feb. 1978 - 31 Jan. 1979

Robert W. Courter Mar. 1979 51 p refs
(Grant AF-AFOSR-3489-78; AF Proj. 2307)
(AD-A067950; AFOSR-79-0476TR) Avail: NTIS
HC A04/MF A01 CSCL 16/2

A study is made of the relationship between aerodynamic models and parameter estimation methods to determine a feasible plan for improving the aerodynamic models which are used for ballistic range data analysis at Eglin AFB. A plan is presented which utilizes a computer graphics terminal to process simulation runs and provide comparisons with experimental data and theoretical data fits. Included in the report are algorithms for performing system simulation and for accounting for mass-offset effects on the motion of the test item. Author (GRA)

N79-26030# Analytical Methods, Inc., Bellevue, Wash.
A VISCOUS/POTENTIAL FLOW INTERACTION ANALYSIS FOR CIRCULATION-CONTROLLED AIRFOILS Final Report
F. A. Dvorak May 1978 52 p refs
(Contract N00600-76-C-1494)
(AD-A067913; Rept-7710) Avail: NTIS HC A04/MF A01
CSCL 20/4

A method developed for the analysis of the incompressible viscous flow over circulation-controlled airfoils is described. A surface vorticity method is used to solve the inviscid portion of the flow and a combination of integral and finite difference methods is used to calculate the development of the viscous layers. An iterative process is used to arrive at final solutions which satisfy an appropriate trailing-edge condition and incorporate the interaction between the viscous and potential regions of the flow. Comparisons between calculated and experimental results show good agreement for surface pressure distributions and lift coefficients over a range of blowing momentum coefficient from 0 to 0.12. A discussion of the possibility of Coanda jet detachment when circulation-controlled airfoils are operating at high subsonic Mach Numbers is included in an Appendix. Author (GRA)

N79-26031# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

OPTIMUM TAIL FAIRINGS FOR BODIES OF REVOLUTION Final Report

A. M. O. Smith, T. R. Stokes, Jr., and R. S. Lee Mar. 1979
54 p refs
(Contract N00014-77-C-0672)
(AD-A067927; MDC-G7823) Avail: NTIS HC A04/MF A01
CSCL 20/4

This report describes a computerized method that will design tails for bodies of revolution that satisfy the Stratford criterion for zero wall shear. Stratford's original two-dimensional solution is extended to axisymmetric flow in order to implement the procedure. The method involves simultaneous solution of the extended Stratford equation and the necessary boundary conditions through the use of an inverse potential flow program. Tails designed with this procedure can be categorized as follows: (1) The entire tail is at incipient separation (no skin friction); (2) The pressure recovery is the most rapid possible; (3) The resultant tail is the shortest possible. The final result is a unique geometry for given freestream conditions and boundary layer transition point. By unique, it is meant that any deviation from the 'ideal' geometry will either cause extensive separation or the tail must become longer and, hence, contribute to skin friction and reduced volumetric efficiency. GRA

N79-26034# National Transportation Safety Board, Washington, D. C.

AIRCRAFT ACCIDENT REPORT: LAS VEGAS AIRLINES, PIPER PA-31-350, N44LV, LAS VEGAS, NEVADA, AUGUST 30, 1978

7 Jun. 1979 38 p
(NTSB-AAR-79-8) Avail: NTIS HC A03/MF A01

About 0747 P.d.t., on August 30 1978, Las Vegas Airlines Flight 44, a Piper PA-31-350 (N44LV), crashed in VFR conditions shortly after takeoff from runway 25 at the North Las Vegas Airport, Las Vegas, Nevada. Flight 44 was a charter flight from Las Vegas, Nevada, to Santa Ana, California, with nine passengers and a pilot on board. After liftoff following a longer-than-normal ground roll, the aircraft pitched nose up, climbed steeply to about 400 ft above the ground, stalled, reversed course, and crashed 1,150 ft beyond and 650 ft to the right of the runway. There was no fire. All persons on board the aircraft were killed. The National Transportation Safety Board determines that the probable cause of the accident was the backed out elevator down-stop bolt that limited down elevator travel and made it impossible for the pilot to prevent a pitchup and stall after takeoff. Author

N79-26035*# National Aeronautics and Space Administration: Ames Research Center, Moffett Field, Calif.

QUIET PROPULSIVE LIFT FOR COMMUTER AIRLINES

Darrell E. Wilcox and John A. Cochran Jun. 1979 29 p refs
(NASA-TM-78596; A-7861) Avail: NTIS HC A03/MF A01
CSCL 01C

The performance of STOL or RTOL aircraft and NASA's research program to provide options for future design and certification of quiet propulsive-life transports is described. M.M.M.

N79-26036# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

FEASIBILITY OF NON-CATAPULT EJECTION AND HAZARD OF AN EJECTION SEAT ROCKET PLUME

Thomas J. Zenobi 23 Jan. 1979 21 p refs
(AD-A067080; NADC-78225-60) Avail: NTIS
HC A02/MF A01 CSCL 01/3

Efforts conducted by the Navy focused on feasibility of utilizing a rocket propelled ejection seat without a catapult. It was speculated that elimination of the catapult would result in significant weight reduction. However, between time of rocket ignition and the time the ejecting crewmember leaves the cockpit, there is a burn hazard to the crewmember created by the rocket exhaust plume from his own rocket as it scatters about the cockpit. The crewman may be exposed to temperatures as high as 5000 F during ejection. Extreme temperature and blast pressure also create severe erosive effects. Methods for protecting the crewmember from the rocket plume which were investigated included venting the plume, containing/shielding the plume, and quenching afterburn of rocket propellant with inert gas. Engineering trade-offs such as weight penalties, complexity of maintenance, cost and anomalies on overall escape system performance were compared between utilization of the catapult and rocket plume protection methods. Based on these engineering trade-offs it was concluded that the catapult is still recommended for use in current aircraft cockpits. Author (GRA)

N79-26037# Calspan Corp., Buffalo, N. Y.

AN OPERATIONAL RESEARCH INVESTIGATION OF THE ICE-DETECTION CAPABILITY AND UTILITY OF THE SURFACE CONDITION ANALYZER (SCAN) SYSTEM AND ITS APPLICABILITY TO NAVY-WIDE USE Final Report, 8 Feb. 1978 - 7 Apr. 1979

E. J. Mack, R. J. Anderson, D. H. Bock, T. A. Niziol, and H. G. Reif Mar. 1979 181 p refs
(Contract N00014-78-C-0284)
(AD-A067174; CALSPAN-6283-M-1) Avail: NTIS
HC A09/MF A01 CSCL 01/2

During 1978, Calspan Corporation conducted an independent research investigation of the basic principles and operational performance of the Surface Condition Analyzer system (SCAN)TM in the detection of icing conditions on runway surfaces and its applicability to Navy-wide use. The results and conclusions derived from this investigation were formulated from data and information garnered from the following sources: site visits and interviews at civil and Naval airfields where SCAN is installed; visits and discussions at the manufacturer's plant; strip-chart records of actual SCAN-output signals, correlated with visual inspection of

runway and sensor surfaces, runway traction, and display terminal readouts, obtained during a two-week operational performance study at Keflavik NAS; study of the manufacturer's drawings and schematics; review of the literature on snow and ice removal and control (SIRC) operations and economic analyses of these procedures as impacted by SCAN; and climatological analyses. The principal conclusion was that, while SCAN will not supplant routine personal inspection of runways, SCAN's ability to provide, on occasion, advance warning of hazardous icing conditions coupled with its surface temperature information (used for more effective chemical application) makes it well worth the investment costs. Author (GRA)

N79-26038# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

DEVELOPMENT OF AN INFLATABLE HEAD/NECK RESTRAINT SYSTEM FOR EJECTION SEATS, UPDATE

Thomas J. Zenobi 19 Dec. 1978 36 p refs
(AD-A067124; NADC-78213-60) Avail: NTIS
HC A03/MF A01 CSCL 06/17

A ring-shaped inflatable head/neck restraint system for ejection seats is being developed at the Aircraft and Crew Systems Technology Directorate, NADC. The purpose of this system is to reduce neck injuries due to violent forward head rotation at the time of ejection thrust on parachute opening shock. Inflation of the neck ring will be conducted by a solid propellant gas generator. Design considerations include form-an-fit, cost effectiveness, packaging and integration into life support equipment.

Author (GRA)

N79-26039# Air Force Engineering Technology Office, Tyndall AFB, Fla.

AN EVALUATION OF THE BIRD/AIRCRAFT STRIKE HAZARD DYESS AIR FORCE BASE, TEXAS

James S. Kent and Ardrah L. Buddin, III Sep. 1978 53 p refs
(AD-A068026; AFETO-TM-8-78) Avail: NTIS
HC A04/MF A01 CSCL 01/2

The Air Force Engineering Technology Office's Bird/Aircraft Strike Hazard (BASH) Team surveyed Dyess AFB from 20 to 30 September 1978. During this period environmental factors which create potential bird strike hazards were observed. Specific recommendations based on observations are provided to reduce the bird strike hazard. Author (GRA)

N79-26040# Royal Aircraft Establishment, Farnborough (England), Dept. of Engineering Physics.

A STUDY OF SMOKE MOVEMENT IN AN AIRCRAFT FUSELAGE

T. J. Methven and J. S. Webster 11 Jan. 1978 31 p refs
(RAE-TM-EP-613; BR61816) Avail: NTIS HC A03/MF A01

The migration of smoke from in-flight fires and possible measures to improve its removal were studied in ground tests on a Comet 4B. Results show that under normal conditions, smoke generated in various sections in the fuselage follows the air flow and disperses throughout the fuselage before passing overboard. Biasing discharge to the front or rear affects smoke clearance only slightly, but directing the total air supply to the compartment in which the smoke is generated has a beneficial effect locally at the expense of adjacent cabins. Tests in the flight deck show that, in smoke laden conditions, flight instruments were best viewed with individual illumination in low ambient light. Further work with higher smoke densities is recommended. Author (ESA)

N79-26041# Lincoln Lab., Mass. Inst. of Tech., Lexington. **UPLINK ATCRBS ENVIRONMENT MEASUREMENTS ALONG THE BOSTON-WASHINGTON CORRIDOR, VOLUME 2: INTERROGATOR CHARACTERISTICS**

Ferenc Nagy, Jr. 28 Feb. 1979 88 p refs
(Contracts DOT-FA71WAI-242; F19628-78-C-0002; FAA Proj. 052-241-04)
(AD-A067944; ATC-83-Vol-2; FAA-RD-78-33) Avail: NTIS
HC A05/MF A01 CSCL 17/7

Airborne measurements of the Air Traffic Control Radar Beacon System (ATCRBS) 1030 MHz uplink environment due to ATC ground interrogators are described. The measurements were made using a special purpose airborne sensor-recorder during a flight from Boston to Washington (at 8500 feet) and back (at 17,500 feet) on 16 December 1977. Data were recorded at 24 locations between Boston and Washington. Specific characteristics of the sources of the interrogations observed from the air during this flight are presented. These characteristics include the identities of 46 of the interrogators, the approximate locations of 22 unidentified interrogators, and the radiated P1, P2, and P3 levels in the form of antenna patterns for six selected interrogators. It was found that approximately 40% of the interrogators employ the standard AAC or ZACA mode interlaces while 20% transmit no Mode C interrogations. The distributions of PRI's and scan periods were found to be relatively free of bunching which would cause undesired synchronization effects. The antenna plots measured from the air show relatively large scan to scan variations due to aircraft motion. Some of the interrogator sites were found to suffer from reflections and sidelobe punch through effects. S.E.S.

N79-26042# Federal Aviation Administration, Washington, D.C. Office of Systems Engineering Management.

REPORT OF THE FAA TASK FORCE ON AIRCRAFT SEPARATION ASSURANCE, VOLUME 1: EXECUTIVE SUMMARY

N. A. Blake et al Dec. 1978 32 p refs
(AD-A067905; FAA-EM-78-19-1-Vol-1) Avail: NTIS
HC A03/MF A01 CSCL 17/7

The system errors, midairs, and near midairs to define the problem were examined. The system element requirements are defined to provide two levels of backup to the ATC system: a separation violation warning and a last-ditch collision advisory and resolution function. The current FAA ASA development programs are discussed, and the changes which are required to transition to an integrated ASA system are reported. S.E.S.

N79-26044 Georgia Inst. of Tech., Atlanta. **A METHOD OF COMPUTING THE PRESSURE DISTRIBUTION ON A SINGLE-BLADED HOVERING HELICOPTER ROTOR Ph.D. Thesis**

Koodige Rajarama Shenoy 1979 167 p
Avail: Univ. Microfilms Order No. 7913950

An iterative method was developed to predict accurately the pressure and velocity distributions over the entire blade and particularly near the tip of the rotor. The blade is represented as a sheet of vorticity wrapped around the blade. This sheet is divided into a grid system and the vortex sheet strength is assumed to vary linearly within each panel. The wake vortex sheet geometry and a first approximation to the blade bound vorticity distribution are then computed using a lifting-line/ blade-element analysis. A new set of vorticity values are obtained by computing the tangential velocity induced at the midpoints of each panel. Geometric coefficients are used in conjunction with the recurrence relations to reduce the computations. The pressure distributions obtained by using the present method of pitch angles of 0 degrees, 6.175 degrees and 11.4 degrees are in good agreement with the experiments. Dissert. Abstr.

N79-26045*# Textron Bell Aerospace Co., Buffalo, N. Y. **AIR CUSHION LANDING GEAR APPLICATIONS STUDY Report, Jan. - Mar. 1979**

T. Desmond Earl Apr. 1979 83 p refs
(Contract NAS1-15202)
(NASA-CR-159002; D7605-927002) Avail: NTIS
HC A05/MF A01 CSCL 01C

A series of air cushion landing gear (ACLG) applications was studied and potential benefits analyzed in order to identify the most attractive of these. The selected applications are new integrated designs (not retrofits) and employ a modified design approach with improved characteristics and performance. To aid the study, a survey of potential users was made. Applications were evaluated in the light of comments received. A technology scenario is developed, with discussion of problem areas, current

technology level and future needs. Feasible development timetables are suggested. It is concluded that near-term development of small-size ACLG trunks, exploration of flight effects and braking are key items. The most attractive applications are amphibious with very large cargo aircraft and small general aviation having the greatest potential. Author

N79-26046* # Textron Bell Helicopter, Fort Worth, Tex.
SYSTEM DESIGN REQUIREMENTS FOR ADVANCED ROTARY-WING AGRICULTURAL AIRCRAFT
 Harold E. Lemont May 1979 231 p refs
 (Contract NAS1-15153)
 (NASA-CR-158938) Avail: NTIS HC A11/MF A01 CSCL 01C

Helicopter aerial dispersal systems were studied to ascertain constraints to the system, the effects of removal of limitations (technical and FAA regulations), and subsystem improvements. Productivity indices for the aircraft and swath effects were examined. Typical missions were formulated through conversations with operators, and differing gross weight aircraft were synthesized to perform these missions. Economic analysis of missions and aircraft indicated a general correlation of small aircraft (3000 lb gross weight) suitability for small fields (25 acres), and low dispersion rates (less than 32 lb/acre), with larger aircraft (12,000 lb gross weight) being more favorable for bigger fields (200 acres) and heavier dispersal rates (100 lb/acre). Operator problems, possible aircraft and system improvements, and selected removal of operating limitations were reviewed into recommendations for future NASA research items. S.E.S.

N79-26047# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

PRELIMINARY AIRWORTHINESS EVALUATION AH-1S HELICOPTER EQUIPPED WITH A GARRETT INFRARED RADIATION SUPPRESSOR AND AN AN/ALQ-144 JAMMER Final Report

Gary L. Bender, Edward E. Bailes, Charles E. Frankenber, Jr., and Sherwood C. Spring May 1978 79 p
 (AD-A067757; USAEFA-77-33) Avail: NTIS HC A05/MF A01 CSCL 01/3

The tests were conducted to determine the effects of installation of the IRS and the AN/ALQ-144 infrared jammer. There was no apparent effect on power required to hover and only a small increase in power required to maintain level flight. Because of a power-available degradation, however, there was a loss of 220 pounds payload in an out-of-ground-effect hover at 4000 feet, 35 C. Additionally, at 2000 feet, 25 C, and 9300 pounds gross weight, there was a reduction in maximum level flight airspeed of 3.5 knots true airspeed in the clean wing configuration. No degradation in handling qualities was caused by IRS or infrared jammer installation. However, one deficiency and six shortcomings inherent in the basic AH-1S were noted. The nonadjustable ventilation system is a deficiency because it blows dirt and dust into the pilot's eyes during operations from unprepared surfaces. GRA

N79-26048# Ministry of Defence, London (England).

HELICOPTER ICING SYMPOSIUM

T. C. Don Nov. 1978 316 p refs Symp. held at London, 6-7 Nov. 1978
 (AD-A067981) Avail: NTIS HC A14/MF A01 CSCL 01/3

This document is a collection of papers presented at the Helicopter Icing Symposium, held in London, England, 6-7 November 1978. The emphasis of the symposium was on helicopter rotor blade icing. Papers covered methods of rotor blade ice protection (electrothermal, ice phobic coatings, microwave, vibratory and mechanical-pneumatic concepts); design and test criteria; ice protection system capabilities and testing and certification methods. Also included are papers on meteorological data; instrumentation; icing tunnel tests and correlations of results to mathematical accretion model; and simulated and natural icing flight tests. Author (GRA)

N79-26049# Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept.

THE CHARACTERISTICS OF THE SPRAY GENERATED BY THE EFFLUX OF VARIOUS AIRCRAFT PROPULSORS IMPINGING NORMALLY ON WATER Technical Report, May - Sep. 1978

Basil S. Papadales, Jr. Jun. 1978 52 p refs
 (WF41421091)
 (AD-A067742; DTNSRDC/ASED-78/07) Avail: NTIS HC A04/MF A01 CSCL 01/3

A review of previous model tests of the efflux from aircraft propulsors impinging normally on water is presented. The height of the resulting spray cloud was found to be a function of the maximum dynamic pressure at the surface after impingement, and the propulsor diameter. A generalized relationship using these variables, based on Froude scaling and which favorably compares with the existing model data is presented. Other characteristics of the water surface and spray cloud are discussed, although there are insufficient data to formulate any general conclusions. Results from tests with Froude-scaled vertical takeoff and landing aircraft models are presented. These results are tentative due to the lack of substantiating full-scale data. The height of a spray cloud and the water depression diameter obtained during Froude-scaled tests of a conceptual ducted fan propulsor are also presented. The spray cloud heights compares favorably with the generalized relationship derived from previous tests. The water depression diameter was found to differ substantially from that determined from previous model tests. Spray cloud heights and water depression diameters are predicted for two conceptual full-scale aircraft propulsors. Author (GRA)

N79-26050# Lockheed-California Co., Burbank.

ICING TESTS OF A UH-1H HELICOPTER WITH AN ELECTROTHERMAL ICE PROTECTION SYSTEM UNDER SIMULATED AND NATURAL ICING CONDITIONS Final Report, 31 Jan. - 31 Mar. 1978

R. H. Cotton Apr. 1979 81 p refs
 (DA Proj. 1L2-63209-D-103)
 (AD-A067737; LR-28667; USARTL-TR-78-48) Avail: NTIS HC A05/MF A01 CSCL 01/3

Natural and simulated icing tests were conducted during February and March 1978 with a UH-1H helicopter equipped with an advanced ice protection system. This was the fourth program of icing tests accomplished with this test aircraft and the second to include natural icing. The objective of this year's program was to expand the icing test envelope, to gather additional data on ice protection system design and performance characteristics, and to obtain specific data for use in a product improvement program for the UH-1 Partial Ice Protection System (Kit A). The testing was conducted at Ottawa, Ontario, Canada. Seven tests in the spray rig and twelve natural icing flights were made totaling 25.8 hours of icing tests. Icing was encountered on seven of the natural icing flights. GRA

N79-26051# National Physical Lab., Teddington (England). Div. of Numerical Analysis and Computer Science.

THE CALCULATION OF OPTIMAL AIRCRAFT TRAJECTORIES

P. E. M. Curtis and D. W. Martin Dec. 1978 18 p refs
 (NPL-DNACS-11/78) Avail: NTIS HC A02/MF A01

Two versions of a method for solving the minimum time-to-climb and minimum fuel-to-climb problems are described. This method uses the energy-state approximation to reduce the two problems to univariate minimization problems which are then solved numerically. The first version uses bilinear interpolation of the engine thrust data. This version runs faster on the computer by a factor of between 6 and 8 than a method in operational use. In order to obtain more accurate optimal trajectories a second version was developed which replaces the bilinear interpolation by natural bicubic spline interpolation. The improvement in accuracy is at the expense of a factor of about 2 in the computer run-time compared with the first version, but the gain over the operational method is still a factor of between 3 and 4. Author (ESA)

N79-26052*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.
A SIMULATION INVESTIGATION OF COCKPIT DISPLAY OF AIRCRAFT TRAFFIC DURING CURVED, DESCENDING, DECELERATING APPROACHES
 George G. Steinmetz May 1979 34 p refs
 (NASA-TM-80098) Avail: NTIS HC A03/MF A01 CSCL 01D

The results of a simulation experiment involving the evaluation of cockpit display of aircraft traffic information are presented. The experiment was conducted using taped time dependent, noninteractive traffic in an approach to landing situation and two levels of pilot control models: 3-D automatic and computer augmented control. The tests involved two cases: the simulation aircraft flew approach paths which (1) followed another aircraft in between two other aircraft, and (2) merged between two other aircraft. Speed control via manual throttles was used in all tests (path stretching was not allowed for maintaining separation between aircraft). The approaches were conducted while the simulation aircraft was conducting a curved, descending, decelerating approach to landing. Performance data sets were examined, and subjective opinions regarding workload were gathered. Traffic positioning was varied to further evaluate the test subjects' monitoring performance. S.E.S.

N79-26053# Aeronautical Research Labs., Melbourne (Australia).
AN EXPERIMENTAL COMPARISON OF THE READABILITY OF TWO DIGITAL ALTIMETERS
 G. R. White Dec. 1978 25 p
 (ARL/Sys-Note-60; AR-001-325) Avail: NTIS HC A02/MF A01

Twelve male volunteer subjects with flying experience were required to read one of two digital altimeters while performing a two dimensional tracking task. It was found that the Smiths Type 3B servo altimeter was read in a significantly shorter time than was the Aero Mechanism Type 8047/20A capsule altimeter. An ergonomic appraisal of the latter instrument and a subjective evaluation by the subjects indicates that the probability of misreading this altimeter is high. Author

N79-26054# Martin Marietta Aerospace, Orlando, Fla.
HIGH ALTITUDE ALTIMETER FLIGHT TEST Final Report, 1 Aug. 1977 - 30 Sep. 1978
 W. G. Martin 30 Sep. 1978 157 p
 (Contract F33615-77-C-1222; AF Proj. 1995)
 (AD-A066904; AFAL-TR-78-143) Avail: NTIS HC A08/MF A01 CSCL 01/4

The HAAFT program was conducted to obtain high altitude radar altimeter data that could be used in a feasibility assessment of High Altitude TERCOM (HATCOM). The HAAFT program involved collecting altimeter data over seven scenes with terrain altitude standard deviations ranging from 25 to 320 feet located in the vicinity of Edward AFB and Point Mugu, California. Two pulse and one FM/CW altimeters were operated simultaneously at nominal altitudes of 5, 20, 30, 45, and 65 kft, AGL. The aircraft three-dimensional position was measured and provided by the AN/FPS-16 radar sets at Edwards AFB and Pt. Mugu. The tracking data were later merged with the data recorded in the aircraft and stored on computer tapes. An inertial navigator was included in the flight test equipment to provide aircraft attitude, velocity, and position data. In addition to the normal altitude measurement data provided by the altimeters, the pulse return waveform for the pulse altimeters and the prediscriminator waveform for the FM/CW altimeter were processed to be recorded on television video cassette recorders. Author (GRA)

N79-26055*# Pratt and Whitney Aircraft Group, East Hartford, Conn.
ROTOR REDESIGN FOR A HIGHLY LOADED 1800 FT/SEC TIP SPEED FAN. 1: AERODYNAMIC AND MECHANICAL DESIGN REPORT
 J. M. Norton, U. Tari, and R. M. Weber Apr. 1979 104 p refs
 (Contract NAS3-20591)
 (NASA-CR-159596; PWA-5523-42) Avail: NTIS HC A06/MF A01 CSCL 21E

A quasi three dimensional design system and multiple-circular-airfoil sections were used to design a fan rotor. An axisymmetric intrablade flow field calculation modeled the shroud of an isolated splitter and radial distribution. The structural analysis indicates that the design is satisfactory for evaluation of aerodynamic performance of the fan stage in a test facility. S.E.S.

N79-26056*# McDonnell Aircraft Co., St. Louis, Mo.
THRUST AND MASS FLOW CHARACTERISTICS OF FOUR 36 INCH DIAMETER TIP TURBINE FAN THRUST VECTORING SYSTEMS IN AND OUT OF GROUND EFFECT
 D. W. Esker and H. A. Roddiger Jun. 1979 105 p refs
 (Contract NAS2-9690)
 (NASA-CR-152239; MDC-A5704) Avail: NTIS HC A06/MF A01 CSCL 21E

The calibration tests carried out on the propulsion system components of a 70 percent scale, powered model of a NASA 3-fan V/STOL aircraft configuration are described. The three X3/6B/T58 turboprop fan units used in the large scale powered model were tested on an isolated basis over a range of ground heights from H/D of 1.02 to infinity. A higher pressure ratio LF336/J85 fan unit was tested over a range of ground heights from 1.55 to infinity. The results of the test program demonstrated that: (1) the thrust and mass flow performance of the X376B/T58 nose lift unit is essentially constant for H/D variations down to 1.55; at H/D 1.02 back pressurization of the fan exit occurs and is accompanied by an increase in thrust of five percent; (2) a change in nose fan exit hub shape from flat plate to hemispherical produces no significant difference in louvered lift nozzle performance for height variations from H/D = 1.02 to infinity; (3) operation of the nose lift nozzle at the higher fan pressure ratio generated by the LF336/J85 fan system causes no significant change in ground proximity performance down to an H/D of 1.55, the lowest height tested with this unit; and (4) the performance of the left and right X376B/T58 lift/cruise units in the vertical lift mode remains unchanged, within plus or minus two percent for the range of ground heights from H/D = 1.02 to infinity. J.M.S.

N79-26057*# National Aeronautics and Space Administration, Hugh L. Dryden Flight Research Center, Edwards, Calif.
EVALUATION OF A SIMPLIFIED GROSS THRUST CALCULATION TECHNIQUE USING TWO PROTOTYPE F100 TURBOFAN ENGINES IN AN ALTITUDE FACILITY
 Frank J. Kurtenbach Jun. 1979 30 p refs
 (NASA-TP-1482; H-1061) Avail: NTIS HC A03/MF A01 CSCL 21E

The technique which relies on afterburner duct pressure measurements and empirical corrections to an ideal one dimensional flow analysis to determine thrust is presented. A comparison of the calculated and facility measured thrust values is reported. The simplified model with the engine manufacturer's gas generator model are compared. The evaluation was conducted over a range of Mach numbers from 0.80 to 2.00 and at altitudes from 4020 meters to 15,240 meters. The effects of variations in inlet total temperature from standard day conditions were explored. Engine conditions were varied from those normally scheduled for flight. The technique was found to be accurate to a twice standard deviation of 2.89 percent, with accuracy a strong function of afterburner duct pressure difference. S.E.S.

N79-26058# AiResearch Mfg. Co., Phoenix, Ariz.
ALTERNATE SUBSONIC LOW-COST ENGINE Final Technical Report, 1 Apr. 1976 - 31 Dec. 1977
 C. F. Baerst and J. W. Sandborn May 1978 169 p refs
 (Contract F33615-76-C-2063)
 (AD-A067277; AiResearch-76-212199(21); AFAPL-TR-78-31) Avail: NTIS HC A08/MF A01 CSCL 21/5

This document presents the final report on the research and development of a turbojet derived from low-cost, high-production turbocharger components and an augmentor based on a low-cost, ramjet sudden-expansion burner. The engine, designated AiResearch ETJ131 Moel 1030, is an afterburning derivative of the AiResearch ETJ131 engine. Changes to the basic ETJ131 included placing the combustor parallel to the engine center line.

incorporating aerodynamic changes to accommodate the additional airflow required to achieve the thrust goal for the Model 1030, and adding an afterburner. Author (GRA)

N79-26060# Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.

THE INFLUENCE OF COMPRESSOR INLET GUIDE VANE/STATOR RELATIVE CIRCUMFERENTIAL POSITIONING ON BLADE WAKE TRANSPORT AND INTERACTION Interim Report, 30 Sep. 1977 - 31 Aug. 1978

G. J. Holbrook and T. H. Okiishi Sep. 1978 126 p refs (Grant AF-AFOSR-2916-76; ERI Proj. 1204) (AD-A067969; ISU-ERI-AMES-79037; TCRL-13; AFOSR-79-0509TR) Avail: NTIS HC A07/MF A01 CSCL 13/7

A periodically sampling hot-wire measurement system was used to obtain numerous periodic-average (Electronically and arithmetically averaged values of periodically sampled data) three-dimensional velocity vector data for flow through the first stage (inlet guide vane, rotor, and stator rows) of a low-speed, multistage, axial-flow research compressor. New data are presented for the maximum noise circumferential position of the first stator blade row. Comparisons are made between these data and similar data previously acquired and reported for the minimum noise configuration of the compressor. The inlet guide vane (IGV) wake avenue was found to interest first stator row blades at two span locations, one near the hub and the other near the tip, for maximum noise and at only one span location, near mid-span, for minimum noise. This difference in IGV wake / stator leading edge intersection patterns resulted in variations of the first stator exit flow deviation angle near the hub and tip portions of the compressor annulus. These variations were explained in terms of the larger fluctuations of stator inlet flow associated with the inlet guide vane wake avenues. GRA

N79-26062*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

A WIND-TUNNEL INVESTIGATION OF TILT-ROTOR GUST ALLEVIATION SYSTEMS Final Report, 1972 - 1978

Norman D. Ham and H. Philip Whitaker Jan. 1978 140 p refs (Contract NAS2-7262) (NASA-CR-152264; ASRL-TR-174-7) Avail: NTIS HC A07/MF A01 CSCL 01C

The alleviation of the effects of gusts on tilt rotor aircraft by means of active control systems was investigated. The gust generator, the derivation of the equations of motion of the rotor wing combination, the correlation of these equations with the results of wind tunnel model tests, the use of the equations to design various gust alleviating active control systems, and the testing and evaluation of these control systems by means of wind tunnel model tests were developed. S.E.S.

N79-26063*# Vought Corp., Hampton, Va.
BOEING 747 AIRCRAFT WITH LARGE EXTERNAL POD FOR TRANSPORTING OUTSIZE CARGO

Jack E. Price, C. Baptiste Quartero, Paul M. Smith, and G. Fred Washburn May 1979 21 p refs (Contract NAS1-13500) (NASA-CR-159067) Avail: NTIS HC A02/MF A01 CSCL 01C

The effect on structural arrangement, system weight, and range performance of the cargo pod payload carrying capability was determined to include either the bridge launcher or a spacelab module on a Boeing 747 aircraft. Modifications to the carrier aircraft and the installation time required to attach the external pod to the 747 were minimized. Results indicate that the increase in pod size was minimal, and that the basic 747 structure was adequate to safely absorb the load induced by ground or air operation while transporting either payload. S.E.S.

N79-26064*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

FULL-SCALE AIRCRAFT SIMULATION WITH CRYOGENIC TUNNELS AND STATUS OF THE NATIONAL TRANSONIC FACILITY

Robert A. Kilgore, William B. Igoe, Jerry B. Adcock, Robert M. Hall, and Charles B. Johnson Apr. 1979 20 p refs Presented at 1st Internatl. Symp. on Cryog. Wind Tunnels, Southampton, England, 3-5 Apr. 1979 (NASA-TM-80085) Avail: NTIS HC A02/MF A01 CSCL 14B

The effect of thermal and caloric imperfections in cryogenic nitrogen on boundary layers was determined to indicate that in order to simulate nonadiabatic laminar or turbulent boundary layers in a cryogenic nitrogen wind tunnel, the flight enthalpy ratio, rather than the temperature ratio, should be reproduced. The absence of significant real gas effects on both viscous and inviscid flows makes it unlikely that there will be large real gas effects on the cryogenic tunnel simulation of shock boundary layer interactions or other complex flow conditions encountered in flight. Condensation effects were studied to determine the minimum usable temperature and indicated that under most circumstances free stream Mach number rather than maximum local Mach number determines the onset of condensation effects. S.E.S.

N79-26067*# Control Data Corp., St. Paul, Minn. Research and Advanced Design Lab.

FEASIBILITY STUDY FOR A NUMERICAL AERODYNAMIC SIMULATION FACILITY: SUMMARY Final Report

N. R. Lincoln May 1979 24 p 4 Vol. (Contract NAS2-9896) (NASA-CR-152286) Avail: NTIS HC A02/MF A01 CSCL 14B

The Ames Research Center of NASA is engaged in the development and investigation of numerical methods and computer technologies to be employed in conjunction with physical experiments, particularly utilizing wind tunnels in the furtherance of the field of aircraft and aerodynamic body design. Several studies, aimed primarily at the areas of development and production of extremely high-speed computing facilities, were conducted. The studies focused on evaluating the aspects of feasibility, reliability, costs, and practicability of designing, constructing, and bringing into effect production of a special-purpose system. An executive summary of the activities for this project is presented in this volume. G.Y.

N79-26073# Aeronautical Research Labs., Melbourne (Australia).
A SIMPLE METHOD OF ADAPTING A WIND TUNNEL SCHLIEN SYSTEM FOR INTERFEROMETRY

N. Pollock Jun. 1978 44 p refs (AD-A067233; ARL/AERO-Note-378) Avail: NTIS HC A03/MF A01 CSCL 20/4

A simple method of adapting a wind tunnel Schlieren system for interferometry is described. This new interferometer arrangement employs a laser light source, a lens which splits off the reference beam after test beam expansion and a lens and Lloyd mirror to recombine the two beams. The reference beam passes through the test section but is contracted to a narrow waist and displaced well away from the model location. The proposed design combines a number of favourable characteristics which render it particularly useful for wind tunnel tests. These characteristics include: simplicity, optical robustness, low vibration sensitivity, modest coherence requirements and ease of interferogram analysis. The main disadvantage is that slightly less than half of the total field of view can be recorded on a single interferogram. Interferograms obtained from tests on a prototype instrument based on a Schlieren system of low mechanical rigidity are presented. Also included is a comparison between aerofoil pressure distributions obtained by direct measurement and by interferogram analysis. Author (GRA)

N79-26076*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

PROCEEDINGS OF WORKSHOPS TO DEFINE ENGINEERING REQUIREMENTS FOR A SPACE VACUUM RESEARCH FACILITY

W. A. Oran, ed., S. T. Wu, ed. (Alabama Univ. in Huntsville), and R. W. Hoffman, ed. (Case Western Reserve Univ., Ohio)

Jun. 1979 152 p refs Workshops held at Huntsville, Ala., 12-13 Jun. 1978 and 3-4 Apr. 1978
(NASA-CP-2091) Avail: NTIS HC A08/MF A01 CSCL 22A

The construction of a molecular wake shield for the shuttle orbiter is presented as well as a collision model with a program depicting emitted molecular density around the spacecraft giving estimates of backscattered flux and other collisional processes.

N79-26224# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

FUEL HYDROGEN CONTENT AS AN INDICATOR OF RADIATIVE HEAT TRANSFER IN AN AIRCRAFT GAS TURBINE COMBUSTOR Final Report, Jun. - Nov. 1976

Thomas A. Jackson and W. S. Blazowski Feb. 1979 24 p refs Presented at the Am. Soc. of Mech. Engr. Winter Ann. Meeting, Atlanta, 27 Nov. - 2 Dec. 1977
(AD-A067709; AFAPL-TR-79-2014) Avail: NTIS HC A02/MF A01 CSCL 21/4

Eleven fuels representing a wide range of hydrogen content were studied using a T56 single can combustor rig. Test fuels included single and double ring aromatic types as well as paraffins blended with each other and with JP-4. Fuel mixtures with hydrogen contents ranging from 9.9 to 15.9 per cent by weight were examined. The combustor inlet conditions simulated the discharge from both low and high pressure ratio gas turbine compressors operating at the cruise condition. Thermocouple data from the T56 liner are correlated with fuel hydrogen content using a new, nondimensional combustor liner temperature parameter. Least-squares mathematical treatment of the data resulted in an excellent second order correlation between the nondimensional temperature parameter and fuel hydrogen content and a simplified radiation analysis is presented which also explains the resulting empirical trends. Author (GRA)

N79-26253*# National Aeronautics and Space Administration, Pasadena Office, Calif.

ECHO TRACKER/RANGE FINDER FOR RADARS AND SONARS Patent Application

Nick J. Constantinides, inventor (to NASA) (JPL) Filed 29 Jun. 1979 22 p
(Contract NAS7-100)

(NASA-Case-NPO-14361-1; US-Patent-Appl-SN-053572) Avail: NTIS HC A02/MF A01 CSCL 20N

An echo tracker/range finder or altimeter is described in which the pulse repetition frequency (PRF) of a predetermined number of transmitted pulses is adjusted so that echo pulses received from a reflecting object are positioned between transmitted pulses and divide their interpulse time interval into two time intervals having a predetermined ratio with respect to each other. The thus-adjusted PRF is related to the range of the reflecting object. In addition, the invention provides a means whereby the arrival time of a plurality of echo pulses is defined as the time at which a composite echo pulse formed of a sum of the individual echo pulses has the highest amplitude. An especially useful application is in determining altitude information for an aircraft or an orbiting spacecraft utilizing a synthetic aperture imaging radar system. However, it could be used with sonar systems, laser ranger finders, or any other kind of rangefinding application in which a number of pulses are received. NASA

N79-26288# National Telecommunication Information Administration, Boulder, Colo. Inst. for Telecommunication Sciences.
AIRCRAFT OBSTRUCTION OF MICROWAVE LINKS Final Report

R. E. Skerjanec and R. W. Hubbard Jan. 1979 68 p refs Sponsored in part by Army Communications-Electronics Engineering Installation Agency
(PB-292372/0; NTIA/REPORT-79/14) Avail: NTIS HC A04/MF A01 CSCL 17B

A limited measurement program at 8 GHz at Atlanta and Chicago Airports was undertaken to determine if a condition existed that could cause excessive error rates on digital systems. Measurements were made of the received signal level together with the impulse response of the transmission medium. Measurement results indicate that during takeoff and landing,

aircraft can cause signal level fades to 20 db. The impulse response measurements at Atlanta did not reveal any delayed or distorted pulses that would indicate excessive multipath and frequency selective fading. However, slight distortion from taxiing aircraft at Chicago was observed. GRA

N79-26374*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.

INVESTIGATION OF A LASER DOPPLER VELOCIMETER SYSTEM TO MEASURE THE FLOW FIELD AROUND A LARGE SCALE V/STOL AIRCRAFT IN GROUND EFFECT

Andrew D. Zalay, Melvin R. Brashears, Archie J. Jordan, Kenneth R. Shriber, and Carl D. Vought May 1979 76 p refs Document includes a microfiche supplement
(Contract NAS2-8959)

(NASA-CR-152212; LMSC-HREC-TR-D568) Avail: NTIS HC E04/MF A01 CSCL 14B

The flow field measured around a hovering 70 percent scale vertical takeoff and landing (V/STOL) aircraft model is described. The velocity measurements were conducted with a ground based laser Doppler velocimeter. The remote sensing instrumentation and experimental tests of the velocity surveys are discussed. The distribution of vertical velocity in the fan jet and fountain; the radial velocity in the wall jet and the horizontal velocity along the aircraft underside are presented for different engine rpm's and aircraft height above ground. Results show that it is feasible to use a mobile laser Doppler velocimeter to measure the flow field generated by a large scale V/STOL aircraft operating in ground effect. S.E.S.

N79-26810*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

TRENDS IN RELIABILITY MODELING TECHNOLOGY FOR FAULT TOLERANT SYSTEMS

Salvatore J. Bavuso Apr 1979 15 p refs
(NASA-TM-80089) Avail: NTIS HC A02/MF A01 CSCL 09B

Reliability modeling for fault tolerant avionic computing systems was developed. The modeling of large systems involving issues of state size and complexity, fault coverage, and practical computation was discussed. A novel technique which provides the tool for studying the reliability of systems with nonconstant failure rates is presented. The fault latency which may provide a method of obtaining vital latent fault data is measured. S.E.S.

N79-26881*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

AN EVALUATION OF LINEAR ACOUSTIC THEORY FOR A HOVERING ROTOR

Charles E. K. Morris, Jr., F. Farassat (Joint Inst. for Advan. of Flight Sci.), and Paul A. Nystrom May 1979 57 p refs
(Grant Nsg-1474)

(NASA-TM-80059) Avail: NTIS HC A04/MF A01 CSCL 20A

Linear acoustic calculations are compared with previously reported data for a small-scale hovering rotor operated at high tip Mach numbers. A detailed calculated description of the distributions of blade surface pressure and shear stress due to skin friction is presented. The noise due to skin friction and loading, in the rotor disk plane, is small compared to thickness noise. The basic conclusions of Boxwell et al about the importance of nonlinear effects are upheld. Some approximations involved in the current theories for the inclusion of nonlinear effects are discussed. Using a model nonlinear problem, it is shown that to use the acoustic analogy, good knowledge of the flowfield is required. M.M.M.

N79-27014# Lehigh Univ., Bethlehem, Pa.

STRUCTURING OF DATA SYSTEMS: PSYCHOPHYSIOLOGICAL DATA FROM THE DYNAMIC FLIGHT SIMULATOR Final Report

Bruce D. Fritchman and John G. Nelson 9 Mar. 1979 39 p refs

(Contract N62269-77-C-0347)

(AD-A067175; NADC-79052-60) Avail: NTIS
HC A03/MF A01 CSCL 14/2

This investigation considered the methods and problems of collection, storage, processing and display of psychophysiological data from dynamic flight simulation in the Naval Air Development Center human centrifuge, using analog, mini, and remote main-frame computers. An integrated data processing system is described. Problems associated with data collection and storage are evaluated, and alternate solutions discussed. Anticipated problems in the development of data processing software are examined, and the applicable basic technology identified. Approaches to the critical problem of orderly and systematic development and maintenance of software for semi-open-shop operations is examined. Author (GRA)

N79-27071*# Iowa State Univ. of Science and Technology, Ames.

MINIMUM ALTITUDE-LOSS SOARING IN A SPECIFIED VERTICAL WIND DISTRIBUTION

Bion L. Pierson and Imao Chen *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 305-318 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

Minimum altitude-loss flight of a sailplane through a given vertical wind distribution is discussed. The problem is posed as an optimal control problem, and several numerical solutions are obtained for a sinusoidal wind distribution. J.M.S.

N79-27072*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

A STUDY OF COURSE DEVIATIONS DURING CROSS-COUNTRY SOARING

Steven M. Sliwa and David J. Sliwa (III). Univ. at Urbana-Champaign *In its* Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 319-353 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

Several models are developed for studying the impact of deviations from course during cross country soaring flights. Analyses are performed at the microstrategy and macrostrategy levels. Two types of lift sources are considered: concentrated thermals and thermal streets. The sensitivity of the optimum speed solutions to various model, piloting and performance parameters is evaluated. Guides are presented to provide the pilot with criterions for making in-flight decisions. In general, course deviations are warranted during weak lift conditions, but are less justifiable with moderate to strong lift conditions. Author

N79-27073*# Liege Univ. (Belgium).
ON GLOBAL OPTIMAL SAILPLANE FLIGHT STRATEGY

Guy J. Sander and Francois-Xavier Litt *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 355-375 refs

Avail: NTIS HC A99/MF A01 CSCL 17G

The derivation and interpretation of the necessary conditions that a sailplane cross-country flight has to satisfy to achieve the maximum global flight speed is considered. Simple rules are obtained for two specific meteorological models. The first one uses concentrated lifts of various strengths and unequal distance. The second one takes into account finite, nonuniform space amplitudes for the lifts and allows, therefore, for dolphin style flight. In both models, altitude constraints consisting of upper and lower limits are shown to be essential to model realistic problems. Numerical examples illustrate the difference with existing techniques based on local optimality conditions. J.M.S.

N79-27076*# Stuttgart Univ. (West Germany). Inst. A for Mechanics.

A GENERAL METHOD FOR THE LAYOUT OF AILERONS AND ELEVATORS OF GLIDERS AND MOTORPLANES

Manfred H. Hiller *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 399-418 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

A method is described which allows the layout of the spatial driving mechanism of the aileron for a glider or a motorplane to be performed in a systematic manner. In particular, a prescribed input-output behavior of the mechanism can be realized by variation of individual parameters of the spatial four-bar mechanisms which constitute the entire driving mechanism. By means of a sensitivity analysis, a systematic choice of parameters is possible. At the same time the forces acting in the mechanism can be limited by imposing maximum values of the forces as secondary conditions during the variation process. J.M.S.

N79-27077*# Politecnico di Torino (Italy).
EXPERIMENTAL INVESTIGATION INTO THE FEASIBILITY OF AN EXTRUDED WING

Piero Morelli and Giulio Romeo *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 419-436 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

Fabrications of extruded aluminum alloy structures are reviewed. The design criteria and the fabrication of the main structure of a sailplane wing made of a few extruded profiles longitudinally connected one to the other are illustrated. Structural tests recently carried out are reported upon. J.M.S.

N79-27078*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

TREATMENT OF THE CONTROL MECHANISMS OF LIGHT AIRPLANES IN THE FLUTTER CLEARANCE PROCESS

Elmar J. Breitbach *In its* Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 437-466 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

It has become more and more evident that many difficulties encountered in the course of aircraft flutter analyses can be traced to strong localized nonlinearities in the control mechanisms. To cope with these problems, more reliable mathematical models paying special attention to control system nonlinearities were established by means of modified ground vibration test procedures in combination with suitably adapted modal synthesis approaches. Three different concepts are presented. J.A.M.

N79-27079*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany).

ADVANCED COMPOSITES IN SAILPLANE STRUCTURES: APPLICATION AND MECHANICAL PROPERTIES

Dieter Muser *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 467-483 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

Advanced Composites in sailplanes mean the use of carbon and aramid fibers in an epoxy matrix. Weight savings were in the range of 8 to 18% in comparison with glass fiber structures. The laminates will be produced by hand-layup techniques and all material tests were done with these materials. These values may be used for calculation of strength and stiffness, as well as for comparison of the materials to get a weight-optimum construction. Proposals for material-optimum construction are mentioned. J.A.M.

N79-27080*# Boeing Commercial Airplane Co., Seattle, Wash.
THE ULTRALIGHT SAILPLANE

John H. McMasters *In* NASA. Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 485-504 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

As presently envisioned, the ultralight sailplane is intermediate in size, cost and performance between current hang gliders and the lower end of the traditional sailplane spectrum. In the design of an ultralight sailplane, safety, low cost, and operational simplicity were emphasized at the expense of absolute performance. An

overview of the design requirements for an ultralight sailplane is presented. It was concluded that by a judicious combination of the technologies of hang gliding, human powered flight, conventional soaring and motor gliding, an operationally and economically viable class of ultralight, self-launching sailplanes can be developed. J.A.M.

N79-27081*# Stanford Univ., Calif.
ANALYTICAL AND SCALE MODEL RESEARCH AIMED AT IMPROVED HANGGLIDER DESIGN

Ilan Kroo and Li-Shing Chang /In NASA, Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 505-521 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

Research consisted of a theoretical analysis which attempts to predict aerodynamic characteristics using lifting surface theory and finite-element structural analysis as well as an experimental investigation using 1/5 scale elastically similar models in the NASA Ames 2m x 3m (7' x 10') wind tunnel. Experimental data were compared with theoretical results in the development of a computer program which may be used in the design and evaluation of ultralight gliders. J.A.M.

N79-27082*# Instytut Lotnictwa, Warsaw (Poland).
IMPROVEMENT OF HANG GLIDER PERFORMANCE BY USE OF ULTRALIGHT ELASTIC WING

Jerzy S. Wolf /In NASA, Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 523-536 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

The problem of the lateral controllability of the hang glider by the pilot's weight shift was considered. The influence of the span and the torsional elasticity of the wing was determined. It was stated that an ultralight elastic wing of a new kind was most suitable for good control. The wing also has other advantageous properties. J.A.M.

N79-27083*# Office National d'Etudes et de Recherches Aérospatiales, Paris (France). Aerospace Mechanics Div.
EXPERIMENTAL STUDY OF THE FLIGHT ENVELOPE AND RESEARCH OF SAFETY REQUIREMENTS FOR HANG-GLIDERS

Claudius LaBurthe /In NASA, Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 537-556 refs

Avail: NTIS HC A99/MF A01 CSCL 01C

The flight mechanic computations were computed, providing both the flight envelopes with all sorts of limits and a fairly precise idea of the influence of several parameters, such as pilot's weight, wing settings, aeroelasticity, etc. The particular problem of luffing dives was thoroughly analyzed, and two kinds of causes were exhibited in both the rules of luffing and aeroelastic effects. The general analysis of longitudinal stability showed a strong link with fabric tension, as expected through Nielsen's and Twaites' theory. Fabric tension strongly depending upon aeroelasticity, that parameter was found to be the most effective design one for positive stability. Lateral stability was found to be very similar in all gliders except perhaps the cylindro-conical. The loss of stability happens in roll at low angle of attack, whereas it happens in yaw at high angle. Turning performance was a bit surprising, with a common maximum value of approximately 55 deg of bank angle for a steady turn. Author

N79-27084*# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
WIND TUNNEL TESTS OF FOUR FLEXIBLE WING ULTRALIGHT GLIDERS

Robert A. Ormiston /In NASA, Langley Res. Center Sci. and Technol. of Low Speed and Motorless Flight Jun. 1979 p 557-589

Avail: NTIS HC A99/MF A01 CSCL 01A

The aerodynamic lift, drag, and pitching moment characteristics of four full scale, flexible wing, ultralight gliders were measured in the settling chamber of a low speed wind tunnel. The gliders were tested over a wide range of angle of attack and at two

different velocities. Particular attention was devoted to the lift and pitching moment behavior at low and negative angles of attack because of the potential loss of longitudinal stability of flexible wing gliders in this regime. The test results were used to estimate the performance and longitudinal control characteristics of the gliders. J.A.M.

N79-27086*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.
TECHNOLOGY REQUIREMENTS AND READINESS FOR VERY LARGE VEHICLES

D. William Conner Jun. 1979 11 p Presented at the AIAA Very Large Vehicle Conf., Arlington, Va., 26-27 Apr. 1979 (NASA-TM-80127) Avail: NTIS HC A02/MF A01 CSCL 02A

Common concerns of very large vehicles in the areas of economics, transportation system interfaces and operational problems were reviewed regarding their influence on vehicle configurations and technology. Fifty-four technology requirements were identified which are judged to be unique, or particularly critical, to very large vehicles. The requirements were about equally divided among the four general areas of aero/hydrodynamics, propulsion and acoustics, structures, and vehicle systems and operations. The state of technology readiness was judged to be poor to fair for slightly more than one half of the requirements. In the classic disciplinary areas, the state of technology readiness appears to be more advanced than for vehicle systems and operations. S.E.S.

N79-27087*# Milco International, Inc., Huntington Beach, Calif.
STATE OF THE ART SURVEY OF TECHNOLOGIES APPLICABLE TO NASA'S AERONAUTICS, AVIONICS AND CONTROLS PROGRAM

Richard K. Smyth, ed. May 1979 332 p refs Prepared in cooperation with ORI, Inc., Silver Spring, Md.

(Contract NASw-2961)

(NASA-CR-159050) Avail: NTIS HC A15/MF A01 CSCL 02A

The state of the art survey (SOAS) covers six technology areas including flightpath management, aircraft control system, crew station technology, interface & integration technology, military technology, and fundamental technology. The SOAS included contributions from over 70 individuals in industry, government, and the universities. Author

N79-27088*# National Aeronautics and Space Administration, Hugh L. Dryden Flight Research Center, Edwards, Calif.
CORRELATION OF PREDICTED AND MEASURED THERMAL STRESSES ON AN ADVANCED AIRCRAFT STRUCTURE WITH DISSIMILAR MATERIALS

Jerald M. Jenkins Jun. 1979 47 p refs (NASA-TM-72865; H-1032) Avail: NTIS HC A03/MF A01 CSCL 02A

Additional information was added to a growing data base from which estimates of finite element model complexities can be made with respect to thermal stress analysis. The manner in which temperatures were smeared to the finite element grid points was examined from the point of view of the impact on thermal stress calculations. The general comparison of calculated and measured thermal stresses is quite good and there is little doubt that the finite element approach provided by NASTRAN results in correct thermal stress calculations. Discrepancies did exist between measured and calculated values in the skin and the skin/frame junctures. The problems with predicting skin thermal stress were attributed to inadequate temperature inputs to the structural model rather than modeling insufficiencies. The discrepancies occurring at the skin/frame juncture were most likely due to insufficient modeling elements rather than temperature problems. A.R.H.

N79-27093*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF A V/STOL TILT NACELLE INLET WITH BLOWING BOUNDARY LAYER CONTROL

Albert L. Johns, Robert C. Williams, and H. C. Potonides (Grumman Aerospace Corp., Bethpage, N. Y.) 1979 13 p refs Presented

at the 15th Joint Propulsion Conf., Las Vegas, Nev., 18-20 Jun. 1979; cosponsored by AIAA, SAE and ASME (NASA-TM-79176; E-043) Avail: NTIS HC A02/MF A01 CSCL 01A

A scale model of a V/STOL tilt nacelle fitted to a 0.508 m single stage fan was tested in the NASA Lewis 9x15 ft low speed wind tunnel to determine the effect of diffuser blowing on the inlet aerodynamics and aeromechanical performance. The test was conducted over a range of freestream speeds (up to 120 knots) and angles of attack (up to 120 deg). Diffuser blowing had a beneficial affect on all performance parameters. The angle of attack range for separation free flow substantially increased, and the fan face distortion significantly reduced with a corresponding increase in total pressure recovery. Discrete narrow band blade stress peaks which were common to the nonblowing (baseline) configuration were eradicated with diffuser blowing.

S.E.S.

N79-27095*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

INFLUENCE OF OPTIMIZED LEADING-EDGE DEFLECTION AND GEOMETRIC ANHEDRAL ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A LOW-ASPECT-RATIO HIGHLY SWEEPED ARROW-WING CONFIGURATION
Paul L. Coe, Jr. and Jarret K. Huffman Jun. 1979 53 p refs (NASA-TM-80083) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation conducted in the Langley 7 by 10 foot tunnel to determine the influence of an optimized leading-edge deflection on the low speed aerodynamic performance of a configuration with a low aspect ratio, highly swept wing. The sensitivity of the lateral stability derivative to geometric anhedral was also studied. The optimized leading edge deflection was developed by aligning the leading edge with the incoming flow along the entire span. Owing to the spanwise variation of unwash, the resulting optimized leading edge was a smooth, continuously warped surface for which the deflection varied from 16 deg at the side of body to 50 deg at the wing tip. For the particular configuration studied, levels of leading-edge suction on the order of 90 percent were achieved. The results of tests conducted to determine the sensitivity of the lateral stability derivative to geometric anhedral indicate values which are in reasonable agreement with estimates provided by simple vortex-lattice theories.

J.M.S.

N79-27096*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

AN EXPLORATORY STUDY OF A FINITE DIFFERENCE METHOD FOR CALCULATING UNSTEADY TRANSONIC POTENTIAL FLOW

Robert M. Bennett and Samuel R. Bland Jun. 1979 22 p refs Presented at AIAA/ASME/ASCE/AHS Struct., Structural Dyn., and Mater. Conf., St. Louis, 4-6 Apr. 1979 (NASA-TM-80105; AIAA-PAPER-79-0768) Avail: NTIS HC A02/MF A01 CSCL 01A

A method for calculating transonic flow over steady and oscillating airfoils was developed by Isogai. The full potential equation is solved with a semi-implicit, time-marching, finite difference technique. Steady flow solutions are obtained from time asymptotic solutions for a steady airfoil. Corresponding oscillatory solutions are obtained by initiating an oscillation and marching in time for several cycles until a converged periodic solution is achieved. The method is described in general terms and results for the case of an airfoil with an oscillating flap are presented for Mach numbers 0.500 and 0.875. Although satisfactory results are obtained for some reduced frequencies, it is found that the numerical technique generates spurious oscillations in the indicial response functions and in the variation of the aerodynamic coefficients with reduced frequency. These oscillations are examined with a dynamic data reduction method to evaluate their effects and trends with reduced frequency and Mach number. Further development of the numerical method is needed to eliminate these oscillations.

S.E.S.

N79-27097*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

A FLIGHT INVESTIGATION OF BASIC PERFORMANCE CHARACTERISTICS OF A TEETERING-ROTOR ATTACK HELICOPTER

Charles E. K. Morris, Jr. Jun. 1979 114 p refs Sponsored in part by the US Army Aviation Research and Development Command, Hampton, Va. (NASA-TM-80112) Avail: NTIS HC A06/MF A01 CSCL 01A

Flight data were obtained with an instrumented AH-16 helicopter having uninstrumented, standard main-rotor blades. The data are presented to facilitate the analysis of data taken when the same vehicle was flown with instrumented main-rotor blades built with new airfoils. Test results include data on performance, flight-state parameters, pitch-link loads and blade angles for level flight; descending turns and pull-ups. Flight test procedures and the effects of both trim variations and transient phenomena on the data are discussed.

Author

N79-27098*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

AN EXPLORATORY INVESTIGATION OF THE EFFECT OF A PLASTIC COATING ON THE PROFILE DRAG OF A PRACTICAL-METAL-CONSTRUCTION SAILPLANE AIRFOIL

Dan M. Somers and Jean M. Foster Jul. 1979 34 p refs (NASA-TM-80092; L-11623) Avail: NTIS HC A03/MF A01 CSCL 01A

The Langley low-turbulence pressure tunnel to determine the effect of a plastic coating on the profile drag of a practical-metal-construction sailplane airfoil was investigated. The model was tested with three surface configurations: (1) filled, painted, and sanded smooth; (2) rough bare metal; and (3) plastic-coated. The results are compared with data for the design airfoil (Wortmann FX 67-K-170/17) from another low-turbulence wind tunnel. The investigation was conducted at Reynolds numbers based on airfoil chord of 1.1 x 10 to the 6th power, 2.2 x 10 to the 6th power, and 3.3 x 10 to the 6th power at a Mach number of 0.10.

A.R.H.

N79-27099*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

PRESSURE DISTRIBUTIONS ON THREE DIFFERENT CRUCIFORM AFT-TAIL CONTROL SURFACES OF A WINGLESS MISSILE AT MACH 1.60, 2.36, AND 3.70 VOLUME 1: TRAPEZOIDAL TAIL

Milton Lamb, Wallace C. Sawyer, Donald L. Wassum, and C. Donald Babb Aug. 1979 345 p (NASA-TM-80097; L-12993) Avail: NTIS HC A15/MF A01 CSCL 01A

The results of pressure distribution tests conducted in the Langley Unitary Plan wind tunnel are presented. The data were obtained for three sets of cruciform aft-tail control surfaces on a wingless missile model at Mach numbers of 1.60, 2.36, and 3.70 for angles of attack from -4 degrees to 20 degrees, model roll angles from 0 degrees to 90 degrees, and tail deflections of 0 degrees and 15 degrees. The test Reynolds number used was 6.6 million per meter.

Author

N79-27100*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

LEADING-EDGE SLAT OPTIMIZATION FOR MAXIMUM AIRFOIL LIFT

Lawrence E. Olson, Phillip R. McGowan (Computer Sci. Corp., Mountain View, Calif.), and Clayton J. Guest (Computer Sci. Corp., Mountain View, Calif.) Jul. 1979 28 p refs (NASA-TM-78566; A-7753) Avail: NTIS HC A03/MF A01 CSCL 01A

A numerical procedure for determining the position (horizontal location, vertical location, and deflection) of a leading edge slat that maximizes the lift of multielement airfoils is presented. The structure of the flow field is calculated by iteratively coupling potential flow and boundary layer analysis. This aerodynamic calculation is combined with a constrained function minimization analysis to determine the position of a leading edge slat so that the suction peak on the nose of the main airfoil is minimized. The

slat position is constrained by the numerical procedure to ensure an attached boundary layer on the upper surface of the slat and to ensure negligible interaction between the slat wake and the boundary layer on the upper surface of the main airfoil. The highest angle attack at which this optimized slat position can maintain attached flow on the main airfoil defines the optimum slat position for maximum lift. The design method is demonstrated for an airfoil equipped with a leading-edge slat and a trailing edge, single-slotted flap. The theoretical results are compared with experimental data, obtained in the Ames 40 by 80 Foot Wind Tunnel, to verify experimentally the predicted slat position for maximum lift. The experimentally optimized slat position is in good agreement with the theoretical prediction, indicating that the theoretical procedure is a feasible design method. Author

N79-27101# Flow Research, Inc., Kent, Wash.
NUMERICAL EVALUATION OF TRANSONIC EQUIVALENCE RULE

M. M. Hafez Sep. 1978 56 p refs
 (Contract N00014-76-C-0880)
 (AD-A067902; FLOW-RR-127) Avail: NTIS
 HC A04/MF A01 CSCL 20/4

A numerical investigation was conducted to explore the applicability of the transonic equivalence rule. It is shown that for wings of small leading edge sweep angle, departure from Whitcomb-Oswatitsch area rule is significant. For sufficiently large or moderate leading edge sweep-angle, however, the agreement is satisfactory. Drag-rise and outer flow field calculations are presented for a number of cases and their equivalent bodies. Nonlinear lift corrections to the classical area rule are examined. There seems to be a surprisingly good agreement between calculated flows around equivalent wing-body combinations with the same wing planform for cases with appreciable lift.

Author (GRA)

N79-27103# Technische Univ., Berlin (West Germany). Inst. fuer Luft und Raumfahrt.
LEE SIDE FLOW FIELD OVER SLENDER DELTA WINGS OF FINITE THICKNESS [LEESEITEN-STROEMUNG BEI SCHLANKEN DELTAFLUEGELN ENDLICHER DICKE]
 Joachim Czodurch 1977 150 p refs In GERMAN; ENGLISH summary
 (ILR-23; ISBN-3-7983-0597-8) Avail: NTIS
 HC A07/MF A01

An experimental and theoretical investigation was carried out to determine the lee side flow field over delta wings at supersonic speeds. The experiments were performed with models of the same slenderness $s/l = 0.3$, but of different cross-section shape. The known types of flow, separated by the Stanbrook-Squire boundary into leading edge and shock induced separation were been verified. However, further types of flow exist and a detailed survey of the boundaries is necessary. The influence of the cross sectional shape on the lee side flow is discussed for the thick wing inside the region of shock induced separation. Parameters such as wedge angle at the center line, angle between upper and lower surface, and the lower side shape are considered. A theoretical method to describe the flow field is outlined where boundary conditions as a result of the experimental study are needed. The computed flow field with shock induced separation is satisfactory. Author (ESA)

N79-27107# Technische Hochschule, Darmstadt (West Germany). Inst. fuer Flugtechnik.
WIND TUNNEL MEASUREMENTS OF DYNAMIC DERIVATIVES IN THE GERMAN FEDERAL REPUBLIC [WINDKANALMESSUNG DYNAMISCHER DERIVATIVA IN DER BUNDES REPUBLIK DEUTSCHLAND]
 Xaver Hafer, Otto Determann, and Juergen Oser 2 May 1978 31 p refs In GERMAN Sponsored by Deut. Forschungsgemeinschaft
 (IFD-5-78) Avail: NTIS HC A03/MF A01

The oscillatory and rotary derivative balances employed are described. Test results obtained with identical models in different wind tunnels using different dynamic balances are compared. Results obtained with a simple standard test appear to be

sufficiently accurate and reproducible. Furthermore, agreement between wind tunnel and flight measurements is good. Emphasis is given to the significance of simple dynamic derivatives for the dynamic behavior of various aircraft. Author (ESA)

N79-27109# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
INVESTIGATIONS OF INTERFERENCE EFFECTS IN A WIND TUNNEL CAUSED BY A MODEL SUPPORT STRUT ON A REFLECTION PLANE MOUNTED HALF MODEL
M.S. Thesis - Roy. Inst. of Technol., Stockholm
 Olle Lindau and Bertil Braennstroem 1978 95 p refs
 (Contract FMV-FK-82223-76-002-21-001)
 (FFA-TN-AU-1335:2) Avail: NTIS HC A05/MF A01

A theoretical and experimental investigation of the interference effects in a wind tunnel, caused by the support strut for complete models, on the flow around a reflection-plane mounted half model was made. The theoretical part consisted of a computer simulation of the flow around a half model in the wind tunnel with and without the support strut. The experimental part consisted of wind tunnel tests with a 1:25 scale model in the 0.5 x 0.5 sq m transonic wind tunnel S5 at Mach numbers from 0.5 to 0.975. Three different struts were investigated. The theoretical estimates of the interference loads at small incidence agree well with the measured values. The effects are in general small except at higher angles of attack where the effects increase. This is especially noticeable in the pitching moment, resulting in the earlier occurrence of the pitch-up. Author (ESA)

N79-27110# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
CALCULATION OF PRESSURE DISTRIBUTION FOR A WING-BODY COMBINATION AT SUBSONIC MACH NUMBERS Final Report
 Sven Hedman 1978 49 p refs
 (Contract FMV-FK-82223-73-009-730906)
 (FFA-TN-AU-1091) Avail: NTIS HC A03/MF A01

Calculation of pressure distribution on a simple wing-body combination was performed at subsonic Mach numbers 0.1, 0.5, 0.7 and 0.8 for 0 deg and 5.73 deg angles of attack with a method derived from the Woodward panel method. These results were compared with two other computational methods, one being a surface panel method and the other a method based on Truckenbrodt lifting surface theory. Comparisons between the three computational procedures show good agreement.

Author (ESA)

N79-27113*# Douglas Aircraft Co., Inc., Long Beach, Calif.
THE 1990 SYSTEM CHARACTERISTICS AND REQUIREMENTS
 In its Cargo Logistics Airlift Systems Study (CLASS), Vol. 3
 Oct. 1978 p 1-64

Avail: NTIS HC A17/MF A01 CSCL 01C

Potential future developments that may occur in the air, truck, rail, and sea transportation industries were identified. Technological and operational developments were qualitatively evaluated for their potential effect upon the vehicle and institutional characteristics of the respective modes. Also identified were the multiplicity of cross impacts that must be considered when viewing air cargo as an integrated transport system. R.E.S.

N79-27114*# Douglas Aircraft Co., Inc., Long Beach, Calif.
AIRFREIGHT FORECASTING METHODOLOGY AND RESULTS
 In its Cargo Logistics Airlift Systems Study (CLASS), Vol. 3
 Oct. 1978 p 65-132

Avail: NTIS HC A17/MF A01 CSCL 01C

A series of econometric behavioral equations was developed to explain and forecast the evolution of airfreight traffic demand for the total U.S. domestic airfreight system, the total U.S. international airfreight system, and the total scheduled international cargo traffic carried by the top 44 foreign airlines. The basic explanatory variables used in these macromodels were the real gross national products of the countries involved and a

measure of relative transportation costs. The results of the econometric analysis reveal that the models explain more than 99 percent of the historical evolution of freight traffic. The long term traffic forecasts generated with these models are based on scenarios of the likely economic outlook in the United States and 31 major foreign countries. R.E.S.

N79-27115*# Douglas Aircraft Co., Inc., Long Beach, Calif.
THE 1990 DIRECT SUPPORT INFRASTRUCTURE
In its Cargo Logistics Airlift Systems Study (CLASS), Vol. 3
 Oct. 1978 p 133-351

Avail: NTIS HC A17/MF A01 CSCL 01C

The airport and cargo terminal were individually analyzed in depth as the principal direct infrastructure components having cross impacts with aircraft carrying cargo. Containerization was also addressed in depth as an infrastructure component since it categorically is linked with and cross impacted by the aircraft, the cargo terminal, the surface transport system, the shipper and consignee, and the actual cargo being moved. R.E.S.

N79-27116# Lockheed-California Co., Burbank.
SUMMARY OF RESULTS FOR A TWIN-ENGINE, LOW-WING AIRPLANE SUBSTRUCTURE CRASH IMPACT CONDITION ANALYZED WITH PROGRAM KRASH Final Report, Jul. 1978 - Jan. 1979

G. L. Wittlin Jan. 1979 122 p refs
 (Contract DOT-FA75WA-3707)
 (AD-A069171; LR-28869; FAA-RD-79-13) Avail: NTIS HC A06/MF A01 CSCL 01/3

The results of using digital computer program KRASH to model and analyze the dynamic response of a twin-engine, low-wing airplane substructure subjected to a 27.5 ft/sec vertical velocity impact are reported. The test was performed previously by NASA-Langley as part of a joint FAA-NASA effort concerning general aviation airplane crash dynamics. A mathematical model description, pertinent test data, a comparison of analysis versus test results and the results of a limited parameter sensitivity using program KRASH are included. Floor and occupant pelvis vertical acceleration responses obtained from test measurement are compared to corresponding analytical results. The effect of model representation and input data selection variations on dynamic behavior are evaluated. S.E.S.

N79-27118# Mitre Corp., McLean, Va. Metrek Div.
DEFINITION, DESCRIPTION, AND INTERFACES OF THE FAA'S DEVELOPMENTAL PROGRAMS. VOLUME 2: ATC FACILITIES AND INTERFACES Final Report

P. O. Dodge, T. R. Simpson, W. F. Potter, G. G. Beeker, H. P. Guerber, J. C. Fowlkes, and F. S. Keblawi Sep. 1978 436 p refs

(Contract DOT-FA79WA-4184)
 (AD-A068401; MTR-7904-Vol-2; FAA-EM-78-16-2-Vol-2)
 Avail: NTIS HC A19/MF A01 CSCL 17/7

The evolution of the air traffic control system facilities is described. Major system improvements currently being developed by the FAA are also described. Information flow between facilities is emphasized. R.E.S.

N79-27119# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DISCRETE ADDRESS BEACON SYSTEM (DABS) AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) INTERFERENCE ANALYSIS Final Report

J. D. Welch and W. H. Harman 27 Nov. 1978 87 p refs
 Prepared for DOT
 (Contract DOT-FA72WAI-261; F19628-78-C-0002)
 (AD-A068565; FAA-RD-78-147) Avail: NTIS HC A05/MF A01 CSCL 17/7

The Discrete Address Beacon System (DABS) of the Air Traffic Control Radar Beacon System (ATCRBS) is provided to improve the surveillance and data link service to suitably equipped aircraft operating on the same ATCRBS frequencies. The assumptions, models, and system operation necessary to assess the potential interference effects of DABS on ATCRBS are presented. S.E.S.

N79-27124# Fondazione Ugo Bordoni, Rome (Italy).
THEORY AND EXPERIMENTS ON PRECISION L-BAND DME

Franco Chiarini (FACE Standard, Pomezia, Italy), Gabriele Falciasacca (Bologne Univ.), and Danio Graziani (FACE Standard, Milan) Dec. 1977 25 p refs
 (FUB-44-1977) Avail: NTIS HC A02/MF A01

A preliminary report is given on studies and experiments conducted on the problems of increasing the accuracy of existing DME systems for use with microwave landing systems (MLS). Studies made on multipath errors suggested the use of a computer model which includes the area, the airport, and the receiver model. A mathematical expression of the receiver model is given. Improvement in accuracy can be obtained if the processing of many measurements is adapted to estimating the aircraft position. This procedure, however, was proved to reduce only the errors due to the electronic equipment. An example of a simple data processing procedure is given. The relationship between shape and frequency spectrum of a pulse was analyzed. A pulse synthesizer built to facilitate the generation of special pulse shapes is described. Results of these investigations are given.

Author (ESA)

N79-27125*# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.

THE INFLUENCE OF FEEDBACK ON THE AEROELASTIC BEHAVIOR OF TILT PROPROPOTOR AIRCRAFT INCLUDING THE EFFECTS OF FUSELAGE MOTION Final Technical Report, 1 Sep. 1976 - 31 Jan. 1978

H. C. Curtiss, Jr., T. Komatsuzaki, and J. J. Traybar Jul. 1979 176 p refs

(Grant NsG-2181)
 (NASA-CR-158778; TR-1441) Avail: NTIS HC A09/MF A01 CSCL 01C

The influence of single loop feedbacks to improve the stability of the system are considered. Reduced order dynamic models are employed where appropriate to promote physical insight. The influence of fuselage freedom on the aeroelastic stability, and the influence of the airframe flexibility on the low frequency modes of motion relevant to the stability and control characteristics of the vehicle were examined. S.E.S.

N79-27126*# Northrop Corp., Hawthorne, Calif.

YF-17/ADEN SYSTEM STUDY Final Report
 N. S. Gowadia, W. D. Bard, and W. H. Wooten (General Electric Co.) Jul. 1979 160 p refs

(Contract NAS4-2499)
 (NASA-CR-144882) Avail: NTIS HC A08/MF A01 CSCL 01C

The YF-17 aircraft was evaluated as a candidate nonaxisymmetric nozzle flight demonstrator. Configuration design modifications, control system design, flight performance assessment, and program plan and cost we are summarized. Two aircraft configurations were studied. The first was modified as required to install only the augmented deflector exhaust nozzle (ADEN). The second one added a canard installation to take advantage of the full (up to 20 deg) nozzle vectoring capability. Results indicate that: (1) the program is feasible and can be accomplished at reasonable cost and low risk; (2) installation of ADEN increases the aircraft weight by 600 kg (1325 lb); (3) the control system can be modified to accomplish direct lift, pointing capability, variable static margin and deceleration modes of operation; (4) unvectored thrust-minus-drag is similar to the baseline YF-17; and (5) vectoring does not improve maneuvering performance. However, some potential benefits in direct lift, aircraft pointing, handling at low dynamic pressure and takeoff/landing ground roll are available. A 27 month program with 12 months of flight test is envisioned, with the cost estimated to be \$15.9 million for the canard equipped aircraft and \$13.2 million for the version without canard. The feasibility of adding a thrust reverser to the YF-17/ADEN was investigated. S.E.S.

N79-27127# Pacer Systems, Inc., Arlington, Va.
REVIEW OF AIRWORTHINESS STANDARDS FOR CERTI-

IFICATION OF HELICOPTERS FOR INSTRUMENT FLIGHT RULES (IFR) OPERATION Final Report, Apr. 1977 - Jun. 1978

J. J. Traybar, D. L. Green, and A. G. DeLucien Feb. 1979
245 p refs
(Contract DOT-FA77WA-3966)
(AD-A068397; PAR-007-79; FAA-RD-78-157) Avail: NTIS
HC A11/MF A01 CSCL 01/3

A review of current technology, existing data applicable to Instrument Flight Rules (IFR) helicopter operation and certification procedures was accomplished. Identification of specific airworthiness requirements for helicopters operating in IFR conditions was studied and special attention was given to aircrew manning configurations, pilot flight control workloads, helicopter trim, static stability, dynamic stability, handling qualities, analysis of time history data and documentation procedures, augmentation systems, autopilots and a review of certain flight test techniques. An analysis was made of the numerous helicopters recently certified for IFR flight in order to establish the various systems utilized including avionics systems, display systems and autopilot type systems. Special emphasis was centered on the study of the most critical IFR flight phases depicted by high workload cruise conditions and marginal stability conditions. Author

N79-27128# Grumman Aerospace Corp., Bethpage, N.Y. System Sciences.

THE COMPUTATION OF OPTIMAL AIRCRAFT TRAJECTORIES

H. G. Moyer Jul. 1979 65 p refs
(RE-577) Avail: NTIS HC A04/MF A01

An aircraft trajectory optimization computer program that was used successfully at Grumman for a variety of problems over a period of many years is described. Three airplanes are simulated: the F-14, F-15, and Advanced Tactical Fighter. The trajectories are in three dimensions over a flat earth. Optimization is achieved by means of the conjugate gradient variational technique. Inequality constraints on the path and equality constraints on the final point are satisfied by penalty integrals and penalty functions, respectively. The equality constraints can be satisfied to the limit of computer accuracy by a technique that avoids increases in the penalty function constants. M.M.M.

N79-27129# McDonnell Aircraft Co., St. Louis, Mo.
AIRCRAFT HYDRAULIC SYSTEMS DYNAMIC ANALYSIS Final Report, 18 Feb. 1977 - 30 Sep. 1978

H. DeGarcia, J. B. Greene, R. J. Levek, and N. J. Pierce Jan. 1978 356 p refs
(Contract F33615-74-C-2016; AF Proj. 3145)
(AD-A067549; AFAPL-TR-78-77) Avail: NTIS
HC A15/MF A01 CSCL 13/7

This report describes the continued development and test verification of digital computer models used to simulate hydraulic systems under dynamic conditions. Frequency and transient models of a variable delivery vane pump and a fixed displacement piston-type hydraulic motor are included. Additional verification and development of the transient model for the piston-type hydraulic pump was accomplished. Verification and development of a computer program to describe the mechanical response of a hydraulic line to internal excitations from a hydraulic pump was begun. This effort was a continuation of the basic contract wherein four computer programs for hydraulic system dynamic analysis were developed. GRA

N79-27130# Army Aviation Research and Development Command, St. Louis, Mo.

RAM PROJECTIONS FOR AIRCRAFT ROTOR BLADES Final Report

Israel Nussbaum Apr. 1979 18 p
(AD-A068822; USAAVRADCOM-TR-79-16) Avail: NTIS
HC A02/MF A01 CSCL 01/3

Data was collected and a comparative analysis was performed on the estimated Reliability and Maintainability (RAM) characteristics of the main rotor blades belonging to two groups of four Army aircraft systems each. The first group is composed of aircraft in the current Army inventory, while the second consists

of developmental and PIP aircraft which will be using the new composite rotor blades. The study was initiated internally as a result of wide discrepancies observed among various aircraft programs in the assumptions, definitions and methodologies used in projecting rotor blade RAM characteristics. The need became apparent to develop and apply a set of factors and criteria that could be used to help achieve uniformity, consistency and validity in the RAM projections. GRA

N79-27131# Rockwell International Corp., El Segundo, Calif. Los Angeles Div.

AIRCRAFT TRANSPARENCY FAILURE AND LOGISTICAL COST ANALYSIS. VOLUME 1: PROGRAM SUMMARY Final Report, Jun. 1977 - Sep. 1978

S. S. Brown Dec. 1978 67 p refs
(Contract F33615-77-C-3060)
(AD-A068719; NA-78-604-Vol-1) Avail: NTIS HC A04/MF A01
CSCL 01/3

The concern for increasing costs in the maintenance of transparency systems has prompted the Air Force Flight Dynamics Laboratory to sponsor this study contract. The objective of this study is to identify the high-cost, high-maintenance transparency components, identify cause of failures, and recommend corrective programs to reduce cost of ownership to the Air Force Logistics Command. The study involved the review of 20 selected aircraft in current Air Force inventory to establish an extensive data base relating to transparency maintenance activity and associated logistical support costs. During this study, a collection of detailed design characteristics, methods of construction, test and qualification, and costing information was assembled. From these data, the basis for design improvements were determined. The approach used in the identification of candidate improvements was to focus on the high-cost contributors to maintenance and repair. Trade studies were subsequently generated to determine the design improvements that resulted in reduced logistical costs. The study results are presented in this report. GRA

N79-27134# Technische Hochschule, Darmstadt (West Germany). Inst. fuer Flugtechnik.

AERONAUTICAL RESEARCH INTO VERTICAL PROBLEMS IN V/STOL AIRCRAFT APPROACH LANDING Final Report [FLUGMECHANISCHE UNTERSUCHUNG ZUM PROBLEM STEILER LANDEANFLUEGE FUER V/STOL-FLUGZEUGE]

Volker Nitsche 18 Aug. 1978 157 p refs In GERMAN
Sponsored by Deut. Forschungsgemeinschaft
(IFD-4-78) Avail: NTIS HC A08/MF A01

Take-off and landing behavior of two typical VTOL aircraft (jet and propeller driven) were investigated from the noise point of view. Various factors (thrust, thrust angle, flap shutter position, transition angles, etc.) influence noise. A digital computer simulation program was used to define a noise protected zone. Certain criteria must be satisfied, such as minimum fuel consumption, minimum take-off time, and minimum noise. In all cases, other than the landing of VTOL propeller craft (where fuel consumption is minimum and noise optimum), increasing excess take-off thrust enlarges the noise protected zone. Air temperature and humidity must be taken into account if reliable results are to be obtained. Author (ESA)

N79-27135# National Aerospace Lab., Amsterdam (Netherlands). Div. of Structure and Materials.

THE REQUIREMENT OF DAMAGE TOLERANCE. AN ANALYSIS OF DAMAGE TOLERANCE REQUIREMENTS WITH SPECIFIC REFERENCE TO MIL-A-83444

J. B. deJonge 16 Jan. 1978 33 p refs Sponsored by the Dept. of Civil Aviation (RLA)
(NLR-TR-77005-U) Avail: NTIS HC A03/MF A01

Various aspects of damage tolerance are discussed with specific reference to a recently issued USAF detailed damage tolerance specification. Main criteria stipulate that if a crack occurs the aircraft structure should be able to sustain a reasonably high load in cracked condition. It is concluded that USAF specifications will stimulate the development of improved manufacturing techniques, although it will tend to favor non-inspectable slow-crack propagation structures rather than easily

inspectable fail-safe structures. It is also felt that USAF requirements are not well suited to civil needs. Author (ESA)

N79-27136*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AN ADVANCED COCKPIT INSTRUMENTATION SYSTEM: THE COORDINATED COCKPIT DISPLAY

D. L. Baty and M. L. Watkins (San Jose State Univ.) Jul. 1979 22 p refs
(NASA-TM-78559; A-7733) Avail: NTIS HC A02/MF A01 CSCL 01D

Cathode Ray Tube (CRT) and computer technologies are described in one approach to the replacement of flight instruments using three separate color CRT's. Each CRT display information pertinent to one of the three orthogonal projections of the aircraft flight situation. Three airline pilot's assessment of the display set is presented. Comments, rankings, and ratings show that the pilots accepted the concept of pictorial flight displays. S.E.S.

N79-27137# Naval Postgraduate School, Monterey, Calif.

APPLICATION OF COLOR-CODING IN AIRBORNE TACTICAL DISPLAYS M.S. Thesis

Hilton L. Conner, Jr. Mar. 1979 96 p refs
(AD-A067558) Avail: NTIS HC A05/MF A01 CSCL 15/1

This thesis analyzes the operational environment and task variables of the Tactical Coordinator in the S-3A for possible application of color coding in the display symbology in the multi-Purpose display. Beginning with the ASW threat to the carrier force under the CV concept, the missions of the S-3A are presented. The roles, tasks and functions of the Tactical Coordinator are identified and form the basis for an analysis of the need of color in airborne displays. Current display design requirements and discrepancies in the S-3A are discussed as a basis for areas of color application. Color research recently conducted is reviewed with the results directed toward the symbology currently used in airborne displays. Author (GRA)

N79-27138*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AERODYNAMICS OF A TILT-NACELLE V/STOL PROPULSION SYSTEM

Mark D. Betzina and Michael D. Falarski Jun. 1979 18 p refs Presented at Workshop of V/STOL Aerodynamics, Monterey, Calif., May 1979
(NASA-TM-78606; A-7849) Avail: NTIS HC A02/MF A01 CSCL 21E

Tests were performed in the Ames 40 by 80 Foot Wind Tunnel on a large-scale, tilt-nacelle V/STOL propulsion system to determine its aerodynamic characteristics. Unpowered nacelle aerodynamics and power induced effects over an angle of attack range from 0 to 105 deg are presented. It is shown that: (1) the characteristics of the unpowered nacelle can be estimated with annular airfoil data, (2) the power-induced effects on the nacelle aerodynamics are significant, and (3) pitching moment can be correlated with lift and thrust. S.E.S.

N79-27139# Rolls-Royce Ltd., Derby (England).

ENGINE PERFORMANCE CONSIDERATIONS FOR THE LARGE SUBSONIC TRANSPORT

B. Wrigley 1969 28 p Lecture given at the Von Karman Inst., Brussels, 23 Apr. 1969
Avail: NTIS HC A03/MF A01

The importance of the design point parameters for a subsonic aircraft and the factors influencing off design performance, including computer matching are presented. Noise reducing features, such as the single fan stage was examined. M.M.M.

N79-27140*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

TURBINE ENGINE ALTITUDE CHAMBER AND FLIGHT TESTING WITH LIQUID HYDROGEN

E. William Conrad 1979 22 p refs Presented at the Intern. DGLR/DFVLR Symp. on Hydrogen in Air Transportation, Stuttgart,

11-14 Sep. 1979

(NASA-TM-79196; E-062) Avail: NTIS HC A02/MF A01 CSCL 21E

Flight engine experiments using liquid hydrogen fuel were reviewed. A few implications of the results to modern turbine engines are presented. A subsequent contract dealing with a positive displacement pump operating on liquid hydrogen is discussed, and some aspects of liquid hydrogen propellant systems, reflected by rocket booster experience are treated. S.E.S.

N79-27141*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

ENERGY EFFICIENT AIRCRAFT ENGINES

Roger Chamberlin and Brent Miller 1979 21 p refs Presented at Aircraft Systems Meeting, New York, 20-22 Aug. 1979; sponsored by AIAA

(NASA-TM-79204; E-089) Avail: NTIS HC A02/MF A01 CSCL 21E

The three engine programs that constitute the propulsion portion of NASA's Aircraft Energy Efficiency Program are described, their status indicated, and anticipated improvements in SFC discussed. The three engine programs are (1) Engine Component Improvement--directed at current engines, (2) Energy Efficiency Engine directed at new turbofan engines, and (3) Advanced Turboprops--directed at technology for advanced turboprop-powered aircraft with cruise speeds to Mach 0.8. Unique propulsion system interactive ties to the airframe resulting from engine design features to reduce fuel consumption are discussed. Emphasis is placed on the advanced turboprop since it offers the largest potential fuel savings of the three propulsion programs and also has the strongest interactive ties to the airframe. Author

N79-27143*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF TWO-STAGE FAN HAVING LOW-ASPECT-RATIO FIRST-STAGE ROTOR BLADING

Donald C. Urasek, William T. Gorrell (Army Aviation Res. and Develop. Command, Cleveland), and Walter S. Cunnam Aug. 1979 132 p Prepared in cooperation with US Army Aviation Research and Development Command, Cleveland
(NASA-TP-1493; AVRADCOM-TR-78-49; E-9237) Avail: NTIS HC A07/MF A01 CSCL 21E

The NASA two stage fan was tested with a low aspect ratio first stage rotor having no midspan dampers. At design speed the fan achieved an adiabatic design efficiency of 0.846, and peak efficiencies for the first stage and rotor of 0.870 and 0.906, respectively. Peak efficiency occurred very close to the stall line. In an attempt to improve stall margin, the fan was retested with circumferentially grooved casing treatment and with a series of stator blade resets. Results showed no improvement in stall margin with casing treatment but increased to 8 percent with stator blade reset. Author

N79-27144# Naval Postgraduate School, Monterey, Calif.

DESIGN OF SHOCK-FREE TRANSONIC FLOW IN TURBOMACHINERY Technical Report, 20 Jun. 1978 - 15 Aug. 1978

Helmut Sobieczky Nov. 1978 42 p refs
(AD-A067703; NPS67-78-005) Avail: NTIS HC A03/MF A01 CSCL 20/4

A new design method for transonic flow in turbomachinery is described. The idea is based on the author's previous experience with hodograph methods but carried out in physical space. If combined with a flow analysis code the new method can be used as a design/analysis tool. Results illustrating this procedure are given for two dimensional flow through cascades and past airfoils. Existing configurations can be made shock-free by computational modifications which are limited to that portion of the design shape which is wetted by supersonic flow.

Author (GRA)

N79-27148# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

STRESSES, VIBRATIONS, STRUCTURAL INTEGRATION

AND ENGINE INTEGRITY (INCLUDING AEROELASTICITY AND FLUTTER)

Apr. 1979 494 p refs In ENGLISH and FRENCH Presented at the Propulsion and Energetics Panel's 52d Meeting, Cleveland, Ohio, 23-28 Oct. 1978
(AGARD-CP-248; ISBN-92-835-0235-3) Avail: NTIS HC A21/MF A01

Experimental stress analysis, stress analysis techniques-life prediction, and engine structural integrity-vibration, containment are covered. Also, engine-airframe integration/compatibility and aeroelasticity and flutter are included.

N79-27149# Avco Lycoming Div., Stratford, Conn. STRUCTURAL ANALYSIS OF A GAS TURBINE IMPELLER USING FINITE-ELEMENT AND HOLOGRAPHIC TECHNIQUES

Peter S. Kuo and Kenneth S. Collinge In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 15 p refs

Avail: NTIS HC A21/MF A01

A rigorous finite element structural analysis method is presented which, combined with the holographic technique, deals with the highly stressed, curved vanes and the vibration of the flexible circular backplate so that the magnitude and the pattern of static, dynamic, and thermal loadings can be improved. The method demonstrates a computerized procedure for the design of a modern centrifugal impeller. Holography used as a means for determining the dynamic behavior of the engine component offers an accurate experimental measurement of natural frequencies and modes. The interference fringe pattern representing the contours of equal surface displacement provides a permanent record for vibration amplitude evaluation. Comparison between the theoretical and the experimental results is made. J.M.S.

N79-27150# Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Lab. de Mechanique des Structures.**THE ANALYSIS OF ENGINE VIBRATIONS [ANALYSE DES VIBRATIONS DE MOTEUR]**

Michel Lalanne, Philippe Trompette, Remy Henry, and Guy Ferraris In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 13 p refs In FRENCH

Avail: NTIS HC A21/MF A01

The control of the vibrations of a structure is generally achieved at some stage of the project by the theoretical determination of frequencies and modes. The principal elements of an aircraft engine, for practical purposes, can be classed in three categories: compressor, combustion chamber, and turbine. These elements are fixed, or in rotation and are then under the Coriolis effect, and at a supplementary stiffening introduced by centrifugal force. The calculation of thick and thin blades, of axisymmetric systems in rotation, and of disk-blade assemblies is reviewed. Once the prototype of the engine is constructed, it can withstand troubling frequencies, and instead of making structural modifications designed to displace these frequencies, damping materials can be selected to provide sufficient reduction in the amplitude of the resonance. The calculation of these types of damped structures is outlined; the finite element method is used. The diverse types of calculations performed in the study of frequencies and modes, and in predicting the damping introduced by the addition of materials, are illustrated by applications to the motor elements. Transl. by A.R.H.

N79-27151# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.**AIRCRAFT ENGINE DESIGN USING EXPERIMENTAL STRESS ANALYSIS TECHNIQUES**

Bernard L. Koff In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 12 p

Avail: NTIS HC A21/MF A01

A perspective of prominent experimental techniques used in current aircraft engine stress analyses is given. The verification

of temperature, stress, steady state and dynamic deformation, pressure, and fatigue strength is addressed. Advancements in instrumentation are described, including: high-energy X-rays and high durability strain gages; computers and software to reduce vast amounts of data; increased photoelastic capabilities; and advancements for reproducing loading and environmental conditions in laboratory component tests. J.M.S.

N79-27153# Motoren- und Turbinen-Union Muenchen G.m.b.H. (West Germany).**A CONTRIBUTION ON THERMAL FATIGUE IN COOLED TURBINE BLADING**

W. Peschel and R. Schreieck In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 10 p refs

Avail: NTIS HC A21/MF A01

Thermal fatigue, an important criterion for predicting the life of cooled turbine blading, is caused by thermal stresses which are not amenable to direct measurement. In the case of turbine blading, temperature distribution in the mean section of the blade can readily be dealt with as a problem of heat conduction in a plane. For stress calculation, it is assumed that the cross section remains plane. Stresses in the sectional plane and normal stresses in the direction of blade span result, the latter being the dominant ones. For thermal fatigue test conditions, stress and strain profiles in the blade are calculated using measured and calculated temperature distributions. Non-elastic material behavior (creep) is taken into account. In the thermal fatigue tests, the pattern of damage vary with superimposed external stresses; this behavior is explained in the light of the calculated stress-strain cycles. J.M.S.

N79-27154# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).**FORECASTING ENGINE LIFE [PREVISION DE LA DUREE DE VIE DES MOTEURS]**

D. Grandoulier In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 10 p In FRENCH

Avail: NTIS HC A21/MF A01

The compromise between light weight and endurance for aircraft gas turbine engines requires the precise prediction of the durability of the engine parts. Those parts whose rupture threatens the integrity of the engine must be rated to meet two criteria: the initiation of a crack must be avoided during the predicted life of the part, and a flaw not detected during a general inspection must not develop to a critical point before the next inspection. A turbine disk is used to present a method for predicting low cycle fatigue life and for showing the importance of knowing the behavior laws of materials. Transl. by A.R.H.

N79-27156# AiResearch Mfg. Co., Phoenix, Ariz. THREE-DIMENSIONAL FINITE-ELEMENT TECHNIQUES FOR GAS TURBINE BLADE LIFE PREDICTION

M. R. Peterson, R. G. Alderson, R. J. Stockton, and D. J. Tree In AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 14 p refs

(Contract F33615-74-C-2012)

Avail: NTIS HC A21/MF A01

The use of three dimensional finite element analyses in conjunction with test derived data to predict the vibratory fatigue life of turbine blades is described. Vibratory strain measurements are interpreted and extended using predicted strain distributions from the finite element analysis. The statistical nature of test data is considered. Also, some techniques employed in three dimensional finite element analyses to enhance their use for stress and vibration analysis are described. These techniques include a method for reduction of the size of the eigenvalue problem for vibration analysis by a transformation to generalized coordinates derived from static solutions. An example of the application of these methods to a turbine blade analysis is presented. Author

N79-27158# Fiat Aviazione S.p.A., Turin (Italy).

SOME THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF STRESSES AND VIBRATIONS IN A RADIAL FLOW ROTOR

A. Grasso, J. J. Blech, and G. Martinelli /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 refs

Avail: NTIS HC A21/MF A01

The problem of an integrally bladed radial compressor under the influence of a centrifugal force is considered. Two calculation methods based also on finite element method are proposed. The first adopts a mixed three dimensional and two dimensional analysis, using plate elements for blades and axisymmetrical ring for the disk coupled by substructuring technique. The second implements axisymmetric anisotropic ring elements for the blades and the isotropic ring elements for the disk. A dynamic analysis of the blade with the finite element method is also presented. As an example the various methods are applied to the centrifugal compressor design of the FIAT 6803 engine and compared with results of experimental investigation. J.M.S.

N79-27159# Pisa Univ. (Italy). Inst. di Macchine.

PREDICTION OF AEROELASTIC INSTABILITIES IN ROTORCRAFT

Dino Dini /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 29 p refs

Avail: NTIS HC A21/MF A01

Design of modern rotorcraft engines requires that aeroelastic considerations be included for prediction of instabilities due to engines-rotors-airframe interference. Computational approaches are presented which have generality in the selection of stress analysis methods and are applicable to rotorcrafts involving a large number of operation variables. An instability criterion for the prediction of fatigue effects of alternating stresses on engine structural integrity is identified and applied to the corresponding airframe behavior during high speed forward flight and severe rotorcraft maneuvers. J.M.S.

N79-27160# National Gas Turbine Establishment, Pyestock (England).

APPLICATION OF ENGINE USAGE ANALYSIS TO COMPONENT LIFE UTILIZATION

M. Holmes /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 15 p refs

Avail: NTIS HC A21/MF A01

Engine parameters were monitored during operation in service aircraft to investigate the maximum life potential of aero engine components. Analytical methods were used for determining low cycle fatigue. The influence of data availability and computing capability on the procedures were investigated by comparing the software appropriate to an airborne unit monitoring engine revolutions per minute with that for a ground based computing facility analyzing recorded flight data. R.E.S.

N79-27161# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.

BOUNDARY-INTEGRAL EQUATION ANALYSIS OF AN ADVANCED TURBINE DISK RIM SLOT

R. B. Wilson, R. G. Potter, and J. K. Wong /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 9 p refs

Avail: NTIS HC A21/MF A01

The mathematical basis and numerical implementation of the boundary-integral equation method are presented. The method was shown to be capable of predicting rapidly varying stress and strain fields in complex geometries, using either plane triangular or higher order elements. Ease of geometrical modeling and higher order boundary data variation combined to make shape function based codes most efficient for design analysis use. R.E.S.

N79-27162*# Massachusetts Inst. of Tech., Cambridge. Dept of Aeronautics and Astronautics.

ENGINE ROTOR BURST CONTAINMENT/CONTROL STUDIES

Emmett A. Witmer, Thomas R. Stagliano, and Jose J. A. Rodal /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 30 p refs

(Grant NGR-22-009-339)

Avail: NTIS HC A21/MF A01

Investigations on the impact-interaction of both complex engine rotor fragments and simple fragments with various types of single-layer and multilayer containment structures were reviewed. The resulting data were used (1) to develop empirical design rules and (2) to evaluate proposed theoretical methods for predicting the impact induced responses of containment structures. Examples of typical numerical methods for predicting the large deflection, elastic-plastic transient structural responses of simple two dimensional and three dimensional containment shields were illustrated. R.E.S.

N79-27163# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

SMALL TURBINES: EXPERIENCES WITH DISK RUPTURES [PETITES TURBOMACHINES: EXPERIENCES SUR LA RUPTURE DES DISQUES]

J. M. Foueillassar and A. R. VonDerMuhl /*n* its Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 16 p In FRENCH

Avail: NTIS HC A21/MF A01

On turbines with small dimensions, the construction of casings capable of integrally retaining all the debris in the case of disk rupture can be realized with a very acceptable mass penalty. Practical experience and systematic tests of disk rupture under real operating conditions provide useful data concerning the shape and size of the most penetrating elements; the shape and most efficacious arrangement of elements serving as casings; and the most adaptable materials to be used for casings. For rotors whose security relies on the fact that the blades tear away without disk rupture, or for the cylinder, properly so-called, in case of failure from excess speed, the tests equally confirm the confidence that can be put in casing elements constructed according to the same principles of evaluation. Transl. by A.R.H.

N79-27164# Sussex Univ., Brighton (England).

AN INVESTIGATION OF VIBRATION DAMPERS IN GAS-TURBINE ENGINES

R. Holmes and B. Humes (Roy. Armament Res. and Develop. Estab., Sevenoaks, Engl.) /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 10 p refs. Sponsored in cooperation with the Natl. Gas Turbine Estab.

Avail: NTIS HC A21/MF A01

The feasibility of using the squeeze-film both as a damper and a load bearing member was investigated. It was found that when the squeeze-film provided a load carrying capability as well as damping, cavitation, which has a deleterious effect, is generated in the film. Equations are presented for predicting the vibration amplitude and the force transmitted to the engine frame when the squeeze-film is used for damping. F.O.S.

N79-27166# Naval Air Propulsion Test Center, Trenton, N.J. Research and Technology Div.

ROTOR BURST PROTECTION: DESIGN GUIDELINES FOR CONTAINMENT

James T. Salvino, Gaetan J. Mangano, and Robert A. DeLucia /*n* AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 16 p refs

Avail: NTIS HC A21/MF A01

The results are presented of tests that were conducted to develop guidelines for the weight optimum design of turbine rotor burst fragment containment rings. The ring materials used for each of the several ring configurations were Kevlar 29 cloth.

centrifugally cast 4130 steel and coiled 304 stainless steel. A comparative assessment of the containment capability for each material is provided in terms of a specific energy variable that was developed for this purpose. Also included in this assessment is the effect of the number of equal pie sector shaped fragments on the ring containment capability. Author

N79-27167# Boeing Co., Seattle, Wash.
ENGINE/AIRCRAFT STRUCTURAL INTEGRATION: AN OVERVIEW

T. E. Dunning, M. N. Aarnes, and G. L. Bailey /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 35 p refs

Avail: NTIS HC A21/MF A01

The structural installation of engines in aircraft is discussed in terms of modeling techniques, development of a computerized data base, and planning the propulsion system tests. Problems encountered in engine installation are described. F.O.S.

N79-27168# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Military Airplane Div.

DYNAMIC PRESSURE LOADS IN THE AIR INDUCTION SYSTEM OF THE TORNADO FIGHTER AIRCRAFT

K. W. Lotter and N. C. Bissinger /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 20 p refs

Avail: NTIS HC A21/MF A01

The engine fact, duct and forward intake peak pressures applied for structural design of the European fighter airplane, Tornado, and the experimental data obtained during the development phase from full scale intake/engine compatibility test are described. S.E.S.

N79-27169# National Aerospace Lab., Amsterdam (Netherlands). Performance and Evaluation Dept.

HANDLING PROBLEMS THROUGH COMPRESSOR DETERIORATION

J. P. K. Vleghert /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 7 p

Avail: NTIS HC A21/MF A01

RNLAF has experienced performance loss and an increased rate of in flight compressor stalls due to compressor deterioration of some of their 15 year old engines. The Maintenance Depot test bed showed that significant loss of air mass flow occurred near the surge line under conditions which were not covered by the normal post overhaul acceptance tests. Impending stall was always preceded by increasing fluctuations, although the level of these pressure fluctuations varied with different engines. A method was developed to routine check for this phenomenon. The surge margin of the affected engines was recovered by replacing the rear compressor casing. S.E.S.

N79-27170# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

SMALL TURBINE ENGINE INTEGRATION IN AIRCRAFT INSTALLATIONS

M. Botman and R. K. Blinco /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 12 p

Avail: NTIS HC A21/MF A01

Various design and development problems related to the integration of small turbine engines in aircraft installations are reviewed. Important considerations in turbo-prop installations are vibration transmissibility, propeller-whirl flutter, engine structure strength and stiffness, mount failure modes, and nacelle clearances. Requirements are adequate compartment ventilation and engine oil cooling with minimum aerodynamic loss. The installations of the PT6 series of turbo-prop engines are discussed. S.E.S.

N79-27171# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).

DETERMINING THE DYNAMIC RESPONSE DUE TO AN IMBALANCE AT THE ATTACHMENTS OF A MOTOR ON A POD [DETERMINATION DES EFFORTS DYNAMIQUES DUS A UN BALOURD AUX ATTACHES D'UN MOTEUR MONTE EN PODE]

B. Schneider /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 16 p refs In FRENCH

Avail: NTIS HC A21/MF A01

The loss of a rotor blade produces an imbalance which is transmitted to the attachments of an engine on a pod. The reactions of these attachments are calculated as a function of the angular velocity of the rotor by means of the matrix of flexibility of the pod, of inertial characteristics of the rigid engine and of the generalized mass, as well as of the frequency of the damping of the distortions of the flexible modes of the motor. A problem is seen regarding the complexity of the vibration tests of an engine; the flexible modes of the engine, whose frequency remains too low for intervening in the coupling, cannot be used because they have not been completely measured. Furthermore, it seems that the damping mode is a fundamental parameter, as in all phenomena of excitation; therefore, particular care must be taken to its determination outside of the test itself. At the same time, the calculation of generalized forces requires knowledge of the deformation of the rotor for each flexible mode used, which imposes the use of specialized lock-ons outside of vibration tests. Transl. by A.R.H.

N79-27172# British Aerospace Aircraft Group, Preston (England). Advanced Projects Dept.

INTEGRATION OF AN AIRFRAME WITH A TURBOFAN AND AFTERBURNER SYSTEM

Michael S. Wooding and Harry Hurdiss (Rolls-Royce Ltd., Derby, Engl.) /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 10 p

Avail: NTIS HC A21/MF A01

Alternative ways for improving the performance of installed military engines are described. The weight, performance, and cost tradeoffs that might result for a single engined fixed wing combat aircraft are discussed. S.E.S.

N79-27173# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

A NEW FACILITY FOR STRUCTURAL ENGINE TESTING

Robert L. B. Swain and James G. Mitchell /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 6 p

Avail: NTIS HC A21/MF A01

A test facility to simulate the maneuver environment an engine actually experiences in flight is presented. The facility and its potential benefits to the engine development process are described. S.E.S.

N79-27174# Centre d'Essais des Propulseurs, Orsay (France).
THE INTEGRITY OF AIRCRAFT JET ENGINES UNDER THE IMPACT OF FOREIGN BODIES [INTEGRITE DES REACTEURS D'AVIONS SOUS IMPACTS DE CORPS ETRANGERS]

Dominique Hedon and Jean Barrere /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 13 p In FRENCH

Avail: NTIS HC A21/MF A01

The ingestion of foreign bodies, especially of birds, remains a major hazard to aircraft. The improvement of the resistance of engines to impacts has, for several years, been the object of important efforts on the part of aircraft manufacturers working with official services. The Centre D'Essais des Propulseurs furnished a special installation for this type of research. The experience acquired from tests made show that consideration of impact resistance must be made part of engine design and can influence the general architecture of the project as well as the definition of internal details or of preparations. Transl. by A.R.H.

N79-27175# Rolls-Royce Ltd., Derby (England). Aero Div.
THE EFFECT OF INTAKE CONDITIONS ON SUPERSONIC FLUTTER IN TURBOFAN ENGINES

D. G. Halliwell /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 8 p refs

Avail: NTIS HC A21/MF A01

The nature of supersonic flutter, to which high tip speed, front stage fans of modern aircraft turbofan engines are susceptible, is introduced. The effect of varying engine intake conditions of altitude, flight speed and ambient temperature were examined, and test data was compared with theory. Some important flight conditions for minimum flutter margins in typical civil and military applications are outlined. The effect of engine intake type is then covered with respect to the degree of pressure distortion presented to the fan. A tentative relationship is derived between this distortion and flutter onset speed. Author

N79-27176# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Inst. fuer Antriebsstechnik.

UNSTEADY ROTOR BLADE LOADING IN AN AXIAL COMPRESSOR WITH STEADY-STATE INLET DISTORTIONS

M. Lecht and H. B. Weyer /n AGARD Stress, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 13 p refs

Avail: NTIS HC A21/MF A01

A steady state measuring technique with conventional probes and pressure tapes combined with an adequate data analysis was used to investigate the unsteady rotor flow with particular respect to the variation of the blade loading during rotor revolution. Some relevant results of this investigation are submitted and discussed. M.M.M.

N79-27177# Liege Univ. (Belgium). Inst. de Mecanique.
DISTORTIONS, ROTATING STALL AND MECHANICAL SOLICITATIONS

J. Colpin /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 24 p refs

Avail: NTIS HC A21/MF A01

A one stage axial flow compressor is studied aerodynamically and mechanically when operating with maldistributed inlet flow, i.e. inlet flow total pressure distortions and rotating stall. A theoretical model is presented which calculates the distortion propagation through the compressor stage. That enables the computation of the unsteady aerodynamic loading of the rotor blades. The theoretical results are successful compared with the measured flow fields. An experimental study defines the rotating stall characteristics of the compressor stage and relates the blades vibrations and stresses with the existence of a distortion and/or rotating stall cell. Author

N79-27178# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

STUDY IN A STRAIGHT CASCADE WIND TUNNEL OF AEROELASTIC INSTABILITIES IN COMPRESSORS

Edmond Szechenyi, Henri Loiseau, and Brigitte Maquennan (SNECMA) /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 13 p refs In FRENCH; ENGLISH summary

Avail: NTIS HC A21/MF A01

Most of the aeroelastic instabilities encountered in turbomachines, in particular in compressor first stages, occur in flow conditions that can not be calculated on purely theoretical bases. The very nature of these instabilities is not always known, and tests in a straight cascade wind tunnel should make it possible, first to understand the physical mechanisms of phenomena observed in compressors. The experimental results would then be used to develop mathematical models to be used for prediction calculations. A straight cascade wind tunnel permits the simulation of subsonic and transonic flows up to very close

to Mach 1 with angles of attack reaching 12 degrees, and of supersonic flows at fixed Mach numbers thanks to interchangeable nozzles. The first tests in this facility brought to light several kinds of flutter. The parametric study, of which the paper gives the first results, shows the influence of reduced frequency, incidence, pitch axis position and Mach number. A few results obtained in supersonic regime are also given. A.R.H.

N79-27179*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

REVIEW OF THE AGARD S AND M PANEL EVALUATION PROGRAM OF THE NASA-LEWIS SRP APPROACH TO HIGH-TEMPERATURE LCF LIFE PREDICTION

Marvin H. Hirschberg /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 9 p refs

Avail: NTIS HC A21/MF A01 CSCL 21E

The strain range partitioning SRP method presented is a significant step forward in high temperature low cycle fatigue life prediction. Several concerns and recommendations regarding SRP were described. These dealt primarily with the problems associated with the application of SRP to cases involving small inelastic strains (and therefore long lives). The difficulties associated with partitioning these narrow hysteresis loops and the present inability of SRP to handle mean stress effects were also noted. M.M.M.

N79-27180# Detroit Diesel Allison, Indianapolis, Ind. Cascade and Flow Systems Research.

THE UNSTEADY AERODYNAMICS OF A CASCADE IN TRANSLATION

Sanford Fleeter, Ronald E. Riffel, Thomas H. Lindsey, and Mark D. Rothrock /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 13 p refs

(Contract N00014-72-C-0351)

Avail: NTIS HC A21/MF A01

The fundamental time variant translation mode aerodynamics are determined for a classical airfoil cascade in a supersonic inlet flow field over a range of interblade phase angles at a realistic reduced frequency value. These experimental data are then correlated with predictions obtained from an appropriate state-of-the-art harmonically oscillating flat plate cascade aerodynamic analysis. M.M.M.

N79-27181*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUPERSONIC UNSTALLED FLUTTER

J. J. Adamczyk, M. E. Goldstein, and M. J. Hartmann /n AGARD Stresses, Vibrations, Struct. Integration and Eng. Integrity (Including Aeroelasticity and Flutter) Apr. 1979 14 p refs

Avail: NTIS HC A21/MF A01 CSCL 21E

A parametric study to show the effects of cascade geometry, inlet Mach number, and backpressure on the onset of single and multi degree of freedom unstalled supersonic flutter is presented. Several of the results are correlated against experimental qualitative observation to validate the models. M.M.M.

N79-27182*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A COMPARISON OF THE V/STOL HANDLING QUALITIES OF THE VAK-191B WITH THE REQUIREMENTS OF AGARD REPORT 577 AND MIL-F-83300

Seth B. Anderson Jul. 1979 38 p refs (NASA-TP-1494; A-7117) Avail: NTIS HC A03/MF A01 CSCL 01C

The handling qualities of the VAK-191B VTOL aircraft are compared with current V/STOL handling qualities requirements. The aircraft handling qualities were superior to other V/STOL fighter aircraft. Several deficiencies which would seriously affect shipboard V/STOL operation includes: (1) poor hovering precision; (2) inadequate mechanical control characteristics; (3) nonlinear

pitch and roll response; (4) an uncommanded movement of the height control lever; (5) low pitch control sensitivity; (6) excessive dihedral effect; and (7) inadequate overall thrust response. The attitude command control system resulted on reduced pilot workload during hover and low speed flight. S.E.S.

N79-27183# Calspan Advanced Technology Center, Buffalo, N. Y.
EFFECTS OF CONTROL SYSTEM DYNAMICS ON FIGHTER APPROACH AND LANDING LONGITUDINAL FLYING QUALITIES, VOLUME 1 Interim Report, Jun. 1977 - Mar. 1978

Rogers E. Smith Mar. 1978 232 p refs
 (Contract F33615-73-C-3051; AF Proj. 2403)
 (AD-A067550; CALSPAN-AK-5280-F-12;
 AFFDL-TR-78-122-Vol-1) Avail: NTIS HC A11/MF A01 CSCL O1/3

The effects of significant control system dynamics on fighter approach and landing longitudinal flying qualities were investigated in flight using the USAF/Calspan variable stability NT-33 aircraft. Two pilots evaluated 49 different combinations of control system and short period dynamics while performing representative approach and landing tasks. The landing task for the majority of the evaluations included an actual touchdown. Pilot rating and comment data, supported by task performance records, indicate that the landing task, in particular the last 50 ft of the task, is clearly the critical task for aircraft with significant control system lags. For these aircraft, a sharp degradation in flying qualities takes place during this critical phase of the landing task; for example, severe pilot induced oscillations occurred during the landing task but were not in evidence during the approach task. The results provide a data base for the development of suitable flying qualities requirements which are applicable to aircraft with significant control system dynamics; the results show that the present landing approach requirements in MIL-F-8785B (ASG) are not adequate; in particular, they are not applicable to aircraft with complex flight control systems. Author (GRA)

N79-27184# Technische Univ., Berlin (West Germany). Inst. fuer Luft und Raumfahrt.

STUDY OF THE THEORETICAL TO REAL CORRESPONDANCE OF AN OPTIMAL CONTROL MODEL AND THE SIGNIFICANCE OF THIS MODEL FOR THE DESCRIPTION OF WORKING METHODOLOGY WITH PARTLY AUTOMATED AIRCRAFT GUIDANCE AND CONTROL SYSTEMS [BEITRAG ZUR IDENTIFIZIERARBEIT DES BBN-MODELLS UND DIE BEDEUTUNG DES MODELLS ALS BESCHREIBUNGSFORM DER ARBEITWEISE DES MENSCHEN IM TEILAUTOMATISCHEN FLUGFUEHRUNGSSYSTEM]

Uwe Kirchhoff 1978 170 p refs In GERMAN
 (ILR-35; ISBN-3-7983-0640-0) Avail: NTIS HC A08/MF A01

Global concepts for the interaction between man and partly automated aircraft guidance and control systems were studied, emphasis being given to working methodology. Linear systems are discussed. An attempt is made to show up to what point the optimal control model provides a good description of the interactions taking place. The faults occurring in this model are determined, and a model in which these faults are eliminated is proposed being fulfilled. Author (ESA)

N79-27185*# Douglas Aircraft Co., Inc., Long Beach, Calif.
AIRCRAFT AND AVIONIC RELATED RESEARCH REQUIRED TO DEVELOP AN EFFECTIVE HIGH-SPEED RUNWAY EXIT SYSTEM

M. L. Schoen, J. E. Hosford, J. M. Graham, Jr., O. W. Preston, R. S. Frankel, and J. B. Erickson Jun. 1979 115 p refs
 (Contract NAS1-15545)
 (NASA-CR-159075) Avail: NTIS HC A06/MF A01 CSCL O1E

Research was conducted to increase airport capacity by studying the feasibility of the longitudinal separation between aircraft sequences on final approach. The multidisciplinary factors which include the utility of high speed exits for efficient runway operations were described along with recommendations and highlights of these studies. M.M.M.

N79-27188# Air Force Human Resources Lab., Brooks AFB, Tex.

F-15 FLIGHT SIMULATOR: DEVELOPMENT AND ANALYSIS OF COMPUTER SCORING ALGORITHM Final Report, Jun. - Sep. 1977

Michael J. McDonald, Bruce A. Smith, David W. Evans, Lester H. Baer, and William H. Nelson Mar. 1979 30 p refs
 (AD-A067765; AFHRL-TR-78-72) Avail: NTIS HC A03/MF A01 CSCL O5/9

This study was designed to develop and evaluate the computer scoring algorithm of the F-15 flight simulator. Subjects were F-15 pilots in the grade of 1st Lt. through Lt. Col. with previous flying experience commensurate with grade and operational assignments. Evaluation involved simultaneous scoring by the computer and Instructor Pilots (IP) of flight departures and approaches. Both scores were then compared to estimate the validity of the computer algorithm. Departure scores were moderately correlated; however, approach scores exhibited moderate to high negative correlation. Interaction from the IPs indicated that scoring parameters measured by the computer were correct. It was determined that the negative correlations on the approaches were a result of the computer initiating scoring whenever a certain range boundary was reached, whereas the IPs began scoring only when the appropriate legs of the approaches were being flown. Because of the correlation of the departure scores, it was concluded that with improvements to the computer scoring procedures for the approaches, the scoring algorithms of the F-15 flight simulator could provide a valuable tool for evaluation of fighter pilots. GRA

N79-27189# ARO, Inc., Arnold Air Force Station, Tenn.
AEROPROPULSION SYSTEMS TEST FACILITY RAKE CALIBRATION TEST IN TUNNEL A Final Report

W. A. Crosby AEDC Dec. 1978 35 p ref
 (AD-A068975; AEDC-TR-78-V49) Avail: NTIS HC A03/MF A01 CSCL 20/4

A pressure test was conducted in the VKF Tunnel A to obtain calibration data on the APTU Free-Jet Nozzle Calibration Rake. The test covered the supersonic Mach number range of 1.76, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0, nominally, at a free-stream unit Reynolds number of 5.0 million per foot. The angle-of-attack range was -6 to +6 deg with typical roll angles of 0 and -90 deg. Model flow-field Schlieren photographs were obtained at all Mach numbers of 0 deg and positive angles-of-attack. GRA

N79-27191# Oxford Univ. (England). Dept. of Engineering Science.

EXTENSION OF RUNNING TIME IN THE RAE HYPERSONIC SHOCK TUNNEL

D. L. Schultz 1978 14 p refs
 (OUEL-1260/78) Avail: NTIS HC A02/MF A01

The running time performance of the RAE 6 inch shock tunnel as a LICH (Ludwig tube isentropic compression heating) or as a free piston compressor (FPC) is compared with its present capability as a function of total temperature and nozzle throat area. Positive results obtained in this analysis suggest the feasibility of proceeding with more detailed design studies. LICH mode and FPC mode schemes for the RAE 6 inch shock tunnel are shown. Author (ESA)

N79-27205# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

WEAPON/AIRCRAFT INTERACTIONS

George G. Brebner *In* Von Karman Inst. for Fluid Dyn. Missile Aerodyn., Vol. 1 Apr. 1974 41 p refs

Avail: NTIS HC A14/MF A01

The aerodynamic aspects of weapon/aircraft interactions are considered. Emphasis is placed on drag of the aircraft/weapon combination, loads acting on the weapon during carriage, and disturbances experienced by the weapon after release or launch. Methods of determining installed drag, carriage loads, and trajectories are discussed. J.M.S.

N79-27246* Lockheed-California Co., Burbank.
FLIGHT SERVICE EVALUATION OF KEVLAR-49 EPOXY COMPOSITE PANELS IN WIDE-BODIED COMMERCIAL TRANSPORT AIRCRAFT Annual Flight Service Report, Jan. 1978 - Dec. 1978

R. H. Stone Mar. 1979 36 p refs
 (Contract NAS1-11621)
 (NASA-CR-159071; AR-5) Avail: NTIS HC A03/MF A01 CSCL 11D

Kevlar-49 fairing panels, installed as flight service components on three L-1011s, were inspected after five years' service. There are six Kevlar-49 panels on each aircraft: a left-hand and right-hand set of a wing-body sandwich fairing; a solid laminate under-wing fillet panel; and a 150 C (300 F) service aft engine fairing. The fairings have accumulated a total of 40,534 hours, with one ship set having 16,091 hours service as of Feb. 11, 1979. The Kevlar-49 components were found to be performing satisfactorily in service with no major problems, or any condition requiring corrective action. The only defects noted were minor impact damage, and a minor degree of fastener hole fraying and elongation. These are for the most part comparable to damage noted on fiberglass fairings. A.R.H.

N79-27321* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMPATIBILITY OF ELASTOMERS IN ALTERNATE JET FUELS

S. H. Kalfayan, R. F. Fedors, and W. W. Reilly 1 Jun. 1979 70 p refs
 (Contract NAS7-100)
 (NASA-CR-158773; JPL-Pub-79-28) Avail: NTIS HC A04/MF A01 CSCL 21D

The compatibility of elastomeric compositions of known resistance to aircraft fuels was tested for potential use in Jet A type fuels obtainable from alternate sources, such as coal. Since such fuels were not available at the time, synthetic alternate fuels were prepared by adding tetralin to a petroleum based Jet A type fuel to simulate coal derived fuels which are expected to contain higher amounts of aromatic and hydroaromatic hydrocarbons. The elastomeric compounds tested were based on butadiene-acrylonitrile rubber, a castable Thiokol polysulfide rubber, and a castable fluorosilicone rubber. Batches of various cross-link densities of these rubbers were made and their chemical stress relaxation behavior in fuel, air, and nitrogen, their swelling properties, and response to mechanical testing were determined. Author

N79-27336* Department of Energy, Washington, D. C. Office of Regulations and Emergency Planning.
FINDINGS AND VIEWS CONCERNING THE EXEMPTION OF AVIATION GASOLINE FROM THE MANDATORY PETROLEUM ALLOCATION AND PRICE REGULATIONS Jun. 1978 85 p

(DOE/ERA-0024) Avail: NTIS HC A05/MF A01
 An added section to the regulation which requires that any amendment submitted to the Congress for the purpose of exempting a petroleum product or refined product category from regulation be supported with certain findings and views on a variety of matters related to the exemption was presented. Based on an analysis of historic and projected supply, demand, and price trends, the DOE concluded that allocation and price controls are no longer necessary for aviation gasoline and that its exemption in addition to satisfying the other requisite criteria of Section 12 of the EPAA, consistent with the attainment of the objectives specified in Section 4 (b)(1) of the EPAA. DOE

N79-27366* Rome Air Development Center, Griffiss AFB, N.Y.
MICROSTRIP ANTENNA ELEMENTS FOR USE IN HEMISPHERICALLY SCANNED ARRAYS

Nicholas P. Kernweis and John McIlvenna Feb. 1979 30 p refs
 (AF Proj. 4600)
 (AD-A068566; RADCR-79-43) Avail: NTIS HC A03/MF A01 CSCL 09/5

This report is an experimental study of various modifications that affect the radiation pattern of a circular disc microstrip

element. The objective is to produce an element pattern with enhanced performance in the angular regions well away from broadside. The study includes the effect of higher order modes, an investigation of circumferential loading, the use of shorting pins at the element edge, and the pattern changes produced by mutual coupling in a closely spaced array. GRA

N79-27435* Rolls-Royce Ltd., Derby (England).
AXIAL COMPRESSOR STALL

R. R. Moritz In Von Karman Inst. for Fluid Dyn. Unsteady Flows in Axial Flow Compressors 1970 56 p refs

Avail: NTIS HC A10/MF A01

Rotating stall is the direct cause of blade failures in resonant vibration as well as the indirect cause of mechanical problems due to the frequently associated duality in compressor behavior. The effects of compressor stall on aircraft engines are examined with emphasis on the mechanical properties of compressor blades, single stage stall, and multistage stall. A.R.H.

N79-27516* Teledyne CAE, Toledo, Ohio.
CERAMIC MAINSHAFT ROLLER BEARING PERFORMANCE IN A GAS TURBINE ENGINE Final Report, Aug. 1976 - Nov. 1978

Glenn W. Hamburg and William F. Prusaitis Feb. 1979 40 p
 (Contracts N00014-76-C-1104; MIPR-AMRDL-75-5)
 (AD-A067904; TCAE-1623) Avail: NTIS HC A03/MF A01 CSCL 13/9

The program tests conducted on a modified J402 turbine engine were to demonstrate the feasibility of using ceramic bearings for high speed gas turbine applications with reduced or no lubrication to the bearing. Six engine tests were conducted, each test complementing the next to establish baseline parameters of the test to follow. Test No. 3 was the first to demonstrate the ceramic bearing operation unlubricated at 39,000 rpm and minimum lubrication of 10cc per minute at 41,200 rpm. Engine Test No. 4, which was a repeat of Test No. 3, was successfully completed and demonstrated 33 minutes of unlubricated operation at 39,000 rpm. All engine tests were conducted with the bearing and bearing housing instrumented for temperature read-out during the test. Engine Tests 3, 4, 5 and 6 were also instrumented for lubrication flow pressure and bearing cavity pressure in order to monitor lubrication to the bearing as a function of pressure differential. Author (GRA)

N79-27518* McDonnell Aircraft Co., St. Louis, Mo.
EFFECT OF VARIANCES AND MANUFACTURING TOLERANCES ON THE DESIGN STRENGTH AND LIFE OF MECHANICALLY FASTENED COMPOSITE JOINTS Interim Report, 15 Feb. - 30 Jun. 1978

Samuel P. Garbo and J. M. Ogonowski Dec. 1978 97 p refs
 (Contract F33615-77-C-3140)
 (AD-A069170; AFFDL-TR-78-179) Avail: NTIS HC A05/MF A01 CSCL 13/5

The objective of this program is development of failure criterion and improved fatigue life prediction methodology of mechanically fastened joints in advanced composite structure. This report summarizes activity for the period 15 February 1978 to 30 June 1978. Program activities are divided into five tasks: Task 1 - Literature Survey; Task 2 - Evaluation of Joint Design Variables; Task 3 - Evaluation of Manufacturing and Service Anomalies; Task 4 - Evaluation of the Effect of Critical Joint Design Parameters on Fatigue Life; Task 5 - Development of Final Analyses and Correlation. This report documents Task 1 - Literature Survey activities. Summarized are the state-of-the-art in design and analysis of mechanically fastened composite joints, selected methodology, conclusions, and recommendations for the remainder of this program. GRA

N79-27522* Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF ENGINE NACELLE STRUCTURE SEARCHING FOR CRACKS

L. X. Nepomuceno 7 Oct. 1976 23 p
 (Rept-7610.909) Avail: NTIS HC A02/MF A01

The observed results of the ultrasonic inspection of the engine nacelle structure of five aircraft are reported. The 45 degree wedge showed better echoes in the thicker tubes and cracks were not detected in any of the inspected nacelles. M.M.M.

N79-27523# Laboratorio de Acustica e Sonica, Sao Paulo (Brazil). **ULTRASONIC INSPECTION OF WING SPAR ATTACHMENT JOINTS AND LUGS IN VISCONT AIRCRAFT**

L. X. Nepomuceno 6 Oct. 1976 7 p
(Rept-7610.910) Avail: NTIS HC A02/MF A01

The observed results of the inspection carried out according to PTL-97 of British Aircraft Corporation are presented. Author

N79-27533# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

EFFECTS OF GEOMETRIC VARIABLES ON STRESS INTENSITY FACTORS FOR CRACK GAGES M.S. Thesis - AFIT. Final Report

Menachem Carmon Feb. 1979 71 p refs
(AD-A068631; AFFDL-TR-79-3002) Avail: NTIS HC A04/MF A01 CSCL 01/3

A cracked metallic coupon, called crack gage, is being considered as a device for monitoring crack growth in aircraft structures. For this purpose, a stress intensity factor solution for the gage has to be known. This study provides stress intensity factor solutions for two basic geometric configurations subjected to prescribed displacements: 1. Edge cracked, trapezoidal shaped gages of uniform thickness. 2. Center cracked gages with varying or stepped thickness. For the trapezoid, the influences of changing the length of the cracked edge, while other edge remains constant, and vice-versa, were investigated. The results obtained do not show significant beneficial changes in stress intensity factor for the range of parameters considered over those of rectangular gages. Stress intensity factors were determined for stepped gages of various geometries. Various thickness ratios, length ratios and aspect ratios were considered, including the specific geometries of two gages now under development. In each case, the stress intensity factor was determined as a function of crack length. GRA

N79-27772*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

METEOROLOGICAL AND OPERATIONAL ASPECTS OF 46 CLEAR AIR TURBULENT SAMPLING MISSIONS WITH AN INSTRUMENTED B-57B AIRCRAFT. VOLUME 2, APPENDIX C: TURBULENCE MISSIONS

David E. Waco (California Energy Resources Conserv. and Develop. Comm., Sacramento) May 1979 188 p refs
(NASA-TM-80045) Avail: NTIS HC A09/MF A01 CSCL 04B

The results of 46 clear air turbulence (CAT) probing missions conducted with an extensively instrumented B-57B aircraft are summarized from a meteorological viewpoint in a two-volume technical memorandum. The missions were part of the NASA Langley Research Center's MAT (Measurement of Atmospheric Turbulence) program, which was conducted between March 1974, and September 1975, at altitudes ranging up to 15 km. Turbulence samples were obtained under diverse conditions including mountain waves, jet streams, upper level fronts and troughs, and low altitude mechanical and thermal turbulence. CAT was encountered on 20 flights comprising 77 data runs. In all, approximately 4335 km were flown in light turbulence, 1415 km in moderate turbulence, and 255 km in severe turbulence during the program. Author

N79-27930*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

TRAILING EDGE NOISE DATA WITH COMPARISON TO THEORY

W. Olsen and D. Boldman 1979 30 p refs Presented at 12th Fluid and Plasma Dynamics Conf., Williamsburg, Va., 23-25 Jul. 1979; sponsored by AIAA
(NASA-TM-79208; E-093; AIAA-79-1524) Avail: NTIS HC A03/MF A01 CSCL 20A

The noise emission generated by the passage of a turbulent airstream over the trailing edge of a semi-infinite plate was measured over a large range of airstream velocity and plate geometry. The experiment was designed to validate trailing edge noise theories. The results show that the peak of the radiation pattern moves from an upstream to a downstream direction as the velocity increases. The measured radiation pattern of the noise was in excellent agreement with that predicted by the recent theory of Goldstein. As predicted, the pattern shape was independent of the nature of the turbulence producing the noise. Author

N79-27931*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

AN EXPERIMENTAL STUDY OF SOUND RADIATION FROM HYPERBOLOIDAL INLET DUCTS

Lorenzo R. Clark and Y. C. Cho Jun. 1979 19 p ref Presented at the 97th meeting of the Acoustical Soc. of America, Cambridge, Mass., 11-15 Jun. 1979

(NASA-TM-80109) Avail: NTIS HC A02/MF A01 CSCL 20A

Sound radiation from hyperboloidal inlet ducts which include a circular cylinder with plane baffle as a limiting case was investigated. Results include the polar angle variation of the pressure level and the phase of the radiated field for various frequencies and various modes incident which were produced using an electronically operated mode synthesizer. Good agreement with a rigorous theoretical prediction was found. A.R.H.

N79-27932*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

ON THE ATTENUATION OF SOUND BY THREE-DIMENSIONALLY SEGMENTED ACOUSTIC LINERS IN A RECTANGULAR DUCT

W. Koch (Institut fuer Theoretische Stroemungsmechanik, DFVLR/AVA, Goettingen, Germany) Jun. 1979 29 p
(NASA-TM-80118) Avail: NTIS HC A03/MF A01 CSCL 20A

Axial segmentation of acoustically absorbing liners in rectangular, circular or annular duct configurations is a very useful concept for obtaining higher noise attenuation with respect to the bandwidth of absorption as well as the maximum attenuation. As a consequence, advanced liner concepts are proposed which induce a modal energy transfer in both cross-sectional directions to further reduce the noise radiated from turbofan engines. However, these advanced liner concepts require three-dimensional geometries which are difficult to treat theoretically. A very simple three-dimensional problem is investigated analytically. The results show a strong dependence on the positioning of the liner for some incident source modes while the effect of three-dimensional segmentation appears to be negligible over the frequency range considered. A.R.H.

N79-27933*# Lockheed-Georgia Co., Marietta.

STUDIES OF THE ACOUSTIC TRANSMISSION CHARACTERISTICS OF COAXIAL NOZZLES WITH INVERTED VELOCITY PROFILES: COMPREHENSIVE DATA REPORT Final Report

P. D. Dean, M. Salikuddin, K. K. Ahuja, H. E. Plumblee, and P. Mungur May 1979 182 p ref
(Contract NAS3-20797)

(NASA-CR-159628) Avail: NTIS HC A09/MF A01 CSCL 20A

The efficiency of internal noise radiation through a coannular exhaust nozzle with an inverted velocity profile was studied. A preliminary investigation was first undertaken (1) to define the test parameters which influence the internal noise radiation; (2) to develop a test methodology which could realistically be used to examine the effects of the test parameters; and (3) to validate this methodology. The result was the choice of an acoustic impulse as the internal noise source in the jet nozzles. Noise transmission characteristics of a coannular nozzle system were then investigated. In particular, the effects of fan convergence angle, core extension length to annulus height ratio and flow Mach numbers and temperatures were studied. Relevant spectral

data only is presented in the form of normalized nozzle transfer function versus nondimensional frequency. A.R.H.

N79-27978# Naval Ocean Systems Center, San Diego, Calif.
AIRCRAFT FIBER-OPTIC INTERCONNECT SYSTEMS PROJECT

T. A. Meador 1 Mar. 1979 47 p refs
 (AD-A068366; NOSC/TR-390) Avail: NTIS
 HC A02/MF A01 CSCL 20/6

The Avioptics Program is an engineering and application development program whose central objective is to support the preparation of fiber-optic transmission technology for use in naval aircraft. The program has been organized and is being managed by the Air Surveillance Systems Project Office code 7309 of the Naval Ocean Systems Center (NOSC). The Avioptics Program Plan is presented in detail in NOSC Technical Document 197.1. The applications of principal interest in the Avioptics Program are the transmission interconnects of aircraft multiplex systems. Included within the scope of this area are digital time division multiplex TDM systems, video multiplex and distribution systems, and such equipment ensembles as armaments, flight control, and voice communications. GRA

N79-28037# Department of Energy, Bartlesville, Okla. Energy Technology Center.

ENTHALPY OF COMBUSTION OF RJ-6

N. K. Smith Apr. 1979 10 p refs
 (Grant AF-AFOSR-0009-78)
 (AD-A067968; AFOSR-79-0508TR) Avail: NTIS
 HC A02/MF A01 CSCL 21/4

In cooperation with the Air Force Office of Scientific Research, this laboratory has studied compounds that may be used to impart particular properties to fuels such as high enthalpy of combustion per unit volume or per unit mass. This report concerns the ramjet fuel RJ-6. Author (GRA)

N79-28058# Department of Energy, Washington, D. C. Office of Regulations and Emergency Planning.

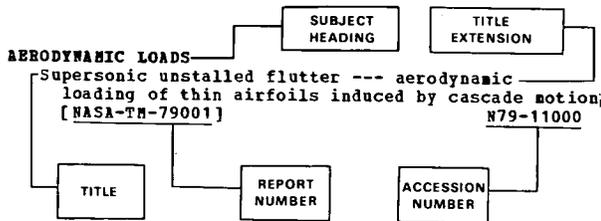
FINDINGS AND VIEWS CONCERNING THE EXEMPTION OF KEROJET FUELS FROM THE MANDATORY PETROLEUM ALLOCATION AND PRICE REGULATIONS

Dec. 1978 105 p refs
 (DOE/ERA-0023) Avail: NTIS HC A06/MF A01

Based on an analysis of historic and projected supply, demand, and price trends, the DOE concluded that allocation and price controls are no longer necessary for kerojet fuel and that exemption of kerojet fuel will be consistent with the attainment, to the maximum extent practicable, of the objectives specified. DOE

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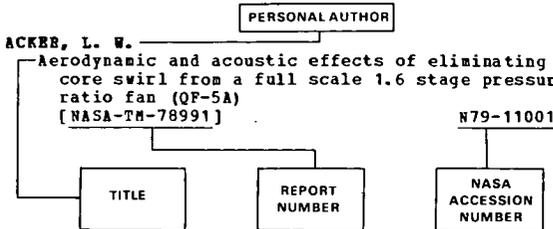
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