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A Continuing Bibliography with Indexes

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

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NASA SP–7037(141)

AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 141

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 October 1981 in

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

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 404 reports, journal articles, and other documents originally announced in October 1981 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.

An annual cumulative index will be published.

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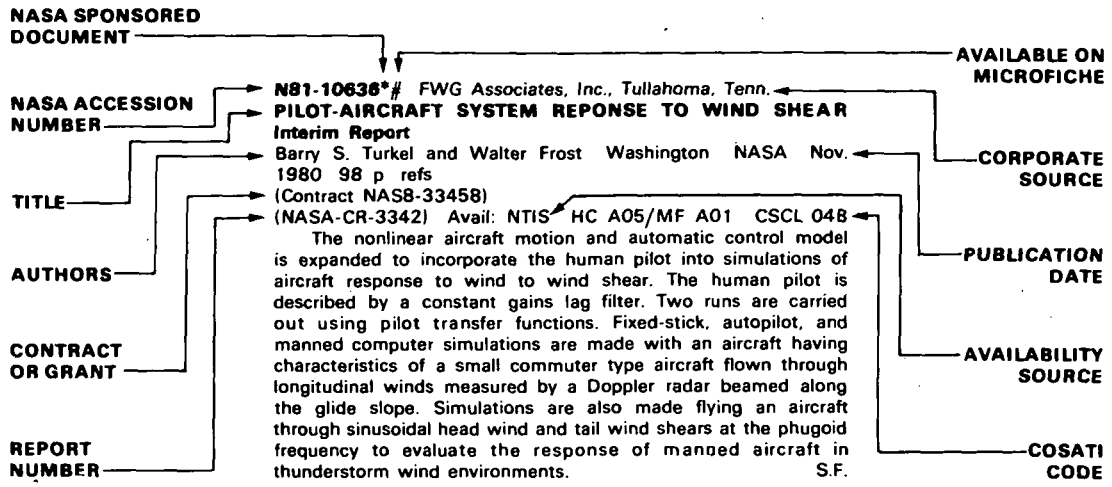

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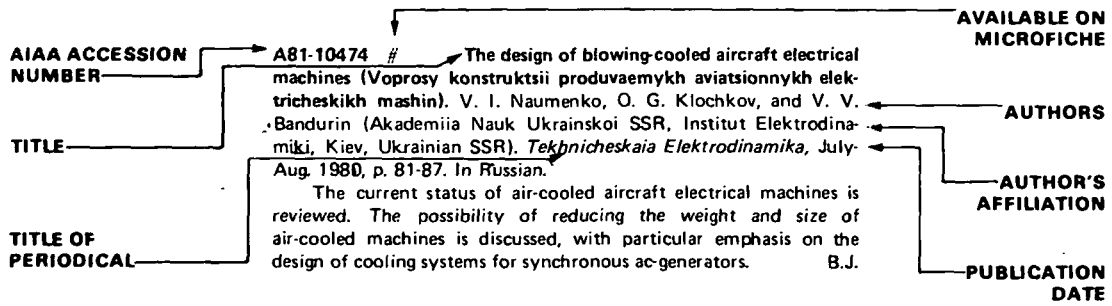

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 141)

NOVEMBER 1981

IAA ENTRIES

A81-40833 # **TF41/Lamilloy Accelerated Mission Test.** D. J. Essman (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), R. E. Vogel, J. G. Tomlinson, and A. S. Novick (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1349.* 8 p.

This paper describes the results of Accelerated Mission Testing (AMT) of a TF41 turbofan engine. The test was conducted to evaluate the durability characteristics of Lamilloy combustors. Lamilloy is an advanced quasi-transpiration cooling material. A 526-hour AMT test was conducted with equal test time at DDA and Wright Patterson Air Force Base (WPAFB). This AMT generally accelerates engine distress at a rate which is estimated to simulate approximately 1000 hours service life on the Lamilloy liners. Pertinent background information on Lamilloy with regard to the TF41 combustion system, results of the DDA AMT test, details of the WPAFB AMT test, final condition of the Lamilloy combustors, and conclusions are presented. (Author)

A81-40834 # **Exploratory development program to improve combustor dome operating characteristics.** R. S. Reilly, C. E. Smith, T. L. DuBell (United Technologies Corp., Government Products Div., West Palm Beach, FL), and W. W. Wagner (U.S. Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1351.* 10 p.

A twelve-month experimental program is presented, during which the dome and primary zone typical of an annular combustor in a gas turbine engine was investigated. The primary objective of the program stipulated the investigation of causal factors of combustor hot streaks and acquisition of design data for use in advanced engine combustor designs to improve liner durability and turbine inlet temperature profiles. Divided into four tasks, the program reviewed recent combustor development histories, designed and evaluated fuel nozzles and swirlers, performed parametric testing of a three-nozzle sector combustor, and analyzed the test results for trends and fundamental front end combustor knowledge. (Author)

A81-40835 # **Improved combustor domes designed for hot streak reduction.** J. R. Taylor (General Electric Co., Cincinnati, OH) and W. W. Wagner (U.S. Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1352.* 10 p.

Results of experimental investigations to determine basic causes of life limiting combustor hot streaks are presented with recommendations for combustor dome and liner design improvements. Detailed measurements were made of airflow and fuel-air ratio patterns in sectors of typical gas turbine combustors for many different configurations. Hot streaks were found to be caused by discrete jets of flame emanating from the swirl cups and by small circumferential variations in dilution hole and swirl cup geometry. Test results also indicated that hot streaks near the combustor exit plane were caused by a small radius bend in the combustor flowpath. (Author)

A81-40836 * # **Improved combustor durability - Segmented approach with advanced cooling techniques.** S. Tanrikut, R. L. Marshall (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, CT), and D. E. Sokolowski (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1354.* 10 p.

Durability characteristics of current combustor liners severely limit liner life requirements of advanced gas turbine engines. This paper summarizes the development of a design which employed an advanced cooling technique and a segmented construction approach as a means to reduce cooling air and improve life through hoop stress reduction. Segmenting enables utilization of alloys with high temperature strength which offers a potential for a four-fold improvement in life relative to hoop construction with conventional materials. Fabrication techniques and results of tests conducted at high inlet pressure and temperature (P = 28 atm. and T = 811 K) are also presented. (Author)

A81-40837 # **Manufacturing technology for low temperature composite engine frames.** S. C. Mitchell (General Electric Co., Aircraft Engine Group, Cincinnati, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1355.* 6 p.

A research program management and status report is presented for an Air Force Manufacturing technology program whose aim is the establishment of organic matrix composite turbofan engine frame fabrication techniques, with emphasis on the relative cost benefits of composite and conventional metal frames. The TF34 engine fan frame was selected as representative of advanced turbofan structures for the 1980-90 period. The composite frame designed and built as a replacement for the existing metal one achieved a 24% reduction in weight and 15% reduction in cost. The program phases described are: (1) overall manufacturing process refinement; (2) verification of manufacturing approach by construction and evaluation of tools; (3) construction of three frames, accompanied by a cost/benefit analysis; and (4) structural quality verification through static testing. O.C.

A81-40838 # **Processing for an improved impact resistant composite blade.** G. C. Murphy (GE Materials and Process Technology Laboratories, Cincinnati, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1356.* 9 p.

A comprehensive introduction is presented of the manufacturing processes developed and evaluated in the course of the Air Forces's low cost, impact-resistant organic matrix fan blade program. The processes and devices employed include: (1) fiber ply preparation and semiautomatic, clicker-press cutting; (2) preform preparation; (3) mold tool and 300-ton press; (4) blade molding; (5) post curing heat treatment and curing; (6) blade root dovetail machining; (7) leading edge wire mesh bonding and nickel plating; (8) outsert bonding; (9) application of polyurethane coating; and (10) blade trimming and tip forming. Among the novel manufacturing methods and blade improvement techniques developed by the program may be included resin transfer molding (RTM), a unidirectional fabric reinforcement weave pattern, a new Araldite resin (polymer matrix) formulation, and Kevlar and E-glass thread stitching methods. The number of man-hours needed for fabrication was reduced by these methods by 58%. O.C.

A81-40839 * # **Composite fan exit guide vanes for high bypass ratio gas turbine engines.** S. S. Blecherman and T. N. Stankunas

(United Technologies Materials Engineering and Research Laboratory, Middletown, CT). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1357.* 8 p. 6 refs. Contract No. NAS3-210376.

Various composite materials were identified for reduced weight applications as fan exit guide vanes in high bypass ratio gas turbine engines. Candidate materials, airfoil geometry and ply orientation were evaluated using NASTRAN finite element analysis. A vane core and shell design approach utilizing several different fiber orientation concepts was selected and variations in bending and torsional stiffness were documented. Material supplicrs and airfoil fabricators were selected to provide panels and airfoils which were inspected, environmentally conditioned and tested. Static and dynamic airfoil tests established durability characteristics for a range of composite material/design approaches. (Author)

A81-40840 # **Boron aluminum blades and vanes.** L. Stoltza and J. Graff (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1359.* 10 p. 8 refs.

A comparative study is presented of the range of structural and construction methods employed to date in the production of boron reinforced aluminum matrix composite fan blades with exceptional foreign object damage (FOD) resistance. Emphasis is placed on (1) the fact that reductions in fan blade weight lead to proportional savings in engine disks, shafts, bearings, etc., and (2) on the possibility of demonstrating cost savings for composite spar/shell construction fan blades through the reductions in fan diameter and number of stages that higher tip speeds and lower blade aspect ratios would permit. Extensive reference is made to the results of impact tests simulating both bird and ice ball strike damage, and it is concluded that lower-cost fabrication methods and material forms make projections of cost-competitive components possible. O.C.

A81-40841 # **V/STOL technology requirements for future fighter aircraft.** G. W. Lind (Grumman Aerospace Corp., Bethpage, NY) and G. Tamplin (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1360.* 13 p.

A comparison was made of the leading V/STOL concepts employed to meet dual mission requirements of counterair and offensive air support and a counterpart S/CTOL fighter design. The prime objective of the study was to explore the viability of a single V/STOL configuration to effectively accomplish a close air support mission using STOL capability, and a counterair mission using V/STOL capability. Results showed the addition of dual role capability to a S/CTOL design producing a 10% increase in takeoff gross weight (TOGW), while the remote augmented lift system (RALS) proved to be 30% heavier in TOGW than the dual role S/CTOL, and when redesigned to meet realistic conditions, the corresponding life cycle cost of the V/STOL was 14% higher than the S/CTOL design. Other results showed the V/STOL insensitive to runway denial, having a lower cost per kill, and providing the RALS concept with superlative combat characteristics by virtue of a large in-flight excess thrust capacity. D.L.G.

A81-40842 * # **Effect of a part-span variable inlet guide vane on the performance of a high-bypass turbofan engine.** G. A. Bobula (U.S. Army, Propulsion Laboratory, Cleveland, OH), R. H. Soeder, and L. A. Burkardt (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1362.* 9 p. 7 refs.

The ability of a part-span variable inlet guide vane to modulate the thrust of a high bypass turbofan engine was evaluated at altitude/Mach number conditions of 4572 m/0.6 and 9144 m/0.93. Fan-tip, gas generator and supercharger performance were also determined, both on operating lines and during fan duct throttling. The evaluation was repeated with the bypass splitter extended forward to near the fan blade trailing edge. Gross thrust attenuation of over 50% was achieved with 50 deg variable inlet guide vane closure at 100% corrected fan speed. Gas generator supercharger performance fell off with variable inlet guide vane closure but this loss was reduced when a splitter extension was added. The effect of variable inlet guide vane closure on gas generator performance was minimal. (Author)

A81-40843 # **Multi-mission V/STOL with vectored thrust engines.** W. J. Lewis (Rolls-Royce, Ltd., Bristol, England) and P. Simpkin (Rolls-Royce, Ltd., Derby, England). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1363.* 8 p.

A mission capability study is presented for the cases of both subsonic (strike aircraft) and supersonic (air superiority aircraft) configurations employing vectorable-thrust, plenum chamber burning (PCB)-augmented powerplants for short takeoff/vertical landing (STOVL) operations. The projected performance of these two aircraft is also compared with conventional aircraft of equivalent payload and mission radius, and the advantages of the STOVL aircraft are assessed. Among the powerplant performance issues covered are: powerplant design, fan pressure ratio, thrust:weight ratio, installation drag and specific fuel consumption. O.C.

A81-40845 # **Development of an integrated fault tolerant engine control.** R. J. Miller and M. E. McGlone (United Technologies Corp., Government Products Div., West Palm Beach, FL). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1365.* 7 p. Navy-sponsored research.

A status report is presented for Air Force, Navy and NASA programs concerned with the development of full-authority, fault-tolerant digital engine control systems. Based on such experience, a development plan is described for a complete integrated digital engine control system for supersonic V/STOL aircraft comprising sensors, fuel management and airflow controls, which promises substantial benefits in life cycle costs, reliability, and weight savings. Among the topics discussed are V/STOL propulsion control integration, reliability, electronic computers, actuation subsystems, high reliability fuel pumping systems, and a development program timetable that spans ten years from initiation to the prototyping of both aircraft and propulsion system. O.C.

A81-40846 # **Recent developments in Naval aircraft jet engine usage.** S. M. Cote (U.S. Naval Material Command, Naval Air Development Center Warminster, PA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1366.* 7 p.

Aircraft jet engine usage analysis has begun to provide an explanation for life limited components observed in Navy tactical aircraft propulsion systems. Dynamic mission elements particular to Naval operations and training such as landing practice, refueling, formation are highlighted because of high frequency throttle movements. Pilot technique is examined and shown to affect throttle movements inversely with hours of experience. Gross weight variations on a particular aircraft tend to increase engine hot time. This knowledge now serves both manufacturers and military services as a basis for improving aircraft gas turbines now in service and in the decades to come. (Author)

A81-40856 # **The influence of blade wakes on the performance of combustor pre-diffusers.** S. J. Stevens, S. P. Harasgama (Loughborough University of Technology, Loughborough, Leics., England), and P. Wray (Rolls-Royce, Ltd., Derby, England). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1387.* 14 p. 11 refs. Research supported by Rolls-Royce, Ltd.; Ministry of Defence Contract No. AT/2170/065/xR.

Results of an experimental investigation of the influence of blade wakes on the performance of several combustor pre-diffusers are presented. Two curved and two straight wall diffusers of different length, area ratio and turning angle were tested with a single stage compressor sited at a number of positions relative to diffuser inlet. Only a small increase in loss was incurred when the wakes from the outlet guide vanes were allowed to decay within the pre-diffuser. Distance along the mean streamline was found to be the most significant parameter influencing the decay of the wakes and, in outwardly curved diffusers, a distance of about four blade chord lengths was required for these effects to be minimized. (Author)

A81-40857 * # **Small gas-turbine combustor study - Fuel injector evaluation.** C. T. Norgren and S. M. Riddlebaugh (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July*

27-29, 1981, AIAA Paper 81-1388. 11 p. 10 refs.

As part of a continuing effort at the Lewis Research Center to improve performance, emissions, and reliability of turbine machinery, an investigation was undertaken to determine the effect of fuel injection technique and fuel type on similar improvements for small gas-turbine combustors. Performance and pollutant emission levels are documented over a range of simulated flight conditions for a reverse-flow combustor configuration using simplex pressure-atomizing, spill-flow return, and splash cone airblast injectors. A parametric evaluation of the effect of increased combustor loading with each of the fuel injector types was obtained. Jet A and an experimental referee broad specification fuel were used to determine and compare effects of burning different types of fuels in a small experimental gas turbine combustor. (Author)

A81-40858 # **Fuel character effects on the TF41 engine combustion system.** R. E. Vogel and D. L. Troth (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1391.* 11 p. USAF-supported research.

Twelve refined and blended fuels incorporating variations in hydrogen content, aromatic type and content, distillation range and viscosity were evaluated to determine the effects of fuel property variation on the performance and exhaust emissions of the TF41 engine combustion system. The study comprised combustor rig tests and data analyses, and combustor hot section durability characteristics were evaluated through computer simulations. It was found that the maximum attainable ignition altitude was severely limited by reduced hydrogen (conversely, increased aromatic) content, and that combustor life was not sensitive to fuel properties due to the independence of life-limiting discharge nozzle wall temperatures from fuel chemistry. Emission levels, smoke formation, combustion efficiency and liner wall temperatures were significantly affected by property variations only at high-power operating conditions. O.C.

A81-40859 * # **Selected results from combustion research at the Lewis Research Center.** R. E. Jones (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1392.* 9 p. 13 refs.

Combustion research at Lewis is organized to provide a balanced program responsive to national needs and the gas turbine industry. The results of this research is a technology base that assists the gas turbine engine manufacturers in developing new and improved combustion systems for advanced civil and military engines with significant improvements in performance, durability, fuel flexibility and control of exhaust emissions. Research efforts consist of fundamentals and modeling, and applied component and combustor research. This paper reports on some of the progress and results that have been achieved recently in all three research areas. (Author)

A81-40860 # **F/A-18A inlet/engine compatibility flight test results.** N. F. Amin (Northrop Corp., Hawthorne, CA) and D. J. Hollweger (McDonnell Douglas Corp., St. Louis, MO). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1393.* 12 p.

The paper reviews the F/A-18A fighter aircraft inlet/engine compatibility flight test results, including supersonic and subsonic maneuvering, with emphasis on the aircraft prime combat maneuvering region. Powered by two turbofan engines and having a high maneuvering capability, the F/A-18A requires the inlet/engine system to be compatible at extreme angles of attack and sideslip. Evaluation instruments included the inlet rake to measure inlet distortion at the engine face, and an analog distortion calculator to screen high response distortion data for subsequent digitization in regions of peak distortions. Results demonstrated satisfactory engine operations, with inlet distortion measuring up to 65 degree angle of attack and 23 sideslip, subsonic maneuvering excursions beyond the variable throttle design goal envelopes, no engine stalls, and low inlet dynamic distortion levels during supersonic aircraft maneuvers. D.L.G.

A81-40861 # **Use of segmented mold process to produce large superalloy engine castings.** W. S. Blazek (TRW, Inc., Turbine Components Div., Minerva, OH) and T. S. Piwonka (TRW, Inc., Materials Research Dept., Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1404.* 7 p. Contract No. F33615-C-5084.

The Segmented Mold Process was developed to overcome the shortcomings of conventional lost wax foundry practice in the manufacture of large thin-wall superalloy engine castings, such as fan frames and diffuser cases. The process consists of making the casting mold in a number of small segments, which are then assembled using a precision fixture and cemented together before the casting is poured. This method allows inspection of the interior surface of the mold, thereby eliminating inclusions which arise from faulty molds. It also allows a higher degree of dimensional accuracy than can be achieved by conventional casting methods. The use of the process on a large (1150 mm diameter) intermediate fan frame casting is described. (Author)

A81-40862 # **Isothermal forging of fan blades.** J. D. Snow and C. R. Cook (TRW, Inc., Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1405.* 7 p. 5 refs. USAF-supported research.

Advanced aircraft engines require blades made from difficult-to-forge alloys and having very thin airfoils with close tolerances for thickness or geometric deviations. Hot die isothermal forging technology has been applied to the precision forging of such blades. Fan blades for the F-100 engine were isothermally forged from Titanium 8Al-1Mo-1V alloy using dies maintained at 1760 deg F. Good form and thickness control were demonstrated, and the metallurgical characteristics of the forgings were entirely acceptable. Problems encountered in the development program and their resolution will be discussed. The reduction in material requirements and in machining operations obtainable with this process can reduce the cost of manufacturing blades. (Author)

A81-40867 # **Degradation and characterization of antimisting kerosene /AMK/.** R. J. Mannheimer (Southwest Research Institute, San Antonio, TX). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1423.* 9 p. 8 refs. U.S. Department of Transportation Contract No. FA79WA-4310.

The effect of elongational flow on polymer degradation has been studied by forcing AMK through metal screens and packed tubes at high velocities. At a specific power of 15 kWs/l, AMK exhibits filtration and ignition properties similar to Jet A in small-scale tests. A glycol/amine carrier fluid developed to promote rapid dissolution of FM-9 polymer in Jet A has been found to increase antimisting effectiveness, reduce gel formation and filtration resistance, and require less degrader power. Other fuel-soluble hydrogen bonding agents produce similar effects with FM-9 in Jet A. At low Reynolds numbers, the flow of AMK through metal screens and paper filters is characterized by a critical velocity that depends on polymer degradation, filter material, pore size, and the presence of hydrogen bonding agents. Below this critical velocity, the flow resistance of AMK is determined by the low shear viscosity. At a slightly higher velocity, the flow resistance increases dramatically. While this phenomenon is commonly observed with many polymer solutions, in the case of FM-9 it is also associated with gel formation that may result in filter plugging. However, at very high velocities, gel formation and filter plugging are no longer evident with either metal screens or packed tubes. (Author)

A81-40868 # **Acceptability of shale derived fuel for Navy aircraft propulsion systems.** P. A. Karpovich and C. J. Nowack (U.S. Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1424.* 6 p. 15 refs.

As part of a joint DOD/DOE synthetic fuels program, 100,000 barrels of shale oil crude was produced by the Paraho process and refined into a spectrum of DOD fuels. The JP-5 fraction which is the subject of this paper, was evaluated in the laboratory in component and full-scale engine tests. Findings are compared to results obtained on a shale derived JP-5 produced earlier in a full scale refining program and with petroleum JP-5. Despite some minor deficiencies in fuel chemistry caused by the severe hydrotreatment of the crude the JP-5 fuel was found to be acceptable for Navy aircraft use. (Author)

A81-40869 # **Analysis of steady, two-dimensional, chemically reacting nonequilibrium flow by an unsteady, asymptotically consistent technique.** R. J. Stiles (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) and J. D. Hoffman (Purdue University, West Lafayette, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1432.* 14 p. 12 refs. Contract No. F33615-79-C-2065.

A steady, two-dimensional, chemically reacting nonequilibrium flow is investigated using the governing equations. Results are presented for C-H-O-N and H-F chemistry systems, and the application of a sub-global oxidation reaction for unburned hydrocarbon in the C-H-O-N system is described. Results are applied to the performance prediction of a ramjet propulsion, and a highly accurate analysis of the entire nozzle flow field is presented. E.B.

A81-40870 # **Interpretation of ramjet combustor test data.** P. T. Harsha and R. B. Edelmann (Science Applications, Inc., Combustion Dynamics and Propulsion Technology Div., Canoga Park, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1433.* 7 p. 13 refs. Contracts No. F49620-80-C-0082; No. F33615-77-C-2062.

Several advanced ramjet combustor concepts utilize sudden-expansion geometries in which the step acts as a flameholding device while also providing the potential for improved overall combustion efficiency. Problems of flame stabilization and flame propagation have been encountered in these types of combustors. Analytical models of the recirculation region downstream of the step in a sudden-expansion combustor are included in a recently developed ramjet performance prediction model. The use of this model to analyze and interpret the performance characteristics of a sudden-expansion combustor is described in this paper, with particular emphasis on the modeling of the flame stabilization region. (Author)

A81-40871 # **Scramjet combustor wall boundary layer analysis.** J. A. Schetz, F. S. Billig, and S. Favin (Johns Hopkins University, Laurel, MD). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1434.* 11 p. 21 refs. Navy-supported research.

A calculation procedure for predicting turbulent mixing and burning and skin friction and wall heat transfer in a scramjet combustor with a central fuel jet from a gas generator has been developed. All the important physical and chemical processes have been modelled, including the upstream influence of heat release in the duct. Calculations for a representative engine with Shelldyne H fuel at Mach 4 and 7 indicate that a combustor 1-2 m long is sufficient to insure complete heat release but that substantial nonuniformity of the combustor exit flow would still exist. The skin friction and wall heat transfer are both shown to be very sensitive to the local pressure gradient and to the impingement of combustion products and turbulence from the central jet mixing and burning zone. However, the responses of these two quantities are not of the same importance, and they are not in phase. (Author)

A81-40873 # **Stress analysis of first turbine vane using a 3-dimensional model with non linear material behavior subjected to transient temperatures.** D. S. Wolf (United Technologies Corp., Government Products Div., West Palm Beach, FL). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1437.* 6 p.

This paper highlights the stress analsysis of a current production high pressure turbine vane using a general purpose finite element program in the modeling of nonlinear material response at high temperatures with significant thermal transient behavior. Comparing the mechanical response of the vane with the fatigue strength of the material, the vane's durability is assessed. The impact of this analysis upon current and future designs will be carried forward by the refinements made to existing design tools. Application of these refinements to fixed turbine airfoils will continue to reduce development time by improving the initial durability of the airfoil. (Author)

A81-40874 # **Blade tip ceramic outer air seal for long life turbine engines.** D. W. Zabierek (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1440.* 19 p. 7 refs.

The paper presents the design logic and test plan development for a ceramic outer air seal, when increasing turbine engine inlet temperatures and stage loading necessitated the development of a durable blade tip seal system. Component rig and core engine tests are also presented, and the results used to assess the ceramic seal's effect on turbine performance, its thermal fatigue, erosion and rub tolerance characteristics, and its application restraints. Structural ceramics were found to be nonviable materials at this time. ZrO2 proved feasible in a graded ZrO2/metallic system, but undefined material properties created delamination and spallation. Although specimen testing identified problems, this was the first seal system to be tested in a gas generator. A clearer definition of the properties of ZrO2 is required to identify the processing requirements of a good seal system. D.L.G.

A81-40875 # **Advanced nozzle integration for supersonic strike fighter application.** P. E. Hiley (McDonnell Aircraft Co., St. Louis, MO) and D. L. Bowers (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1441.* 13 p.

A status report is presented for the second part of the Advanced Nozzle Concepts configuration design program, which is being conducted to help define the role of future tactical fighters. The analytical/experimental program covers advanced axisymmetric and two-dimensional nozzles and their installation on air-to-surface and air-to-air fighter configurations of generically different design. Wind tunnel testing conducted for several air-to-surface nozzle/vehicle combinations from Mach 0.6 to 2.2 has defined relative installation drag penalties and aerodynamic interaction effects due to thrust vectoring and reversing. It is shown that for the supersonic strike fighter type investigated, STOL capability thrust reversal and trim thrust vectoring can be achieved without significant penalty. Extensive wind tunnel data are presented in graphic form for comparison of configuration alternatives. O.C.

A81-40878 * # **Subsonic/supersonic nonvectored aeropropulsive characteristics of nonaxisymmetric nozzles installed on an F-18 model.** F. J. Capone (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA), B. L. Hunt (Northrop Corp., Hawthorne, CA), and G. E. Poth (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1445.* 12 p. 18 refs.

An experimental program on a model of the F-18 airplane has been conducted to determine the performance of nonaxisymmetric nozzles relative to the aircraft's baseline axisymmetric nozzle at Mach numbers from 0.60 to 2.20. The performance of a two-dimensional convergent-divergent nozzle, a single expansion ramp nozzle (ADEN) and a wedge nozzle were compared to the baseline axisymmetric nozzles. The nonaxisymmetric nozzles (except ADEN) were designed for vectoring and reversing. The axisymmetric nozzle did not have these capabilities. The comparisons presented here are for the nozzles in their full forward thrust mode and for the aircraft at zero angle of attack. The results demonstrate that nonaxisymmetric nozzles can be installed on a close-spaced twin engine fighter with equal or higher performance than the axisymmetric nozzle over the range of Mach numbers tested. (Author)

A81-40879 # **Effect of in-flight thrust reverser deployment on tactical aircraft stability and control.** D. J. Lorincz, C. Chiarelli, and B. L. Hunt (Northrop Corp., Aircraft Div., Hawthorne, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1446.* 10 p. 19 refs.

Wind tunnel studies were conducted in the Northrop 7 x 10-foot Low-Speed Wind Tunnel to measure the aerodynamic interference of in-flight thrust reversing on the longitudinal and lateral-directional stability and control characteristics of an advanced twin-jet fighter configuration. The test configuration simulated approach and landing conditions using non-metric 2D-CD type nozzles with the reverser fully deployed and operating at maximum dry power. The in-flight thrust reverser produced some change in the longitudinal stability of the model but is not considered significant. The control effectiveness

of the all-movable vertical tail was reduced by the reversed exhaust plume, while the directional stability of the model was increased. The aerodynamic interference was minimized with the reverser nozzles in the farthest aft location and canted outward 25 deg from the vertical tail plane. (Author)

A81-40880 # **A-10/TF34 Turbine Engine Monitoring System evaluation and implementation.** R. G. Christophel (USAF, San Antonio Air Logistics Center, Kelly AFB, TX). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1447.* 7 p. 11 refs.

The operation and interfaces of the A-10 aircraft TF34 powerplant Turbine Engine Monitoring System (TEMS) are discussed, with emphasis on functions, capabilities and limitations. Among the system elements covered are: (1) electronic processor unit; (2) umbilical disconnect unit; (3) diagnostic display unit; (4) data collection unit; and (5) peripheral ground equipment. The data acquisition functions of the system are both automatic and manual. Before incorporation of the TEMS system into the A-10 force, it will be necessary to validate and establish engine maintenance and management procedures based on TEMS data and to integrate TEMS data into the USAF maintenance and logistics process. O.C.

A81-40882 * # **An integrated transportation and operations comparison of space and ground based OTV's.** E. E. Davis (Boeing Co., Advanced Space Systems, Seattle, WA) and J. J. Rehder (NASA, Langley Research Center, Space Systems Div., Hampton, VA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1456.* 12 p. Contract No. NAS1-16088.

This paper presents the results of a comparison of space vs. ground basing of orbital transfer vehicles (OTV). The comparison was done assuming an 11-year mission model beginning in 1995 and averaging over 100 MT of payloads per year to GEO. When analyzed from a total transportation standpoint, the launch system employed had the greatest impact on the basing mode comparison. A launch fleet consisting of both a basic STS and a Shuttle derivative cargo vehicle provided the least cost. Only a small advantage (3%) was found in flight performance for the space based (SB) OTV once it incorporated the necessary provisions for space debris protection and on-orbit maintenance. Propellant storage and transfer losses associated with the SB OTV amounted to 12% of the actual flight propellant requirement. Turnaround of the SB OTV required a crew of 3 and 40% duty cycle. The life cycle cost comparison including all involved space elements indicated less than a 10% difference between basing modes. The SB OTV however is judged to provide more flexibility in launch manifesting, simplified recovery operations and greater potential for improvement. (Author)

A81-40887 # **Semi-empirical analysis of liquid fuel distribution downstream of a plain orifice injector under cross-stream air flow.** J. S. Chin, H. K. Jiang (Beijing Institute of Aeronautics and Astronautics, Beijing, Communist China), and M. H. Cao. *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1467.* 9 p.

A simple, flat-fan spray model is proposed, which can with two empirical parameters predict both the value and the position of liquid fuel distribution curve maximums downstream of a plain orifice injector under high-velocity cross flow. It was found that the model is useful in the preliminary design of the fan air flow portion of a turbofan afterburner, due to its ability to predict the influence on liquid fuel distribution of (1) such flow parameters as air velocity and viscosity, pressure and temperature; (2) injector parameters such as diameter and injection velocity; and (3) liquid properties including viscosity, density, and surface tension. O.C.

A81-40888 * # **A parametric study of staged fuel injector configurations for scramjet applications.** E. H. Weidner and J. P. Drummond (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1468.* 13 p. 8 refs.

A parametric study of staged (multiple) perpendicular fuel injector configurations has been conducted using a computer code which solves the two-dimensional elliptic Navier-Stokes equations. The program computes the turbulent mixing and reaction of hydrogen fuel and air and allows the study of separated regions of the flow immediately preceding and following the injectors. The validity of the code is demonstrated in a cold flow helium injection study with a single injector. Results are presented that describe the flow field near opposing staged injectors over a range of parameters. Parameters that are varied include injector size, fuel split, and distance between injectors. Comparisons of the configurations are made to assess their mixing and potential flame-holding qualities. (Author)

A81-40891 # **Effect of oxygen addition of low pressure ignition performance of aero gas turbine engine at simulated altitude facility.** N. K. Chen, Y. H. Zhao, S. S. Wu, Q. S. Zhao (Beijing Institute of Aeronautics and Astronautics, Beijing, Communist China), and J. S. Chin. *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1471.* 9 p.

An experimental investigation was conducted on the effect of oxygen addition on the altitude ignition performance of a turbine engine when launch cruise missiles required higher altitude and Mach number capabilities in order to achieve better missile performance. The J69-T41-A engine was used for tests with and without oxygen addition in two phases at subatmospheric pressure in a prechamber. Results showed improvements in light-up performance with a maximum light-up altitude increase of 5000-7000 meters, a maximum light-up Mach number from 0.36 to 1.1, and a maximum combustor inlet velocity increase from 25-30 m/sec to 60-90 m/sec. Best results were obtained when oxygen addition was applied locally in a direction opposite the air/flow, and used with a high energy igniter plug and a rich mixture. However, because parameters could not be freely varied in the engine, further investigation of ignition with oxygen addition on a compact rig is suggested. D.L.G.

A81-40895 # **Strong pressure waves in air-breathing engines.** V. E. Haloulakos (McDonnell Douglas Astronautics Co., Huntington Beach, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1475.* 8 p.

Fuel ingestion, damage from foreign objects, or a simple high-pressure-compressor stall can cause strong pressure waves in air-breathing engines. These waves travel at sonic and supersonic velocities throughout all the engine compartments, where they may cause structural damage. A computer program for unsteady compressible gas flow has been used to analyze and evaluate the transient flow phenomena caused by these waves. Starting with a steady-state gas flow input defining nominal pressures, velocities, and temperatures, a pressure pulse simulating an explosion is placed at some specified location. The program then computes the variations of all the flow parameters as a function of time at every point throughout the engine. The program is modularly constructed and can simulate any engine gas flow geometry by means of judicious numbering and connection of the various modules. The program has been successfully used to assess the severity of high-pressure waves in numerous cases and has correlated very well with experimental data. (Author)

A81-40897 # **External burning propulsion analysis.** D. W. Harvey and J. C. Davis (McDonnell Douglas Astronautics Co., Huntington, Beach, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1477.* 9 p. 15 refs. USAF-supported research.

An analysis is presented for the case of external burning propulsion (EBP) in which individual gas jets merge into an injectant annulus. The evolution of the annulus is calculated from the base plane to the point of reattachment, and from there to the critical point; including among its elements (1) mixing and momentum flux across the bounding shear layers, (2) fractional equilibrium chemistry, and (3) the effects of axial symmetry. Experimental data are used to estimate the inner and outer mixing half-angles of EBP systems and to evaluate performance predictions based on the present analysis. Experimental trends are found to be predicted well enough to strongly recommend future research in areas covered by the analysis for which no data as yet exist. O.C.

A81-40898 # **A strategy for developing the next generation fighter/attack aircraft engine.** D. A. Gissendanner (U.S. Department

of Defense, Washington, DC). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1478.* 7 p.

The paper discusses the process of forming a cohesive team involving the DOD, the Armed Services and the propulsion and airframe contractors to improve the development process of the next generation tactical fighter/attack aircraft engine. Among suggestions to improve the current programs are: starting the engine development schedule before the aircraft schedule, adequately specifying fundamental mission/system/engine requirements, basing engine designs on verified technology, clearly defining engine maintenance and support concepts, and accurately assessing program costs. Emphasized are competitive hardware demonstrations, extensive component/engine verification and validation, and a joint Service management concept. Learning from past difficulties will be a key element in initiating a late 1980's full scale engineering development program. D.L.G.

A81-40900 # **NAPC gyroscopic moment test facility.** H. C. Scott (U.S. Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1480.* 7 p.

The design features and operational capabilities and procedures of the Naval Air Propulsion Center (NAPC) gyroscopic moment test facility are described. The device is able to withstand engine thrust of up to 50,000 lbs, a gyroscopic load of 45,000,000, and a rotational speed of up to 3.6 radians/sec. Rig acceleration and deceleration rates are 0.22 to 0.63 radians/sec squared and 0.24 to 0.47 radians/sec squared, respectively. The maximum engine diameter accomodated is nine feet, and the maximum live load 25,000 lbs. The device determines the ability of engines to operate satisfactorily under imposed gyroscopic moments during flight maneuvers, and constitutes a viable alternative to the running of a complex flight test program. O.C.

A81-40903 * # **Prediction of swirling reacting flow in ramjet combustors.** D. G. Lilley (Oklahoma State University, Stillwater, OK), J. W. Samples (U.S. Military Academy, West Point, NY), and D. L. Rhode. *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1485.* 12 p. 34 refs. Grant No. NAG3-74.

Numerical computations have been undertaken for a basic two-dimensional axisymmetric flowfield which is similar to that found in conventional gas turbine and ramjet combustors. A swirling flow enters a larger chamber via a sudden or gradual expansion. The calculation method involves a staggered grid system for axial and radial velocities, a line relaxation procedure for efficient solution of the equations, a two-equation turbulence energy-turbulence dissipation rate turbulence model, a stairstep boundary representation of the expansion flow, and realistic accommodation of swirl effects. The results include recirculation zone characterization and predicted mean streamline patterns. Predictions with and without chemical reaction are obtained. An associated isothermal experimental flow study is providing a useful data base. Successful outcomes of the work can be incorporated into the more combustion- and hardware-oriented activities of industrial concerns. (Author)

A81-40904 # **Firebrand ramjet propulsion system development.** G. R. Ranslem (Marquardt Co., Van Nuys, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1486.* 12 p.

Test results for the first two development phases of the Navy Firebrand anti-ship target vehicle's ramjet powerplant are reported. Cruise propulsion thrust for the vehicle is supplied by two identical, normal shock inlet ramjet engines, whose simulated flight test performance with integrated fuel controls is reported. Among the other topics covered are: (1) basic mission description for the target vehicle; (2) development objectives; (3) test program plan; (4) engine design; (5) test installation; (6) heavy duty engine test results; (7) fuel control system; and (8) propulsion system performance. Among the program accomplishments are to be counted a ramburner drag coefficient of 4.0, high altitude cruise performance insensitivity to fuel temperature variations, and the obtaining of engine ignition with flares at a variety of simulated speed/altitude conditions. O.C.

A81-40906 # **An experimental study on air intake performance for a rocket/ramjet engine.** T. Miyamoto, H. Matsumoto (Japan Defense Agency, Technical Research and Development Institute, Tokyo, Japan), T. Tanioka, and M. Kodama (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1488.* 7 p.

A side inlet typical of fixed-configuration rocket/ramjet propulsion missiles was examined in a supersonic wind tunnel to determine (1) overall performance and (2) the effects of guide vanes mounted in a curved duct. Supercritical operating conditions were identified at various free stream Mach numbers, and the total pressure recovery under supercritical conditions was found to lie at a low level by comparison to a corresponding, conventional intake of variable configuration. It was also determined that the guide vanes improve the total pressure recovery deficit caused by flow distortion. At the limit of suprecritical operation, total pressure recovery was found to be 0.7-0.75, at flow Mach numbers of 1.8-2.0. Detailed graphic reductions of wind tunnel test data are presented. O.C.

A81-40908 # **Development of exhaust nozzle internal performance prediction techniques for advanced aircraft applications.** D. W. Speir and J. T. Blozy (General Electric Co., Aircraft Engine Business Group, Evendale, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1490.* 11 p. 5 refs.

The development of experimental and theoretical methods for the study and prediction of advanced thrust-vectoring nozzle internal performance, from the 1950s to the present and on to 1990, is described. In addition, a detailed account is given of design and development methods currently being applied to two-dimensional convergent-divergent (CD) and single expansion ramp (SERN) vectorable nozzles. Among the topics covered are (1) the configuration and evaluation of candidate exhaust systems; (2) analytical methods for potential flow and boundary layer analysis; (3) nozzle testing facilities and typical nozzle configurations tested; and (4) nonaxisymmetric nozzle internal performance prediction procedures. O.C.

A81-40910 # **Full authority digital electronic control /FADEC/ - Variable cycle engine demonstration.** J. E. Hurtle, P. D. Toot, R. P. Wanger (General Electric Co., Cincinnati, OH), and R. W. Vizzini (US Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1498.* 8 p. 7 refs. Contract No. N00019-76-C-0423.

The FADEC program is concerned with the development and the testing of a compact lightweight engine mounted electronic control for turbofan engines. A YJ 101-2x1 variable cycle engine was used in the considered study. In addition to the control functions of earlier turbofan engines, the FADEC control on the variable cycle engine must also control the forward bypass transition valve, the forward variable area bypass injector, and the aft variable area bypass injector, which make possible changes in the bypass ratio of the engine. The FADEC accepts information from 14 external engine sensors or feedback devices, five internally mounted pressure sensors, and a data link with the test site control room. The FADEC utilizes multilayer ceramic modules. The FADEC engine control circuits are partitioned into nine modules. The engine test and the test results are discussed. FADEC demonstrated its capability to perform small and large thrust changes rapidly in all variable cycle engine regimes while maintaining engine component steady state and dynamic limits. G.R.

A81-40911 # **Reliability assurance of electronic engine controls.** R. C. Thomas, R. W. Conrad, and R. W. Cording (Bendix Corp., Energy Controls Div., South Bend, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1499.* 8 p.

Joint developmental programs by Boeing and Bendix Corporation and key activities involved in the construction and flight testing of reliable Electronic Engine Control (EEC) systems for gas turbine engines are described. The first program, Electronic Propulsion Control System (EPCS) evolved the turbine controller design concepts with the flight test demonstration completed in 1980, while the second program, the ongoing Electronic Control Reliability Evaluation Program (ECORE), established the reliability of electron-

ic turbine controls. A microprocessor based EEC was ready for production in 1980, and detailed requirements for operation of the JT9D-7D engine on the 747 aircraft were developed. The design configurations of EEC, EPCS and ECORE are described and block diagrams are given. The validation tests, the module and system integration programs and the testing procedures are discussed. E.B.

A81-40912 * # **Flight test of a full authority Digital Electronic Engine Control system in an F-15 aircraft.** W. J. Barrett, J. P. Rembold (United Technologies Corp., Government Products Div., West Palm Beach, FL), F. W. Burcham, and L. Myers (NASA, Flight Research Center, Edwards, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1501.* 12 p.

The Digital Electronic Engine Control (DEEC) system considered is a relatively low cost digital full authority control system containing selectively redundant components and fault detection logic with capability for accommodating faults to various levels of operational capability. The DEEC digital control system is built around a 16-bit, 1.2 microsecond cycle time, CMOS microprocessor, microcomputer system with approximately 14 K of available memory. Attention is given to the control mode, component bench testing, closed loop bench testing, a failure mode and effects analysis, sea-level engine testing, simulated altitude engine testing, flight testing, the data system, cockpit, and real time display. G.R.

A81-40913 # **Combat survivability with advanced aircraft propulsion development.** L. Throndson (U.S. Naval Weapons Center, China Lake, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1506.* 10 p.

Realization of potentially high combat loss rates, for aircraft operating against modern air defenses, has become a prime driver in advanced military aircraft design. The propulsion system is the chief contributor to aircraft signature, and one of the most vulnerable of major aircraft systems. Therefore, attention is being directed to survivability in initial advanced engine cycle studies. Various approaches to airframe-propulsion integration are being explored to provide means for reduced susceptibility and vulnerability. Special contracted propulsion survivability studies are being conducted attached to the Navy-Air Advanced Technology Engine Study (ATES), which covers long-range propulsion planning and investigation of multiple application core engines (MACE). (Author)

A81-40947 # **A jet engine monitor /JEM/ for the TA-7C.** C. D. Smith (Howell Instruments, Inc., Fort Worth, TX). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1562.* 8 p.

An engine monitoring system has been developed for use on the TF30-P-408 engine. The JEM system combines gas generator trend monitoring, hot section deterioration information and overtemperature and overspeed indications in a single unit that provides easy-to-read, up-to-date data that is available immediately upon landing. Red warning flag indicators on the unit front face trip when preprogrammed engine temperature and speed limits are exceeded. (Author)

A81-40948 # **Aerodynamic characteristics of an advanced technology propeller for commuter aircraft.** C. Rohrbach and H. S. Wainauski (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1565.* 13 p. 7 refs.

The aerodynamic design of the new HS1 airfoils featured in the advanced technology commuter aircraft, is discussed. It is emphasized that propellers for the new commuter aircraft must meet stringent performance and low cabin and far-field noise requirements with minimum weight. The special features of the high design lift airfoils are listed as: high lift-to-drag ratios over a wide lift coefficient range; high critical Mach numbers at low operating lift coefficients; high maximum lift coefficients; low aero twisting moments; favorable structural and manufacturing shape and favorable erosion and foreign object damage shape. The wind tunnel data are compared with predicted performance while data on a model commuter propeller incorporating HS1 airfoils are compared to that of a similar model featuring NACA Series 16 airfoils. Finally, the predicted performance of the new propellers installed on representative commuter aircraft is compared to test data. E.B.

A81-40949 # **Some propeller developments in the United Kingdom.** C. M. Pearce (Dowty Rotol, Ltd., Cheltenham, Glos., England). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1566.* 9 p.

The variable pitch propeller offers very significant efficiency advantages over competing means of aircraft propulsion. Current generation turbopropeller transports operate typically to Mach numbers around 0.5. Technology advances have been made over the last decade, and improved techniques of design and manufacture have been evolved. The improvements developed in the U.K., for propeller blade aerofoil sections, advances in blade constructional techniques and control system philosophy are described. The resulting propeller designs are compared with existing propeller designs. Future installations offer the possibility of increasing forward aircraft speeds to Mach 0.7 - 0.8 using advanced multi-bladed propellers. The basic technology now exists to mechanise these designs, and considerable improvements in efficiency over existing propulsive systems are offered. (Author)

A81-40963 * # **JT9D performance deterioration results from a simulated aerodynamic load test.** E. G. Stakolich (NASA, Lewis Research Center, Cleveland, OH) and W. J. Stromberg (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, CT). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1588.* 16 p.

This paper presents the results of testing to identify the effects of simulated aerodynamic flight loads on JT9D engine performance. The test results were also used to refine previous analytical studies on the impact of aerodynamic flight loads on performance losses. To accomplish these objectives, a JT9D-7AH engine was assembled with average production clearances and new seals as well as extensive instrumentation to monitor engine performance, case temperatures, and blade tip clearance changes. A special loading device was designed and constructed to permit application of known moments and shear forces to the engine by the use of cables placed around the flight inlet. The test was conducted in the Pratt and Whitney Aircraft X-Ray Test Facility to permit the use of X-ray techniques in conjunction with laser blade tip proximity probes to monitor important engine clearance changes. Upon completion of the test program, the test engine was disassembled, and the condition of gas path parts and final clearances were documented. The test results indicate that the engine lost 1.1 percent in thrust specific fuel consumption (TSFC), as measured under sea level static conditions, due to increased operating clearances caused by simulated flight loads. This compares with 0.9 percent predicted by the analytical model and previous study efforts. (Author)

A81-40964 # **A perspective on developing new inlet distortion measurement and predictive methods.** J. Mace and D. Sedlock (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1589.* 10 p. 8 refs.

Various statistical properties of compressor face total fluctuations, such as coherence and correlation coefficients, are estimated from wind tunnel data taken from an 0.15 scale F-16 inlet. It is shown that: (1) estimation of the correlation coefficient between engine face dynamic probes shows statistically significant correlations between adjacent probes on the same rake; (2) the pressure correlation is independent of location within either a low or high total pressure region and could be expressed as a scalar function of distance within those two regions; and (3) a systematic procedure based on multiple regression is found to estimate peak distortion using substantially fewer than the usual 40 dynamic probes at a compressor face. O.C.

A81-40965 # **Performance analysis of a family of planar pulse generators.** R. E. Peacock (U.S. Naval Postgraduate School, Monterey, CA) and D. K. Das (Cranfield Institute of Technology, Cranfield, Beds., England). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1590.* 9 p. Research sponsored by the Ministry of Defence

of England.

With immediate application to a research project investigating unsteady flows in turbomachines but with a wider application in areas where controlled rapidly time-varying air flows are required, a series of discrete frequency generators was developed. Of simple geometry to maintain total costs low, each generator consisted of a row of stationary followed by rotating spokes producing a cyclic partial interruption to the flow. The generated pulse waveform depended upon pulse frequency, but within limits maintained low harmonic content reducing in the axial direction. Planar variations, both in magnitude and phasing were found to be small, producing a spatial disturbance with low planar content. (Author)

A81-40966 # **TELS - A facility to observe the effect of simulated flight maneuver loads on turbine engines.** D. E. Hagford (Fluidyne Engineering Corp., Facilities Div., Minneapolis, MN) and H. E. Hewgley (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, TN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1591.* 9 p. 5 refs.

The current status of the Turbine Engine Loads Simulator (TELS) designed for installation at the USAF/AEDC is described. TELS will be a large centrifuge test facility capable of simulating the flight maneuvering loads (both inertial and gyroscopic) on operation full-scale turbine engines. The loads to the test engines will be generated by rotating the centrifuge at rates up to 33 rpm with the axis of the test engine positioned at radii up to 40 feet and at various angles to the centrifuge plane of rotation. The combination of radial distance and centrifuge rpm will establish the inertial loadings on the test engine while the combination of rpm and angle between the test engine axis and the centrifuge plane of rotation will control the gyroscopic loads. (Author)

A81-40967 # **A compact installation for testing vectored-thrust engines.** W. H. Cunningham and J. F. Boytos (U.S. Naval Air Propulsion Test Center, Trenton, NJ). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1592.* 10 p.

An installation has been built to test the 'Pegasus' engine in its vectored-thrust mode, in a conventional enclosed sea-level test cell, in response to the Navy's requirement for test facilities for V/STOL propulsion systems. Its main features are: four vane cascades, whose design has some unique characteristics; and vertical and slant thrust measurement capability. The major criteria for the installation were met; effects on engine performance were minimal, and engine steady-state and transient operation was satisfactory from idle through maximum power. The overall performance of cascade turning vanes operating at high subsonic Mach numbers and high Reynolds numbers was also investigated. (Author)

A81-40968 # **A successful step toward an advanced supersonic transport engine - Acoustic and emission results from the Pratt and Whitney Aircraft Variable Cycle Engine Program.** J. S. Westmoreland and A. B. Packman (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, CT). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1593.* 10 p. 13 refs.

Test results of the successful NASA acoustic evaluation of the supersonic transport Variable Stream Control Engine (VSCE) are presented. The engine, simulated by the attachment of a three-stage combustor duct burning system with coannular nozzles to a testbed F100 turbofan engine, was found to be environmentally and operationally feasible; with burner emissions being extremely low and duct burner noise not being evident in the far field. Among the topics covered are: (1) VSCE and testbed engine configurations; (2) duct burner configuration and emissions/performance evaluation; (3) system performance goals at sea-level takeoff and supersonic cruise conditions; (4) VSCE acoustic goals and test results, including aft fan component and jet exhaust noise; and (5) estimates of flyover noise. O.C.

A81-40969 * # **NASA VCE test bed engine aerodynamic performance characteristics and test results.** M. W. French and C. L. Allen (General Electric Co., Lynn, MA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1594.* 10 p. 6 refs. NASA-sponsored research.

The Core Driven Fan Stage (CDFS) Variable Cycle Engine (VCE) has been identified as a leading candidate for advanced supersonic cruise aircraft. A scale demonstrator version of this engine has been designed and tested. This testbed engine features a split fan with double bypass capability, variable forward and aft mixers, and a variable area low pressure turbine nozzle to permit exploration and optimization of the cycle in both single and double bypass modes. This paper presents the aerodynamic performance characteristics and experimental results obtained from both the core engine and full engine tests. (Author)

A81-40970 * # **Advanced supersonic transport propulsion and configuration technology improvements.** W. T. Rowe, H. R. Welge, E. S. Johnson, and L. S. Rochte (Douglas Aircraft Co., Long Beach, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1595.* 13 p. 6 refs. Contract No. NAS1-16147.

This paper presents the results of recent Douglas Aircraft Company integration studies for an advanced supersonic transport. The studies include technology improvements such as superplastic formed and diffusion-bonded titanium sandwich primary structure, composite secondary structure, bicone engine inlet, improved mechanical suppressors based on flight test data, improved aerodynamic efficiency based on wind tunnel test data, and updated performance for both variable-cycle and low-bypass-ratio engines. Technology development requirements for an economically viable and environmentally acceptable advanced supersonic transport are defined through these studies. A new Douglas Aircraft Company baseline supersonic transport designed to carry 350 passengers is defined for cost comparisons. (Author)

A81-40971 * # **Turbine bypass engine - A new supersonic cruise propulsion concept.** L. C. Franciscus (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1596.* 9 p. 7 refs.

Engine performance and mission studies were carried out for a single-spool turbine bypass engine (TBE) concept. Comparisons were made between the TBE, a conventional single-spool turbojet, and the Pratt and Whitney Variable Stream Control Engine (VSCE). The airplane assumed for the study was a Mach 2.32 commercial supersonic transport. The nominal mission was a 4000 n mi total range with a 300 n mi subsonic cruise leg. The figure of merit was the minimum takeoff gross weight for the mission. Comparisons of the three engines were also made for the 4000 n mi total range with longer subsonic cruise legs. (Author)

A81-40972 * # **Aerodynamic and acoustic behavior of a YF-12 inlet at static conditions.** L. H. Bangert, E. P. Feltz, L. A. Godby, and L. D. Miller (Lockheed-California Co., Burbank, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1597.* 10 p. NASA-supported research.

An aeroacoustic test program was performed with a YF-12 aircraft at ground static conditions. The objective was to collect acoustic and aerodynamic data that could determine the cause of YF-12 inlet noise suppression observed earlier. The results showed that the far-field noise level was lower with the YF-12 inlet than with a bellmouth inlet at engine speeds above 5500 rpm. The differences were about 5 PNdB to 11 PNdB, depending on YF-12 inlet configuration and on engine speed. Measurements showed that YF-12 inlet noise suppression was not caused by flow choking. The spike support struts were probably responsible, as in that region the spectral peak near the blade passing frequency disappeared between 6000 and 6600 rpm, and multiple pure tones were greatly reduced. (Author)

A81-40973 * # **The supersonic fan engine - An advanced concept in supersonic cruise propulsion.** L. C. Franciscus (NASA, Lewis Research Center, Mission Analysis Office, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1599.* 9 p. 11 refs.

Engine performance and mission studies were conducted for a novel turbofan engine concept incorporating a supersonic through-flow fan, and comparisons were made with two supersonic transport

(SST) engine concepts of equivalent thrust and technological sophistication. It was found that in the case of an SST with a cruise speed of Mach 2.32, the through-flow fan engine may yield ranges 10 to 20% greater than the two alternatives considered. The engine has a conventional core, with the supersonic fan being driven by a concentric low-pressure turbine that is uncoupled with the single, high pressure turbine/compressor core spool. Among the topics discussed are the methods of analysis employed and perturbation studies concerning supersonic fan adiabatic efficiency, fan discharge characteristics and propulsion system weight. O.C.

A81-41003 # **Comparative efficiency of penetrating steam and air cooling of gas turbine blades (Sravnitel'naia effektivnost' pronikaiushchego parovogo i vozdushnogo okhlazhdeniia lopatok gazovykh turbin).** L. V. Arsen'ev, V. G. Polishchuk (Leningradskii Politekhnicheskii Institut, Leningrad, USSR), V. M. Epifanov (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR), and V. I. Gus'kov. *Promyshlennaia Teplotekhnika,* vol. 3, July-Aug. 1981, p. 49-56. 10 refs. In Russian.

The flow rate of the cooling agent during the penetrating steam and air cooling of gas turbine blades has been calculated using a method based on a simple integral theory proposed by Kutateladze and Leontev (1972). Analysis of the results obtained indicates that the use of superheated steam as a cooling agent makes it possible to reduce the cooling agent flow rate by 1.5-2 times, while increasing the depth of cooling and temperature field uniformity. V.L.

A81-41028 # **Selection of turbine parameters for steam-hydrogen engine schemes (Osobennosti vybora parametrov turbin dvigatelei parovodorodnykh skhem).** N. N. Bykov and M. A. Chekalov. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 13-18. In Russian.

The problem of turbine parameter selection for steam-hydrogen schemes is investigated analytically. It is shown that specific characteristics of such schemes, combined with differences in the physical properties of combustion gases and hydrogen, make parameter selection criteria for steam-hydrogen engines essentially different from those for conventional gas turbines. Some of these differences are examined. V.L.

A81-41029 # **Thermodynamic comparison of the efficiencies of semiclosed- and open-loop air cooling systems of gas turbine engines (Termodinamicheskoe sravnenie effektivnosti poluzamknutykh i otkrytykh vozdushnykh sistem okhlazhdeniia gazoturbinnykh dvigatelei).** E. A. Manushin. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 18-23. 7 refs. In Russian.

The performance of semiclosed- and open-loop cooling systems of gas turbine engines has been evaluated in terms of their efficiencies and specific power for equal pressure increases and initial gas temperatures. The semiclosed cooling schemes are found to be the more efficient over the entire initial gas temperature range investigated (1370-1870 K). V.L.

A81-41032 # **Excitation of surging type oscillations due to aperiodic external effects (Vozbuzhdenie kolebanii, podobnykh pompazhnym, pri neperiodicheskikh vneshnikh vozdeistviiakh).** I. L. Pis'mennyi. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 34-37. In Russian.

Oscillations in multishaft turbojet engines caused by aperiodic external effects are investigated analytically with reference to a simplified air-gas duct model. It is shown that aperiodic external effects, such as a decrease in the fuel feed rate, may produce oscillations similar to surging which however are not accompanied by an increase in the turbine temperature and are characterized by higher frequencies. V.L.

A81-41033 # **An experimental study of heat transfer on turbine rotor blades (Eksperimental'noe issledovanie teploobmena na poverkhnosti rabochikh lopatok turbiny).** V. P. Pochuev and V. F. Shcherbakov. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 37-41. In Russian.

Local heat transfer between gas and rotating turbine blades has been studied experimentally at Re2 approximately 200,000 in the gas temperature range 840-1200 K (after the combustion chamber). Heat fluxes have been determined by the method of thin-body transients. Local heat transfer on rotating blades is compared to that on stationary blades. V.L.

A81-41039 # **Change of static pressure on the rotating blades of an axial-flow compressor during surging (Izmenenie staticheskikh davlenii na vrashchaiushchikhsia lopatkakh osevogo kompressora vo vremia tsikla pompazha).** I. K. Shatalov. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 62-66. In Russian.

Results of an experimental study of a surging in a single-stage axial-flow compressor indicate that the static pressure fluctuations during surging are maximum on the convex surface of the leading edge of the blades. It is also shown that during surging the peripheral parts of the rotating blades are subject to the highest dynamic loads. V.L.

A81-41041 # **Efficiency of cantilever compressor stator blades (Ob effektivnosti primeneniia napravliaiushchikh apparatov kompressora s konsol'nymi lopatkami).** A. N. Aniutin, A. F. Brekhov, L. N. Buslik, G. A. Girich, V. N. Ershov, and B. G. Reznik. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 72-74. In Russian.

The use of cantilever stator blades has been investigated as an alternative to blades supported at both ends for a compressor stage of an aircraft gas turbine engine. The experiments were carried out at a peripheral speed of 180 m/s. It is found that the aerodynamic characteristics of the cantilever scheme are equal to (or even somewhat better than) those of the blades supported at both ends for radial gaps at the hub up to 3% of the blade height which in the case studied corresponded to 1 mm. V.L.

A81-41048 # **Investigation and improvement of an elbow-type gas outlet of a turboprop engine (Issledovanie i sovershenstvovanie gasovypusknogo ustroistva TVD s kolenoobraznym patrubkom).** A. M. Zakharov, L. I. Raikin, and S. N. Zelenov. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 94, 95. In Russian.

A81-41049 # **An experimental study of heat transfer in rotating slots and bends (Eksperimental'noe issledovanie teploobmena vo vrashchaiushchikhsia shcheliakh i povorotakh).** G. A. Kogan and A. A. Dergach. *Aviatsionnaia Tekhnika,* no. 1, 1981, p. 96-98. In Russian.

A81-41090 * # **Transonic swept wings studied by the lifting-line theory.** H. K. Cheng, S. Y. Meng (Southern California, University, Los Angeles, CA), R. Chow (Grumman Aerospace Corp., Bethpage, NY), and R. C. Smith (NASA, Ames Research Center, Aeronautics Div., Moffett Field, CA). *AIAA Journal,* vol. 19, Aug. 1981, p. 961-968. 46 refs. Contract No. N00014-75-C-0520; Grants No. NCR-530-501; No. NCA2-OR-730-601.

Transonic swept wings are analyzed as a lifting-line problem under a small-disturbance approximation. Basic concepts and principal results of the asymptotic theory are discussed. The study focuses on straight oblique wings and V-shaped swept wings, of which the local centerline curvature can be equated to zero. The three-dimensional (3-D) perturbation of the nonlinear component flow admits a similarity flow structure but requires that all wing sections are generated from a single airfoil profile; the reduced 2-D problems in this case are solved only once for all span stations. Examples of solutions involving high subcritical and slightly supercritical component flows are demonstrated and compared with surface pressure data from 3-D computer codes based on the full-potential equation (FLO 22). Except in the neighborhood of leading edges, where the small-disturbance assumption breaks down, and in the vicinities of wing tips and the symmetry plane, where neither the theory nor the 3-D codes may claim full validity, reasonable agreement is consistently found. The explicit results from the upwash analysis, along with the similarity flow structure, provides a rational approach to the control of 3-D effects in transonic aerodynamic design studies. (Author)

A81-41199 # **An investigation of the recovery from an engine failure in a twin engine augmentor wing aircraft using the NAE Airborne Simulator.** D. E. Sattler, M. Sinclair, S. Kereliuk (National Aeronautical Establishment, Ottawa, Canada), and R. H. Fowler (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *(Canadian Aeronautics and Space Institute, Flight Test Symposium, Ottawa, Canada, Mar. 25, 1980.) Canadian Aeronautics and Space Journal,* vol. 27, 1st Quarter, 1981, p. 26-40. 10 refs.

A brief piloted simulation program was conducted using the NAE Airborne Simulator to investigate the airworthiness aspects of a

twin engine augmentor wing aircraft experiencing an engine failure during final approach. Three evaluation pilots flew a series of STOL approaches (-7.5 degree glideslope to a 4000 ft runway) consisting of normal two engine approaches and approaches on which an engine was failed at a height ranging from 17 to 92 ft above the runway elevation. Quantitative and qualitative flight evaluation data were collected illustrating that acceptable touchdown sink rates could be achieved following an engine failure at any point on the approach, provided that adequate pilot warning systems and automatic thrust compensation systems were available, and that correct pilot recovery technique was employed. (Author)

A81-41255 Effect of engine noise on aircraft wing laminar boundary-layer stability. R. A. Mangiarotty (Boeing Co., Seattle, WA). *Acoustical Society of America, Journal,* vol. 70, July 1981, p. 98-109. 11 refs.

It is noted that high-intensity acoustical disturbances can cause transition of controlled laminar flow. An investigation is carried out to determine whether the installation of main propulsion engines on an aircraft wing could cause excessive transition of laminar to turbulent flow. A method is developed for analyzing the influence of noise on the stability of a controlled laminar boundary layer; the method is based on the Tollmien-Schlichting traveling wave solution, on the Orr-Sommerfeld equation and some wind tunnel experimental data. It is found that wing-mounted, high-bypass-ratio engines with sufficient acoustic treatment for controlling turbomachinery noise would not cause excessive loss of wing laminar flow. C.R.

A81-41333 Evolution of transport wings - From C-130, C-141, and C-5 to C-XX. R. O. Lowrey (Lockheed-Georgia Co., Marietta, GA). *Lockheed Horizons,* Summer 1981, p. 14-22.

An overview of wing design technology is presented with particular reference to the C-130 Hercules, C-141 Starlifter, C-5 Galaxy and C-XX designs. The establishment of technical feasibility is discussed in terms of aerodynamic technology, structural technology, electronic technology and economic factors. Each of the four wing designs is examined in terms of wing features dominated by cruise flight (wing span, cross section, airfoil shape, wing planform) and features dominated by takeoff and landing. S.C.S.

A81-41335 Night flight of helicopters (Nachtflug von Hubschraubern). R. Beyer (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *DFVLR-Nachrichten,* vol. 33, June 1981, p. 8-11. In German.

By equipping the helicopter with navigation systems, control systems, and suitable displays in the cockpit, it is possible to conduct a flight at night, in the absence of external visual aids, according to instrument flight rules (IFR). In the case of the helicopter, it was necessary to develop new control systems to relieve the pilot from guiding and control operations, thus, making it possible for him to concentrate on the performance of IFR flight operations. There are other types of night operations for helicopters which depend on the aid of suitable systems to ensure adequate visibility conditions for the pilot. A basic concept used in this connection involves taking a picture of the environment with the aid of a camera suitable for night photography, and presenting this picture to the pilot on a monitor in the cockpit. Another approach makes use of a device, which is similar in appearance to binoculars and provides adequate visibility to the pilot by amplifying residual light. G.R.

A81-41336 Improving the economy of subsonic transport aircraft by means of aerodynamic approaches (Verbesserung der Wirtschaftlichkeit von Unterschall-Transportflugzeugen durch aerodynamische Massnahmen). H. Körner (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Entwurfsaerodynamik, Braunschweig, West Germany). *DFVLR-Nachrichten,* vol. 33, June 1981, p. 11-13. In German.

The rapidly increasing prices for fossil fuels make it necessary for the aircraft manufacturers to give more attention to economical aspects of aircraft operation. Novel, fuel-saving technologies are being explored. In the area of subsonic transport aircraft, efforts of industry and research institutes in West Germany are concentrated on the improvement of the Airbus. Approaches employed for reducing fuel consumption are related to the design of transonic profiles, the reduction of lift-dependent drag, the reduction of surface friction drag, the reduction of interference drag, the design of a transonic propeller, an active/adaptive wing, advanced bypass engines, flight management, and weight reduction in connection with new design methods and the use of new materials for primary structural units. G.R.

A81-41399 # Forecasting the 80s - An outlook on aerospace developments of the decade by the Technical Committees of the AIAA. *Astronautics and Aeronautics,* July-Aug. 1981, p. 20-22, 24, 26 (58 ff.).

A81-41516 An evaluation of vacuum centrifuged titanium castings for helicopter components. L. J. Maidment and H. Paweletz (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. *Volume 1.* Warrendale, PA, Metallurgical Society of AIME, 1980, p. 467-475. 6 refs.

The considered investigation included the determination of the mechanical properties of centrifugally cast experimental components, taking into account static and dynamic strength, fracture toughness, and crack propagation characteristics. In the second part of the investigation, cast rotor heads were subjected to flight simulation tests. Two advantages concerning an employment of cast rotor heads are related to a significant saving in raw material and a reduction in machining time. However, forged and cast rotor head blanks cost approximately the same, in spite of the reduced amount of material needed in the case of the cast rotor head. After an assessment of the various factors, it is concluded that a large scale use of cast rotor heads could only be justified on an economic basis. At present, however, the only economic advantage concerning an employment of cast rotor heads is related to a moderate reduction in machining costs. This factor alone does not make casting an economically viable alternative to forging, in view of cost intensive acceptance and inspection procedures required. G.R.

A81-41634 Effect of beta flecks on the fatigue behaviour of Ti-6Al-6V-2Sn. K. Rüdinger and D. Fischer (Thyssen-Edelstahlwerke AG, Krefeld, West Germany). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 3. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 1907-1916. 9 refs.

The fatigue behavior of Ti-6Al-6V-2Sn alloy has been investigated with a view to obtaining more data on the effect of the low-alpha structural segregations, the so called beta flecks, on the properties of annealed titanium mill products for application in airframe structures. Results confirm that mechanical properties including notched to unnotched tensile strength ratio of Ti-6Al-6V-2Sn in the annealed condition are not impaired by the presence of beta flecks. In all materials tested the minimum values of AMS specifications were exceeded. V.L.

A81-41637 Structural applications for titanium castings. A. L. Donlevy, J. R. Newman, and E. A. Williams (TiTech International, Inc., Pomona, CA). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 3. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 2187-2195. 13 refs.

A description is presented of a series of casting case studies which document tests conducted in the U.S. and Europe, taking into account a pitch yaw nozzle, hot gas deflector plates, an arrestor hook for F-15 fighter aircraft, and an advanced missile combustion duct. A list with a sampling of other actual structural titanium castings includes a helicopter rotor hub, impellers for small jet engines, inducers for waterjet propulsion units, engine hoist tubes, optical housings for laser systems, a cargo rail for an aircraft cargo system, and torque tubes for brakes. A table which lists a representative sampling of static test results obtained from 'cut up' titanium castings is also provided. A compilation of fatigue strength data for cast Ti6Al-4V alloys is also presented. G.R.

A81-41640 Development in powder metallurgy /PM/ Ti6Al4V technology for aircraft parts. W. Keinath (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany), R. Mohs (Fried. Krupp GmbH, Essen, West Germany), and W. Bunk (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 3. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 2215-2221.

The use of powder metallurgy (PM) techniques for aircraft applications is briefly discussed with reference to an example involving the development of a helicopter part of PM Ti6Al14V alloy. Attention is given to powder characterization, powder handling techniques, powder degassing, canning, and optimization of the process variables during hot isostatic pressing. Structural features and mechanical properties of parts obtained by hot isostatic pressing are examined. V.L.

A81-41647 From sponge to powder alternatives in titanium processing. R. Ruthardt, H. Stephan, and W. Dietrich (Leybold-Haraeus GmbH, Hanau, West Germany). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 3. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 2289-2299.

Alternative techniques for the production of titanium ingots and powder from raw material ingots, sponge, powder or scrap are examined in light of the material requirements for high-efficiency aircraft gas turbine engines. Attention is given to vacuum arc and electron beam melting methods for the production of titanium ingots, and methods for titanium powder production from the melt which combine melting techniques such as arc, plasma or electron beam melting with means for melt disintegration generally based on centrifugal forces. The environmental cleanliness of the various processes is discussed, and cost considerations in the development of powder production equipment are addressed. A.L.W.

A81-41649 Titanium net shapes by a new technology. I - F-14A parts evaluation. R. H. Witt (Grumman Aerospace Corp., Bethpage, NY) and W. T. Highberger (U.S. Naval Air Systems Command, Washington, DC). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 2. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 2309-2313.

Recent investigations have shown that manufacturing costs can be reduced by making use of an approach based on the production of net or near-net shapes by means of a hot isostatic pressing (HIP) method. The major work that remains to gain acceptance of this process in the industry relates to scale-up of the process for large parts and development of a design data base. A description is presented of the status of Navy programs that have been directed toward attaining this goal. The Crucible Ceramic Mold HIP process considered consists of encapsulating metallic prealloyed titanium powders in a suitably shaped mold, inserting the mold in a special can surrounded by a compressible medium, evacuating, and sealing the can. The assembly is then isostatically pressed. Attention is given to the powder process, F-14A aircraft parts, and the feasibility of producing a fuselage brace. G.R.

A81-41650 Titanium net shapes by a new technology. II - F-18A parts evaluation. G. R. Chanani (Northrop Corp., Hawthorne, CA), W. T. Highberger (U.S. Naval Air Systems Command, Washington, DC), and C. A. Kelto (USAF, Materials Laboratory, Wright-Patterson AFB, OH). In: Titanium '80 science and technology; Proceedings of the Fourth International Conference on Titanium, Kyoto, Japan, May 19-22, 1980. Volume 3. Warrendale, PA, Metallurgical Society of AIME, 1980, p. 2314-2319. Contract No. F33615-77-C-5005.

The overall objective of the considered program is the application of low-cost titanium powder metallurgy technology to advanced Naval aircraft structures. The specific objective is the reduction of the cost of manufacturing selected titanium components for the F-18. This is to be accomplished by an approach involving the hot isostatic pressing (HIP) of titanium powder to produce a near-net shape of the F-18A Arrestor Hook Support Fitting (AHSF). The F-18A AHSF serves as the fuselage attachment of the arrestor hook used for cable braking in carrier landing. In an evaluation of the obtained results, it is found that the overall dimensions and shape of the first iteration AHSF were very good considering the complexity of the part. The heat treated part did not have any significant residual surface stresses. Fractographic investigation together with the mechanical test results did not indicate any harmful effect of tungsten particles. The tensile properties of the annealed P/M material were found to meet the specification requirements of wrought titanium material. G.R.

A81-41725 Vibrations in technical equipment. Volume 3 - Oscillations of machines, structures, and their components (Vibratsii v tekhnike. Volume 3 - Kolebaniia mashin, konstruktsii i ikh elementov). Edited by F. M. Dimentberg and K. S. Kolesnikov. Moscow, Izdatel'stvo Mashinostroenie, 1980. 545 p. In Russian.

The present volume contains calculations of the vibrations of elastic elements and systems associated with modern technical equipment. The types of equipment considered include: power generating machinery, steam and turbine plants, internal combustion engines and related drive systems, rolling stock, ship structures, automobiles, caterpillar-tracked vehicles, and aircraft. V.L.

A81-41748 # Critical considerations in the design of supersonic combustion ramjet /scramjet/ engines. P. J. Waltrup, F. S. Billig, and M. C. Evans (Johns Hopkins University, Laurel, MD). *(AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, CT, June 30-July 2, 1980, AIAA Paper 80-1284.) Journal of Spacecraft and Rockets*, vol. 18, July-Aug. 1981, p. 350-356. 19 refs. Contract No. N00024-78-C-5384.

The design and estimation of the performance of a supersonic combustion ramjet (scramjet) engine is critically dependent on the geometry and efficiency of each of the engine components. Therefore, it is mandatory to be cognizant of all the available experimental data and theoretical modeling that has been established if a credible design is to be obtained. The purpose of this paper is to reiterate norms for component geometries, lengths, internal losses, and combustion kinetics that have been established and/or substantiated in the technical literature and to illustrate the sensitivity of engine performance to deviations from those norms. A specific examplary design is presented and used to illustrate these effects. The results show that the maximum predicted net engine thrust can be overestimated by as much as 45% if more idealistic assumptions, similar to those used in the design of conventional subsonic combustion ramjet engines, are used. (Author)

A81-41752 Status report - Global Positioning System. D. W. Henderson and H. Coriat (USAF, Space Div., Los Angeles, CA). *(Institute of Navigation, National Aerospace Meeting, Dayton, OH, Mar. 11-13, 1980.) Navigation*, vol. 27, Spring 1980, p. 54-64.

Significant Global Positioning System (GPS) activities since a concept validation phase with the Defense System Acquisition Review Council are reviewed. With the potential of providing highly accurate three-dimensional position, velocity and time, the system is made up of space, control and user segments. Phase II activities include developing and deploying operational prototype spacecraft, installing operational ground and control systems, and developing approximately 50 user equipment sets for evaluation on nine host vehicles of the four Services. Phase I follow-on tests include manpack testing to evaluate GPS susceptibility under realistic electromagnetic conditions and compare GPS data with other navigational aids, air drop tests, operational rendezvous, Phantom F4 bombing, differential navigation, and Coast Guard evaluations. After nine months of engineering development, user equipment designs aimed at reducing life cycle costs are emerging, and follow-on tests for Phase II activities are being implemented, with results indicating Navstar GPS having significant impact in both military and civilian sectors. D.L.G.

A81-41753 Standard INS program status. H. L. Daniel and D. B. Hulslander (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *(Institute of Navigation, National Aerospace Meeting, Dayton, OH, Mar. 11-13, 1980.) Navigation*, vol. 27, Spring 1980, p. 65-71.

In an effort to establish a competitive development program for a form, fit and function medium accuracy inertial navigation system, the Aeronautical Systems Division began designing and testing four preproduction Standard Inertial Navigation Systems (INS). Prepro-

duction program testing at the Central Inertial Guidance Test Facility, and A-10 flight testing at the Air Force Flight Test Center are presented. Other tests include verification and safety of flight tests, and maintainability demonstrations. Acquisition and logistics support approach for the A-10 aircraft is described, and details of the production contract are given. Future Standard INS competition is also discussed, with emphasis on the ability to maintain viable competition. D.L.G.

A81-41758 Doppler radar systems for helicopters. H. Buell (Singer Co., Kearfott Div., Wayne, NJ). *(Institute of Navigation, Annual Meeting, 36th, U.S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation* vol. 27, Summer 1980, p. 124-131.

It is pointed out that a dead-reckoning navigation system using a Doppler radar as the velocity sensor, and the helicopter's magnetic compass and vertical gyro as the sources of heading, pitch and roll, is a simple low-cost system ideally suited to helicopters. A Lightweight Doppler Navigation System (LDNS) designed specifically for helicopters and low-performance aircraft is discussed. The system weighs under 30 pounds, consists of only two boxes and a display, and has a predicted MTBF of over 2000 hours. All computations in the LDNS are performed in a general-purpose LSI-chip computer. Attention is given to navigation systems for helicopters, the AN/ASN-128 LDNS, aspects of system operation, the physical characteristics of the LDNS, and recent changes to the ASN-128. G.R.

A81-41759 Flight control strategies for performance computers. J. M. H. Bruckner and J. S. Sadowsky (Rockwell International Corp., Collins Div., Cedar Rapids, IA). *(Institute of Navigation, Annual Meeting, 36th, U.S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation,* vol. 27, Summer 1980, p. 132-141. 9 refs.

The possibility of a gap in the performance obtained by flying flight schedules generated by optimal control theory versus more conventional constant IAS/Mach speed schedules is discussed. It is found that minimum cost handbook profiles can be developed which are typically within 0.5 to 1% of optimal. Since flight technical errors yield performance degradations on the order of 1-2%, these profiles are more than adequate for manual flight control. Under autopilot and autothrottle control in climb and descent, flight technical errors are no longer dominant. For these applications open loop IAS schedules can be developed which yield performance equivalent to the more sophisticated approaches. G.R.

A81-41760 Omega station 10.2 kHz signal coverage prediction diagrams. R. R. Gupta, S. F. Donnely (Analytic Sciences Corp., Reading, MA), P. B. Morris, and R. L. Vence, Jr. (U.S. Coast Guard, Washington, DC). *(International Omega Association Symposium, Bergen, Norway, Aug. 5-7, 1980.) Navigation,* vol. 27, Summer 1980, p. 142-161. 15 refs.

Omega is a very low frequency radio wave navigation system utilizing phase or phase difference measurements designed to provide a position fix for users all over the world. Bortz et al. (1976) published a set of Omega signal coverage diagrams for the 10.2 kHz signals. These diagrams display the global availability of usable signals for the two possible extreme cases of local temporal conditions, including local summer noon and local winter midnight. New Omega signal coverage diagrams for 10.2 kHz signals have been developed for potential use with both moderate-performance receivers and new higher-performance receivers. Specifically, the new diagrams display the predicted regions of global accessibility of usable signals for each Omega station at a given global time based on each of two signal access criteria. Attention is given to the Omega signal propagation mechanism and models, individual station diagrams, and composite signal coverage prediction diagrams. G.R.

A81-41761 Optimal processing of GPS signals. E. M. Copps, G. J. Geier, W. C. Fidler (Intermetrics, Inc., Huntington Beach, CA), and P. A. Grundy (Intermetrics, Inc., Cambridge, MA). *(Institute of Navigation, Annual Meeting, 36th, U.S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation,* vol. 27, Fall 1980, p. 171-182. 10 refs. Navy-supported research.

This paper formulates a Kalman estimator as an optimal tracker/navigator for GPS. The approach is motivated by considering the signal and navigation processing performed by a GPS set not as separate functions, but as a single integrated function. The practical realization of this integrated tracker/navigator is discussed, and simulation results are presented which permit comparison of its performance with that of more conventional, partitioned designs. (Author)

A81-41762 Flight test investigation of LORAN-C for civil aviation applications. R. H. Pursel (FAA, Technical Center, Atlantic City, NJ). *(Institute of Navigation, Annual Meeting, 36th, U. S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation,* vol. 27, Fall 1980, p. 183-188.

The FAA Technical Center investigated the LORAN-C for helicopter IFR operation as part of the FAA's Helicopter Development Program. Ten areas covered by the program include navigation systems development, with emphasis on the use of the LORAN-C for enroute navigation purposes. Flight test data collected used both fixed and rotary wing aircraft in the Gulf of Mexico, offshore New Jersey, Appalachian areas, and the Northeast corridor experimental RNAV route. Data indicated consistent results and compliance with AC-90-45A enroute accuracy requirements. Accuracy in the western test area deteriorated in a westerly and/or northerly direction, and signal to noise ratios were in excess of +5db throughout all areas. Future tests include nonprecision approach accuracies and procedures for LORAN-C, using a high accuracy tracking system for position determination, and an instrumented van for on-site data processing and analysis. D.L.G.

A81-41763 Evaluation of LORAN-C for non-precision approach applications. E. D. McConkey (Systems Control, Inc. /VT/, Champlain Technology Industries Div., West Palm Beach, FL). *(Institute of Navigation, Annual Meeting, 36th, U. S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation,* vol. 27, Fall 1980, p. 189-199.

A TDL-711 Micro-Navigator installed in a twin engine Piper Aztec was tested for the accuracy and operational suitability of the LORAN-C in mountainous areas at low altitudes. The effects of using different triads at the same location and select locations, and the flight technical error were also determined. Results showed the LORAN-C signal-in-space to be stable and dependable at all altitudes flown, with significant errors observed in the conversion of the received time difference values into position and guidance signals. Errors were traced to the propagation model in the navigation processor, and selection of the wrong triad or reversion to an alternate triad during station outages caused guidance in error by several thousand feet or more. With modifications, however, the LORAN-C system should be capable of supporting nonprecision approaches in remote areas. D.L.G.

A81-41764 Analysis of helicopter operations and the use of MLS in the offshore environment. R. Loh. *(Institute of Navigation, Annual Meeting, 36th, U. S. Naval Postgraduate School, Monterey, CA, June 23-26, 1980.) Navigation,* vol. 27, Fall 1980, p. 226-236. 11 refs. U.S. Department of Transportation Contract No. FA80WA-4370.

A study was made to determine if the Microwave Landing System (MLS) could satisfy requirements for performing precision approach and landing onto an offshore heliport. Included in the study were use of a pilot's questionnaire to help determine the requirements, a preliminary analysis of MLS with respect to satisfying the requirements, and a cost-benefit analysis to determine if the life cycle cost can be eliminated by potential benefits. Results indicate the potential to satisfy the determined requirements, including lowest acceptable operating minimums of 150 feet ceiling and 1/4 nmi visibility. However, based on crew movements alone, dollar benefits alone cannot amortize the MLS costs, except in rare cases. D.L.G.

A81-41776 Effect of mixed phosphate ester fluids on aircraft hydraulic servo valve erosion. T. R. Beck (Electrochemical Technology Corp., Seattle, WA), J. F. Curulla, B. C. Hainline, A. Lauba, and D. C. Sullivan (Boeing Commercial Airplane Co., Renton, WA). *Society of Automotive Engineers, Aerospace Fluid Power and Control Technologies Meeting, Washington, DC, Apr. 21-25, 1980, Paper 801100.* 13 p. 10 refs.

The erosive effects of aircraft phosphate ester hydraulic fluids on servo valves are investigated. Chemical tests performed to classify the erosion characteristics of fluid mixtures are described. Accelerat-

ed tests conducted to identify erosive and nonerosive mixtures of presently available fluids are discussed. Tests are described which were performed with a matrix of test fluids to establish methods that will predict the effects measured in erosion tests. It was found that the erosiveness of fluid mixtures can be determined by means of two laboratory measured electrochemical properties: wall current and threshold corrosion current density. The theory of electrochemical erosion is discussed, and laboratory test methods used to identify the erosion potential of mixtures are described. E.B.

A81-41777 Cost benefits of nonmetallic spline couplings. H. W. Brown and J. T. Miller (Arinc Research Corp., Annapolis, MD). *Society of Automotive Engineers, Aerospace Fluid Power and Control Technologies Meeting, Washington, DC, Apr. 21-25, 1980, Paper 801101.* 8 p.

Spline couplings are used extensively in rotating machinery and components to transmit torque or otherwise connect two rotating shaft members. With the introduction of high-performance plastics in the 1960s, a totally new concept in spline couplings was developed. Polyimide materials afforded the desired high temperature properties, self-lubricating qualities, and chemical resistance. However, these materials, like metals, are fatigue-sensitive when subjected to the cyclic stresses that occur when a spline coupling operates in a misaligned mode. Because of the difficulty of controlling misalignment in aircraft interface splines, particular attention was given to the improvement of fatigue resistance in the coupling. Nonmetallic splines impose a one-piece, high-strength plastic bushing between driving and driven components of the coupling. Metal-to-metal contact is eliminated. G.R.

A81-41799 Aircraft instruments - Principles and applications /2nd edition/. E. H. J. Pallett (Civil Aviation Authority, Airworthiness Div., Redhill, Surrey, England). London and Marshfield, MA, Pitman, 1981. 431 p. $34.95.

Requirements and standards concerning aircraft instruments are considered along with instrument elements and mechanisms, instrument displays, panels and layouts, pitot-static instruments and systems, primary flight instruments (attitude indication), heading indicating instruments, remote-indicating compasses, aircraft magnetism and its effects on compasses, the measurement of engine speed, the measurement of temperature, the measurement of fuel quantity and fuel flow, engine power and control instruments, integrated instrument and flight director systems, and flight data recording. Attention is given to the flight director indicator, the course deviation indicator, the pitch command facility, the basic accelerometer principle, the fatigue meter, aircraft integrated data systems, an automatic temperature control system, and effects of fuel temperature changes. G.R.

A81-41823 * Helicopter theory. W. Johnson (NASA, Ames Research Center, Moffett Field, CA; U.S. Army, Washington, DC). Princeton, N.J, Princeton University Press, 1980. 1110 p. 966 refs. $95.

A comprehensive presentation is made of the engineering analysis methods used in the design, development and evaluation of helicopters. After an introduction covering the fundamentals of helicopter rotors, configuration and operation, rotary wing history, and the analytical notation used in the text, the following topics are discussed: (1) vertical flight, including momentum, blade element and vortex theories, induced power, vertical drag and ground effect; (2) forward flight, including in addition to momentum and vortex theory for this mode such phenomena as rotor flapping and its higher harmonics, tip loss and root cutout, compressibility and pitch-flap coupling; (3) hover and forward flight performance assessment; (4) helicopter rotor design; (5) rotary wing aerodynamics; (6) rotary wing structural dynamics, including flutter, flap-lag dynamics ground resonance and vibration and loads; (7) helicopter aeroelasticity; (8) stability and control (flying qualities); (9) stall; and (10) noise. O.C.

A81-41871 Aircraft radio systems. J. Powell (Brunel Technical College, Bristol, England). London and Marshfield, MA, Pitman, 1981. 262 p. 19 refs. $68.

Basic principles of radio are considered along with a categorization of airborne radio equipments, communication systems, automatic direction finding, VHF omnidirectional range (VOR), the instrument landing system, hyperbolic navigation systems, distance measuring equipment, ATC transponder, weather avoidance, Doppler navigation, radio altimeter, area navigation, and current and future developments. Attention is given to audio integrating systems, the Omega navigation system, the Decca navigator, weather radar, the Doppler effect, the Doppler spectrum, the Doppler shifts for a four-beam Janus configuration, the aircraft velocity in earth coordinates expressed in terms of Doppler shifts, the development organization, a generalized area navigation system, the microwave landing system, microwave aircraft digital guidance equipment, collision avoidance, and the current generation of ARINC characteristics. G.R.

A81-41903 # Light aviation in the United States - September 1980 (L'aviation légère aux Etats-Unis - Septembre 1980). O. Becart, R. Berthou, O. Dumas, M. Guigou, J.-P. Hardange, P. Jarrige, H. Laporte-Weywada, and O. Legate. Toulouse, Ecole Nationale Supérieure de l'Aéronautique et de l'Espace, 1981. 215 p. In French.

The book represents the results of a study undertaken in September, 1980, to assess the state of light aviation in the United States. Reports are presented on the major manufacturers of light aircraft, and on the correlation between the price and the mass of the aircraft produced. The history, functions and relations to the private pilot of the FAA are discussed, and the airspace overseen by the agency is presented. The characteristics of the American private pilot are then considered, including numbers, demographics, motivations and means of access to aircraft, and the various pilot associations are surveyed. Reports are also presented on a flight in a light aircraft from Greensboro to Washington, The National Air and Space Museum in Washington, the USAF Museum in Dayton, and Hartsfield International Airport in Atlanta. A.L.W.

A81-41924 * # Pilot guidance and display considerations for energy efficient flight profiles. K. H. Samms and S. A. Morello (NASA, Langley Research Center, Hampton, VA). *AIChE, ASME, IEEE, ISA, and SME, Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Paper.* 8 p. 9 refs.

Two computer programs are applied to energy efficient flight operation in order to minimize aircraft operating costs. One algorithm (OPTIM) computes vertical flight profiles which optimize direct operating costs, including fuel and time costs, for an aircraft flying over a fixed range and with a fixed time-of-arrival. The second program (TRAGEN) simulates an aircraft steered to fly along a specified vertical flight trajectory, in order to examine fuel and cost penalties involved in flying nonoptimal trajectories. Constraints such as air traffic control procedures, and atmospheric and weight conditions are considered and supported by graphs and diagrams. The use of the algorithms as preflight planning tools is discussed, emphasizing OPTIM's future application for on-board energy management. Finally, research questions concerning pilot guidance and display considerations for advanced energy/flight management systems are addressed. J.F.

A81-42051 A large executive jet design project. J. P. Fielding (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal,* vol. 85, June 1981, p. 215-219.

The large executive jet design project of the College of Aeronautics, Cranfield Institute of Technology, is described. The design specification included the following features: cabin height of 6 ft, 1 in. to allow 97% of male passengers to stand upright; cruise Mach number of 0.75 with a range of 3500 n mi with reserves; good fuel economy and satisfaction of noise requirements; first cost of $7m at 1979 values and good maintainability; 35 to 40 seats at 30-35 in. seat pitch; engines that are new generation fans with low fuel consumption, noise, and pollution; freight role; and long range and endurance in maritime reconnaissance role. A design description is given, and it is concluded that the resulting aircraft appears to be feasible and warrants further investigation. P.T.H.

A81-42052 High pressure fuel pumps - Their design and evolution /The 13th J. D. North Memorial Lecture/. H. S. Bottoms (Lucas Aerospace, Ltd., Shirley, Surrey, England). *Aeronautical Journal,* vol. 85, June 1981, p. 220-233. 11 refs.

The current status of piston pumps and internal gear pumps for aircraft applications is reviewed. Specifically, it is noted that the swash plate pump has been developed from an N sq rt of Q of 2 with

250 hours life up to an N sq rt of Q of 7.5 with time between overhauls of 12,000 hours (where N is maximum speed in rpm divided by 1000 and Q is the flow at N in gph divided by 1000). It has therefore reached the economic limit of development unless some significant material development occurs; this pump, however, is still the first choice if very high pressures are required. In addition, the radial variable stroke pump is at an early stage of development, and will be used where high speed and high pressure are required. The twin pinion gear pump has been developed up to an N sq rt of Q of 13 with up to 15,000 hours between overhaul. The internal gear pump design provides the basis for a significant improvement in performance and life, but will most likely be overtaken by the centrifugal pump. P.T.H.

A81-42139 Structural aspects in applications of adhesive bonding (Konstruktive Gesichtspunkte bei der Verwendung geklebter Verbindungen). R. J. Schliekelmann. *VDI-Berichte*, no. 360, 1980, p. 137-143. In German. (FOK-BO-1238)

The strength of an adhesively bonded joint depends not only on the chemical composition of the adhesive, but also on the adhesive forces between the adhesive film and the metal surfaces, the cohesive characteristics of the metals, the oxide layer on the metal surface, and the preliminary treatment of the metal surfaces. The adhesive is a synthetic product, subject to elastic deformation and viscoelastic stress, resulting from variations in temperature, humidity and rates of load application. The longitudinal seam of a commercial fuselage, designed for short, but frequent flights, is used as an example to test these effects. The adhesive bond is required to endure temperature ranges of +50 C to -55 C and show reliability after being subject to high degrees of stress. An epoxy/nitrile rubber glue is solidified by magnetic compression and then rivets are attached to further fasten the seams. Flat test pieces were first subjected to varying degrees of temperature and humidity; those that were both adhesively bonded and riveted showed more than twice the bonding strength of those that were merely riveted. Fatigue and cracking tendencies, as well as the effects of humidity, were tested on cylindrical pieces placed in water tanks under pressures of 1.80 bar. The cylindrical fuselage test showed good bonding results after a 18 month period and 121,000 simulated flights. J.F.

A81-42173 Some applications of the turbulence amplifier to airborne systems. D. L. Taylor (Lockheed-California Co., Burbank, CA). *Fluidics Quarterly*, vol. 13, June 1981, p. 21-33.

The turbulence amplifier relies on the disruption of a laminar air stream by a small actuating signal that consists of a transverse jet. The dynamic pressure head, generated by the passage of an aircraft through the atmosphere will provide sufficient supply pressure at 130 mph and sufficient control pressure at 30 mph. This means that, in certain applications, no external power source is required, which is of significant interest to airborne applications. As a result of this feature, three systems were investigated for practicability. A description is presented of the development and performance of laboratory models of these three applications. An ice detection and de-icing control system was designed to sense icing conditions on a wing leading edge, and to use the sensed data to operate a de-icing control system. A demonstration model for a control surface asymmetry detection and rectification system was built, and a stall warning system was studied. G.R.

A81-42176 * # The E3 combustors - Status and challenges. D. E. Sokolowski and J. E. Rohde (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1353*. 23 p. 17 refs.

The technology programs for the Energy Efficient Engine (E3) combustors are outlined, status and test results to date are summarized, and present and future challenges indicated. The NASA-sponsored programs, which are being conducted at the General Electric Company and Pratt & Whitney Aircraft, are making important technology advances. Both combustor designs utilize an annular configuration with two-zone combustion for low emissions, advanced liners for improved durability, and short, curved-wall, dump prediffusers for compactness. Advanced cooling techniques and segmented construction characterize the advanced liners in both programs. Liner segments are made from castable, turbine-type materials. At this time, analysis and design activities have been completed; experimental evaluations are progressing. Test results are verifying both design concepts for combustion, cooling, and mechanical integrity. All goals appear capable of being met, with the exception of NO(x). (Author)

A81-42178 # Engine usage prediction for advanced fighter aircraft. C. C. Dietrick and K. L. Schuppan (McDonnell Aircraft Co., St. Louis, MO). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1367*. 11 p. 7 refs.

A description is presented of the engine usage prediction procedure developed by an American aerospace company, and initial results are provided from engine usage analyses conducted in advanced weapon system studies. Duty cycle requirements are considered, taking into account Type I, Type III, and Type IV (or partial) cycles. Procedures developed for projecting advanced engine duty cycles provide the capability to predict Type I, Type III, and partial cycles and hot-time accumulations and to predict duty cycle sensitivities to changes in peacetime missions and aircraft performance. Attention is given to usage models, peacetime mission analysis, usage model validation, and advanced aircraft usage analysis. G.R.

A81-42179 # Engine duty cycle estimation for conceptual design aircraft. R. F. Dannenhoffer (Grumman Aerospace Corp., Bethpage, NY). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1368*. 7 p.

An introduction is given to the requirements and achievements to date of computer programs for the estimation of conceptual design aircraft engine duty cycles. Given the necessary airframe and subsystem data, such computer models must (1) determine the aggregate mission mix to be flown; (2) project a representative mission mix for the applicable operating commands; (3) generate a segment-by-segment time history of engine operation for each mission, and (4) tabulate steady-state and cyclic throttle data in a form suitable for use by engine manufacturers. Attention is given to the FLIONE model, among whose available mission segments are terrain following, ground attack, air combat maneuvers, air-to-air refueling and ASW. Extensive tables and flowchart data are provided for the TRAFTRAM, SPADS and FLIONE programs covered. O.C.

A81-42184 # F-16 variable-geometry inlet design and performance. L. G. Hunter, Jr and J. E. Hawkins (General Dynamics Corp., Fort Worth, TX). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1394*. 8 p.

A conformal, variable-geometry inlet design, developed specifically for possible application to advanced versions of the F-16, is reviewed. The key features of the inlet, the design methodology, the inlet control system, and prototype hardware development are discussed. Wind tunnel model data are included which show the airplane forebody flow field and inlet performance in terms of engine-face pressure recovery, distortion and turbulence. Engine stability audit results using worst-case distortion patterns are presented and compared with basic F-16 fixed-geometry inlet data. The prototype hardware design effort and successfully completed wind tunnel program provide a high level of confidence for successfully integrating a variable-geometry inlet with the F-16 airframe. (Author)

A81-42185 # An approach to conformal inlet diffuser design for integrated propulsion systems. J. L. Koncsek (Boeing Military Airplane Co., Seattle, WA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1395*. 7 p. 7 refs.

A computer program was developed to aid in the design of subsonic diffusers of complex shapes. The code combines a versatile procedure for detailed design of the contours with an approximate analysis of the diffuser performance. Several diffuser models of high entry aspect ratio and/or large exit-to-entry offset were designed with the program. The predicted performance agreed well with test results when the flow remained attached throughout the duct. The code proved to be a useful tool in the design of diffusers. It can also be applied to the design of other internal flow systems, such as exhaust nozzles. (Author)

A81-42186 * # **Zero-length inlets for subsonic V/STOL aircraft.** E. R. Glasgow, W. E. Beck (Lockheed-California Co., Burbank, CA), and R. R. Woollett (NASA, Lewis Research Center, Cleveland, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1396.* 10 p. 18 refs. Contract No. NAS3-21461.

Zero-length inlet performance and associated fan blade stresses were determined during model tests in the NASA-LeRC 9-by 15-foot low-speed wind tunnel. The inlet models, which were installed on a 20-inch diameter fan unit, had different inlet lip contraction ratios as well as unslotted, slotted, and double slotted inlet lips. The inlet angle-of-attack boundaries for onset of flow separation were identified and compared to the operating requirements of several generically different subsonic V/STOL aircraft. The zero-length inlets, especially those with slotted lips, were able to satisfy these requirements without compromising the maximum cowl forebody radius. As an aid to the inlet design process, a unique relationship was established between the maximum surface Mach number associated with the separation boundary and the maximum-to-throat surface velocity ratio. (Author)

A81-42187 # **Experimental investigation of a high-aspect-ratio supersonic inlet.** W. H. Ball, J. Syberg (Boeing Military Airplane Co., Seattle, WA), and L. E. Surber (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1397.* 13 p.

Tests were conducted in the AEDC 16S wind tunnel to measure the internal aerodynamic performance of a 0.27-scale high aspect-ratio, external compression, two-dimensional, side-mounted inlet. The inlet incorporated throat slot and distributed bleed, large diffuser offset, and variable ramps. Configuration variables included sideplate cutback, diffuser turning vanes, throat rakes, and forebody. Testing was accomplished from Mach 1.60 to 2.20. Compressor face and throat total pressure profiles, compressor turbulence levels, and inlet surface static pressures were recorded to determine diffuser and overall inlet performance. Test results indicate the high-aspect-ratio inlet is a viable design option for future supersonic aircraft. (Author)

A81-42188 # **Engine life methodologies for conceptual design.** J. Osmer, R. J. Novotnoi (United Technologies Corp., Government Products Div., West Palm Beach, FL), and E. G. Blevins (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1398.* 8 p.

Several computer-aided design techniques have been developed for application to gas turbine conceptual design; a blade/disk attachment synthesis program and a live disk synthesis program. These techniques provide effective quantification of life and performance impacts on the gas turbine design. These synthesis design techniques are being used in conceptual design studies to size attachments and disks. These analyses are producing engine conceptual designs with the attribute of a more equitable balance of life and performance characteristics. An example is presented, illustrating the minor rotor weight changes when disk lives are doubled. (Author)

A81-42189 # **The use of engine operating experience in the preliminary design of aircraft gas turbine combustion systems.** R. E. Stenger (General Electric Co., Cincinnati, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1399.* 9 p.

It is shown that a major improvement in combustor life was obtained as the result of an aggressive engine development program supported by advanced analyses. Although the F101 combustor had successfully passed verification testing, accelerated endurance testing uncovered life limiting distress. Modificiations were made to eliminate this distress and a major improvement in life capability resulted. The current configuration has achieved a five-fold increase in life when compared to the initial design. The Operational Severity Analysis (OPSEV) Program is used to calculate the relative severity of various missions and engine usage cycles. Together, the data base generated by the F101 program and the OPSEV Program provide a basis which can be used during preliminary design activities to obtain combustors which have the proper amount of cooling to achieve the required operational life. G.R.

A81-42190 # **Methodology for engine/aircraft selection with life and utilization considerations.** J. E. Holmes (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) and M. D. Reitz (USAF, Aeropropulsion Laboratory, Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1401.* 6 p.

Prediction of potential engine usage during the conceptual design phase can result in significant benefits throughout the engine development and production process. The Air Force Life and Utilization Criteria Indentification in Design (LUCID) effort addresses gas turbine structural requirements with respect to life capability and installed life. The LUCID program provides a means of weighing tradeoffs between engine life, vehicle usage and performance. Life-limited parts are identified and used as indicators when certain sections have sufficient or insufficient life capability for the projected engine usage. A failure model analysis, involves the definition of engine usage data, material properties and component geometry to determine operating loads and environments for a given time value. The load/metal temperature data forms the basis for a damage assessment, which is then used to predict the component installed life. Adjustment of engine weight and/or performance considers the levels of component technologies, the gas turbine general arrangement and mission/application requirements. The method is applied to an advanced tactical fighter, and results are displayed for the aircraft's HPCI and HPTI wheel/low cycle fatigue and the HPTI blade/stress rupture and low cycle fatigue. J.F.

A81-42195 * # **Fundamental studies of antimisting fuels.** V. Sarohia (California Institute of Technology, Jet Propulsion Laboratory, Fluid and Thermal Sciences Group, Pasadena, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1422.* 11 p. 7 refs. NASA-FAA-supported research.

Research is currently being undertaken to determine the various physical characteristics of antimisting fuel. It is an endeavor to prevent post-crash fuel mist fires. The following studies were done: (1) drop and jet breakup studies using an image processing technique, (2) flammability of fuel mist under simulated plane crash conditions; (3) skin friction measurements; (4) determination of the tensile viscosity of non-Newtonian antimisting fuel as a function of the extensional rate; and (5) water compatibility measurements. The results indicate that the mechanism which prevents antimisting fuel breakup is related to the time-dependent tensile viscosity of antimisting fuel under stress. Drag reduction phenomenon was also observed at Reynolds numbers higher than 20,000. Uptake of water by the antimisting fuel is higher than that for the neat fuel. In addition, its rate of absorption depends on the concurrent degree of agitation. (Author)

A81-42196 # **Modeling of ramjet combustors using simple reactor theory.** R. L. Rutz (Marquardt Co., Van Nuys, CA). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1429.* 14 p. 12 refs.

Simple reactor theory is employed to model the main features of steady state one-dimensional and inviscid combusting flow in a center-dump ramjet engine. The combustor's upstream recirculating and flameholding zone is considered to be a perfectly stirred reactor (PSR) providing ignition and preliminary combustion of the inlet fuel-air mixture. A plug flow reactor (PFR) is used to model the combustor's downstream burnout flow region. Combining the two reactor types and subjecting the combination to the given constraints of engine length and test performance allows inference of various aspects of the combustor behavior. (Author)

A81-42199 # **F100 engine diagnostic system status to date.** J. A. Boyless and D. C. Butts (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA paper 81-1448.* 9 p.

An Engine Diagnostic System (EDS), proposed for the F100 engine, was tested in five specifically modified Tactical Air Command F-15A aircraft, during a two-phase 16 month flight evaluation period at Langley AFB, Virginia. The first phase was conducted from March 1980 through December 1980 with phase two continuing until June 1981. After almost 4,000 engine operating hours and

encompassing more than 1,000 flights, EDS has successfully demonstrated four of five original design requirements. These were recording engine operating time and cycle data, event detection, engine trim, and trend and performance data collection. The diagnostic and troubleshooting goal was not demonstrated fully. In this paper the majority of the data presented covers the first phase, March through December 1980. (Author)

A81-42204 # **Combined environment reliability testing /CERT/ as applied to engine mounted electronic controls.** J. A. Bonanno (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) and T. M. Randolf (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, FL). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1500.* 9 p.

Combined Environmental Reliability Testing (CERT) accelerated development prior to a unit's entry into service is shown to be particularly applicable to engine-mounted electronic hardware because: (1) unit reliability is highly sensitive to engine environment severity; (2) the accumulation of equivalent flight hours would be more costly and time-consuming; and (3) CERT permits immediate incorporation and evaluation of corrective actions. The environments in which such powerplant electronics systems as those of the F100 turbofan tested are representative of the actual F-15 and F-16 aircraft in which they will be used. The environmental capabilities of the CERT facility described include altitudes of 0-60,000 ft, 5-85% relative humidity, and ambient and coolant temperatures between -65 and 245 F. O.C.

A81-42205 # **Advanced technology engine studies /ATES/ - A status report.** W. S. Willis (General Electric Co., Aircraft Engine Business Group, Evendale, OH). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1502.* 13 p. Contract No. N00019-80-C-0227.

An overview and status report are presented for the Advanced Technologies Engine Studies (ATES) program, which is being conducted to determine ways of improving operational readiness and reducing the life cycle costs of new weapons systems. The systems under study include attack, marine assault and ASW Advancing Blade Concept (ABC) helicopter powerplants, advanced manned bomber and strategic airlifter mixed-flow turbofans, a multi-role supersonic aircraft augmented turbojet, a separated-flow subsonic V/STOL turbofan, a supersonic V/STOL turbofan with Remote Augmented Lift System (RALS), and an advanced tactical supersonic aircraft mixed-flow augmented turbofan. Attention is also given to the Multiple Application Core Engine (MACE) concept's application to both helicopter and subsonic aircraft engines. O.C.

A81-42206 # **ATES activity and status at Detroit Diesel Allison.** R. M. Wood (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1504.* 10 p.

An overview is presented of the Advanced Technology Engine Studies (ATES) being conducted under Navy/Air Force contract, comprising evaluation and design tradeoffs for high temperature, variable-cycle turbojets for high performance tactical systems and fuel efficient turboprop/turboshaft engines for ASW patrol and multi-mission V/STOL aircraft. Engine cycles and technology elements resulting in significant aircraft performance improvements are covered, as well as life cycle cost trends. Among the elements mentioned are: (1) compressor pressure ratio; (2) turbine gas inlet temperature; (3) compressor configuration; (4) high pressure turbine active tip clearance control; and (5) compressor and turbine wheel materials. O.C.

A81-42210 * # **Factors influencing the predicted performance of advanced propeller designs.** L. J. Bober (NASA, Lewis Research Center, Cleveland, OH) and L.-K. Chang (Purdue University, West Lafayette, IN). *AIAA, SAE, and ASME, Joint Propulsion Conference, 17th, Colorado Springs, CO, July 27-29, 1981, AIAA Paper 81-1564.* 19 p. 9 refs.

The assumptions on which conventional propeller aerodynamic performance analyses are based can be seriously violated when advanced high speed propellers are analyzed. Studies have been performed using a lifting line representation for the propeller to determine the sensitivity of predicted propeller performance to various assumptions in the analysis. Items which have been studied include the method of determining blade section lift and the effects of blade section drag, camber and blade sweep. The effects of nonuniform flow into the propeller and compressibility have also been studied. Comparisons of analytical and experimental results are presented to demonstrate the overall validity of the results. (Author)

A81-42356 # **Selection of notch geometry and notching technique for studying the fracture toughness of materials and full-scale structures (Vybor geometrii i sposoba naneseniia nadrezov pri issledovanii treshchinostoikosti materialov i naturnykh konstruktsii).** S. P. Malashenkov, G. Iu. Bengus, and A. G. Vovnianko. In: Crack resistance of materials and structural elements. Kiev, Izdatel'stvo Naukova Dumka, 1980, p. 280-287. In Russian.

A study has been carried out in order to develop an efficient notching technique for testing materials and structures, in particular aircraft structures of D16 alloy. Notching by electrocorrosive machining was found to be the most effective technique when testing large quantities of structural components. V.L.

A81-42431 # **Engineering approaches for cost savings with ILS glide-slope installations.** R. H. McFarland (Ohio, University, Athens, OH). In: National Aerospace Symposium; Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 3-7. 11 refs.

The major objective of the considered investigation is to provide an illustration of how an engineer may effect considerable cost savings by constructing a ground plane that will provide an acceptable path with minimum terrain requirements and concomitant minimum costs. It is pointed out that there are two types of non-image glide-slope systems operating in the U.S. today that are compatible with existing airborne equipment. These are the waveguide-type and the endfire, slotted cable array. The costs for these are higher than for the image systems. A description is given of specific engineering approaches which reduce to a minimum the amount of earth movement that need be accomplished to provide a satisfactory reflecting area for the contemporary UHF ILS image glide slope. The objective is to identify that earth which must be moved such that the glide slope will meet Category I performance specifications as promulgated by the Federal Aviation Administration and ICAC. The basic terrain requirements to produce an acceptable signal for the user in the air space are illustrated. G.R.

A81-42432 Ω # **Helicopter navigation in the 80's.** G. A. Gilbert (Glen A. Gilbert and Associates, Inc., Washington, DC). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 8-16. 6 refs.

It is pointed out that civil benefits from the use of rotorcraft have been very significant since 1960 and will grow in the future as technology advances keep pace with needs. A fundamental goal for helicopter operations (as well as for civil aviation in general), is to have a high accuracy navigation system with global coverage. For optimum IFR helicopter routings and approaches, an RNAV (area navigation) system is needed. Attention is given to new ideal navigation goals and new candidate RNAV systems. Navstar GPS is considered to be the one system now in process of being implemented which offers the most likely potential for meeting the ideal navigation goals. A description is provided of the proposed architecture for the application of the DOD Global Positioning System in an integrated navigation and advanced Air Traffic Control System serving civil aviation as well as the military. G.R.

A81-42433 # **Evaluation of Loran-C for enroute navigation and non-precision approach within the state of Vermont.** W. L. Polhemus (Polhemus Associates, Inc., Cambridge, VT). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 17-35. Research supported by the Research and Special Programs Administration.

A81-42434 # **CAINS II - An application of standard laser gyro inertial and computer technology for existing naval carrier aircraft.** R. H. Meyers (U.S. Naval Air Systems Command, Washing-

ton, DC) and D. Brienza (U.S. Navy, Naval Avionics Center, Indianapolis, IN). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 38-43.

The AN/ASN-92 Carrier Aircraft Inertial Navigation System (CAINS) was developed in the late sixties to meet the navigation requirement of the new generation of carrier based aircraft: E-2C, F-14, S-3A, and A-6E. Drawbacks of CAINS are related to mean time to repair, calibration requirements, and weaknesses concerning the gimbal/gyro design configuration, which add a substantial burden to system Life Cycle Cost (LCC). The most promising alternative to the CAINS AN/ASN-92 is the Ring Laser Gyro (RLG) INS mounted in a strapdown configuration. Another aspect of CAINS that has a serious impact on system reliability and LCC is the airborne navigation digital computer. The alignment/navigation computation of CAINS involves four different computers. The CAINS II approach to the solution of this problem is the utilization of the standard Navy digital computer, the AN/AYK-14. The CAINS II program was initiated in 1976, for the purpose of investigating and developing significant reliability improvement in the CAINS systems of the E-2C, F-14, S-3A and A-6E. G.R.

A81-42435 # **Impact of EFIS on navigation.** A. J. Dandekar (Rockwell International Corp., Collins Air Transport Div., Cedar Rapids, IA). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 69-71.

The Electronic Flight Instrument System (EFIS) replaces the traditional electromechanical flight instruments with multicolor cathode ray tube (CRT) displays that are driven by programmable 'symbol generators'. The information integration and data presentation flexibility offered by the EFIS displays easily matches and exceeds the on-board navigation computer display needs. This paper describes the EFIS configuration, its capabilities, and growth potential and its impact on navigation and flight control. (Author)

A81-42436 * # **Recommendations for the NASA Avionics program for the 1980's.** C. R. Spitzer, E. A. Brummer, and W. R. Jones (NASA, Langley Research Center, Avionics Planning Office, Hampton, VA). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 85-89.

NASA is examining the merits of a significant expansion of its avionics, controls, and human factors technology program for the 1980's. The rationale for an expanded program is related to two factors. One factor is related to a utilization of recent and anticipated significant advances in microelectronics. The second factor is the need to develop new concepts in avionics and control systems for more efficient aircraft operation and better utilization of extremely limited airport capacity. Substantial benefits could be realized in three major categories, including improved aircraft efficiency, improved flight operations, and improved/extended operational capability. The NASA Avionics, Controls, and Human Factors Technology Plan is the report of a task force of agency personnel working in close cooperation with industry, DOD, and FAA. Attention is given to the NASA role, aircraft controls, crew station technology, flight management, integration and interfacing, commercial transports, general aviation, rotorcraft, V/STOL, and high performance aircraft. G.R.

A81-42437 * # **Low-frequency radio navigation for the Army's Mobile Automated Field Instrumentation System /MAFIS/.** D. E. Wallis (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 98-103. Army-NASA-sponsored research.

The Jet Propulsion Laboratory is engaged in the early phases of conceptual, preliminary design, and feasibility demonstration studies leading to determination of a design and implementation of the Army's proposed Mobile Automated Field Instrumentation System (MAFIS). An overview is provided of the current design concept for an experimental radio navigation subsystem to be implemented in the field as a part of the MAFIS study effort. Objectives of MAFIS include mobility, field-ruggedness and longevity of equipment, and low acquisition and life-cycle costs. The navigation subsystem comprises a 4-station radio transmitter network, plus the navigation receivers, network monitoring receivers and communications links, and interface to the command/control 'central' for transmitter status monitoring. Attention is given to accuracy goals, radio propagation effects, transmitter arrangement, radio-frequency allocations, position initialization and lane resolution, and transmitter and receiver functions. G.R.

A81-42439 # **Impact of terrain correlation elevation reference data on Boeing's Air Launched Cruise Missile.** M. D. Mobley and J. I. Brown (Boeing Aerospace Co., Seattle, WA). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 108-112.

This paper describes the Boeing Air Launched Cruise Missile (ALCM) Navigation System with a primary emphasis on the Mission Planning Methods and Equipments. Some recent ALCM test results are also provided. The large amounts of terrain reference data which has to be managed, has had significant impact on the missile, carrier aircraft and ground equipments design. The major trades which developed the current ALCM baseline for these equipments are presented. (Author)

A81-42440 # **Status report on Position Location Reporting System /PLRS/.** H. H. Bahr (U.S. Army, Communications Research and Development Command, Fort Monmouth, NJ). In: National Aerospace Symposium, Dayton, OH, March 11-13, 1980, Proceedings. Washington, DC, Institute of Navigation, 1980, p. 113-119.

The Position Location Reporting System (PLRS) is a time-division, multiple-access automated tactical data system capable of position location, navigation, identification and limited data communications. The PLRS is not intended to be an independently operated command and control system, but will provide friendly situation data to appropriate command and control facilities. It performs this mission via a PLRS network which consists of one Master Unit, one Alternate Master Unit and a varying number of User Units which will be assigned to an Army division or equivalent. Through use of secure, anti-jam communications techniques, the PLRS allows commanders to monitor the positions of participating user units under their command and allows the users to obtain their own positions as well as exchange a limited amount of other data. (Author)

A81-42558 # **Effect of oxygen-containing additives on the antiwear properties of fuels for gas-turbine aircraft engines (Vliianie kislorodsoderzhashchikh prisadok na protivoiznosnye svoistva topliv dlia aviatsionnykh GTD).** A. F. Gorenkov and E. I. Domkin. *Khimiia i Tekhnologiia Topliv i Masel,* no. 7, 1981, p. 23-26. 10 refs. In Russian.

The effect of oxygen-containing additives on the antiwear properties of fuel T-7 for gas turbine engines has been investigated under friction of sliding and rolling. Based on test results, the additives have been arranged in order of increasing effectiveness: ionol (0.003%), a mixture of 50% tetrahydrofurfuryl and methyl alcohols (0.3%), ethyl Cellosolve (0.3%), and hydrocarbon acids (0.003%). It is shown that the antiwear effect is largely determined by the functional group structure, while the structure of the hydrocarbon radical is less important. V.L.

A81-42603 # **The indication of the characteristics of aircraft controllability with prediction in dynamic ergatic systems (K voprosu indikatsii kharakteristik upravliaemosti samoletov s predvideniem v dinamicheskikh ergaticheskikh kompleksakh).** L. N. Degtiarenko (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Kibernetika i Vychislitel'naia Tekhnika,* no. 50, 1980, p. 85-88. In Russian.

The necessity of prediction in the problem of the indication of the characteristics of maximum controllability of aircraft arises when the regions of admissible values of flight parameters are not regions of the maximum controllability of the aircraft as a dynamic system. Such regions can be determined by such factors as structural stability, heating of the vehicle, and psychophysiological factors. In this case, for motion of the phase point within the region it is necessary to indicate the condition under which it goes beyond the limits of the region. In this paper, a deterministic approach is taken to this problem. B.J.

A81-42629 **New roles for the F-15 eagle.** R. Braybrook. *Air International,* vol. 21, Aug. 1981, p. 61, 62-68, 82, 83.

An account is given of weapons and electronics developments to date for the F-15 C, D and E ('Strike Eagle') variants, as well as export program plans involving Israel, Japan and Saudi Arabia. The new aircraft differ from the F-15 A and B variants in having programmable radar signal processors, an additional 907 kg of internal fuel, and provision for a pair of conformal tanks which can together carry an additional 4,422 kg of fuel. Among the new weapons systems incorporated by the F-15E are: (1) the High Speed Anti-Radiation Missile (HARM); (2) Maverick TV-guided weapons; (3) a 30-mm gun pod; (4) Harpoon anti-shipping missiles; and (5) the Pave Tack IR tracker/laser-spot designator pod. Attention is also given to the enhancement of air-to-ground mission capabilities by the APG-63 programmable Synthetic Aperture Radar (SAR). O.C.

A81-42630 **AMX - Italo-Brazilian bantam battler.** *Air International,* vol. 21, Aug. 1981, p. 69-74.

A development program and airframe design description is presented for the Italian-Brazilian AMX light air/ground fighter, which has been conceived as a replacement for the Italian Air Force's G.91 and F-104 aircraft in the ground-support and interdiction roles. Expected to enter service by 1990, the fighter is powered by a single Mk 807 (Spey) engine and incorporates such armaments as 1000-lb bombs, a 20-mm rotary cannon and Sidewinder missiles. The low-low-low mission profile envisaged is entirely subsonic, and covers a 335-km tactical radius. Emphasis is put on the design's short-runway capabilities and ease of maintenance, and attention is given to the advantages resulting from co-production arrangements with the Brazilian manufacturer, EMBRAER. O.C.

A81-42678 **Wind tunnel tests of sailwings for Darrieus rotors.** P. S. Revell and K. W. Everitt (Warwick, University, Coventry, England). *Wind Engineering,* vol. 5, no. 2, 1981, p. 73-90. 5 refs.

Wind tunnel tests have been made to investigate the aerodynamics of sailwings intended for use in vertical axis wind turbines. The tests were made over the full range of angles of incidence and used a number of different membranes and pre-tensions. The majority of tests used a rigid trailing edge but a limited number of tests was made using a wire or nylon cord in a circular-arc shaped trailing-edge. The tangential and radial force coefficients were measured as also was the chordwise component of membrane tension. It is concluded that such turbines should produce a high starting torque and that their performance will be influenced by the trailing edge elasticity and pre-tension at quite low tip speed ratios. (Author)

A81-42704 # **Application of the Semi-Loof thin shell element to the analysis of aircraft engine structures.** M. S. Elkelish, A. Elsawaf, and M. Barsoum (Pratt and Whitney Aircraft of Canada, Ltd., Quebec, Canada). *(American Society of Mechanical Engineers, International Gas Turbine Conference and Products Show, Houston, TX, Mar. 8-12, 1981.) ASME, Transactions, Journal of Engineering for Power,* vol. 103, July 1981, p. 511-513, 531. 7 refs.

Most gas turbine engine structures consist of thin shells with multiple junctions. The curved isoparametric shell element gives *unsatisfactory results when used for very thin shells. The Semi-Loof* shell element was developed especially to deal with thin shell structures with sharp corners and multiple junctions. The Semi-Loof shell program was used at P & WC for the analysis of large engine structures. Application to the analysis of an engine static structural model, for which experimental data are also available, has confirmed the efficiency of the Semi-Loof shell element in comparison with the conventional isoparametric element. (Author)

A81-42726 **Strategies for aircraft interior noise reduction in existing and future propeller aircraft.** F. B. Metzger (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810560.* 15 p. 10 refs.

The problem of noise control in a propeller-driven aircraft is considered from a source noise and aircraft design standpoint. Efforts are being made to develop better noise criteria for propeller aircraft comfort evaluation. A greater understanding of the noise transmission path from the source to the interior of the aircraft is being achieved, and noise reduction is being improved by light-weight fuselage wall treatment. Modification of the blade tip as well as counter rotation propellers are discussed as potential means for reducing noise at the fuselage surface. Concepts such as dynamic absorption and synchrophasing are also considered. Development in these areas is reviewed as is their potential for reducing interior noise in existing and future propeller-driven aircraft of all classes. It is believed that these strategies will substantially reduce noise, but have less impact on weight, cost and performance than those imposed on past and current aircraft designs. J.F.

A81-42728 * **Summary of typical parameters that affect sound transmission through general aviation aircraft structures.** F. Grosveld, R. Navaneethan, and J. Roskam (Kansas, University, Lawrence, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810562.* 24 p. 11 refs. Grant No. NCC1-6.

This paper presents results of a systematic experimental investigation of parameters which affect sound transmission through general aviation structures. Parameters studied include angle of sound incidence, panel curvature, panel stresses, and edge conditions for bare panels; pane thickness, spacing, inclination of window panes, and depressurization for dual pane windows; densities of hard foam and sound absorption materials, air gaps, and trim panel thickness for multilayered panels. Based on the study, some promising methods for reducing interior noise in general aviation airplanes are discussed. (Author)

A81-42730 * **Transonic wing design using potential-flow codes - Successes and failures.** R. M. Hicks (NASA, Ames Research Center, Moffett Field, CA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810565.* 34 p. 28 refs.

The state-of-the-art of transonic wing design by use of computer codes based on the potential flow-theory is presented. The capabilities and limitations of these codes are exemplified by several experiment-theory correlations, including an assessment of pressure distribution from isolated wing and wing-body codes. Computer codes using both conservative and nonconservative differencing schemes were used, and the effects of boundary-layer corrections were considered. Results showed that calculations from a full potential, isolated code correlate well with data from an isolated wing test, but may give poor predictions of the aerodynamic characteristics of some wing-body configurations. Boundary-layer correlations were found to have only moderate effects on experiment-theory correlation. Aeroelastic effects were considered important for high aspect ratio wings of low to moderate thickness, and viscous effects were minimal for typical cruise conditions, even for Reynold's numbers as low as two million. The effect of wind-tunnel walls on experiment-theory correlations remained inconclusive. A wing-body code was used to calculate the flow field about a wing-body configuration with body-mounted engines, typical of the transonic Biz-Jet aircraft. J.F.

A81-42732 **Free flight research at Lockheed-Georgia.** M. W. M. Jenkins (Lockheed-Georgia Co., Marietta, GA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810567.* 25 p. 17 refs.

The manned Caproni A21J sailplane is fully instrumented and capable of recording up to 32 channels of data. The Ames/Microturbo TRS-18 engine delivers 200 pounds of static thrust at sea level. A 0.3 scale, remotely controlled research vehicle version of the Caproni A21J is capable of speeds up to 75 mph, each engine giving about 4 pounds of static thrust at 18,000 rpm. Also fully instrumented, this unmanned vehicle telemeters up to 24 channels of data and operates at 173 MHz frequency. In-flight experiments have already been performed since 1976 in the areas of spanwise blowing, laminar-flow control, acoustics, parameter identification, command augmentation, and fiber optics. Techniques used in these experiments as well as their results are discussed. Photographs of both aircraft are provided, and diagrams and graphs from the experiment results are given. J.F.

A81-42734 **Aircraft multi-bus electrical system using a Hall-effect sensing device.** I. W. Moody (Beech Aircraft Corp., Wichita, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810569.* 8 p.

The multi-bus electrical system, using a Hall-effect sensing device, is designed to meet FAR requirements. The system allows the automatic separation of a faulted bus through the use of the Hall-effect device. Should the loss of both generators occur, the battery will automatically become isolated from the loads associated with the generators as well as automatic isolation of the electric heat and the air conditioning motor. The battery is capable of supplying essential power for at least 30 minutes (if a 34-AH NiCad is used) in night, IFR, icing conditions. The system can be pre-flight tested from the cockpit and this capability can be used by field service for problem solving in the field. (Author)

A81-42735 **Multiplexing in general aviation aircraft.** R. G. Buscher (Cessna Aircraft Co., Wallace Div., Wichita, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810570.* 7 p.

The use of multiplex techniques for the intersystem transmission of data in a general aviation aircraft is discussed. Trade-off factors in the application of multiplexing to the transmission of signals between avionic and electrical units in an aircraft are considered, based on the Cessna Citation III equipment layout. Several factors are considered, including the signals to be multiplexed, maintenance of signal integrity, the formats to be used, and the data rates, resolution and ranges. It is shown that multiplexing of critical signals, such as the engine parameters, can be achieved with today's technology, and can result in lower labor costs, quicker turn-around time when faults occur, and a reduced system weight. J.F.

A81-42736 **Dielectric electrostatic charge reduction.** R. L. Truax (TCOM Corp., Columbia, MD). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810571.* 14 p. 5 refs.

Triboelectric charging of aircraft exterior plastic structure is a source of radio interference, especially at the low frequencies used for long range navigation. Stored surface charges may also reach potentials sufficient to result in electrostatic puncture of the dielectric. Additionally electronic components may fail as a result of transients caused by dielectric surface currents or punctures. Resistive, or other conductive exterior surface coatings are subject to erosion, and may be impractical when transparency is required. If improperly bonded, or maintained, such coatings may result in electrical arcing noise through the UHF band. Some alternatives are presented, suitable for windshield and radome applications, along with electrostatic charging test data. Also discussed are several test and instrumentation methods, including a new improved ground test method applicable to full scale aircraft. (Author)

A81-42737 **Evaluation of multi-viscosity oils designed for aircraft reciprocating engines.** W. E. Garrelts (Illinois, University, Savoy, IL). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810572.* 19 p.

Six, one hundred eighty brake horsepower aircraft reciprocating piston engines have been operated for one year using three different multi-viscosity oils. Two of the oils were semi-synthetic blends and the third was an ashless dispersant. These three oils were compared with six (6) identical aircraft using a single grade aviation oil. Preliminary results have indicated that the engines utilizing multi-viscosity oils exhibited improved cold-weather starting characteristics, averaged lower oil consumption, and displayed similar wear rates when compared to the six control aircraft using straight-weight oil. (Author)

A81-42738 **The new aviation multiviscosity oil, SAE 20W-50 for general aviation.** R. A. Mengelkamp and K. H. Yochum (Phillips Petroleum Co., Bartlesville, OK). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810573.* 7 p. 7 refs.

Shear stable, heat resistant viscosity index improvers (butadiene-styrene co-polymers) have been developed to produce a new generation ashless dispersant SAE 20W-50 general aircraft oil. The SAE 20W-50 shows a significant improvement in viscosity over Grade 100 oils at temperatures in the range of 150-200 C, resulting in better oil economy and bearing lubrication under high temperature operating conditions. Moreover, the hydrogenated butadiene-styrene viscosity index improver shows a higher level of temperature shear stability over other improvers. The oil has a low volatility, and its ashless properties minimize combustion chamber deposits as well as carbon and varnish deposits. The oil meets the requirements of Avco-Lycoming Specification 301F and Teledyne Continental Specification MHS-24B, and has already been successfully used for two years in both the Arctic and tropic conditions. J.F.

A81-42740 **Airfoils for light transport aircraft.** R. J. D. Poole and P. Teeling (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810576.* 9 p. Research supported by the National Research Council of Canada.

This paper presents data from tests in a two-dimensional pressurized wind tunnel of two new wing sections suitable for light transport aircraft, and a NACA 633-418 airfoil. The two new airfoils had maximum thickness/chord ratios of 18% and 21% and they were designed to achieve improved high lift and low drag by exploiting considerable aft loading and blunt trailing edges. (Author)

A81-42741 **Analytical studies on the effects of cooling flows on light aircraft drag.** S. R. Fox and F. O. Smetana (North Carolina State University, Raleigh, NC). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810577.* 9 p.

A source-paneling body analysis computer program was modified to permit arbitrary panels to be opened to receive or exhaust cooling air flow. It was found that exhausting the cooling air into concave regions such as before the windshield or behind the canopy resulted in decreased drag, probably because of the streamlining effects of the airflow. This suggests that the drag of single-engine light aircraft could be reduced by redesigning the cowl to entrap air below the propeller axis and exhaust the cooling portion of it (but not the engine exhaust) through flush ports in front of the windshield. (Author)

A81-42742 **Antennas-avionics systems relationship.** R. A. O'Neill (Dorne and Margolin, Inc., Bohemia, NY). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810579.* 6 p.

The relationship of the antenna to the avionics system, its location on the aircraft, and installation considerations are discussed. Factors such as antenna height, spacing from other similar antennas and reflective surfaces, ground plane-area, shape, size and conductivity will affect the operating characteristics of an antenna; these factors should be considered by not only the antenna design engineer, but the black box design engineers and airframe design engineers as well. Drag, mounting, side loads, weight, size, and esthetics are factors affecting antenna location and must be reviewed from various airborne positions. The location of an antenna is, for the most part, determined by the system function (communication, navigation, pulse, or radar). Finally, the antenna must be selected for compatibility with the aircraft. Stress, side load, and mechanical considerations can be more stringent than the electrical criteria on antennas for higher performance aircraft. J.F.

A81-42743 **AFCS integration requirements.** B. H. Chmaruk and T. R. Lamb (Rockwell International Corp., Collins Avionics, Cedar Rapids, IA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810580.* 11 p. 12 refs.

Special integration requirements need to be met in order to obtain the desired operation of an Automatic Flight Control System (AFCS) when installed in an aircraft. How these requirements are applied during the integration process will determine the performance, reliability, safety, and certificability of the AFCS. A short description of the AFCS and periphery systems is given; a block

diagram illustrates the AFCS components in greater detail: flight instruments, controllers, sensors, computation and amplification equipment, and servo motors. Regulatory requirements are considered, as well as location of the equipment, installation design criteria, human factors, sensor installation tolerances, interfaces with aircraft systems, and customer needs. J.F.

A81-42744 * The state of the art of general aviation autopilots - Now and in the future. J. Roskam and M. J. See (Kansas, University, Lawrence, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810582.* 22 p. 19 refs. Contract No. NAS1-16255.

A study was performed under contract with NASA-Langley Research Center to document the state of the art of general aviation (GA) autopilots and provide information about the current status of GA autopilot technology. Results are based on findings obtained from general and product literature, as well as interviews with manufacturers, users and service centers. The autopilot systems are divided into three categories - wing leveler, automatic, and integrated flight control systems, and a listing of currently available autopilots and their available options is presented. Various autopilot components are discussed, such as the display, data entry devices, and computers; gyroscopes, altitude sensors, airspeed sensors and accelerometers are presented as the primary sensor types. Electromechanical servos, pneumatic and hydraulic actuators are compared in their ability to improve airframe response. Recommendations concerning potential areas of further research and possible areas of improvement are also presented. J.F.

A81-42745 Impact of advanced propeller technology on aircraft/mission characteristics of several general aviation aircraft. I. D. Keiter (Cessna Aircraft Co., McCauley Accessory Div., Vandalia, OH). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810584.* 14 p. 21 refs.

Studies of several General Aviaton aircraft have indicated that the application of advanced technologies to General Aviation propellers can reduce fuel consumption in future aircraft by a significant amount. Propeller blade weight reductions acheived through the use of composites, propeller efficiency and noise improvements achieved through the use of advanced concepts and improved propeller analytical design methods result in aircraft with lower operating cost, acquisition cost and gross weight. (Author)

A81-42746 General aviation propeller noise reduction - Penalties and potential. R. J. Klatte (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810585.* 19 p. 7 refs.

Results of a study are reported in which the influence of noise reduction on weight and cost of propellers used in General Aviation aircraft was evaluated. Aircraft performance was not to be degraded by installation of the reduced noise propellers. Only propeller modifications were permitted. Engine modifications, such as introduction of a gearbox to reduce noise by reduction of RPM, were not permitted in the study. Major factors in noise reduction found promising in the study were (1) optimization of performance by use of the best available airfoils, (2) use of thin airfoils and a narrow elliptical tip blade planform, and (3) increasing the number of blades consistent with maintaining aircraft performance. For the three aircraft studied (a single engine, a light twin and a heavy twin) the flyover noise reduction potential varied from 3 to 8 dBA with no weight and/or cost penalties. Also, in some cases, engine noise would have to be reduced to achieve greater reductions. The progress by General Aviation aircraft manufacturers in reducing noise is indicated by the finding that the most recent aircraft design had the smallest noise reduction potential. (Author)

A81-42747 * Noise and performance of general aviation aircraft - A review of the MIT study. G. P. Succi (Bolt Beranek and Newman, Inc., Cambridge, MA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810586.* 10 p. 18 refs. Research supported by the U.S. Environmental Protection Agency; Contract No. NAS1-15154.

The primary objective of the study was to explore the possibility of reducing noise from a general-aviation-type propeller without altering significantly its aerodynamic performance or the engine characteristics. Our study of this possibility involved aerodynamic and acoustic theory, design, construction, and wind tunnel testing of model propellers, design and manufacture of full-scale propellers, and, finally, flight tests. One propeller exhibited an overall measured reduction of 4.8 dBA during a flight test. This reduction was achieved with minimal changes in performance. (Author)

A81-42750 Helicopter noise - Is technology the answer. R. J. King (Hughes Helicopters, Culver City, CA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810591.* 10 p. 5 refs.

Industry concerns in helicopter noise rulemaking and the technical challenges of compliance are discussed. Areas beyond regulatory requirements where work is needed to improve helicopter acceptance on noise standards, and recommendations for developing the technology for noise control with consideration given to performance and economic consequences are also given. Requirements for high speed and productivity are found to be in conflict with those for noise, and improvements where the conflict can be resolved are defined. It is concluded that funding and facilities for helicopter noise technology development must become available in time to maintain economic growth in face of new de-escalation requirements. D.L.G.

A81-42751 Helicopter accidents. B. J. Webster (International Air Safety, Ltd., Alexandria, VA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810592.* 7 p.

This paper provides a statistical breakdown of U.S.A. helicopter accidents by cause/factor, phase of operation, and, percent of material failure/malfunction, cause/factor accidents by major component or system for the years 1977, 1978, and 1979. A listing of specific recurring malfunctions and their primary causes, plus possible solutions are provided. A listing of important industry requirements to improve the helicopter safety record is included. (Author)

A81-42752 Predicting fatigue crack growth on aircraft structures. B. L. Smith (Wichita State University, Wichita, KS) and S. Y. Lee (Boeing Co., Wichita, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810593.* 10 p. 21 refs.

This paper presents a technical overview of the portion of fracture mechanics that deals with the theory and practice of predicting fatigue crack growth. The use of the stress intensity factor for predicting crack growth in various shaped structural members subjected to cyclic loading is introduced. Fracture toughness, crack growth rate, and crack growth retardation from overloads are also explained. Example problems are presented to enhance the clarity of explanations. (Author)

A81-42754 * Development of a simple, self-contained flight test data acquisition system. R. R. L. Renz, R. Clarke, M. A. Mosser, J. Roskam, and D. Rummer (Kansas, University, Lawrence, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810596.* 14 p. 16 refs. Grant No. NsG-4019.

This paper describes a simple, self-contained flight test data acquisition system. The system makes use of the latest sensor and microprocessor technology available, to reduce overall system costs. Coupled with this is the use of modern control theory techniques allowing minimization of data requirements, as well as flight time requirements. Capability of the system includes primarily stability and performance analysis of general aviation airplanes, although system versatility has been designed into the package. Presented are details of the prototype system constructed, as well as details of the data reduction technique utilized. Preliminary results of the flight test program have also been included which demonstrate the capability of this system. (Author)

A81-42755 **Status of dynamic flight test technology - Model identification for flight simulation.** J. A. Mulder and J. G. den Hollander (Delft, Technische Hogeschool, Delft, Netherlands). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810597.* 18 p. 19 refs.

Dynamic flight test technology has by now emerged as a valuable tool for assessment of aircraft performance characteristics and stability and control characteristics. In this paper emphasis is on applications in the context of flight simulation. It is shown that after flight path reconstruction and reconstruction of the motion of the primary control system a linear and stepwise identification procedure can be applied for the development of aerodynamic models and models f primary control force characteristics. These models can be implemented in mathematical models for aircraft flight simulation. (Author)

A81-42756 * **Analytical techniques for the analysis of stall/spin flight test data.** L. W. Taylor, Jr. (NASA, Langley Research Center, Hampton, VA) and V. Klein (Joint Institute for Advancement of Flight Sciences, Hampton, VA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810599.* 13 p. 13 refs.

Analytical techniques for the analysis of stall/spin flight test data are reviewed by discussing (1) certain special flight instrumentation issues, (2) the mathematical modeling techniques, and (3) the analysis of post stall and spinning flight of general aviation airplanes. The angles of attack, sideslip, roll, pitch, and yaw are derived from measurements of angular velocity and linear acceleration. The key to the success of this approach is to simultaneously estimate both the biases in the instrumentation and the initial conditions. Techniques for determining stability derivatives from flight data are applied to angles of attack too high for stabilized flight. This practice greatly expands the range over which aerodynamic characteristics can be determined from flight test. Nonlinear terms in certain aerodynamic functions are shown to be valid by comparing them with the trends of results at different angles of attack. A very old technique of studying spins is extended and applied to some modern light airplanes. Airplanes for which the wing provides the dominant moments during spins, offer the possibility of linking spin characteristics to longitudinal data. (Author)

A81-42757 **The effect of proplets and bi-blades on the performance and noise of propellers.** J. P. Sullivan, L. K. Chang, and C. J. Miller (Purdue University, West Lafayette, IN). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810600.* 10 p. 9 refs.

An analytical technique for predicting the aerodynamic performance of propellers with tip devices (proplets) using vortex lattice method shows that the ideal efficiency of a fixed diameter propeller can be improved by 1-5%. By suitable orientation and sweep of the proplet, the noise analysis method presented predicts that propellers with tip devices will have approximately the same noise as propellers without tip devices. Therefore proplets can be added to a fixed diameter propeller to improve the efficiency with no increase in noise or the noise may be reduced by decreasing the diameter with no loss in aerodynamic efficiency. (Author)

A81-42758 * **Low and high speed propellers for general aviation - Performance potential and recent wind tunnel test results.** R. J. Jeracki and G. A. Mitchell (NASA, Lewis Research Center, Cleveland, OH). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810601.* 27 p. 24 refs.

A survey is presented of current research efforts in general aviation, low-speed propeller design and high-speed propfan design, with attention on such features as (1) advanced blade shapes, with novel airfoils and sweep, (2) tip devices, (3) integrated propeller/nacelle designs, (4) area-ruled spinners, (5) lightweight, all-composite blade construction, and (6) contra-rotating propfan systems. The potential overall improvements associated with these design modifications are calculated to lie at 10-15% for low-speed rotors and 15-30% for high-speed ones. Emphasis is placed on noise reduction, blade drag, performance prediction methods and wind tunnel testing of alternative rotor configurations. Extensive use of graphs is made in performance comparisons between alternative blade and rotor designs. O.C.

A81-42759 **Propeller performance and design as influenced by the installation.** H. V. Borst (Henry V. Borst and Associates, Wayne, PA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810602.* 15 p. 14 refs.

The performance of a propeller is influenced by the effects of the airplane components including the nacelle, fuselage and wing. These bodies induce flow velocity changes in the propeller plane which changes the blade load distribution from that in free air and thus effects the propeller performance. The flow field in the wake of the propeller influences the drag of the propeller nacelle and the lift of the wing. In addition, the mutual interference of the pressure fields induced by the propeller and bodies influence the performance. This includes a drag increase due to interference between the blade inboard section and the spinner. The effects of these mutual interactions between the propeller and its supporting bodies on performance is discussed along with methods for determining the performance changes. Illustrations are given to show the magnitude of the changes in performance due to the interactions and how the losses can be eliminated or reduced. With proper attention to the design of the propeller installation, the potential for improving the overall performance is large. (Author)

A81-42760 **Investigation of a flight test method for the measurement of propeller thrust.** S. J. Miley, L. S. Miller (Texas A & M University, College Station, TX), K. Hall, and H.-J. Tsai (Mississippi State University, Mississippi State, MS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810603.* 9 p. 19 refs.

A full scale wind tunnel test was performed with a general aviation aircraft to investigate the use of the slipstream momentum survey method as a means of measuring propeller thrust in flight. Aircraft angle of attack is shown to have significant influence on the momentum measurements. Thrust values obtained from the slipstream momentum correlated well with overall aircraft force measurements; however, insufficient data regarding the slipstream static pressure variation resulted in a systematic error in the results. The need for detail static pressure measurements in the slipstream is demonstrated. (Author)

A81-42761 **A prediction procedure for propeller aircraft flyover noise based on empirical data.** M. H. Smith (Cessna Aircraft Co., Wichita, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS. Apr. 7-10, 1981, Paper 810604.* 13 p. 11 refs.

Forty-eight different flyover noise certification tests are analyzed using multiple linear regression methods. A prediction model is presented based on this analysis, and the results compared with the test data and two other prediction methods. The aircraft analyzed include 30 single engine aircraft, 16 twin engine piston aircraft, and two twin engine turboprops. The importance of helical tip Mach number is verified and the relationship of several other aircraft, engine, and propeller parameters is developed. The model shows good agreement with the test data and is at least as accurate as the other prediction methods. It has the advantage of being somewhat easier to use since it is in the form of a single equation. (Author)

A81-42762 **Vortex drag reduction by diffusing vanes - Design for the 'Thrush' agricultural aircraft.** J. E. Hackett (Lockheed-Georgia Co., Marietta, GA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810605.* 15 p. 17 refs.

The use of low aspect ratio, often untapered wings on agricultural aircraft leads to strong tip vortices, high induced drag and disruption of spray patterns. Wing tip devices which modify the trailing vortex offer performance and flow improvements. A systematic experimental program has led to a patented vortex diffuser device for drag reduction which comprises a winglet-like vane mounted from a boom which trails a wing tip. Flight test experiments on an RCRV model indicate slight degradation of lateral stability with such vortex diffusers fitted but substantial degradation for winglets. The design of Vortex Diffuser Vanes for the 'Thrush' agricultural aircraft is described. Instrumented flight tests are scheduled for Spring, 1981. (Author)

A81-42763 * Effects of wingtip modifications on handling qualities of agricultural aircraft. C. P. van Dam (Kansas, University, Lawrence, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810606.* 13 p. 28 refs. Grant No. NsG-1633.

The effect of wingtip modifications on the stability and control characteristics of an agricultural airplane has been studied by means of a nonplanar quasi-vortex-lattice method. The method is used to compute the changes in steady state and perturbed state lateral-directional stability and control derivatives produced by wingtip mounted winglets, vortex diffuser vanes, and tip extensions. The study shows that the combination of the excessive positive dihedral effect produced by the winglets and adverse yaw due to aileron deflection can have a detrimental effect on the roll control characteristics of the airplane. Introduction of an aileron-rudder-interconnect, and reduction of the effective dihedral by canting-in of the winglets, or addition of a lower winglet can eliminate the roll control problems. (Author)

A81-42765 Leading edge high lift devices for agricultural aircraft. K. H. Bergey (Oklahoma, University, Norman, OK). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810608.* 8 p. 9 refs.

This paper covers the results of a series of analytic and test programs on the installation of fixed leading-edge slats to standard agricultural aircraft. The results show that very considerable improvements in performance and safety are possible with relatively simple slat configurations. So-called 'thin' single-surface slats were found to perform as well as more complex conventional slats for this particular application. The 'thin' slats have a number of advantages in cost and weight, and in their ability to be retrofitted to existing aircraft. The application of 'thin' slat technology - both fixed and automatic - to a broader range of general aviation aircraft would seem to have a great deal of merit for improving safety and performance. (Author)

A81-42766 Matrix load analysis method for flexible aircraft structures. G. W. Martin, Sr. *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810610.* 14 p.

An integrated loads and stress analysis program has been written to shorten the time involved in analyzing the effect of flexibility on load distribution. The program was set up to efficiently interface with NASTRAN although any other similar structural analysis program could be used. The required matrices, coupling the aerodynamic and structural response to applied loads, are constructed automatically in the computer program. Comparisons are presented between the program output and experimental data for an actual flight article verifying the method presented. (Author)

A81-42767 * Determination of crash test pulses and their application to aircraft seat analysis. E. Alfaro-Bou, M. S. Williams (NASA, Langley Research Center, Hampton, VA), and E. L. Fasanella (Kentron International, Inc., Hampton, VA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810611.* 18 p. 13 refs.

Deceleration time histories (crash pulses) from a series of twelve light aircraft crash tests conducted at NASA Langley Research Center (LaRC) were analyzed to provide data for seat and airframe design for crashworthiness. Two vertical drop tests at 12.8 m/s (42 ft/s) and 36 G peak deceleration (simulating one of the vertical light aircraft crash pulses) were made using an energy absorbing light aircraft seat prototype. Vertical pelvis acceleration measured in a 50 percentile dummy in the energy absorbing seat were found to be 45% lower than those obtained from the same dummy in a typical light aircraft seat. A hybrid mathematical seat-occupant model was developed using the DYCAST nonlinear finite element computer code and was used to analyze a vertical drop test of the energy absorbing seat. Seat and occupant accelerations predicted by the DYCAST model compared quite favorably with experimental values. (Author)

A81-42768 Simulation of aircraft seat response to a crash environment. J. W. Coltman, A. O. Bolukbasi, and D. H. Laananen (Simula, Inc., Tempe, AZ). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810612.* 10 p. 6 refs. U.S. Department of Transportation Contract No. FA03-80-C-00098.

A new structural analysis method is being developed for incorporation into the seat/occupant model (Program SOM-LA), which is intended for use in evaluating the crashworthiness of aircraft seats. The analytical technique is described, and its capabilities are demonstrated in the simulation of the dynamic test of an actual aircraft seat. Computer simulation results are presented and compared with the test data. (Author)

A81-42769 Crashworthy design concepts for airframe structures of light aircraft. J. D. Cronkhite (Bell Helicopter Textron, Fort Worth, TX). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810613.* 15 p. 7 refs.

Crashworthy concepts for airframe structures of general aviation aircraft have been investigated under the sponsorship of NASA Langley Research Center. Several crashworthy concepts of energy-absorbing lower floor structures were developed. Design support tests were conducted to determine the performance of these concepts. Five concepts were selected for fabrication as full-scale floor test sections. These floor test sections were designed to have a high strength structural platform, capable of attaching crashworthy, energy-absorbing seats, supported by an underfloor crush zone that provides energy absorption and controls the loads to this platform. The design of these floor sections was analytically verified with NASTRAN for the static conditions and with KRASH for the dynamic conditions. From the five selected concepts, eighteen floor sections (three or four sections of each concept) were fabricated and delivered to the NASA Langley Research Center where they were tested under static and dynamic loading conditions. As a result of this investigation, it appears as though several of the crashworthy concepts are feasible and can be incorporated into the airframe design of future general aviation aircraft. (Author)

A81-42770 * Aircraft subfloor response to crash loadings. H. D. Carden and R. J. Hayduk (NASA, Langley Research Center, Hampton, VA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810614.* 23 p. 8 refs.

Results are presented of an experimental and analytical study of the dynamic response to crash loadings of five different load-limiting subfloors for general aviation aircraft. These subfloors provide a high-strength structural floor platform to retain the seats and a crushable zone to absorb energy and limit vertical loads. Experimental static load-deflection data and dynamic deceleration response data for the five subfloors indicated that the high-strength floor platform performed well in that structural integrity and residual strength was maintained throughout the loading cycle. The data also indicated that some of the subfloor crush zones were more effective than others in providing nearly constant load for a range of displacement. The analytical data was generated by characterizing the nonlinear crush zones of the subfloor with static load-deflection data and using the DYCAST nonlinear finite element computer program. Comparisons between experimental and analytical data showed good correlation for the subfloors in which the static deformation mode closely approximated the dynamic deformation mode. (Author)

A81-42771 U.S. Army crashworthiness program. G. T. Singley, III (U.S. Army, Aviation Research and Development Command, St. Louis, MO). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810615.* 15 p. 25 refs.

It has been found that large improvements in crash survival could be made if consideration were given in the initial aircraft design to a number of general survivability factors, including the crashworthiness of aircraft structure, the tiedown chain strength, the occupant acceleration environment, the occupant environment hazards, and postcrash hazards. The general subjects considered in the current edition of the 'Aircraft Crash Survival Design Guide' are briefly considered. The overall objective of crashworthiness design is to eliminate unnecessary injuries and fatalities in relatively mild impacts. The Army aircraft crashworthiness R and D program has demonstrated the feasibility of producing rotary-wing aircraft designs in accordance with the 'Crash Survival Design Guide'. G.R.

A81-42772 **Human factors aspects of emergency egress from a business jet.** T. J. Armstrong and R. G. Snyder (Michigan, University, Ann Arbor, MI). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810617.* 14 p. 28 refs.

Past research has shown that although occupants often survive crash impacts of business jet aircraft, they are often injured either in the course of egress or because they are unable to evacuate. A physical task analysis was performed to evaluate procedures for emergency egress from a typical business jet to demonstrate how possible human factors problems can be identified. First, the tasks required for the flight crew to evacuate via all possible routes were determined. Second, each task was divided into a series of physical elements, such as reach and grasp, corresponding to each movement or exertion. Third, physical aspects of the aircraft affecting performance of each element such as location and force, were measured. The physical requirements of each element were compared with available human factors data, to rate its difficulty. Selected aspects of the analysis are discussed. (Author)

A81-42773 **Avco Lycoming's ALF 502 high bypass fan engine.** M. Cusick (Avco Corp., Avco Lycoming Div., Stratford, CT). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810618.* 11 p.

The first high bypass fan engine incorporated a standard Lycoming T55L-7 as a core engine and a gear driven 6:1 bypass ratio fan. An exceptionally low specific fuel consumption together with a higher thrust could be verified during testing in 1964. Attention is given to the aircraft using the ALF 502, the engine section, the engine modules, the fan module, the gas producer module, the combustor turbine module, the accessory gearbox module, the reduction in jet and core generated noise, the emission characteristics of the engine, engine diagnostics, a trend analysis, and the performance of boroscope inspections. G.R.

A81-42774 **Electronic fuel controls - Who needs them.** D. J. Hawes (Aviation Electric, Ltd., Montreal, Canada). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810619.* 11 p.

Electronic fuel controls, in which the computation of the fuel flow to the engine is carried out electronically, can process electrical signals, incorporate systems monitoring functions, and interface with other 'black boxes'. Three main types of electronic controls are discussed - electronic trims, supervisory controls, and full authority controls; and the contraints of cost, reliability, integrity, and benefit are considered. The major advantages of the modern digital electronic fuel control are the size and versatility of its memory and the higher level of logic it can perform. The NDEC (Speed Based /N/ Digital Electronic Control) is presented as an example, and a detailed system diagram is provided. Applications of the system in the general aviation market are discussed, including its use in helicopters, turbofans, turboprops, and agricultural aircraft. J.F.

A81-42775 **Electronic control system for a modern turboprop engine.** J. S. Frew and M. F. Keck (Garrett Turbine Engine Co., Phoenix, AZ). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810620.* 13 p.

The basic objective of this study is to create an integrated fuel control and propeller governor system fully compatible with engine characteristics, so that optimum engine performance would be attained during all ground and flight operations, within the engine operating envelope. The system requires less aircraft linkage, a reduction in the number of engine control components, a reduction in the hydromechanical unit complexity, and ease of control settings adjustment, compared to the current production control systems. The system provides automatic starting, engine starting speed switching functions, acceleration fuel scheduling, fuel governor, power settings, engine torque limiting, engine gas temperature limiting, engine gas temperature signal modification to provide single red line operation, isochronous propeller governing, overspeed protection, and monitoring functions. The monitors will switch the computer and system to manual mode when the monitor limits are exceeded, and flight may be continued. (Author)

A81-42776 **Small turbofan engines - Their impact on general aviation aircraft.** L. R. l'Anson and W. F. Schneider (Avco Corp., Avco Lycoming Div., Stratford, CT). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810622.* 15 p.

The application of small turbofan engines to general aviation aircraft is evaluated with consideration given to the selection of engine cycle parameters, such as fan pressure ratio, bypass ratio and exhaust system. Gas power produced by a gas generator to thrust or flight power for propulsion of a fixed wing aircraft is discussed with emphasis on relating conversion efficiency to specific thrust, bypass and jet velocity ratios, and performance benefits achievable with a mixed exhaust system. The 8.4 bypass ratio fan is found to offer the best fuel economy, with a higher take-off thrust than the low bypass ratio fan, resulting in a 5 percent shorter take-off field length. Fixed flow exhaust improves conversion efficiency and reduces specific fuel consumption by 3 percent. Finally, for cruise speeds above 0.6 Mach number, the power sizing criterion is cruise, providing excess power for OEI climbout, with a resulting increase in propulsion system weight and drag. D.L.G.

A81-42777 * **Full-scale study of the cooling system aerodynamics of an operating piston engine installed in a light aircraft wing panel.** V. R. Corsiglia and J. Katz (NASA, Ames Research Center, Moffett Field, CA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810623.* 13 p.

Measurements of the drag and of the nacelle internal pressures on a wing and nacelle that housed a horizontally opposed piston engine were made in the 40- by 80-Foot Wind Tunnel at Ames Research Center. These tests are follow-ons to earlier tests made with the same wing and nacelle but in which the engine was replaced with an electric motor and an adjustable orifice plate. In the initial tests the orifice plate was used to control the rate of cooling-air flow through the nacelle and thereby to simulate a range of gasoline engine types. Good agreement was found between the results of those tests and of the test reported here. Also, the upper and lower plenum pressure and cooling-air flow rate were found to be related by conventional equations used to represent the flow through orifices. Tests were run with three cooling air inlet sizes over a free-stream velocity range from 50 to 150 knots, an angle of attack range from 0 deg to 10 deg, and a cowl-flap deflection range from 0 deg to 30 deg. The data were analyzed by computing a flow coefficient similar to that used in the analysis of orifices. It was found that all of the flow coefficient values fell within a band that varied linearly with inlet area. The linear mean line through this band provides an estimate of the relationship between cooling-air flow rate and upper plenum pressure over a wide range of test conditions. (Author)

A81-42778 * **An overview of general aviation propulsion research programs at NASA-Lewis Research Center.** E. A. Willis and W. C. Strack (NASA, Lewis Research Center, Cleveland, OH). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810624.* 21 p. 19 refs.

This paper presents a brief overview and technical highlights of general aviation (g/a) propulsion research efforts and studies which have been underway at NASA's Lewis Research Center (LeRC) for the past several years. The review covers near-term improvements for current-type piston engines, as well as studies and limited corroborative research on several advanced g/a engine concepts, including diesels, small turboprops and both piston and rotary stratified-charge engines. Also described is basic combustion research, cycle modeling and diagnostic instrumentation work that will be required to make the new engines a reality. The discussion emphasizes the most recently-completed studies and the basic underlying research work, which have not been reported previously. (Author)

A81-42779 * **Aerodynamic design data for a cruise-matched high performance single-engine airplane.** B. J. Holmes and C. C. Croom (NASA, Langley Research Center, Hampton, VA). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810625.* 13 p. 8 refs.

Design data are presented for a class of high-performance single-engine business airplanes. The design objectives include a cruise

speed of 300 knots, a cruise altitude of 10,700 m (35,000 ft), a cruise payload of six passengers (including crew and baggage), and a no-reserves cruise range of 1300 n.mi. Two unconventional aerodynamic technologies were evaluated: the individual and combined effects of cruise-matched wing loading and of a natural laminar flow airfoil were analyzed. The trade-off data presented illustrate the ranges of wing geometries, propulsion requirements, airplane weights, and aerodynamic characteristics which are necessary to meet the design objectives. Very large design and performance improvements resulted from use of the aerodynamic technologies evaluated. It is shown that the potential exists for achieving more than 200-percent greater fuel efficiency than is achieved by current airplanes capable of similar cruise speeds, payloads, and ranges. (Author)

A81-42780 Binocular Camera for cockpit visibility of general aviation aircraft. A. J. Barile (FAA, Technical Center, Atlantic City, NJ). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810628.* 9 p. 6 refs.

A history of cockpit visibility studies and requirements with regard to aircraft safety, human factors, collision avoidance, and accident investigations is presented. The Federal Aviation Administration's development of the Binocular Camera is reviewed, and the technical details of a new and improved camera are discussed. The Binocular Camera uses two 65 mm wide angle F6.8 lenses and covers an 88 1/2 deg field of vision. The camera produces images, representative of what the human eyes see before the brain integrates them into one, thus making it possible to analyze the effect of obstruction to vision. The improvements, applications, and uses of the camera in the research, development, and operations of general aviation aircraft are discussed. J.F.

A81-42781 * Summary of high-lift and control surface research on NASA general aviation airfoils. W. H. Wentz, Jr. and C. Ostowari (Wichita State University, Wichita, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810629.* 8 p. 46 refs. Research sponsored by the Boeing Commercial Airplane Co. and NASA.

Summary findings and bibliographical information are presented for airfoil and airfoil-related research conducted at Wichita State University during the past decade. Topics include flap, aileron, and spoiler design data for new airfoils, extensive flow measurements, modifications to older airfoils, new symmetrical sections and contributions to analytical methods for cases with partial separation. (Author)

A81-42782 An assessment of advanced technologies for application to general aviation. G. T. Matsuyama (U.S. Air Force Academy, Colorado Springs, CO) and D. L. Kohlman (University of Kansas Center for Research, Inc., Lawrence, KS). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810630.* 39 p. 6 refs.

A study directed toward the identification and evaluation of applicable advanced technologies for general aviation was performed. An extensive data base was generated through visits to 31 general aviation manufacturers and 3 NASA research centers as well as through an exhaustive literature search. An evaluation technique was developed which allowed candidate technologies to be ranked according to potential benefit. Finally, design studies were performed for a 6-passenger personal/business airplane and a 19-passenger commuter airplane. The General Aviation Synthesis Program (GASP) was utilized during the design studies for propulsion system and vehicle sizing as well as mission performance analysis. This paper discusses the formulation and results of the evaluation technique and the design studies for the two airplanes. The results of the technology evaluation indicated that propulsion, aerodynamic, and composite technologies are extremely attractive to general aviation. When these technologies were incorporated into the design synthesis of the two airplanes, higher wing loadings and smaller airplanes resulted. Fuel savings of 50% for the 6-passenger airplane and 40% for the commuter were realized. (Author)

A81-42784 Fibre reinforced composite applications at De Havilland. L. K. John (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810640.* 11 p.

An overview is given of general aviation aircraft constructor's experience to date with fiber-reinforced plastic composite secondary structures. The 50-passenger Dash 7 aircraft discussed makes extensive use of Kevlar- and Kevlar/graphite-reinforced epoxy composites in structures ranging in complexity from simple fairings to such loadbearing structures as the cabin shell and floor. Among the topics covered are (1) the selection of composite materials, (2) environmental resistance design criteria such as ultraviolet radiation and moisture degradation, lightning strike protection and flammability requirements, and (3) the development of aramid fiber composites for, and their application in, the Dash 7 commuter aircraft. O.C.

A81-42785 * Development of simplified airborne computations for fuel conservative descents in a time-based metered air traffic environment. C. E. Knox (NASA, Washington, DC). *Society of Automotive Engineers, Business Aircraft Meeting and Exposition, Wichita, KS, Apr. 7-10, 1981, Paper 810642.* 18 p. 9 refs.

The NASA has developed and flight-tested a simple flight management descent algorithm designed to improve the accuracy of delivering an airplane in a fuel-conservative manner to a metering fix at a time designated by air traffic control. This algorithm provides a three-dimensional path with terminal area time constraints (four-dimensional) for an airplane to make an idle-thrust, clean-configured (landing gear up, flaps zero, and speed brakes retracted) descent to arrive at the metering fix at a predetermined time, altitude, and airspeed. The descent path is calculated for a constant Mach/airspeed schedule from linear approximations of airplane performance with considerations given for gross weight, wind, and nonstandard pressure and temperature effects. Applications of the four-dimensional and descent planning capabilities of the algorithm to conventional airplanes is being investigated. This report describes the flight management descent algorithm and presents the results of the flight tests flown with the Terminal Configured Vehicle airplane. (Author)

A81-42793 # The effect of various factors on the vibration characteristics of composite blades of gas turbine engines (Vliianie razlichnykh faktorov na vibratsionnye kharakteristiki lopatok gazoturbinnykh dvigatelei iz kompozitnykh materialov). G. G. Kartashov (Kuibyshevskii Aviatsionnyi Institut, Kuibyshev, USSR). *Mekhanika Kompozitnykh Materialov,* May-June 1981, p. 486-493. 8 refs. In Russian.

The theory of anisotropic laminate plates is used to study the properties of natural frequency spectra and vibration modes of clamped cantilever plates; the analysis is applicable to the investigation of composite compressor blades. Attention is given to the appearance of coupled modes, and the effect of the relative dimensions of the plates on the range in which natural frequencies can be controlled is investigated. Limits on frequency variations with variations of the reinforcement angle are determined, and the effect of the character and degree of material inhomogeneity on the nature frequencies is evaluated. In addition, an analysis is presented of the effect of transverse shear, normal compression, and moment of inertia on the vibration characteristics of the plates. The computational results are confirmed by experimental results. P.T.H.

A81-43128 # Acoustic spectrum analysis for gyro bearings. C. E. Heitzman (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1616.* 7 p.

An acoustic system analyzer has been developed that will be an aid in bearing analysis for displacement gyros. The phenomenon of the Fourier Transform has made possible the development of an optical processor that operates by the interaction of light from a light emitting diode array sweeping across a binary frequency mask and through lenses onto a vidicon tube. This arrangement performs the Fourier Transform of large time samples of sound in a parallel process, preserving amplitude, frequency and phase information. The resultant information can then be entered into a computer for programmed analysis or displayed for visual analysis of the condition of gyro-bearings. (Author)

A81-43129 # **Avionics Availability Study.** E. J. Kunay (USAF, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1619.* 8 p.

Avionics availability is a key element in mission readiness and performance of military aircraft. The Avionics Availability Study explored potential improvements in the acquisition of avionics and its support with the goal of increasing avionics availability. Analysts evaluated a variety of alternatives for improving avionics availability and ranked them on the basis of wartime aircraft sortie production, peacetime life cycle cost, and a resulting benefit-cost ratio. The study demonstrated a useful approach for making aircraft investment decisions, and included some broad, generic recommendations for acquisition of future aircraft weapon systems. (Author)

A81-43130 # **Portable servoactuator test system.** G. L. Bame, Jr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1620.* 4 p.

The Portable Servoactuator Test System (PSTS) is an Air Force project aimed at reducing support costs associated with electrohydraulic servovalves. The project is divided into two phases. Phase I will design and test a breadboard PSTS. Phase II will produce and field test six PSTS suitcase testers. The PSTS is to be an electronic device, packaged in a portable case, that will test an actuator on the aircraft. Using 28 volt DC power and 400 cycle, 120 volt, single phase AC power, the PSTS will drive the actuator under test via an electrical current input into an electrohydraulic servovalve. Hydraulic power will also be required. G.R.

A81-43132 # **Runway and deck temperatures in vertical takeoff/landing operations.** H. Fluk (U.S. Naval Air Engineering Center, Lakehurst, NJ). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1623.* 8 p. 6 refs.

The Navy's recent interest in high temperature V/STOL B aircraft has led to new studies involving high energy jet plumes. The accuracy of a prediction of the temperature in runways and metal decks subjected to VTOL operations is discussed, taking into account gas temperature and heat transfer correlation. Isotherms in concrete are considered along with isotherms in ground covers, and isotherms in metal decks. Maximum temperature trends are examined, giving attention to heating time, engine temperature, and the influence of height. Questions of deck buckling are also investigated. A buckling incident involving an AV8A Harrier aircraft occurred aboard the LPH Tripoli. G.R.

A81-43133 # **Design concepts for minimizing hot-gas ingestion in V/STOL aircraft.** R. E. Kuhn. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1624.* 9 p. 21 refs. Research supported by the Rockwell International Corp.

The reingestion of hot exhaust gas can seriously reduce the performance of V/STOL aircraft. Past research on hot-gas ingestion is reviewed and design concepts that can be used to minimize ingestion are identified. Both the near field effects of the fountain flows created by multiple jet configurations and the far field effects of wind or aircraft forward motion are considered. Techniques for minimizing hot gas ingestion that are discussed include: jet exit arrangements to simplify the fountain flow, shields designed to favorably redirect the fountain flow that impinges on the aircraft, minimizing the amount of hot gas projected ahead of the aircraft and locating the inlets as high as possible. (Author)

A81-43137 # **Flow control for an airborne laser turret.** J. R. Schonberger, A. E. Fuhs (U.S. Naval Postgraduate School, Monterey, CA), and A. M. Mandigo. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1637.* 11 p. 6 refs. USAF-supported research.

Airflow control techniques are examined as possible means of suppressing the unsteady flow about a high-energy laser pointer-tracker turret on an aircraft. The unsteady flow causes jitter and optical path distortions, increasing the time required to damage a target. A hollow fairing with suction inlets located behind the turret combined with fuselage boundary layer suction at the turret base is selected as a flow control method. A one-third scale model of the turret and fairing is tested in a wind tunnel, and various turret/fairing geometrical parameters and flow rates through the suction apparatus are investigated. A 16.8 in. diameter turret is tested in a 5 x 5 ft wind tunnel, at Reynolds number of 300,000 and optimum steady flow conditions are achieved with a flow factor of 0.4, the flow factor being the ratio of the area of streamtube at freestream conditions entering the suction inlets and the projected area of the laser turret. K.S.

A81-43138 # **The F-16 Halon tank inerting system.** J. K. Klein (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1638.* 9 p. 7 refs.

The F-16 multimission fighter employs a new lightweight approach towards providing fuel tank inerting. The F-16 inerting system stores and effectively distributes Halon 1301 (bromotrifluoro-methane) to the air space above the fuel level to provide a nonexplosive atmosphere within the fuel tanks when activated. Background information includes a trades study with alternate inerting concepts. Resolution of component and system development problems is discussed and engine and airframe compatibility testing as well as system level tests are detailed. The results of initial F-16 operating experience is highlighted and a projection is made towards future applications. It is concluded that halon fuel tank inerting is a viable candidate for tactical and strategic aircraft weapon systems. (Author)

A81-43139 # **Investigation of landing gear alternatives for high performance aircraft.** A. R. DeWispelare (USAF, Institute of Technology, Wright-Patterson AFB, OH) and R. P. Stager (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1639.* 9 p. 5 refs.

Various landing gear configurations are investigated for improvements of aircraft performance during ground operation on rough runways by reducing attachment point loads. Runway profile, aircraft airframe, aerodynamics, and landing gear are discussed. Alternative landing gear including active gear, nose gear alternatives, and modified nose/modified main gear are also presented. It is concluded that landing gear can be designed to significantly improve operations on rough/repaired runways, but is sensitive to aircraft weight, velocity, and pavement upheaval. In addition, active gear is found to provide the best force attenuation capabilities, with significant load alleviation improvements achieved by changing to alternative gear. D.L.G.

A81-43140 # **Finite element analysis of a bird-resistant monolithic stretched acrylic canopy design for the F-16A aircraft.** R. E. McCarty (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1640.* 12 p. 19 refs.

The dynamic structural response (to the impact of a 4 lb bird at 350 kt) of a newly proposed monolithic stretched acrylic material canopy design for the F-16A aircraft is predicted, using the Materially and Geometrically Nonlinear Analysis (MAGNA) finite element computer program. Two versions of the canopy design are studied, one having a nominal thickness of 0.90 in. and the other a normal thickness of 0.75 in. Transient dynamic materially nonlinear, large displacement analyses are performed, and results obtained for the 0.90 in. thick design indicate that it would withstand a 4 lb 350 kt bird impact with some margin of safety; those for the 0.75 in. thick design indicate lower but acceptable performance. Analysis results warrant full scale fabrication and testing by the Air Force. It is concluded that MAGNA will significantly cut the time and cost required to develop new systems, and application in other areas of structural mechanics is envisaged due to the high efficiency of MAGNA for large nonlinear three dimensional problems. K.S.

A81-43141 # **Atmospheric electricity hazards protection for advanced technology flight vehicles.** R. C. Beavin (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Insti-*

tute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1642. 6 p.

The interagency Advanced Development Program (ADP) established to demonstrate Atmospheric Electricity Hazards Protection (AEHP) for advanced technology aircraft is described, with emphasis on the protection of aircraft electrical and electronic subsystems against the induced electrical transients of aircraft-lightning interactions. Among the topics considered are: (1) atmospheric electricity environmental assessment; (2) flight vehicle structure impact; (3) electronics susceptibility; (4) vulnerability assessment; (5) test vehicle preparation; (6) protection evaluation; and (7) design criteria and guidelines. The electromagnetic treats presented by electromagnetic pulse (EMP) and interference (EMI) are also covered by the program described. O.C.

A81-43142 * # **Flight test evaluation of advanced symbology for general aviation approach to landing displays.** D. R. Downing, W. H. Bryant, and K. R. Yenni (NASA, Langley Research Center, Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1643.* 9 p. 5 refs.

This paper describes a set of flight test experiments which were designed to evaluate the relative utility of candidate displays with advanced symbology for General Aviation IFR operations in the terminal area. This symbology was previously evaluated as part of the NASA Langley Research Center's Terminal Configured Vehicle Program for use in commercial airlines. The advanced symbology included vehicle track-angle, flight path angle and a perspective representation of the runway. These symbols were selectively drawn on a CRT display along with the roll attitude, pitch attitude, localizer-deviation and glideslope deviation. In addition to the CRT display, the instrument panel contained standard turn and bank, altimeter, rate of climb, airspeed, heading and engine instruments. The symbology was evaluated using tracking performance and pilot subjective ratings for an ILS capture and tracking task. (Author)

A81-43143 # **Measurement of natural aircraft icing conditions.** M. K. Politovich and W. R. Sand (Wyoming, University, Laramie, WY). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1646.* 9 p. 5 refs. U.S. Department of Transportation Contract No. FA03-81-R-50006.

The Department of Atmospheric Science at the University of Wyoming has instrumented a Beechcraft Super 200T aircraft for atmospheric research. In addition to the standard meteorological parameters, the aircraft is equipped to measure and record the entire hydrometeor spectra. Super-cooled cloud liquid water is measured using four different schemes. Icing rate is recorded along with all the parameters which determine the aircraft performance. Results of flights made to determine the characteristics of icing below 10,000 ft MSL are presented. Representative cloud microphysical parameters which are conducive to icing are shown in the form of vertical profiles in an icing environment and horizontal measurements in the areas of most severe icing in wintertime stratiform clouds. (Author)

A81-43144 # **Propulsion system installation design for high-speed prop-fans.** B. H. Little, Jr. (Lockheed-Georgia Co., Propulsion and Acoustics Dept., Marietta, GA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1649.* 10 p. 12 refs.

A configuration design study is presented for the engine/gearbox arrangement, nacelle/forebody matching and air inlet contours of an advanced, wing-mounted tractor turboprop powerplant. Among the topics considered in addition to the elements mentioned are: the minimum nacelle diameter and ideal forebody shape for avoidance of blade root choking, inlet types, areas and consequent boundary layer effects, and diffuser duct design. Emphasis is put throughout on the interactive nature of the design problems presented, and it is concluded that crucial performance prediction capabilities are not yet available for the interactive aerodynamic behavior of such design elements as propfan rotors. The integration of a given nacelle configuration into the wing of the aircraft for which it is intended is held to pose similar uncertainties. O.C.

A81-43146 * # **The influence of leading-edge thrust on twisted and cambered wing design for supersonic cruise.** H. W. Carlson and D. S. Miller (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1656.* 8 p. 18 refs.

A study of leading-edge thrust phenomena at supersonic speeds has shown that although these forces are not large, they can be a significant factor in the design of wings for supersonic cruise. It is seen that the rather severe twisted and cambered wing surfaces resulting from the application of present design methods, which ignore leading-edge thrust, can be replaced by more moderate surfaces with little or no loss in aerodynamic efficiency if realistic possibilities for the attainment of some fraction of the theoretical thrust are taken into account. (Author)

A81-43147 # **Effects of yaw on leading edge vortex flap aerodynamics.** J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, VA) and R. H. Thomas. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1660.* 8 p. 5 refs.

Subsonic wind tunnel tests were conducted to determine if previously reported aerodynamic performance improvements on a delta wing with leading edge vortex flaps (LEVF) were maintained in yaw. Tapered and constant chord LEVF were tested on a 60 deg delta wing at yaw angles up to 20 deg and angles of attack to 45 deg. The previously discovered L/D improvements due to LEVF remained at yaw angles to 20 deg. Constant chord LEVF proved superior to tapered LEVF in yaw except for the pitching moment instability noted earlier in nonyawed tests. The use of LEVF reduced rolling moment tendencies in yaw. It is concluded that the use of LEVF in yaw is not detrimental and may, in fact, improve some aspects of yawed flight for delta wings. (Author)

A81-43152 # **Wind tunnel experiments on the divergence of swept wings with composite structures.** M. Blair (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and T. A. Weisshaar (Purdue University, West Lafayette, IN). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1670.* 8 p. 17 refs.

Several flexible composite wing models have been designed and tested for aeroelastic divergence at various sweep angles. These fixed-root models use sectioned aerodynamic shells that are mounted to interchangeable internal graphite-epoxy plates. These plates provide wing stiffness and simulate various off-axis composite structural configurations. Test results, obtained from subcritical testing using a modified Southwell method, clearly identify basic relationships between wing sweep, composite fiber orientation, and fixed root divergence speed. One test was run to the divergence speed. Good agreement is shown between the Southwell prediction and the divergence hard point. (Author)

A81-43156 * # **Advanced turboprop cargo aircraft systems study.** J. C. Muehlbauer (Lockheed-Georgia Co., Marietta, GA) and S. J. Morris (NASA, Langley Research Center, Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1684.* 11 p. 21 refs.

Parametric studies were conducted to define the effects of advanced propeller (propfan) characteristics on aircraft direct operating costs, fuel consumption, and noiseprints. Selected propfan aircraft realized 21-percent fuel savings and 15-percent lower DOCs relative to advanced turbofan aircraft. While both the propfan and turbofan aircraft satisfied current federal noise regulations, the propfan aircraft had smaller noiseprints at 90-EPNdB noise levels but larger noiseprints at lower noise levels. Several techniques for reducing the propfan aircraft noiseprints were explored; some of these contribute substantial reductions in noiseprint areas. Also, a propfan aircraft for the C-X role was studied. (Author)

A81-43157 # **Wright Field turboprop study.** R. C. Lorenzetti and P. P. Dull (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1685.* 6 p.

The considered investigation was conducted as part of an effort

to reduce aircraft fuel costs. Turboprops are very fuel efficient at speeds below Mach 0.6. One of the most promising approaches to reduce fuel consumption in the speed range from Mach 0.6 to 0.8 is related to an employment of the swept eight to ten blade propeller (propfan) being developed by NASA. All studies to date indicate that turboshaft engines with propfans might save 15% or more of the fuel used by a turbofan engine of comparable technology. Attention is given to a turboprop status review, contractor studies, the NASA propfan program, an in-house performance study, specific problems which have to be solved to make a twin-turboprop, 100-150 passenger transport a viable possibility for the early 1990s, and turboprop dilemmas. G.R.

A81-43158 # **On certification of composite structures for USAF aircraft.** J. W. Goodman, J. W. Lincoln, and C. L. Petrin (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1686.* 9 p. 20 refs.

Major issues affecting the certification of composite structures are related to the effect of moisture and temperature on long term serviceability, damage tolerance of parts with manufacturing flaws, the durability of parts with typical service-induced damage, the behavior of bolted and bonded joints, and techniques for demonstrating structural integrity, including moisture and temperature. The requirements of the Aircraft Structural Integrity Program (ASIP) are examined, taking into account difficulties regarding the evaluation of composites, aspects of design information, design analysis, and full scale testing. Development programs are considered along with problems concerning choosing and producing composites. The state-of-the-art is discussed, taking into account materials and design, testing techniques, the analytical prediction of useful life of a composite component, and inspection criteria. Details of certification procedures are also provided. G.R.

A81-43159 # **C-X - A case for scenario-oriented requirements.** T. D. Pilsch (USAF, Military Airlift Command, Scott AFB, IL). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1690.* 11 p. 28 refs.

A discussion is presented of the novel characteristics of the Air Force's recent C-X Request For Proposal (RFP) document, which relies on a set of mission scenarios to influence design solutions among industry engineers. The synthesis of these scenarios, and the identification of the potential strengths and weaknesses of the use of detailed mission scenarios to define aircraft, are covered. Special attention is given the crucial issue of airfield availability, suitability and condition. It is expected that the scenario method of RFP documentation will stimulate innovative responses from designers that the conventional, performance-defining RFP would discourage. O.C.

A81-43161 # **A dynamic shimmy analysis.** W. E. Krabacher (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1700.* 6 p. 9 refs.

Shimmy is the self-induced swiveling of an aircraft nose landing gear. A shimmy model considered by Moreland (1954) was found useful to investigate shimmy phenomena. However, this model has only been capable of a static analysis. By a static analysis is meant that all mathematical model parameters are held constant as the velocity is incremented. The combined effect of the variation of various parameters due to aerodynamic lift produces a significant effect upon the prediction accuracy of the model. For these reasons, a description is presented of a dynamic shimmy analysis. Aircraft ground speed is taken as a primitive parameter. Once this parameter is known the vertical load on the gear can be determined for that speed from an equation which gives vertical load as a function of speed. Attention is given to the basic equations of motion, the dynamic factors of the analysis, and the results of the dynamic analysis. G.R.

A81-43162 # **The technical and managerial challenge of integrated flight/fire control.** J. Hunter and R. Holdridge (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1706.* 8 p.

An employment of an Integrated Control System results in a greatly decreased workload for the pilot compared to an aircraft employing separate subsystems. The decreased workload gives the pilot more time and attention for crisis management. A description is presented of the problems encountered in the Integrated Flight/Fire Control (IFFC) Program, taking into account also the approaches used to solve these problems. Four specific problem areas related to the technical and program management aspects of integrated control are considered, giving attention to interfaces, software design and testing, integration testing, and system flexibility and follow-on planning. An IFFC system uses weapon aiming error from the fire control system to assist the pilot in flying the aircraft. Expected mission improvements include more accurate and quicker weapon delivery and improved attacker survivability. The IFFC program includes the design, fabrication, ground test, and flight test of an IFFC system on an F-15B aircraft. G.R.

A81-43163 # **LQG controls for highly maneuverable aircraft.** G. L. Hartmann, C. S. Greene (Honeywell Systems and Research Center, Minneapolis, MN), and G. Stein (Honeywell Systems and Research Center, Minneapolis, MN; MIT, Cambridge, MA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1709.* 11 p. 16 refs. Contract No. ET-78-C-01-3391; Grant No. AF-AFOSR-80-0013.

Multivariable techniques are being pursued which extend classical single-input single-ouput frequency domain methods and others which exploit the more recent state space- and optimization-oriented philosophy. This paper utilizes the linear-quadratic-guassian (LQG) methodology from the latter category. However, the approach taken here is frequency domain-oriented. LQG is treated as a tool to achieve multi-variable loop shaping in the classical tradition rather than as an optimization tool. This paper reviews feedback design objectives, relates them to desired frequency domain properties and shows how the LQG methodology can be applied to achieve multi-loop shaping in the presence of model uncertainty. Three control modes for an unstable, highly maneuverable, remotely piloted aircraft are designed to demonstrate the technique. Versions of these designs have been verified and flight tested. (Author)

A81-43164 # **Fiber-reinforced composites - The future for aeropropulsion.** T. M. Cordell (USAF, Materials Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1713.* 6 p.

A brief history and a review (up to the 1980's) of the use of fiber-reinforced composites in subsonic and supersonic aeropropulsion systems is presented, in an effort to support NASA and the DoD in their attempt to explore new ways of reducing operational costs of aircraft and aeropropulsion systems. The engine is divided into the rotating (blades, disks, shafts) and the nonrotating (vanes, cases/containment, ducts, nozzle components) structural components, and an assessment of each is given. Beginning with boron fibers, new materials development is discussed. The most significant recent developments in metal matrix materials are in the area of improved processing, mainly the establishment of super-plastic forming/diffusion bonded processing techniques for titanium and the introduction of high quality powder processing for aluminum. In the 1980's composite aircraft on the drawing boards should be designed with composite engines. K.S.

A81-43165 # **Hydrogen fueled catalytic combustion for low thrust expendable turbojet engine.** W. C. Elrod (USAF, Institute of Technology, Wright-Patterson AFB, OH), J. D. Durniak (USAF, Carswell AFB, NM), and L. E. Taylor. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1715.* 5 p. 8 refs.

The performance of low cost expendable turbojet engines established from commercially available automotive type turbosuperchargers was investigated. The engine development centered primarily around obtaining a combustor design that would provide acceptable performance. Several types of combustors, both conven-

tional and non-conventional, were examined. A hybrid design evolved incorporating fuel injection into a low velocity recirculation region in the dome followed by a catalytic element and requiring no ignition system when operated with hydrogen fuel. In addition, the catalytic element served to reduce the pattern factor at the combustor exit and should insure complete reaction of the fuel/air mixture. (Author)

A81-43166 # **Industrial leadership of an aircraft design class.** T. D. Reed (Oklahoma State University, Stillwater, OK) and E. F. Kraus (Cessna Aircraft Co., Wallace Div., Wichita, KS). *American Institute of Aeronautics and Astronautics, Aicraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1723.* 12 p. 6 refs.

An aircraft-design class at Oklahoma State University was led by personnel from the Wallace Division of Cessna Aircraft Co. during the 1981 spring semester. The class was assigned the design of a 30-passenger, turboprop transport; a design project similar to part of a study which Cessna personnel had recently completed under NASA sponsorship. The class was organized into four technology groups: (1) aerodynamics and performance, (2) propulsion, (3) stability and control, and (4) a configuration group. Class meetings were held on-campus one afternoon per week and were supplemented with four class trips to Cessna. The last trip consisted of an oral presentation to a panel of Cessna engineers who had direct experience with the design of small transport aircraft. The lecture contents, reference materials, and group dynamics are discussed. Along with results of the students' design efforts, the responses of students to the format of this course are also summarized. Finally, the advantages of involving engineers from industry in aircraft design classes are summarized, and two criteria are identified as being essential to a successful course. (Author)

A81-43169 # **The turboprop aircraft role in the 1980s.** J. W. Sandford (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1730.* 11 p.

An examination is presented of the operating economics of turboprop aircraft. After a discussion of the roles currently being played by such aircraft, a projection is made of their importance to world airline systems in the 1980s and 1990s. Specific comparisons between turbojet/turbofan and turboprop aircraft applications are given, and extensive reference is made to the design and performance features of (1) the Dash 8 30-passenger aircraft and (2) the Dash 7 and 7000 (50 and 72 passengers, respectively) aircraft; which are proposed as examples of what will best exploit the emerging market in commuter aircraft. O.C.

A81-43170 # **The PW100 commuter powerplant.** M. D. Stoten (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1731.* 7 p.

The studies which led to the design of the PW100 family of turbine engines are described, emphasizing the commuter airline application. The needs of this particular market as understood by the engine manufacturer are discussed. The engine studies which were performed are described, including studies of various component layouts as well as the thermodynamic cycle optimization, and engine to airframe integration. Some current ratings of the engine are shown with the appropriate airframes. Finally, the need for flexibility in rating the engine is illustrated, as well as the desire to make a commercial engine suit the needs of various market segments. Some of the changes necessary to suit the engine to these other markets are described. (Author)

A81-43171 # **Articulating user requirements for the commuter aircraft industry.** R. L. Kaplan (Rumson Corp., McLean, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1733.* 8 p. 6 refs.

The paper presents the magnitude estimation scaling (MAGNES) technique for synthesizing the collective desires of the airline community and providing a weighted priority list of parameters, including range payload, cruise speed, passenger comfort and fuel economy. Also discussed is the technique's insight into special requirements of major operator subgroups so that the ultimate design can be optimized for the broadest market appeal. In addition, the designer's dilemma, MAGNES as a research tool, and a typical application are presented. MAGNES is found to be a mathematically defensible synthesis of the user desires that permits the making of judicious trade-offs with more reliability, sensitivity and utility than other popularly employed research methodology. D.L.G.

A81-43172 # **Standard Avionics Testbeds.** J. C. Slavicek (USAF, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1734.* 7 p.

The Standard Avionics Testbed program is a first attempt to make the 4950th Test Wing, Wright-Patterson AFB, Ohio, more flexible, responsive, and economical. The program will be a continuous effort consisting of several iterations and updates, as a response to test environment and customer needs. The objective of the Standard Avionics Testbed program is to prepare and maintain aircraft in a project-ready status. A list of common test instrumentation items was compiled, and the use of a standard test pallet station was recommended to decrease the time needed for installation and removal. Three main areas of flight test were chosen for initial planning and action, including electromagnetic countermeasures, electrooptical/infrared, and communication and navigation. Customer requirements are continually reviewed to evaluate present aircraft capabilities and prepare changes to the existing fleet. Savings in time, as well as in design, fabrication, modification, and demodification steps are cited as advantages in maintaining testbed aircraft in a standard configuration. J.F.

A81-43173 # **Application of pulse code modulation technology to aircraft dynamics data acquisition.** D. Brown (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1736.* 10 p. 10 refs.

This paper discusses the application of PCM (pulse code modulation) digital techniques to record dynamics data (20 kHz bandwidth) during flight tests. This approach is compared with current FM (frequency modulation) analog data recording technology and is found to provide a significant increase in both dynamic range and number of data channels recorded simultaneously. The design of a PCM airborne recording system is presented which will be capable of recording simultaneously 144 channels of 20 kHz data with 66 dB dynamic range during an eight hour flight. The objective is to reduce the costs associated with flight testing required to solve vibration/acoustic problems and to define/verify design specifications. (Author)

A81-43175 * # **On making things the best - Aeronautical uses of optimization /Wright Bros. lecture/.** H. Ashley (Stanford University, Stanford, CA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1738.* 33 p. 176 refs. Grants No. AF-AFOSR-79-0061; No. NGL-05-020-243.

The paper's purpose is to summarize and evaluate the results of an investigation into the degree to which formal optimization methods have contributed practically to the design and operation of atmospheric flight vehicles. The nature of this technology is reviewed and illustrated with simple structural examples. A series of published successful applications is described, from the fields of aerodynamics, structures, guidance and control, optimal trajectories and vehicle configuration optimization. The corresponding improvements over conventional analysis are assessed. Speculations are offered as to why these tools have made such little headway toward acceptance by designers. The growing need for their use in the future is explained; they hold out an unparalleled opportunity for improved efficiencies. (Author)

A81-43376 **Modelling of gusts and wind shear for aircraft assessment and certification.** J. G. Jones (Royal Aircraft Establishment, Flight Systems Dept., Bedford, England). *Indian Academy of Sciences, Proceedings (Engineering Sciences),* vol. 3, Mar. 1980, p. 1-30. 45 refs.

The paper examines the development of a statistical discrete-gust model of turbulence which takes a discrete ramp gust as a basic element from which representative gust patterns may be built up and related to probability of occurrence. On this basis an alternative approach to aircraft certification has been proposed in which the assessment of a particular design (of the aircraft or the gust alleviation system) involves a systematic search over a specified family of equiprobable gust patterns for a worst case which produces maximum aircraft response. An important feature of the method is that the worst-case response may be directly related to the statistical characteristics of response when the input has a random character representative of real turbulence. The technique is illustrated with particular reference to the assessment of autoland systems in severe wind shear and to limit-load criteria. B.J.

A81-43395 # **Conditions for safe separation of external stores.** E. E. Covert (MIT, Cambridge, MA; USAF, European Office of Research, Colorado Springs, CO). *Journal of Aircraft,* vol. 18, Aug. 1981, p. 624-630. 5 refs.

The trajectory of external stores ejected from a carrier aircraft is studied with the goal of developing straightforward safe separation criteria. It is shown that the initial velocity and initial acceleration provide a means of defining a sufficient condition for safe separation. This condition is sufficiently simple that it can be programmed on handheld computers. Since the condition is only sufficient, any store that fails to satisfy the condition requires a further more detailed study to determine whether its separation is safe or not. (Author)

A81-43396 # **Vertical momentum of the fountain produced by multijet vertical impingement on a flat ground plane.** K. T. Yen. *Journal of Aircraft,* vol. 18, Aug. 1981, p. 650-654. 10 refs.

An analysis of the vertical momentum flux for the fountain produced by multijet vertical impingement on a flat ground plane is presented. The jets are considered to have equal thrust and the same exit diameter, equally spaced on a bolt circle. Analytical formulas for both the core and arms of the fountain have been derived and show the dependence on the height, planform size, and number of jets. Preliminary numerical comparison with some experimental data indicates the formulas to be capable of producing acceptable predictions. Comparison made with Kuhn's empirical formulas revealed some similarity as well as differences between the two sets of formulas. Additional work needed for the development of prediction methods for lift losses is suggested. (Author)

A81-43520 # **Technology for rustproofing aircraft and helicopters (Tekhnologiia okraski samoletov i vertoletov).** I. I. Denker. Moscow, Izdatel'stvo Mashinostroenie, 1980. 120 p. 7 refs. In Russian.

Materials and techniques employed for corrosion protection of aircraft and helicopters are discussed in detail. Attention is given to the fundamentals of corrosion and metals protection; structural materials used in aircraft; composition and properties of paints, solvents, plasticizers, cutting agents, dessicants, pigments, and fillers; surface preparation, and coating techniques. The techniques discussed include air and airless paint spraying, electrostatic spraying, dip coating, brush application, and electrical deposition. Chapters on special-purpose coatings, quality control, and safety techniques are included. V.L.

A81-43563 Real-time fluoroscopic imaging system for honeycomb bond structures. M. T. Wilcox and D. L. Hanson (General Dynamics Corp., Fort Worth, TX). *(American Society for Nondestructive Testing, Spring Conference, Philadelphia, PA, Mar. 24-27, 1980.) Materials Evaluation,* vol. 39, Aug. 1981, p. 844-848. 6 refs.

General Dynamics utilizes an automated, specially designed, real-time fluoroscopy imaging system for NDT inspection of lightweight, composite bonded F-16 aircraft components for core defects, foreign objects and bonding voids. The remotely operated material handling and X-ray system allows operator selection of video recording and radiographic capabilities in automatic or manual modes. Many options are available to modify or increase the present system's capabilities. Implementation of the real-time imaging system has resulted in reduced inspection man-hours, improved techniques and increased savings. (Author)

A81-43583 Nonlinear estimation of generalized vector shot processes. A. Z. Meiri (Armament Development Authority, Haifa, Israel) and B. Porat (Technion - Israel Institute of Technology, Haifa, Israel). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-17, July 1981, p. 520-530. 11 refs.

A class of nonlinear filters for dynamical systems driven by generalized Poisson processes is developed. One of the filters, the maximum a posteriori (MAP) filter, is shown by a numerical example to be superior to other known predictors in getting the highest target hit probabilities, and it is relatively simple to implement. This filter has applications in both fire control and air traffic control of maneuvering piloted vehicles. (Author)

A81-43606 Composites - A solution to aluminum honeycomb maintenance costs. C. W. Schneider (Lockheed-Georgia Co., Advanced Structures Dept., Marietta, GA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 66-76. USAF-sponsored research.

The way in which composites can be used to cure chronic repair and maintenance problems on in-service aircraft is described. It is noted that several programs have been conducted to show that composite replacement parts can be a cost-effective alternative to continued repair of honeycomb assemblies. In one recently completed program, which produced 10 composite left-hand leading edges for an extended service evaluation as a honeycomb replacement, significant cost reductions were shown for composite vs. honeycomb leading edge production. It is shown that reduced repair and maintenance costs can offset the acquisition costs of the composite spares. The service history of honeycomb structures is surveyed. Attention is given to the production aspects and the limited service experience that has thus far been accumulated for composite leading edges. C.R.

A81-43607 * **NASA service experience with composite components.** H. B. Dexter and A. J. Chapman (NASA, Langley Research Center, Hampton, VA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 77-99. 19 refs.

NASA Langley has been active in sponsoring flight service programs with advanced composites during the past decade. A broad data base and confidence in the durability of composite structures are being developed. Flight service experience is reported for more than 140 composite aircraft components with up to 8 years service and almost two million successful component flight hours. Composite components are being evaluated on Boeing, Douglas, and Lockheed transport aircraft. Components are currently under development for service evaluation on Bell and Sikorsky helicopters. Design concepts and inspection and maintenance results are reported for components currently in service. Components under development in the NASA Aircraft Energy Efficiency (ACEE) program are discussed. Results of flight, outdoor ground, and controlled laboratory environmental tests on composite materials used in the flight service programs are also presented. (Author)

A81-43615 S-3A composite spoilers service experience. R. C. Knight (Vought Corp., Dallas, TX) and E. L. Rosenzweig (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 186-196. 5 refs.

In August of 1976, Vought Corporation and the Naval Air Development Center embarked on a five-year program to evaluate the performance of S-3A graphite/epoxy lower spoilers in a service environment. A total of 14 shipsets (28 total spoilers) were put into service with Naval squadrons. Ten shipsets were installed on squadron aircraft, with four shipsets retained as spares. To date, the S-3A composite spoilers have logged in excess of 10,500 flight hours, accomplishing over 12,600 landings. While no incidences of spoiler damage during flight have been reported, a variety of damages have occurred during maintenance and handling. A summary of spoiler usage, damages, repairs, and post service testing is detailed in the following text, along with a discussion of the problems encountered

in monitoring and maintaining composite structure in service.
(Author)

A81-43616 **Commercial composite component service experience.** R. L. Stoecklin (Boeing Military Airplane Co., Seattle, WA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 197-209.

It is noted that substantial effort has been expended, and continues to be expended, in order to establish the practicality of using advanced composite materials for commercial airplane structures. As part of this effort, flight service test data are used to complement laboratory test results and to validate the long-term structural integrity of the material, design, and manufacturing process. Several programs for obtaining relevant in-service experience are described. It is noted that both the 757 and 767 have made commitments to design the following components in advanced composite materials: rudder, elevators, ailerons, landing gear doors, spoilers, cowl panels, and numerous fixed panels and fairings. C.R.

A81-43617 **A-7 composite outer wing service experience.** J. H. Pimm (Vought Corp., Dallas, TX) and F. J. Fechek (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 210-222. USAF-supported research.

The performance of composite outer wing panels (COWP's) installed in Air Force A-7D aircraft in 1977 is evaluated. The structure of the panels is described, as in the manufacturing procedure. The normal maintenance procedures are listed. It is noted that to date, no major defect, mishap, or occurrence has required significant corrective action on the composite outer wing panels. Of the minor discrepancies that have been uncovered, a representative sampling is presented and discussed. C.R.

A81-43624 **Manufacture of cost-affordable high performance titanium components for advanced Air Force systems.** D. Eylon (Metcut Research Associates, Inc., Materials Research Group, Wright-Patterson AFB, OH), M. Field (Metcut Research Associates, Inc., Cincinnati, OH), F. H. Froes, and G. E. Eichelman (USAF, Materials Laboratory, Wright-Patterson AFB, OH). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 356-367. 41 refs. Contract No. F33615-79-C-5152.

Near net shape technologies and machining of titanium alloy aerospace components are investigated for lower cost and high performance in advanced Air Force systems. Near net shape technologies discussed include casting powder metallurgy, superplastic forming and diffusion bonding, which are found to reduce input of titanium alloy mill product, cut back required machining, and improve properties. Titanium alloy machining advancements include lowering the cost and improving surface integrity leading to better fatigue strength. Also discussed is the increasing role of non-aerospace industry, which is expected to share the burden of titanium technology development, and increase effective production. D.L.G.

A81-43627 **Development of graphite-epoxy covers for L-1011 advanced composite vertical fin.** A. C. Jackson (Lockheed-California Co., Burbank, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 414-423.

Three ship sets of covers have been fabricated for the L-1011 advanced composite vertical fin (ACVF). The work was performed in connection with a contract, which calls for the design and fabrication of three full-scale fin boxes for static test, damage tolerance, and fail-safe tests. The tests verified the analysis methods used. Test failures were generally higher than predicted demonstrating that the allowables used were conservative. All predictions were made using average material property data. The structural integrity of the covers has been demonstrated to be adequate to proceed with the fabrication of the full scale covers for the three fin boxes. G.R.

A81-43628 **Advanced composite applications in McDonnell Dougals commercial transport aircraft.** D. J. Watts and N. R. Lee (Douglas Aircraft Co., Long Beach, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 424-437. 8 refs.

Applications of graphite/epoxy and Kevlar/epoxy material on DC-9 and DC-10 aircraft are discussed. A review is presented of the development program necessary for the introduction of composite structures in commercial aircraft, giving particular attention to the necessity to develop a secondary composite structure for flight service evaluation. This flight service evaluation will provide a valuable insight into the service durability and maintenance characteristics of these composite materials to the mutual benefit of the commercial airline operators and the aircraft manufacturer. A description is presented of the Kevlar/epoxy DC-9 tailcone and the DC-9 Super 80 hybrid Kevlar/graphite/epoxy engine nacelle structure. Future plans are discussed for the development and production utilization of advanced composite structures. G.R.

A81-43629 **Composite Wing/Fuselage Program.** J. Eves (Northrop Corp., Hawthorne, CA). In: Materials 1980; Proceedings of the Twelfth National Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 438-448. 5 refs. USAF-sponsored research.

To provide the confidence levels required to encourage the widespread use of composites in primary structural applications, structural validation procedures and durability design methodology are needed. The Wing/Fuselage Program has been planned to provide a data base that will facilitate both the development of low cost validation procedures and the verification of the durability design methodology. In obtaining this data base, the program will validate the durability of the detail design concepts, exercise the manufacturing techniques in a production environment, and perform detailed cost tracking. Attention is given to the program objective, the baseline vehicle, the preliminary design, test specimen selection, durability design methodology, durability testing methodology, and manufacturing technology. G.R.

A81-43630 **Electrical/electromagnetic concerns associated with advanced composite materials in aerospace systems.** C. L. Blake and J. C. Corbin, Jr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 449-460. 17 refs. USAF-sponsored research.

It is pointed out that an increasing use of composites instead of metal in aircraft structures can lead to substantial changes in the electromagnetic characteristics of the aircraft. Largely taken-for-granted features of the all-metal aircraft, such as readily available 'common ground' return paths for signal and power, and a low impedance, high conductivity outer skin for carrying direct lightning strike currents, will have to be reexamined. A new technology data base will have to be established if design changes have to be made to assure safe and satisfactory aircraft operation. In connection with the considered development, an assessment study was requested by Air Force Headquarters. The primary objective of the assessment was to determine the status of advanced composite material development in areas associated with possible electrical/electromagnetic (E/EM) impacts to aerospace systems. Attention is given to the conduct of the study, the scope of the study, implementation studies, design capability, design data, and E/EM concerns. G.R.

A81-43631 **Graphite thermoplastic YC-14 outboard elevator.** S. Oken (Boeing Aerospace Co., Seattle, WA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 461-481.

To demonstrate the improved performance and cost savings made available by use of advanced fiber reinforced thermoplastics (AFRTP), full-scale components were fabricated and tested. The components evaluated were YC-14 outboard elevators that were 19 feet long and had a maximum chord of 18 inches. They were tested both statically and in fatigue. Evaluation results showed that the

graphite/thermoplastic elevators offered a 27% weight savings and over a 20% cost when compared to equivalent aluminum structure. The work performed in this program was sponsored by Material and Flight Dynamics Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson AF Base, OH. (Author)

A81-43636 Advanced titanium metallic materials and processes for application to naval aircraft structures. W. T. Highberger (U.S. Naval Air Systems Command, Washington, DC), G. R. Chanani, and G. V. Scarich (Northrop Corp., Aircraft Div., Hawthorne, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 539-553. 6 refs.

A description is given of three major efforts to reduce the cost or improve the performance of titanium components on naval aircraft. The efforts are related to isothermal rolling, hot isostatic pressing (HIP) of titanium powder, and superplastic forming/diffusion bonding (SPF/DB) of Ti-6Al-4V and CORONA-5. Three programs to produce near-net shape parts by HIP of titanium powder for two Navy aircraft, the F-14 and the F-18, are reviewed. The first program demonstrated the feasibility of manufacturing a HIP titanium powder component, an F-14 fuselage fitting, and established its flight worthiness, reproducibility, and economics. Success with the small F-14 fuselage fitting led to a scale-up effort on the F-18 aircraft arrestor hook support fitting. In the third program an F-14 nacelle frame with a flying weight of 53 pounds will be fabricated by electron beam welding four HIPed powder subcomponents into an oval-shaped frame section. G.R.

A81-43637 Advanced aluminum metallic materials and processes for application to naval aircraft structures. W. T. Highberger (U.S. Naval Air Systems Command, Washington, DC), G. V. Scarich, and G. R. Chanani (Northrop Corp., Aircraft Div., Hawthorne, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 554-562. 9 refs.

The use of hot isostatically pressed aluminum castings and aluminum-lithium alloys has been explored in an effort to reduce the cost and improve the performance of aluminum components in naval aircraft. It is found that hot isostatic pressing of A201-T7 alloy improves its ductility, toughness, and fatigue strength. The resulting mechanical properties of A201-T7 are competitive with those of 7075-T7351 and 7050-T73651, two commonly used aircraft structural alloys. Aluminum-lithium alloys have demonstrated high modulus and low density with adequate strength. V.L.

A81-43638 Concurrent superplastic forming/diffusion bonding of titanium airframe components. G. W. Stacher (Rockwell International Corp., North American Aircraft Div., Los Angeles, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 563-571. 5 refs.

Concurrent superplastic forming and diffusion bonding titanium fabrication processes are compared to conventional titanium manufacturing methods for application to advanced aircraft structures. Superplasticity in conjunction with diffusion bonding is found to result in significant cost and weight savings averaging between 30 and 50 percent. The process also permits the manufacturing of parts that could not otherwise be produced, including parts formed from single sheet and formed and bonded hollow sections, and complex sandwich structures. Fabricated sandwich structures also discussed include T-38 strut doors, landing gear cylinders, and wing panels. The B-1 aircraft is given as an example, featuring 26 different titanium configurations. D.L.G.

A81-43642 Quality assurance of an epoxy resin prepreg using HPLC. G. L. Hagnauer and D. A. Dunn (U.S. Army, Army Materials and Mechanics Research Center, Watertown, MA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 648-655.

Since the processability and properties of epoxy-based composites are related to the chemical composition of prepreg materials, quality assurance methods are needed to guarantee that the compositions of prepregs are consistent from batch-to-batch. This paper discusses the implementation of high performance liquid chromatography (HPLC) as a quality assurance method to monitor the composition of the glass fiber-epoxy resin prepreg SP250. The prepreg composition is evaluated and test procedures are developed to 'fingerprint' and quantitatively analyze specific resin components. Formulation standards are used for calibration and variations in the composition of SP250 prepreg batches obtained over a four year period are monitored and analyzed statistically. The effects of formulation changes, prepregging operations, and prepreg staging and aging on chemical composition are considered. (Author)

A81-43644 * A low-cost forward fairing for the Bell Long Ranger Helicopter. H. Zinberg (Bell Helicopter Textron, Fort Worth, TX). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 678-687. NASA-Army-sponsored research.

A description is presented of work concerned with determining the effects of long-term flight service on advanced composite helicopter airframe components. The helicopter chosen for the program is the Long Ranger Model 206L. The components to be evaluated include the baggage door, litter door, vertical fin, and forward fairing. Only the vertical fin is classified as primary structure. Loss of any of the other components will not compromise safety of the aircraft. Attention is given to the program objectives, the design of the forward fairing, the fabrication procedures, the exterior surface, the cocure procedure, material tests, and initial cost-tracking. The considered program demonstrates the ability to produce an acceptable fairing by the 'one-shot' cocured process and, based on learning curve experience, production costs will be low. The low-temperature 200 F cure does not affect the structural properties to an unacceptable degree. A method for obtaining a smooth, exterior painted surface for Kevlar/epoxy fabric has been developed. G.R.

A81-43645 * Development of repair procedures for graphite/epoxy structures on commercial transports. R. H. Stone (Lockheed-California Co., Burbank, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 688-701. Contract No. NAS1-15269.

A program is currently being performed for NASA-Langley on development of composite repair procedures adapted to the requirements of commercial airlines. The first phase of the program included a survey of airline damage experience and airline maintenance and repair capabilities for composite structures. A survey was also conducted for available data on composite damage tolerance. The second phase of the program evaluated various depot and field level repairs ranging from precured bonded graphite flush patches to mechanically attached aluminum patches. Based on airline survey results, the emphasis was on field repairs. The results verified the effectiveness of field type repairs for lightly loaded composite structure. (Author)

A81-43646 Manufacturing the F-16 composite horizontal tail. R. J. Stout (General Dynamics Corp., Fort Worth, TX). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980.
Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 702-713.

The F-16 horizontal tail, which is currently being produced at a rate of approximately 40 units/month, consists of graphite/epoxy skins adhesively bonded to aluminum honeycomb core and a welded one-piece titanium spar, rib, and pivot shaft. A general manufacturing sequence and data on the impact of relative humidity on production facilities and on materials properties are presented. (Author)

A81-43650 Metallographic analysis techniques used during the Cast Aluminum Structures Technology /CAST/ program. J. W.

Faber (Boeing Commercial Airplane Co., Seattle, WA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 768-775. Contract No. F33615-76-C-3111.

During the manufacturing development activities of the CAST program, an extensive amount of work was conducted to gain an understanding of the metallurgical structure of aluminum casting alloy A357 and its relationship to foundry variables such as chilling. An important part of the work involved the study of dendrite arm spacing (DAS) in the casting microstructure. This paper discusses how DAS technology was applied in the CAST program. Also discussed are procedures used for measuring DAS on the surface of YC-14 body/nose landing gear support bulkhead castings by means of portable grinding, polishing, etching, and replicating equipment. (Author)

A81-43652 High-char-forming composite laminates. N. R. Byrd, T. L. Sterrett, and D. Peek (Douglas Aircraft Co., Long Beach, CA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 808-815.

Use of graphite/resin composites in engine nacelles has been restricted because the resin is flammable. Fiberglass/polyimide and graphite/polyimide laminates were treated with various phosphorylated polymers to obtain enhanced fire-resistance and high-char-yield products after exposure to a 2000 F flame for 15 minutes. Tensile, flexural shear, and interlaminar shear strengths were determined. Polymeric phosphorylated hydrazides were found to give the best fire-resistance. (Author)

A81-43653 Textile materials for commercial transportation vehicles. S. A. Hasselbrack (Boeing Commercial Airplane Co., Seattle, WA). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 816-828.

Complete laboratory testing has been done on two hundred fabrics that encompass a wide variety of fiber types and fire-retardant (FR) finishes. Texturized filament FR polyester, FR rayon, FR rayon/wool blends or combinations, and wool or wool/nylon blends treated with an FR finish that also inhibits smoke production have been found to possess good flammability characteristics with acceptable asthetic and in-service durability characteristics. Selected fabrics were evaluated for 'wear' on the Boeing Seat-Wear Tester, for which limited correlations with in-service wear are available. A large number of carpets comprised principally of wool, wool blends, nylon and Nomex have been tested. Improved flammability characteristics have been achieved by using the low-smoke FR finish on wool, and by the incorporation of a new backcoating material. In-service carpet wear has been evaluated by a simulated airline food/beverage cart moving back and forth over a test sample. Future work is designed to study the effect of fabric construction on flammability characteristics. (Author)

A81-43663 Materials and processes for a small remotely piloted vehicle. A. Molcho (Israel Aircraft Industries, Ltd., Lod, Israel). In: Materials 1980; Proceedings of the Twelfth National Technical Conference, Seattle, WA, October 7-9, 1980. Azusa, CA, Society for the Advancement of Material and Process Engineering, 1980, p. 971-976.

A small remotely piloted vehicle (R.P.V.) was designed and built to perform various civil and military tasks. Materials selection considerations, design and fabrication processes, are discussed both for prototype and for production series. Some of the more problematical components such as the main landing gear are discussed in more detail demonstrating the special problems involved with this type of flight vehicle. (Author)

A81-43708 * Airborne antenna pattern calculations. T. J. Knerr, P. R. Schaffner, R. R. Mielke (Old Dominion University, Norfolk, VA), and M. C. Gilreath (NASA, Langley Research Center, Flight Electronics Div., Hampton, VA). In: SOUTHEASTCON '80; Proceedings of the Region 3 Conference and Exhibit, Nashville, TN, April 13-16, 1980. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 69-73. 7 refs. Grant No. NsG-1655.

A procedure for numerically calculating radiation patterns of fuselage-mounted airborne antennas using the Volumetric Pattern Analysis Program is presented. Special attention is given to aircraft modeling. An actual case study involving a large commercial aircraft is included to illustrate the analysis procedure. (Author)

A81-43715 # Digital controls in a large engine test facility. J. R. Rickard and D. C. Bond (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, TN). In: SOUTHEASTCON '80; Proceedings of the Region 3 Conference and Exhibit, Nashville, TN, April 13-16, 1980. New York, Institute of Electrical and Electronics Engineers, Inc., 1980, p. 107, 108.

The Aeropropulsion System Test Facility (ASTF) considered, consists of an air supply system composed of six axial-flow compressors driven by synchronous electric motors ranging up to 52,500 HP, air heating and cooling devices, test cells, and twelve exhaust compressors also driven by synchronous electric motors. In operation, air is metered into a test cell containing an engine. The air is conditioned in terms of temperature, pressure, and flow rate to simulate conditions anticipated by the engine in its expected operating environment. Air paths in ASTF are established by opening and closing large 'butterfly' valves that interconnect the system ducting. A key element in achieving safe operation is a Configuration Control System (CCS). A CCS is provided on each side of the test cell. Each CCS is designed as a minicomputer-based digital data acquisition, processing, and control system. Each is capable of providing both analog voltages (for setting control valves) and tristate relay contacts (for actuating configuration valves). G.R.

A81-43770 Directionally solidified Soviet superalloy - ZHS6-K. S. N. Tewari (Defence Metallurgical Research Laboratory, Hyderabad, India). *Journal of Materials Science*, vol. 16, Aug. 1981, p. 2193-2197. 14 refs.

Directional solidification of the Soviet superalloy, ZHS6-K, has been carried out in an argon atmosphere. Tensile and stress-rupture properties have been measured for the investment cast and directionally solidified (DS) alloy. The DS alloy shows a several fold increase in rupture life and ductility compared with the investment cast alloy. It also shows improved tensile properties. Stress-rupture and tensile fracture behavior has been examined. (Author)

A81-43773 Possibility of development of an electron-fractographic method for measuring stress level produced by fatigue fracture of the material. G. V. Bondal and T. V. Kolesnikova. *(Zavodskaia Laboratoriia*, vol. 46, Dec. 1980, p. 1133-1136.) *Industrial Laboratory*, vol. 46, no. 12, June 1981, p. 1280-1283. Translation.

Gas turbine compressor blades of EI961 steel were fractured in a vibrator at four different bending stress levels and the fractures were examined in an electron microscope. The objective of the study was to correlate changes in the pitch of a groove formed along the fatigue crack length with the level of applied stress. An empirical expression has been obtained which can be used to determine the stress (in MPa) causing the fatigue fracture of a part with an error not exceeding 7.5%. V.L.

A81-43774 Determination of fatigue life by testing materials for thermal fatigue. A. I. Vashunin and P. I. Kotov (Moskovskii Aviatsionny i Tekhnologicheskii Institut, Moscow, USSR). *(Zavodskaia Laboratoriia*, vol. 46, Dec. 1980, p. 1136-1139.) *Industrial Laboratory*, vol. 46, no. 12, June 1981, p. 1283-1286. 6 refs. Translation.

The thermal fatigue behavior of EP693VD alloy has been investigated in the temperature range 473-1133 K in order to assess the usefulness of thermal fatigue data for predicting the fatigue life of components under low-cycle nonisothermal loading. It is shown that in thermal fatigue testing with varying rigidity, the amount of accumulated one-sided strain in the fracture zone tends toward the limiting plasticity of the material. The use of thermal fatigue curves as a basis for determining the resistance to nonisothermal low-cycle fatigue is only possible with accumulated quasistatic damage of less than 5% of the plasticity available. V.L.

A81-43890 **Calculation of the impingement of cloud droplets in a cylinder by the finite-element method.** P. McComber (Québec, Université, Chicoutimi, Canada) and G. Touzot (Compiègne, Université de Technologie, Compiéqne, France). *Journal of the Atmospheric Sciences*, vol. 38, May 1981, p. 1027-1036. 10 refs. Research supported by the National Research Council of Canada and Ministère de l'Education de Québec.

The numerical solution of equations describing the motion of water droplets in the airflow around a cylinder is obtained by the finite element method. The velocity field of the droplets is determined by the solution of the nonlinear partial differential equations using a Newton-Raphson iterative procedure, which yields local impingement efficiencies at the cylinder surface from which the total collection efficiency may be found by numerical integration. Comparison of the results with those obtained by Langmuir (1946) with an analog computer shows a maximum difference of 13 percent for the total collection efficiencies. An example is also given of the application of the finite element scheme to the determination of local impingement efficiency for an arbitrary shape. O.C.

A81-43933 # **From paleoaeronautics to altostratus - A technical history of soaring.** M. K. Chen and J. H. McMasters (Boeing, Commercial Airplane Co., Seattle, WA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1611*. 22 p. 38 refs.

An overview of the evolutionary process which has led to the technical and aesthetic triumph of the modern sailplane is presented. An unconventionally long time scale is selected in order to place this significant but often poorly appreciated line of aeronautical development in proper historical context. The story progresses from the true dawn of flight, with the emergence of biological flying devices (animophilous seeds, pterosaurs), through a discussion of future trends in sailplane development. Technological advances in aerodynamics, materials and structures, which in their culmination, have made possible the construction of sailplanes with wings of aspect ratio approaching 40 and measured lift-to-drag ratios of over 50 are discussed. (Author)

A81-43934 * # **Historical trend in the research and development of aircraft.** M. L. Spearman (NASA, Langley Research Center, Aeronautical Systems Div., Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1613*. 9 p.

Results are presented from a study of aircraft design trends undertaken to determine the relationship between research, development, test and evaluation and aircraft mission capability, requirements and objectives. It is shown that while in some cases a performance objective was the primary research driver, research was the driver in the formulation of objectives in others. Among the topics discussed are: (1) speed considerations such as compressibility, propulsion and test techniques; (2) airframe considerations such as swept, delta, trapezoidal and variable-sweep planforms and mission commonality; (3) research aircraft; (4) the recent impact of computer-aided design; (5) Soviet aircraft development approaches and (6) a comparison of Soviet and U.S. military aircraft design trends. Attention is given to experimental and prototype aircraft programs which, although cancelled, anticipated significant subsequent developments. O.C.

A81-43935 # **Turboprop engine propulsion for the 1990's.** H. J. Banach and C. N. Reynolds (United Technologies Corp., Pratt and Whitney Aircraft Group, Hartford, CT). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1648*. 9 p. 5 refs.

Continuing interest in fuel efficient Prop-Fan propulsion has highlighted the need for a large horsepower advanced technology turboprop engine. The initial application could be in a 100-150 passenger short/medium range aircraft. An engine concept which could provide from 9,000 to 25,000 SHP for commercial and military applications, and which could be available for introduction to service by 1990, is described. Results of engineering studies which support the preliminary design of the power unit and the approach being taken to defining the reduction gear are presented. Key technology issues related specifically to the propulsion system are identified. (Author)

A81-43936 # **Axisymmetric approach and landing thrust reversers.** J. P. Blackman and M. F. Eigenmann (McDonnell Aircraft Co., St. Louis, MO). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1650*. 11 p. 5 refs.

An analytical study has been made of the potential benefits and penalties associated with the incorporation of axisymmetric nozzle thrust reversers on fighter aircraft, to be deployed on the aircraft final approach. Three thrust reverser concepts were investigated; two were designed for integration downstream of the primary nozzle throat and the other upstream. Integration and performance analyses of two of the concepts were conducted on a current twin-engine fighter, the F-15C, while the third was on an advanced air-to-surface (ATS) combat aircraft. The results indicate that approach thrust reversers can be incorporated in the current fighter to provide a balanced field length capability for only small weight, mission performance, and maneuverability penalties. For the advanced ATS aircraft, a significant reduction in takeoff gross weight was possible by using a thrust reverser rather than aerodynamic means (large wing and parabrake) to attain balanced field length capability. All thrust reverser concepts were shown to provide significant reductions in aircraft landing ground roll for all runway conditions. (Author)

A81-43937 # **Engine life and usage methodologies for conceptual design.** G. Blevins (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and J. G. Osmer (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, FL). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1651*. 9 p.

A methodology for the quantification of relative life/performance tradeoffs during the conceptual design phase of gas turbine engine development is presented. This methodology, which identifies the sensitivity of engine performance and weight with changes in life cycle history, will aid in the balancing of performance and life cycle goals. A computer aided design (CAD) system incorporating this methodology has been developed and demonstrated for the case of an advanced turbofan engine, for which fan, compressor, high and low pressure turbine blades and blade/disk attachments, and disks, were designed. Component life and other design criteria were addressed for the range of stresses and design-limiting modes of the various components. O.C.

A81-43938 # **Investigation of influences on the definition of engine usage for future systems.** R. J. May, Jr., D. R. Chaffee, R. P. Stumbo, and M. D. Reitz (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1652*. 9 p. 8 refs.

The use of more realistic engine usage predictions in the preliminary design of advanced propulsion systems is being encouraged by both the Air Force and the Navy. Several engine usage prediction models are under development in industry, but very little continuously recorded operational engine data exists from today's weapon systems. The Aero Propulsion Laboratory obtained about 240 hours of this type of data from several different systems and analyzed it to determine key influences for predicting engine usage. Using data from the Engine Usage Data Acquisition Program, these influences are presented with conclusions showing the relative importance of some of these factors to usage projections for future aircraft propulsion systems. (Author)

A81-43939 # **Topside weapons release - An analytical study.** H. A. King and B. W. Wedan (Northrop Corp., Aircraft Div., Hawthorne, CA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1655*. 20 p. 9 refs.

The Northrop/NEAR Store Separation Code has been used in the investigation of the novel concept of over-aircraft weapon carriage and launch. Studies have been made of various launch techniques for achieving safe separation, including piston ejection and J-Hook mechanisms, for powered and un-powered weapons. The work has concentrated on two baseline aircraft, the F/A-18 and an

Advanced Research Configuration with a flat fuselage upper surface. Consideration has been given to the operational practicality of the release systems. The theoretical studies presented indicate that the top side separation concept has the potential to be a viable solution to the problem of low level weapon delivery. (Author)

A81-43940 # **Some recent applications of high-lift computational methods at Boeing.** J. H. McMasters and M. L. Henderson (Boeing Commercial Airplane Co., Seattle, WA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1657.* 11 p. 9 refs.

An overview of the long term research effort at Boeing which has led to the development of a quasi three-dimensional viscous flow computational analysis/design methodology for multi-element high lift wing/body combinations is presented. Three examples of the application of this methodology are discussed: (1) design of a variable thickness airfoil, (2) takeoff lift-to-drag ratio improvement of a transport aircraft, and (3) maximum lift improvement of a multi-element flapped wing. (Author)

A81-43941 # **Experimental and analytical development of an advanced supersonic fighter concept.** R. R. Smith and V. Dahlem (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1659.* 7 p. 10 refs.

A presentation is made of the variety of slender, aerodynamically highly efficient supersonic aircraft configurations suitable for military use that have been developed to date by NASA. Using an aerodynamic prediction method that combines impact theory and potential theory, three configurations were proposed for single-engined fighters with highly swept wing planforms: two 74 deg-sweep planform designs derived from the SCAT-15 SST airframe family with differing airfoils, and one with a 60 deg-sweep delta planform. Wind tunnel tests were conducted at Mach numbers from 0.4 to 3.5, and the resulting test data were compared to both the hybrid-theory method and a conventional linearized potential method. O.C.

A81-43942 # **Comparison of model testing with computer simulations of an air landing system.** D. L. Fischer (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1663.* 5 p.

A time history simulation program was developed to model and predict performance of Air Cushion Landing Systems (ACLS). The accuracy of the computer program (EASY-ACLS Dynamic Simulation Program) was tested in the Mobility Development Laboratory, Wright Patterson AFB, Ohio, using a quarter scale dynamic model of the XC-8A ACLS aircraft. The results of drop test computer simulations are compared with actual test data: computer time history data showed the same characteristic shape and had reasonable matching of peak and minimum values to that of actual test data. The trunk volume had the greatest effect on the pressure and air flow in these computer simulations: a change of 0.9% in trunk volume resulted in a 33% change in trunk pressure and a 18% change in air flow. The accuracy of the computer program to predict ACLS aircraft performance makes it a valuable analysis tool for ACLS technology. J.F.

A81-43943 # **Spin research on a twin-engine aircraft.** R. R. Tumlinson, M. L. Holcomb, and V. D. Gregg (Beech Aircraft Corp., Wichita, KS). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1667.* 9 p. 13 refs.

Since 1972, NASA has been active on a broad research program to provide improved technology in the stall/spin area of general aviation. To date, this effort has involved only single-engine aircraft. Beech Aircraft Corporation has extended this research into a flight test program involving fully-developed spins on the Model 76 'Duchess' - the first such program on a light, twin-engine airplane. With NASA cooperation, the program has included spin tunnel and rotary balance testing at the Langley Research Center with radio control model testing and flight testing at Beech. The program culminated with approximately 150 spin maneuvers building up to fully-developed spins and successful recoveries. (Author)

A81-43944 # **General aviation aircraft rear-seated occupant protection - Shoulder restraints in rear seats.** R. G. Snyder (Michigan, University, Ann Arbor, MI). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1669.* 12 p. 80 refs.

The NTSB has recommended since 1964 that shoulder harnesses be required for each occupant of general aviation aircraft. The FAA presently requires a shoulder harness for each front seat in certain newly manufactured small airplanes, but not for other seat positions. This paper brings together technical background and current experience to evaluate whether shoulder harnesses should be required in rear seats. It is concluded that installation and use of shoulder harnesses in rear seats of general aviation aircraft would significantly increase occupant protection and decrease the incidence of fatal or disabling (paraplegic) spinal injuries in survivable crashes. (Author)

A81-43945 # **A preliminary divergence and flutter evaluation of an X-wing aircraft.** D. Gimmestad (Boeing Military Airplane Co., Seattle, WA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1671.* 7 p. 10 refs.

A preliminary divergence and flutter evaluation of an X-wing aircraft has been performed. This evaluation shows that the aeroelastic characteristics of the X-wing are unique. Weight, natural frequency and other properties were computed. This study has revealed no critical aeroelasticity problems that would preclude development of an X-wing aircraft. (Author)

A81-43946 * # **Lift-enhancing surfaces on several advanced V/STOL fighter/attack aircraft concepts.** D. A. Durston and S. C. Smith (NASA, Ames Research Center, Moffett Field, CA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1675.* 17 p. 16 refs.

An analysis of the relative influences of forward lift-enhancing surfaces on the overall lift and drag characteristics of three wind-tunnel models representative of V/STOL fighter/attack aircraft is presented. Two of the models are canard-wing configurations and one has a wing leading-edge extension (LEX) as the forward lifting surface. Data are taken from wind-tunnel tests of each model covering Mach numbers from 0.4 to 1.4. Overall lift and drag characteristics of these models and the generally favorable interactions of the forward surfaces with the wings are highlighted. Results indicate that larger LEX's and canards generally give greater lift and drag improvements than ones that are smaller relative to the wings. (Author)

A81-43947 # **An overview of ejector theory.** J. L. Porter, R. A. Squyers (Vought Advanced Technology Center, Dallas, TX), and K. S. Nagaraja (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1678.* 18 p. 46 refs.

A Summary/Overview of Ejector Augmentor Theory is presented. The results of the study are presented first in a description of the fundamental considerations relevant to ejector augmentor design and performance and second in a discussion of the physical phenomena associated with the various components comprising an ejector augmentor: primary nozzles, secondary inlet, mixing section and diffuser. In the theoretical discussion a limit value of static augmentation ratio which depends only on the ratio of primary to secondary stagnation pressure is formulated, and is shown that the best published experimental results approach 90% of the limit value. Conclusions regarding theoretical ejector technology based on this study are made, and recommendations for needed theoretical ejector technology research and development programs are presented. (Author)

A81-43948 # **Some eiector characteristics.** K. S. Nagaraja (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1679.* 9 p. 7 refs.

An analysis of ejector flows is developed which shows the relative effects of mixing and diffusion, and the order in which they are realized, on the performance characteristics of ejectors. It is shown that although mixing prior to diffusion generally enhances the efficiency of pressure recovery, in certain cases - e.g. in the case of ejectors with large inlet area ratios (of the order of 15 or above), the effectiveness of pressure recovery does not depend on whether mixing precedes diffusion or vice versa. When one considers other losses such as frictional loss, it is likely that simultaneous mixing and diffusion will prove to be advantageous. It is further shown that in contrast to the performance realizable from constant area mixing ducts, the ejector thrust augmentation becomes greater if the primary and the secondary streams are mixed in a constant pressure mixing duct prior to diffusing the flows. The analysis, which is based on the inviscid, incompressible assumptions, is also adapted for deriving the duct geometry in the case of constant mixing pressure. (Author)

A81-43949 # **A synopsis of the Navy A-7 Aircraft Fuel Conservation program.** W. E. Mallett (Vought Corp., Dallas, TX) and M. Herskovitz (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1681.* 8 p. 8 refs.

A description is given of the Navy Aircraft Fuel Conservation program, with emphasis on fuel conservation methods devised for the A-7 aircraft. The fundamental elements of the program are reductions in (1) aircraft weight; (2) aerodynamic drag; (3) engine specific fuel consumption; and (4) fuel losses. Weight reduction is implemented through comprehensive use of plastic composite and titanium alloy secondary structures and accessories, and the incorporation of lighter subsystems (generator, radar, armor, etc.). Aerodynamic improvements include the application of fairings and fillets to various portions of the fuselage and wing. In addition, the efficiency of peripheral pneumatic and hydraulic systems' power extraction from the engine is increased through redesign. A description is given of the onboard Flight Performance Advisory System. O.C.

A81-43950 * # **Progress in supersonic cruise technology.** C. Driver (NASA, Langley Research Center, Aeronautical Systems Div., Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1687.* 11 p. 23 refs.

It is reported that nine years of NASA research have yielded significant design solutions in such matters pertaining to large supersonic cruise vehicles as aerodynamics, structures, propulsion, noise reduction, takeoff and landing procedures, and advanced configuration concepts. Attention is given to the incremental performance gains achieved over the years (with the Concorde SST as baseline reference), arrow wing planform performance potential, superplastic forming/diffusion bonding of titanium alloy primary structures, advanced engine cycles, twin-fuselage high-capacity configurations, and the potential military payoff of SST research. It is concluded that the greatest promise for future research and development lies in fiber-reinforced, high-temperature metal structures and the twin-fuselage configuration. O.C.

A81-43952 # **Military aircraft technology - Needs and trends for the 80's.** R. C. Barlow, G. K. Richey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and K. I. Collier (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1691.* 10 p.

A series of recommendations are made toward the design of the next generation of tactical and strategic combat aircraft, with emphasis on STOL operation and advanced avionics and fire control systems. Among the topics covered are thrust reversal and vectoring, novel landing gear designs, integrated digital flight/fire control electronics, alternative mission profiles, and advanced aerodynamic and structural airframe technology integration. Attention is given such novel construction techniques as superplastic forming/diffusion bonding of titanium alloy, advanced composites, and cast aluminum alloy primary structures. Consideration is also given to the configuration design goals of low IR signatures and low radar cross-section. O.C.

A81-43953 # **Development of airframe structural design loads prediction techniques for flexible military aircraft - Theoretical development.** J. J. Hosek, P. F. Lyons (General Dynamics Corp., Fort Worth, TX), and C. J. Schmid (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1696.* 18 p. 28 refs. Contracts No. F33615-C-74-3010; No. F33615-C-75-3131; No. F33615-C-77-3030.

A computerized structural design loads prediction technique (FLEXLODS) was developed for application to general flexible aircraft having multiple lifting surfaces, bodies and external store combinations. The technique unifies the structural and aerodynamic technologies which yield equations of motion for computing the steady and unsteady response over the Mach range. The program has both preliminary and detail design capabilities. For preliminary design usage, the program contains algorithms that compute the airplane stiffness and aerodynamic influence coefficients, the respective algorithms utilize as input the gross airplane parameters such as aspect ratio, wing area, thickness ratio, fuselage fineness ratio, material properties, etc. In this manner, it is possible to conduct in a rapid fashion technical analyses that are brief and specifically aimed at an evaluation of the effect of changes in the major design parameters that are uniquely associated with the vehicle's physical aerodynamic and structural features under flexible conditions. (Author)

A81-43954 # **Development of airframe structural design loads prediction techniques for flexible military aircraft - Applications.** P. F. Lyons, J. J. Hosek (General Dynamics Corp., Fort Worth, TX), and C. J. Schmid (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1697.* 11 p. 8 refs. Contracts No. F33615-C-74-3010; No. F33615-C-75-3131; No. F33615-C-77-3030.

The FLEXLODS program is of modular construction. The functions and computations are performed independently by each respective module. In this manner, each module is easily verified as to its credibility on an individual basis prior to its integration into the total system. For example, in the structural area correlations will be shown between analytical results and experimental data as to the structural deformation characteristics utilizing various wing planforms; and in the aerodynamic area correlations between analytical results and experimental data such as chordwise distributions, span load distributions, total vehicle lift, pitching moment data, etc., will be provided. (Author)

A81-43955 # **AFTI/F-16 advanced multimode control system design for task-tailored operations.** A. F. Barfield, B. W. Van Vliet (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and D. C. Anderson (General Dynamics Corp., Fort Worth, TX). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1707.* 17 p.

The Advanced Fighter Technology Integration (AFTI) F-16 Advanced Development Program, is modifying an F-16A to be a testbed for evaluating new technologies. One important technology being developed is the tailoring of the flight control laws to specific tasks such as bombing or dogfighting. The design sought to use the unique independent six-degree-of-freedom capability of the aircraft with the inherent flexibility of the digital computer to achieve the optimum dynamic response for each task. The design requirements and the detailed flight control designs are presented with piloted simulation results. Problems encountered with the approach, their solutions, and their application to flight test are also discussed. (Author)

A81-43956 # **Precision flight path control in carrier landing approach - A case for integrated system design.** P. Martorella, C. P. Kelly, and R. Nastasi (Grumman Aerospace Corp., Bethpage, NY). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1710.* 11 p. 6 refs.

Landing high-performance aircraft on a Carrier is a demanding task, requiring precision control of the flight path. Stability

Augmentation Systems (SAS), Approach Power Compensators (APC), Direct Lift Control (DLC), subystems are usually employed to augment the basic airframe flying qualities. Current specifications dictate separate design criteria for each subsystem. This does not necessarily assure good flight path control. Total flight path response criteria and a unified control system design to meet these criteria, utilizing the horizontal tail, throttle, and DLC as integrated controllers, have been developed. These criteria include not only the path response to pilot commands and air turbulence, but also key pilot interface parameters such as angle-of-attack and attitude excursions. The resulting integrated design for SAS, APC, and DLC subsystems achieved superior flight path response with minor modification to existing hardware. (Author)

A81-43959 * # **Can advanced technology improve future commuter aircraft.** L. J. Williams and D. B. Snow (NASA, Langley Research Center, General Aviation and Commuter Technology Office, Hampton, VA). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1729.* 10 p. 10 refs.

The short-haul service abandoned by the trunk and local airlines is being picked up by the commuter airlines using small turboprop-powered aircraft. Most of the existing small transport aircraft currently available represent a relatively old technology level. However, several manufacturers have initiated the development of new or improved commuter transport aircraft. These aircraft are relatively conservative in terms of technology. An examination is conducted of advanced technology to identify those technologies that, if developed, would provide the largest improvements for future generations of these aircraft. Attention is given to commuter aircraft operating cost, aerodynamics, structures and materials, propulsion, aircraft systems, and technology integration. It is found that advanced technology can improve future commuter aircraft and that the largest of these improvements will come from the synergistic combination of technological advances in all of the aircraft disciplines. The most important goals are related to improved fuel efficiency and increased aircraft productivity. G.R.

A81-43960 # **Aircraft ground mobility system for the F-16 aircraft.** J. R. Hampton (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Conference, Dayton, OH, Aug. 11-13, 1981, Paper 81-1735.* 8 p.

The Aircraft Ground Mobility System (AGMS) addresses the problem of transporting aircraft from the revetments to a usable section of runway following an attack on the airfield. The AGMS provides this capability by allowing the aircraft to be towed or taxied over hastily cleared pavement or unstabilized soil surfaces. The AGMS consists of wide durable track segments which can be quickly attached around the outer periphery of the aircraft tire. Application of the AGMS to the F-16 aircraft reduces the nominal over ground tire bearing pressure from 275 psi to 80 psi. A two phase test program was conducted at WPAFB, with a third phase scheduled for late summer 1981 at Edwards AFB. Phase I and II tests demonstrated satisfactory operation of the GF-16 aircraft over debris strewn runways and off-runway surfaces. (Author)

STAR ENTRIES

N81-28049 Purdue Univ., Lafayette, Ind.
THE THEORETICAL PERFORMANCE OF HIGH EFFICIENCY PROPELLERS Ph.D. Thesis
Li Ko Chang 1980 163 p
Avail: Univ. Microfilms Order No. 8113653

The vortex lattice method is used to analyze the performance of propellers, and techniques of numerical optimization are devised to determine the optimum propeller blade shapes. Results are given for NASA SR-1, SR-2, SR-3, NACA 109622, and CESSNA 172 propellers. Comparison of the predicted power coefficients and the experimental results show good agreement at different advance ratios j. The ideal efficiency shows good agreement for a two blade propeller except that a slight under-estimate of the induced effect causes a slight over estimate of the ideal efficiency. A propeller proplet, which is a small airfoil section mounted at the tip, is investigated using the vortex lattice method. The efficiency improvement is 2% - 6.8% depending upon the propeller blade employed. A cant angle Beta sub 2 of the proplet controls the load distribution. Optimum condition can be approached by assigning a negative value of Beta sub w (toed out proplet). A linear function between the percentage of improvement in efficiency and proplet height is found to be within twice the proplet height boundary. Dissert. Abstr.

N81-28055*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.
UNPOWERED AERODYNAMIC CHARACTERISTICS OF A 15-PERCENT SCALE MODEL OF A TWIN-ENGINE COMMUTER AIRCRAFT
Daniel G. Morgan, Thomas L. Galloway, and Bruno J. Gambucci (Kendan Associates) Jul. 1981 74 p
(NASA-TM-81284; A-8552) Avail: NTIS HC A04/MF A01 CSCL 01A

An experimental investigation was conducted in the Ames 12-Foot Pressure Wind Tunnel to determine the unpowered aerodynamic characteristics of a 15-percent-scale model of a twin-engine commuter aircraft. Model longitudinal aerodynamic characteristics were examined at discrete flap deflections for various angle-of-attack and wind-tunnel-velocity ranges with the empennage on and off. Data are presented for the basic model configuration consisting of the fuselage, wing, basic wing leading edge, double slotted flaps, midengine nacelles, and empennage. Other configurations tested include a particle-span drooped leading edge (dropped outboard of the engine nacelles), a full-span drooped leading edge, low- and high-mounted engine nacelles, and a single-slotted flap. An evaluation was made of the model mounting system by comparing data obtained with the model mounted conventionally on the wind-tunnel model-support struts and the model inverted. Author

N81-28060# Naval Postgraduate School, Monterey, Calif.
FLOW CONTROL ABOUT AN AIRBORNE LASER TURRET M.S. Thesis
James Robert Schonberger Dec. 1980 65 p refs
(AD-A100110; NPS-67-80-018) Avail: NTIS HC A04/MF A01 CSCL 20/4

A high-energy laser system inflicts damage on a target by radiating large amounts of thermal energy onto a small area. Airflow about the laser turret housed on top of an aircraft is unsteady, and causes problems in beam control. These problems are jitter, which is vibration of the laser beam, and optical path distortions. The theory of flow around a cylinder and around a sphere was examined, and several airflow control techniques were investigated as possible means of suppressing the unsteadiness of the flow. A fairing and turret-base suction apparatus was selected, and was experimentally tested in a wind tunnel. During the course of the experiment, several parameters were varied, as follows: blower flow rate, spacing between turret and fairing nose piece, and flow rate in five separate ducts. Results of the tests utilizing the tapered symmetric nose piece indicate that the fairing and base-suction technique eliminates the unsteadiness. Further research and testing are required to develop this technique for actual use on aircraft. Author (GRA)

N81-28069# Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
TROUBLE SHOOTING IN AERONAUTICS AND THE USEFULNESS OF MICROSCOPES
J. Schijve Sep. 1980 18 p refs Presented at 7th European Congr. on Electron Microscopy. Session on Impact of Electron Microscopy on Soc., the Hague, 25-29 Aug. 1980
(VTH-LR-305) Avail: NTIS HC A02/MF A01

The usefulness of the scanning electron microscope and transmission electron microscope for materials fatigue investigations in aeronautics is illustrated by case histories of practical applications. Civil air safety as a motive for these studies is cited. The detailed examination of fracture surfaces on aircraft structures is described. Fatigue crack growth analysis, microscopical observation and fractography as part of accident investigations are reviewed. Author (ESA)

N81-28070*# Research Triangle Inst., Research Triangle Park, N. C.
FEASIBILITY OF COLLISION WARNING, PRECISION APPROACH AND LANDING USING GPS, VOLUME 1 Final Contractor Report, May 1979 - Jul. 1980
W. H. Ruedger Mar. 1981 120 p refs
(Contract NAS1-15833)
(NASA-CR-165675; RTI/1825/01-01F) Avail: NTIS HC A06/MF A01 CSCL 17G

The use of GPS, with an appropriately configured data link, to enhance general aviation avionic functions encountered in the terminal area and on approach was investigated with emphasis on approach and landing guidance and collision warning. The feasibility of using differential GPS to obtain the precision navigation solutions required for landing was studied. Results show that the concept is sound. An experimental program was developed to demonstrate this concept. The collision avoidance/warning concept was examined through the development of a functional system specification. A.R.H.

N81-28076# Federal Aviation Administration, Washington, D.C. Office of Systems Engineering Management.
AN ANALYSIS OF THE REQUIREMENTS FOR, AND THE BENEFITS AND COSTS OF THE NATIONAL MICROWAVE LANDING SYSTEM (MLS)
William C. Reddick, Seymour M. Horowitz, Eugene S. Rehrig, and Gilbert P. Christiana Jun. 1980 75 p refs
(AD-A100136; FAA-EM-80-7) Avail: NTIS HC A04/MF A01 CSCL 17/7

This report consists of three volumes, i.e.: (1) this Executive Summary, (2) Volume I comprising the detailed study analysis, and (3) Volume II which contains reprints of important studies supporting the analysis included in the report. The analysis assesses the comparative desirability of implementing the MLS equipment option in place of the currently installed ILS as the long term National standard for precision guidance service. An evaluation period of 20 years, to the year 2000, was used for this assessment. An implementation strategy was devised to achieve the estimated National requirement for 1250 ground installations by the year 2000 and providing precision guidance service, alternatively, with the ILS or MLS equipment option. The study's method was to examine the technical and performance specifications for the MLS and to estimate the dollar amounts of benefits resulting from the portion of these specifications which could be quantified. The dollar amounts of comparative costs to the community of aviation users and to the FAA from the alternative use of MLS instead of ILS were, likewise, estimated. The study results show that implementation of MLS can provide sizeable benefits in excess of costs, in varying degrees, to the different aviation user groups (i.e., air carriers, commuter airlines, general aviation and the military). Author (GRA)

N81-28077# Federal Aviation Administration, Washington, D.C.
THE FAA PLANS AND PROGRAMS FOR THE FUTURE AIRPORT AND AIR TRAFFIC CONTROL SYSTEM
13 Nov. 1980 184 p refs Presented at the Office of Technol. Assessment Seminar
(AD-A100370) Avail: NTIS HC A09/MF A01 CSCL 17/7

Contents' FAA's Role in Providing a Safe and Efficient System; FAA Forecasts of Aviation Activity, 1981-1992 - Airport and Airway System Capacity and Delay Overview' Today's ATC System-Problems and Need for Change; An Overview of the FAA Engineering and Development Program; Scenario for the Future System - The Roadmap of the System of the Future - The Impact of Alternative Approaches in Air Traffic Control System Evolution; Airport Capacity Increases - Opportunities, Limitations, and Choices; Near Term System Improvements; Long Term ATC System Improvements; and Nontechnological Alternatives for Balancing Airport/Airspace Supply and Demand. GRA

N81-28079# European Space Agency, Paris (France).
APPLIED TECHNIQUES FOR THE CONTROL OF APPROACH TRAFFIC
Albrecht Seyfried, Manfred Schubert, and Uwe Voelckers Jan. 1981 28 p refs Transl. into ENGLISH from "Angewendete Techniken zur Steuerung des Anflugverkehrs" DFVLR-Mitt-79-20, DFVLR, Brunswick, Oct. 1979 Original report in GERMAN previously announced as N81-14992
(ESA-TT-668; DFVLR-Mitt-79-20) Avail: NTIS HC A03/MF A01

Flow control measures applied in a selected local traffic area were investigated by the analysis of real traffic recordings as well as from controller interviews. The internal procedures consist of variable control of the individual aircraft within the approach control terminal maneuvering area (TMA), i.e., the local approach phase. Flight profiles of shorter or longer duration are prescribed in order either to accelerate or retard respectively, the approach flight of aircraft within this region. The external control procedures of the approach controllers takes into account entry rates at the sector control. The retardation of traffic outside the approach control TMA is largely achieved through holding procedures. The acceleration of individual flights is possible through the direction of traffic onto shorter routes. The degree to which the various flow control techniques should be considered in a future computer assisted air traffic conrol system is discussed. Author (ESA)

N81-28080# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Stabsabteilung Programhvorbereitung.
A METHOD FOR EVALUATING RADIO NAVIGATION SYSTEMS FOR THE TERMINAL MANEUVERING AREA
Jens Fromm and Joachim Majus Feb. 1981 27 p refs
(DFVLR-Mitt-81-02) Avail: NTIS HC A03/MF A01

The methodology of standard cost/benefit analysis fails in the case of the evaluation of radio navigation system technologies for the terminal maneuvering area. The proposed problem-matched method defines those system configurations as 'feasable' evaluation alternatives that fulfill predefined quantitative requirements with respect to position fix capability. Among the feasable alternatives of each candidate technology there is one 'minimal cost solution'. These minimal cost figures form the basis of the assessment of the candidate technologies. The method is demonstrated by way of a fictitious example. Author (ESA)

N81-28081 Oklahoma State Univ., Stillwater.
HANDLING QUALITIES OF LARGE FLEXIBLE AIRCRAFT Ph.D. Thesis
Supat Poopaka 1980 71 p
Avail: Univ. Microfilms Order No. 8113329

The effects on handling qualities of elastic models interaction with the rigid body dynamics of a large flexible aircraft are studied by a mathematical computer simulation. An analytical method to predict the pilot ratings when there is a severe modes interaction is developed. The handling qualities are determined for a longitudinal tracking task using a large flexible aircraft with parametric variations in the undamped natural frequencies of the two lowest frequency, symmetric elastic modes made to induce varying amounts of mode interaction. The modified model of the human pilot response developed proved successful in discriminating when the pilot can or cannot separate rigid from elastic response in the tracking task. The modified pilot model is much better in predicting the elastic modes interaction effect on the handling qualities than the standard optimal control model of the human pilot. Dissert. Abstr.

N81-28083*# National Aeronautics and Space Administration, Washington, D. C.
AIRCRAFT ENERGY EFFICIENCY, OVERVIEW
[1981] 7 p
(NASA-Facts-96/9-80; NASA-TM-80454) Avail: NTIS HC A02/MF A01 CSCL 01C

Six advanced technology development projects that could cut fuel consumption of future civil air transports by as much as 50 percent are highlighted. These include improved engine components; better engine design; thin short blades for turboprop aircaft; using composite primary structures for weight reduction; the use of supercritical wings, higher aspect ratio, and winglets for improved aerodynamics; active controls; and laminar flow control. The time span of each of the six efforts and NASA's expected expenditures are also discussed. A.R.H.

N81-28084*# Vought Corp., Dallas, Tex.
A MATHEMATICAL MODEL FOR VERTICAL ATTITUDE TAKEOFF AND LANDING (VATOL) AIRCRAFT SIMULATION. VOLUME 1: MODEL DESCRIPTION APPLICATION Final Report
Robert L. Fortenbaugh Dec. 1980 228 p refs 3 Vol.
(Contract NAS2-10294)
(NASA-CR-166129-Vol-1) Avail: NTIS HC A11/MF A01 CSCL 01C

A mathematical model of a high performance airplane capable of vertical attitude takeoff and landing (VATOL) was developed. An off line digital simulation program incorporating this model was developed to provide trim conditions and dynamic check runs for the piloted simulation studies and support dynamic analyses of proposed VATOL configuration and flight control concepts. Development details for the various simulation component models and the application of the off line simulation program, Vertical Attitude Take-Off and Landing Simulation (VATLAS), to develop a baseline control system for the Vought SF-121 VATOL airplane concept are described. E.A.K

N81-28085*# Vought Corp., Dallas, Tex.
A MATHEMATICAL MODEL FOR VERTICAL ATTITUDE TAKEOFF AND LANDING (VATOL) AIRCRAFT SIMULATION. VOLUME 2: MODEL EQUATIONS AND BASE AIRCRAFT DATA
Robert L. Fortenbaugh Dec. 1980 90 p refs 3 Vol.
(Contract NAS2-10294)
(NASA-CR-166129-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 01C

Equations incorporated in a VATOL six degree of freedom off-line digital simulation program and data for the Vought SF-121 VATOL aircraft concept which served as the baseline for the development of this program are presented. The equations and data are intended to facilitate the development of a piloted VATOL simulation. The equation presentation format is to state the equations which define a particular model segment. Listings of constants required to quantify the model segment, input variables required to exercise the model segment, and output variables required by other model segments are included. In several instances a series of input or output variables are followed by a section number in parentheses which identifies the model segment of origination or termination of those variables. E.A.K.

N81-28086*# Vought Corp., Dallas, Tex.
A MATHEMATICAL MODEL FOR VERTICAL ATTITUDE TAKEOFF AND LANDING (VATOL) AIRCRAFT SIMULATION. VOLUME 3: USER'S MANUAL FOR VATOL SIMULATION PROGRAM
Robert L. Fortenbaugh Dec. 1980 425 p refs 3 Vol.
(Contract NAS2-10294)
(NASA-CR-166129-Vol-3) Avail: NTIS HC A18/MF A01 CSCL 01C

Instructions for using Vertical Attitude Takeoff and Landing Aircraft Simulation (VATLAS), the digital simulation program for application to vertical attitude takeoff and landing (VATOL) aircraft developed for installation on the NASA Ames CDC 7600 computer system are described. The framework for VATLAS is the Off-Line Simulation (OLSIM) routine. The OLSIM routine provides a flexible framework and standardized modules which facilitate the development of off-line aircraft simulations. OLSIM runs under the control of VTOLTH, the main program, which calls the proper modules for executing user specified options. These options include trim, stability derivative calculation, time history generation, and various input-output options. E.A.K.

N81-28087# Sikorsky Aircraft, Stratford, Conn.
ADVANCING BLADE CONCEPT (ABC) TECHNOLOGY DEMONSTRATOR Final Report, Jan. 1972 - Jun. 1980
A. J. Ruddell, W. Groth, and R. McCutcheon Apr. 1981 303 p refs
(Contracts DAAJ02-72-C-0020; DAAJ02-75-C-0009; DA Proj. 1F2-63211-D-157)
(AD-A100181; SER-69065; USAAVRADCOM-TR-81-D-5) Avail: NTIS HC A14/MF A01 CSCL 01/3

The XH-59A Advancing Blade Concept (ABC) demonstrator aircraft has completed five years of ground and flight tests in both the helicopter and auxiliary propulsion configurations. This testing was supported by wind tunnel tests, analytical developments, and flight simulation studies. Testing as a pure helicopter was accomplished in two phases. To verify control system adequacy, a low speed test program was flown (0 to 80 knots) from July to September 1975. The balance of the flight envelope was explored in progressive steps from November 1975 to March 1977. A power-limited maximum level flight speed of 156 KTAS was reached in this phase. 186 KTAS was achieved in a shallow

dive and an extensive maneuver envelope was developed. Between April 1978 and May 1980 the aircraft was flown with two J-60 engines installed to provide auxiliary propulsion. A maximum airspeed of 238 KTAS in level flight was reached and a sizable maneuver envelope was developed through 220 KTAS. A total of 106 flight hours were accumulated in the pure helicopter and auxiliary propulsion modes. Test results to data have verified the capability of the Advancing Blade Concept to meet its predicted technical goals. No major surprises or unanticipated problems have been encountered. GRA

N81-28088# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Aerospace Medical Div.
THE RESULTS OF AFAMRL REMOTELY PILOTED VEHICLE (RPV) SIMULATION STUDIES 7 AND 8
Nilss M. Aume and Robert G. Mills May 1981 40 p refs Prepared in cooperation with Dayton Univ., Ohio
(Contract F33615-77-C-0520; AF Proj. 2313)
(AD-A100551; AFAMRL-TR-80-98) Avail: NTIS HC A03/MF A01 CSCL 01/3

In RPV Study VII, the main interest was in the composition of three teams of five operators each: do independent teams whose individual members belong to one team perform differently from teams whose members are chosen from a limited pool of operators such that each operator performs on two teams? In RPV Study VIII, another aspect of team compostition was investigated: how is the performance of an individual operator reflected in the performance of a team and across teams of varying sizes? In both studies, the operators were highly experienced in the control of the simulated RPV system. Both studies employed scenarios requiring that support RPVs provide coverage for a set of weapon delivery/strike RPVs. The RPV system was assumed to operate in an environment where a radio frequency has to be shared by multiple users, so that a time slot for command and telemetry transmissions becomes available for RPV system use only on a periodic basis. The results of RPV Study VII indicated that average performance remained unchanged from independently constituted teams to pooled constituted teams. However, the variability in terms of standard deviations of dependent measures was reduced. The results of RPV Study VIII indicated that operator-centered tasks are largely unaffected by team size on the same tasks. Workload, in terms of the number of RPVs to be controlled, had an effect on performance by itself but had no differential effect over team sizes or operators. GRA

N81-28089# Michigan State Univ., East Lansing. Div. of Engineering Research.
PACER LIME: AN ENVIRONMENTAL CORROSION SEVERITY CLASSIFICATION SYSTEM, PART 1 Final Report, 15 Sep. 1978 - 31 Dec. 1979
Robert Summitt Wright-Patterson AFB, Ohio AFWAL Aug. 1980 129 p refs
(Contract F33615-78-C-5224; AF Proj. 3930)
(AD-A100496; AFWAL-TR-80-4102-Pt-1; TR-80-4102-Pt-1) Avail: NTIS HC A07/MF A01 CSCL 01/3

A system has been developed for rating the corrosivity of aircraft operational environments. This system takes account of weather, atmospheric pollutant, and geographical factors to compute a severity index for three aspects of corrosion maintenance: aircraft washing, repainting, and repair needs. Computed ratings are in good agreement with aircraft corrosion experience and atmospheric testing programs at several locations. Author (GRA)

N81-28090# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
OPTIMIZATION OF STRATEGIC AIRLIFT IN FLIGHT REFUELING M.S. Thesis
Vernon P. Bordelon, Jr. and John C. Macotte, Jr. Mar. 1981 214 p refs
(AD-A101137; AFIT/GST/OS/81M-3) Avail: NTIS HC A10/MF A01 CSCL 01/2

During the 1980s increases in the potential use of Strategic Airlift to transport equipment and personnel is anticipated. The capabilities of Strategic Airlift aircraft are extended through the inclusion of efficient in-flight refueling. The primary objective of this research was to develop a method which determines the combination of in-flight refueling rendezvous point, takeoff fuel loads and tanker base which results in the minimum total fuel consumption for an airlifter and tanker aircraft. The experimental design included the creation of two models. An analytic flight planning model determined the optimal rendezvous point and the takeoff fuel loads for the aircraft in a specific mission scenario. A SLAM simulation model verified the operational feasibility of the results of the analytic model by simulating the flights of aircraft. GRA

N81-28091# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
QUANTIFYING REACTIVE MANEUVERS M.S. Thesis
John J. Alt Mar. 1981 220 p refs
(AD-A101136; AFIT/GST/OS/81M-1) Avail: NTIS HC A10/MF A01 CSCL 01/3

There is currently no value of survivability attributed to an aircraft's reactive maneuver capability. In this experiment, exposure to enemy ground threats for various levels of information feedback to the aircrew were compared. This was done in an attempt to isolate the maneuverability factor. The Threat Model Penetration Simulation Analysis (TMPSA) model produced by the University of Dayton Research Institute was the penetration model used. The conclusion of this experiment was that only order of magnitude differences in capabilities can be captured with this model. It is recommended that two simple changes be made to TMPSA. These changes would allow more precise values for reactive maneuvers to be derived. Author (GRA)

N81-28092# Aeronautical Research Labs., Wright-Patterson AFB, Ohio. Directorate of Avionics Engineering.
AFSC STANDARDIZATION CONFERENCE, 1553, 1589, 1750, 1760, ADA. VOLUME 1: PROCEEDINGS
Erwin C. Gangl Nov. 1980 560 p refs Conf. held in Dayton, Ohio, 18-20 Nov. 1980
(AD-A100575; ASD-TR-80-5050-Vol-1) Avail: NTIS HC A24/MF A01 CSCL 01/3

This is a collection of unclassified papers to be distributed to the attendees of the AFSC Avionics Standardization Conference at the Convention Center, Dayton, Ohio. The purpose of the conference is to state AF policy on standardization, educate government and industry management, and present and demonstrate hardware and software tools. GRA

N81-28093# Aeronautical Research Labs., Wright-Patterson AFB, Ohio. Directorate of Avionics Engineering.
AFSC STANDARDIZATION CONFERENCE, 1553, 1589, 1750, 1760, ADA. VOLUME 2: PROCEEDINGS STANDARDS
Erwin C. Gangl, ed. and Stephen E. Smith, ed. Nov. 1980 476 p refs Conf. held in Dayton, Ohio, 18-20 Nov. 180
(AD-A100577; ASD-TR-80-5050-Vol-2) Avail: NTIS HC A21/MF A01 CSCL 01/4

This is a collection of unclassified papers to be distributed to the attendees of the AFSC Avionics Standardization Conference at the Convention Center, Dayton, Ohio. The purpose of the conference is to state AF policy on standardization, educate government and industry management, and present and demonstrate hardware and software tools. GRA

N81-28094*# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
COATING FOR PREVENTION OF TITANIUM COMBUSTION Final Report, 9 Feb. 1979 - 9 Jun. 1980
V. G. Anderson, M. Funkhouser, and P. McDaniel Sep. 1980 76 p refs
(Contract NAS3-21815)
(NASA-CR-165360; FR-13370) Avail: NTIS HC A05/MF A01 CSCL 21E

A limited number of coating options for titanium gas turbine engine components were explored with the objective of minimizing potential combustion initiation and propagation without adversely affecting component mechanical properties. Objectives were met by two of the coatings, ion-plated platinum plus electroplated copper plus electroplated nickel and ion vapor deposited aluminum. Author

N81-28095*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE E3 COMBUSTORS: STATUS AND CHALLENGES
Daniel E. Sokolowski and John E. Rohde 1981 24 p refs Presented at 17th Joint Propulsion Conf., Colorado Springs, Colo., 27-29 Jul. 1981; sponsored by AIAA, SAE and ASME
(NASA-TM-82684; E-904) Avail: NTIS HC A02/MF A01 CSCL 21E

The design, fabrication, and initial testing of energy efficient engine combustors, developed for the next generation of turbofan engines for commercial aircraft, are described. The combustor designs utilize an annular configuration with two zone combustion for low emissions, advanced liners for improved durability, and

short, curved-wall, dump prediffusers for compactness. Advanced cooling techniques and segmented construction characterize the advanced liners. Linear segments are made from castable, turbine-type materials. M.G.

N81-28096*# General Dynamics Corp., Fort Worth, Tex.
STUDY OF AN ENGINE FLOW DIVERTER SYSTEM FOR A LARGE SCALE EJECTOR POWERED AIRCRAFT MODEL Final Report
R. J. Springer, B. Langley, T. Plant, L. Hunter, and O. Brock Jul. 1981 138 p refs
(Contract NAS2-10680)
(NASA-CR-166163) Avail: NTIS HC A07/MF A01 CSCL 21E

Requirements were established for a conceptual design study to analyze and design an engine flow diverter system and to include accommodations for an ejector system in an existing 3/4 scale fighter model equipped with YJ-79 engines. Model constraints were identified and cost-effective limited modification was proposed to accept the ejectors, ducting and flow diverter valves. Complete system performance was calculated and a versatile computer program capable of analyzing any ejector system was developed. A.R.H.

N81-28097*# Pennsylvania State Univ., University Park. Turbomachinery Lab.
END WALL FLOWS IN ROTORS AND STATORS OF A SINGLE STAGE COMPRESSOR Semiannual Progress Report
T. R. Govindam, B. Lakshminarayana, A. Pandya, and M. Pouagare Aug. 1981 50 p refs
(Grant NsG-3212)
(NASA-CR-164635; PSU/TURBO-R81-7) Avail: NTIS HC A03/MF A01 CSCL 21E

A solution of the flow in the rotor end wall region, including the effects of tip clearance flow, is presented. A method for leakage flow measurement at the tip of a compressor rotor blade is discussed. Measurements are given for a rotor hub wall boundary layer. T.M.

N81-28099# AeroChem Research Labs., Inc., Princeton, N. J.
CORRELATION OF SOOT FORMATION IN TURBOJET ENGINES AND IN LABORATORY FLAMES Final Report, Aug. - Sep. 1980
Robert K. Gould, Douglas B. Olson, and Hartwell F. Calcote Feb. 1981 69 p refs
(Contract F49620-77-C-0029; AF Proj. 1900)
(AD-A100525; AEROCHEM-TP-407; AFESC/ESL-TR-81-09) Avail: NTIS HC A04/MF A01 CSCL 21/4

Data obtained from aviation gas turbine combustor tests have been examined to determine the effects of fuel properties on soot-related measurements such as engine smoke number, combustor flame radiation, and/or combustor linear temperature. Some tests of smaller laboratory combustors used to simulate these large combustors were also examined. From the existing data it is clear that soot production is a strong function of the fuel chemical composition. Variations in the physical properties of the fuel do not correlate well with soot-related effects. In studies in which a broad range of fuel properties was examined, correlation of soot-related effects with basic fuel compositional parameters including (1) the hydrogen content of the fuel; (2) the aromatic content of the fuel; and (3) the amount of multiple-ring aromatics in the fuel show that typically only the first of these correlates well. However, it has also been shown that fuel compositions can be chosen for which this correlating parameter fails. GRA

N81-28100# Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
AERODYNAMIC AND AEROELASTIC RESEARCH ON TIPVANE TURBINES
G. J. W. vanBussel, P. C. Hensing, and G. A. M. vanKuik Aug. 1980 22 p refs
(VTH-LR-302) Avail: NTIS HC A02/MF A01

The present status of the tipvane project is surveyed. Tipvanes are small auxiliary wings mounted at the tips of turbine blades in such a way that a diffuser effect is generated, resulting in a mass flow augmentation past the turbine disk. A gross power coefficient of 1.5, measured in a wind tunnel with turbine blades simulated by gauzes, is reported. Two research efforts are treated in greater detail: (1) analytical aerodynamics accompanied by experimental verification; and (2) aeroelastic work, theoretical as well as experimental. The first is characterized by the particular flow phenomena induced by the tipvanes, such as interfering tip vortices. The second reveals the very low torsional frequency of the blade-tipvane configuration. The field test installation, to be erected, is described. Author (ESA)

N81-28102*# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.
PILOT-OPTIMAL MULTIVARIABLE CONTROL SYNTHESIS BY OUTPUT FEEDBACK
David K. Schmidt and Mario Innocenti Jul. 1981 24 p refs
(Grant NAG4-1)
(NASA-CR-163112) Avail: NTIS HC A02/MF A01 CSCL 01C

A control system design approach for optimal stability augmentation, systems, using limited state feedback theory with the specific inclusion of the human pilot in the loop is presented. The methodology is especially suitable for application to flight vehicles exhibiting nonconventional dynamic characteristics and for which quantitative handling qualities specifications are not available. The design is based on a correlation between pilot ratings and objective function of the optimal control model of the human pilot. Simultaneous optimization for augmentation and pilot gains are required. E.A.K.

N81-28103# Kuhn (Richard E.), Newport News, Va.
AN ENGINEERING METHOD FOR ESTIMATING THE LATERAL/DIRECTIONAL CHARACTERISTICS OF V/STOL CONFIGURATIONS IN TRANSITION Final Technical Report
Richard E. Kuhn Feb. 1981 61 p refs
(Contract N62269-80-C-0366)
(AD-A100386; NADC-81031-60) Avail: NTIS HC A04/MF A01 CSCL 20/4

A method for estimating the power induced increments of side-force and yawing and rolling moments in the transition speed range is presented and compared with available data. The study shows that in addition to the expected inlet effects and the lateral shift in the induced downloads on the body and wing there is a large favorable sidewash induced at the vertical tail as well as suction pressures induced on the leeward side of the body that add significantly to the side-force and rolling and yawing moments. Author (GRA)

N81-28104# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.
FLUTTER ANALYSIS OF TWO-DIMENSIONAL AND TWO-DEGREE-OF-FREEDOM MBB A-3, CAST 7, AN TF-8A SUPERCRITICAL AIRFOILS IN SMALL-DISTURBANCE UNSTEADY TRANSONIC FLOW Final Report, Nov. 1979 - Oct. 1980
T. Y. Yang, Alfred G. Striz, and P. Guruswamy Mar. 1981 116 p refs
(Grant AF-AFOSR-3523-78; AF Proj. 2307)
(AD-A100334; AFWAL-TR-81-3004) Avail: NTIS HC A06/MF A01 CSCL 20/4

Flutter analyses at transonic Mach numbers are performed for three supercritical airfoils: (1) MBB A-3; (2) CAST 7; and (3) TF-8A wing section at the 65.3% semispan station. For all airfoils, two degrees of freedom, pitching and plunging, are considered. The unsteady aerodynamic data are obtained by using two separate transonic aerodynamic computational codes: (1) LTRAN2 based on the time integration method and (2) STRANS2 and UTRANS2 based on the harmonic analysis method. The steady aerodynamic results are shown in the form of upper and lower surface pressure curves. The unsteady aerodynamic coefficients are obtained for various values of low reduced frequencies by pitching the airfoils about the quarter chord axis. Unsteady results are presented as plots of unsteady coefficients versus angle of attack for the MBB A-3 airfoil and versus Mach number for the CAST 7 and TF-8A airfoils. GRA

N81-28105# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
FLIGHT CONTROL SYSTEM ANALYSIS AND DESIGN FOR A REMOTELY PILOTED VEHICLE WITH THRUST VECTORING UNIT M.S. Thesis
Brian Leigh Jones Dec. 1980 155 p refs
(AF Proj. 2403)
(AD-A100808; AFIT/GAE/AA/80D-12) Avail: NTIS HC A08/MF A01 CSCL 01/4

This study investigated the stability and control of a remotely piloted vehicle (RPV) with a thrust vectoring unit attached. All

geometric and aerodynamic data was generated and used to analyze the RPV. Specific handling qualities were developed and compared with the RPV characteristics. This comparison indicated that the RPV was too oscillatory in both the phugoid and dutch roll modes. Also, the RPV displayed a dominant spiral mode. A flight control system was synthesized to eliminate these traits. Evaluation of this flight control system was conducted through the use of three different sensitivity studies and a nonlinear simulation. In addition, a model matching application was examined for this RPV. Model matching entails using design procedures to synthesize an expanded flight control system so that the RPV has dynamic characteristics similar to the F-15.
Author (GRA)

N81-28106# Loughborough Univ. of Technology (England). Dept. of Transport Technology.
A STRUCTURAL LOAD ALLEVIATION CONTROL SYSTEM FOR A LARGE TRANSPORT AIRCRAFT
D. McLean and R. A. Prasad Jul. 1980 110 p refs
(Grant SRC-GR/A/21344)
(TT-8002) Avail: NTIS HC A06/MF A01

The results of applying linear optimal control theory in order to provide significant reductions in the bending moments at the root (and other stations) of the highly flexible wing of a large transport aircraft are presented. Digital simulation was employed The effects of neglecting higher frequency bending modes and/or omitting unsteady aerodynamic effects are demonstrated and discussed. The efficiency of lower-order feedback control laws is also demonstrated, and the dynamic requirements for the servo-actuators associated with the active control surfaces are shown to be such that they can be achieved with present-day electrohydraulic components. Structural load alleviation is shown possible and it is demonstrated that the synthesis problem is manageable even when based on incomplete mathematical models and imperfectly synthesized feedback control.
Author (ESA)

N81-28107# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
CHARACTERISTICS OF FLIGHT SIMULATOR VISUAL SYSTEMS
May 1981 89 p refs
(AGARD-AR-164; ISBN-92-835-1386-X) Avail: NTIS HC A05/MF A01

Physical parameters that characterize the simulator visual system and determine its fidelity are identified and defined. These characteristics are discussed in terms of the three basic categories of spatial, energy and temporal properties, and for each of the parameters there is a description of its effect, a definition of its appropriate units or descriptors, a discussion of methods of measurement and of its use or importance to imagery quality.
S.F.

N81-28108# Ohio State Univ., Columbus. Lab. of Aviation Psychology.
METHODOLOGICAL APPROACHES TO IDENTIFYING RELEVANT FEATURES FOR VISUAL FLIGHT Final Report
Dean H. Owen and Richard S. Jensen Jan. 1981 179 p refs
(Contract F49620-79-C-0070; AF Proj. 2313)
(AD-A100199; AFOSR-81-0479TR) Avail: NTIS HC A09/MF A01 CSCL 05/10

A variety of optical variables relevant to rectilinear locomotion were mathematically isolated, and a paradigm was developed to determine whether optical invariants have a consistent effect on performance. Two experiments were undertaken to explore the efficacy of a paradigm designed to determine the functional utility of global optical invariants. The two tasks chosen were detection of loss in altitude and detection of loss in forward speed. The paths of simulated locomotion were constrained to rectilinear travel with no lateral movement in order to maintain a manageable level of complexity of optical flow analysis. In each case an optical variable proved to be a functional invariant by the criterion that performance was consistent even though the environment variables producing the optical invariant had radically different values. The two functional invariants were of the same type, i.e., specifying fractional or proportional change as the relevant information for displacement of the self with locomotion.
GRA

N81-28109# Ohio State Univ., Columbus. Dept. of Psychology.
ASSESSMENT OF SCENE COMPLEXITY AND CUE VALIDITY IN VISUAL FLIGHT SIMULATION Final Report, 15 Mar. 1979 - 14 Nov. 1980
Harvey G. Shulman and Paul D. Isaac 1 Mar. 1981 65 p refs
(Contract F49620-79-C-0070; AF Proj. 2313)
(AD-A100200; AFOSR-81-0480TR) Avail: NTIS HC A04/MF A01 CSCL 05/10

The human visual system is theorized to behave as a set of spatial frequency filters. The project developed the means to measure and manipulate the spatial frequency content of computer generated images representative of those to be used in future flight simulators. Experimental measurement of perceived clarity and complexity showed that spatial frequency content influences the process of image segregation and formation. The results encourage the use of spatial frequency metrics for prediction of human performance.
Author (GRA)

N81-28111# Vereinigte Flugtechnische Werke-Fokker G.m.b.H., Bremen (West Germany).
FROM THE CIVIL COMPONENT PROGRAM 'IFAS': FUNDAMENTALS OF ENGINE SIMULATION, USING TURBOPOWERED SIMULATOR (TPS) TECHNOLOGY IN WIND TUNNEL TESTS Final Report
Wolfgang Burgsmueller Bonn Bundesministerium fuer Forschung und Technologie Dec. 1980 49 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-80-030; ISSN-0170-1339) Avail: NTIS HC A03/MF A01

Basic information about engine simulation in a wind tunnel is presented. The so-called TPS technology is defined, and test arrangements along with methods of operation are described. Under which conditions the TPS approach is most efficient is considered and comparison with other types of engine simulators is made. The test procedure, using a TPS in a wind tunnel is specified as to inputs, data acquisition, and data reduction. The TPS calibration method is given, including setup of the calibration chamber and derivation of the relevant thermodynamic formulas.
Author (ESA)

N81-28176*# Rensselaer Polytechnic Inst., Troy, N. Y.
COMPOSITE STRUCTURAL MATERIALS Semiannual Progress Report, 30 Sep. 1980 - 30 Apr. 1981
George S. Ansell, Robert G. Loewy, and Stephen E. Wiberley Jul. 1981 189 p refs Sponsored in part by AF
(Grant NGL-33-018-003)
(NASA-CR-164634; SAR-40) Avail: NTIS HC A09/MF A01 CSCL 11D

The composite aircraft program component (CAPCOMP) is a graduate level project conducted in parallel with a composite structures program. The composite aircraft program glider (CAPGLIDE) is an undergraduate demonstration project which has as its objectives the design, fabrication, and testing of a foot launched ultralight glider using composite structures. The objective of the computer aided design (COMPAD) portion of the composites project is to provide computer tools for the analysis and design of composite structures. The major thrust of COMPAD is in the finite element area with effort directed at implementing finite element analysis capabilities and developing interactive graphics preprocessing and postprocessing capabilities. The criteria for selecting research projects to be conducted under the innovative and supporting research (INSURE) program are described.
E.D.K.

N81-28189# Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost. Technological Centre.
THIRTY YEARS EXPERIENCE WITH PRIMARY ADHESIVE BONDED STRUCTURES
Rob J. Schliekelmann 1980 32 p
(FOK-BO-1240) Avail: NTIS HC A03/MF A01

The historical development of techniques used in the fabrication and quality control of adhesive bonded structures for to the F-27 and F-28 aircraft is reviewed. The evolution of the use of metal bonding from reinforcement of riveted joints to primary structures is illustrated. Thin sheet bonded laminates are shown to have better fracture toughness leading to lower crack propagation speed and higher residual strength in the cracked state. The hot air high pressure autoclave, using an aluminum blanket/aluminum pebbles for pressure distribution during curing, is depicted. Quality control is performed separately for adhesion and cohesion. Electron microscopy is used to verify the condition of anodized surfaces. The in-house development of sonic and holographic bond testers is mentioned. Flying hours and related

service life data for the world wide fleet of F-27 and F-28 aircraft are given. Author (ESA)

N81-28190# Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost. Technological Centre.
NONDESTRUCTIVE TESTING OF ADHESIVE BONDED JOINTS
Rob J. Schliekelmann Apr. 1980 38 p refs
(FOK-BO-1241) Avail: NTIS HC A03/MF A01

Nondestructive test methods currently used in the aircraft industry are surveyed. Advantages and disadvantages are cited and preferred methods are identified for given airframe manufacturers. Comparative evaluation results for methods used for metal to metal and for honeycomb sandwich structures bonded with a modified epoxy adhesive film are shown. Adherend surface inspection methods are included. Cohesion testing, using capacitance measurement and thermal inspection methods are covered. Acoustic emission, radiography, acoustic inspection, sonic testing, ultrasonic techniques and holographic interference methods are considered. Nondestructive acceptance testing is discussed in terms of the joint geometry problem. Equipment and test recordings are shown. Author (ESA)

N81-28276# Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.
BEHAVIOR OF FUELS AT LOW TEMPERATURES Interim Report
E. A. Frame Sep. 1980 29 p refs
(Contract DAAK70-80-C-0001)
(AD-A100332; AFLRL-138) Avail: NTIS HC A03/MF A01 CSCL 21/4

In developing the filter/separator component of the Arctic Fuel Dispensing Equipment, MERADCOM is considering two options: (1) development of a completely new filter/separator or (2) modification of the current Military Standard filter/separator for use at low temperatures. This report contains test data on the low-temperature behavior of five test fuels - JP-4, JP-5, JP-8, DF-A, and DF-1 as well as two additional test fuels made by adding icing inhibitor (ethylene glycol monomethyl ether) to the DF-A and DF-1. Four additional fuels were obtained from Alaska (JP-4, Jet A-1, DF-A, and JP-5) and low temperature behavior of these field samples was determine. This report contains (1) a brief summary of industry practice in handling fuels at low temperatures, (2) inspection properties of test fuels, (3) viscosities and conductivities of fuels at low temperatures, (4) fuel contaminant behavior at low temperatures, and (5) fuel system icing inhibitor effects at low temperatures. Author (GRA)

N81-28277# Southwest Research Inst., San Antonio, Tex. Mobile Energy Div.
FUEL MICROEMULSIONS FOR JET ENGINE SMOKE REDUCTION Final Report, 4 Jul. 1979 - 15 Mar. 1980
D. W. Naegeli, G. E. Fodor, and C. A. Moses Tyndall AFB, Florida Air Force Engineering and Services Center May 1980 52 p refs
(Contract F08635-79-C-0213)
(AD-A100489; SWRI-MED118; AFESC/ESL-TR-80-25) Avail: NTIS HC A04/MF A01 CSCL 21/4

Several ethanol/fuel, methanol/fuel and water/fuel microemulsions were prepared with JP-4 and JP-8 base fuels and the appropriate surfactants. Both metallic (ferrocene) and nonmetallic (hydrazine) smoke reducing additives were examined for possible synergistic effects when combined with the microemulsified fuels. The fuels were tested at the takeoff, climb, cruise and ground idle operating condition, and the exhaust smoke, flame radiation and gaseous emissions were measured. The exhaust smoke and flame radiation were significantly reduced by the additions of alcohols and water to the base fuels. Ethanol was found to be most cost effective because it required the least amount of surfactant, which was the most expensive fuel component. The tendency of the microemulsions to form soot was found to correlate with H/C ratio in the same way as typical petroleum-base fuels. Ferrocene, which is well known for its ability to reduce exhaust smoke, had the same effect on the microemulsions as the base fuels; it did not affect flame radiation. Hydrazine was not an effective additive for reducing exhaust smoke. Author (GRA)

N81-28489# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
FATIGUE PROPERTIES OF ADHESIVE-BONDED LAMINATED SHEET MATERIAL OF ALUMINUM ALLOYS
J. Schijve, H. T. M. vanLipzig, G. F. J. A. vanGestel, and A. H. W. Hoeymakers Dec. 1978 40 p refs
(VTH-LR-276) Avail: NTIS HC A03/MF A01

Comparative fatigue tests were carried out on centrally cracked specimens and lug type specimens, both made from solid sheet and laminated sheet, consisting of five 1 mm sheets of 2024-T3 Alclad material bonded by FM 123/5. Most tests were carried out under constant amplitude loading, but growth delays due to peak loads were also studied. Cracks through the laminated material as well as cracks only partially through the material are considered. Significance of the results for application in aircraft structures is analyzed. Results indicate that laminated sheet material can significantly improve the damage tolerance quality of an aircraft structure. Author (ESA)

N81-28493# Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
FATIGUE CRACK GROWTH IN 7475-T7651 MATERIAL UNDER FLIGHT SIMULATION LOADING. INFORMATION FROM A DOUGLAS REPORT
J. Schijve Jan. 1980 11 p refs
(VTH-M-392) Avail: NTIS HC A02/MF A01

The results of an extensive investigation on crack propagation in aluminum alloy sheet material under flight simulation loading are summarized. The effets of various modifications in load spectra on crack growth were studied. One hundred and sixteen different flight simulation load histories were generated and then used for crack growth predictions based on linear damage accumulation. The load histories represent possible load spectra for the wing lower surface of a STOL transport (C-15). Tests were carried out with thirty-three histories in order to verify the predictions. The experimental data is synthesized; interesting trends are identified, and the significance of the results, especially for verification of crack growth prediction methods, is discussed. The effects of material thickness, multiple overloads, design stress level and minimum stress range applied in the test are described. Author (ESA)

N81-28606*# National Aeronautics and Space Administration, Washington, D. C.
NATURE OF THE ANNOYANCE AND NOISE ANNOYANCE RELATION AROUND AIRPORTS
Jacques Francois May 1981 27 p refs Transl. into ENGLISH from Rev. d'Acoustique (France), v. 12, no. 48, 1979 p 70-78 Original language document was announced as A80-30814 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-3198)
(NASA-TM-75873) Avail: NTIS HC A03/MF A01 CSCL 13B

A survey of 5,000 individuals living around Orly Airport is described. The psobic index was used as the noise index which indicated the intensity of the annoyance experienced by people living around the airport. The results indicate that sensitivity to noise is related to certain personal factors. E.A.K.

N81-28608*# National Aeronautics and Space Administration, Washington, D. C.
INCIDENCES FROM MODIFICATIONS OF THE COMPUTATIONAL METHODS OF THE PSOPHIC INDEX
Jacques Francois May 1981 32 p Transl. into ENGLISH of "Incidences des Modifications de la Methode de Calcul de l'Indice Psophique" rept. Inst. Francais Publique, Paris, Nov. 1975 p 1-26 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-3198)
(NASA-TM-76577) Avail: NTIS HC A03/MF A01 CSCL 13B

In France, the level of annoyance in areas around airports is represented by the psophic index N. Various modifications were proposed in the method of calculating this indexing order to improve the index as an annoyance indicator. The quality of the modified N index as a prognosis index for annoyance caused by aircraft noise is included. T.M.

N81-28610*# National Aeronautics and Space Administration, Washington, D. C.
EVALUATION OF THE DISTURBANCE CAUSED BY AIRCRAFT NOISE BY OPINION SURVEYS
Jacques Bremond May 1981 17 p refs Transl. into ENGLISH from Med. Aeron. et Spatiale, Med. Subaquatique et Hyperbare (France), v. 18 no. 72, 1979 p 269-274 Original language document was announced as A80-32597 Transl. by Kanner (Leo) Associates, Redwood City, Calif.

(Contract NASw-3199)
(NASA-TM-76579) Avail: NTIS HC A02/MF A01. CSCL 13B

A survey on the disturbance caused by aircraft noise was evaluated. The use of a questionnaire as a scale rather than considering isolated question responses is seen as more objective. A standardized structure for questionnaires of the opinion surveys on aircraft noise, which includes a set of questions permitting the analysis of the disturbance caused by different daily activities is recommended. The statistical processing of the answers, to achieve the most reliable evaluation of disturbance felt are discussed. E.A.K.

N81-28783*# Kentron International, Inc., Hampton, Va.
ISSYS: AN INTEGRATED SYNERGISTIC SYNTHESIS SYSTEM
A. R. Dovi Feb. 1980 257 p refs
(Contract NAS1-13500)
(NASA-CR-159221) Avail: NTIS HC A12/MF A01 CSCL 09B

Integrated Synergistic Synthesis System (ISSYS), an integrated system of computer codes in which the sequence of program execution and data flow is controlled by the user, is discussed. The commands available to exert such control, the ISSYS major function and rules, and the computer codes currently available in the system are described. Computational sequences frequently used in the aircraft structural analysis and synthesis are defined. External computer codes utilized by the ISSYS system are documented. A bibliography on the programs is included. E.A.K.

N81-28785# TRW Defense and Space Systems Group, Redondo Beach, Calif.
AIRBORNE SYSTEMS SOFTWARE ACQUISITION ENGINEERING GUIDEBOOK FOR SOFTWARE COST ANALYSIS AND ESTIMATING Final Report
R. W. Wolverton Sep. 1980 173 p refs
(Contract F33657-76-C-0677; AF Proj. 2238)
(AD-A100215; TRW-30323-6012-TU-00; ASD-TR-80-5025)
Avail: NTIS HC A08/MF A01 CSCL 09/2

This guidebook assists Air Force Program Office engineering and management personnel in costing embedded software for avionics applications. A methodology for cost reporting and avoiding the '90 percent complete' syndrome is presented. An annotated bibliography gives the author's personal view of source material relevant to avionics software costing using modern programming practices. Author (GRA)

N81-28786# TRW Defense and Space Systems Group, Redondo Beach, Calif.
AIRBORNE SYSTEMS SOFTWARE ACQUISITION ENGINEERING GUIDEBOOK FOR CONTRACTING FOR SOFTWARE ACQUISITION Final Report
R. Agnos Aug. 1980 69 p
(Contract F33657-76-C-0677; AF Proj. 2238)
(AD-A100217; TRW-30323-6007-TU-00; ASD-TR-80-5024)
Avail: NTIS HC A04/MF A01 CSCL 09/2

This report is one of a series of guidebooks whose purpose is to assist Air Force Program Office and Engineering personnel in the acquisition of weapon systems containing software. This guidebook provides information about the technicalities of DOD contracting to enable Program Office and Software Engineering personnel to effectively work the Procuring Contracting Officer (PCO) and other members of the acquisition team. Author (GRA)

N81-28787# TRW Defense and Space Systems Group, Redondo Beach, Calif.
AIRBORNE SYSTEMS SOFTWARE ACQUISITION ENGINEERING GUIDEBOOK FOR APPLICATION AND USE OF THE GUIDEBOOKS (SERIES OVERVIEW) Final Report
L. Parriott Oct. 1980 55 p
(Contract F33657-76-C-0677; AF Proj. 2238)
(AD-A100216; TRW-30323-6003-TU-00; ASD-TR-80-5028)
Avail: NTIS HC A04/MF A01 CSCL 09/2

This guidebook serves as an introduction to the Airborne Systems Software Acquisition Engineering guidebook series which describes significant activities and events in the software acquisition life cycle of airborne embedded computer systems acquired within the framework of Air Force 800-series documents. This guidebook contains a brief description of the other fifteen guidebooks and discusses the application and use of the various guidebooks during the acquisition of embedded weapon system software. Author (GRA)

N81-28788# TRW Defense and Space Systems Group, Redondo Beach, Calif.
AIRBORNE SYSTEMS SOFTWARE ACQUISITION ENGINEERING GUIDEBOOK FOR SUPPORTABLE AIRBORNE SOFTWARE Final Report
K. Meyer Oct. 1980 83 p refs
(Contract F33657-76-C-0677; AF Proj. 2238)
(AD-A100213; TRW-30323-6015-TU-00; ASD-TR-80-5026)
Avail: NTIS HC A05/MF A01 CSCL 09/2

This report is one of a series of guidebooks whose purpose is to assist Air Force Program Office and engineering personnel in the acquisition and engineering of airborne systems software. This guidebook addresses topics relevant to software supportability. It provides guidance for preparation of the Computer Resources Integrated Support Plan (CRISP) and discusses the acquisition of supportable airborne software through review of the development effort. Author (GRA)

N81-28789# TRW Defense and Space Systems Group, Redondo Beach, Calif.
AIRBORNE SYSTEMS SOFTWARE ACQUISITION ENGINEERING GUIDEBOOK FOR SOFTWARE DEVELOPMENT AND SUPPORT FACILITIES Final Report
F. Kishi Sep. 1980 122 p
(Contract F33657-76-C-0677; AF Proj. 2238)
(AD-A100214; TRW-30323-6019-TU-00; ASD-TR-80-5027)
Avail: NTIS HC A06/MF A01 CSCL 09/2

This report is one of a series of guidebooks whose purpose is to assist Air Force Program Office and Engineering personnel in the acquisition and engineering of airborne systems software. This guidebook addresses ground-based facilities used for software development, modification, integration, and testing on Avionics Embedded Computer Systems (ECS) during both the Full Scale Engineering Development phases and the Operations and Support phase of the ECS life cycle. It provides assistance to the Air Force Program Office in the acquisition of software development and support facilities in the specific areas of (1) establishing requirements for facility acquisition; (2) performing facility planning; and (3) establishing procedures used development/acquisition and operations. Author (GRA)

N81-28810*# Washington Univ., St. Louis, Mo. Center for Computational Mechanics.
ADAPTIVE FINITE ELEMENT TECHNOLOGY IN INTEGRATED DESIGN AND ANALYSIS Final Report, 1 Oct. 1979 - 31 Dec. 1980
B. A. Szabo, P. K. Basu, D. A. Dunavant, and D. Vasilopoulos Jan. 1981 94 p refs
(Grant NsG-1640)
(NASA-CR-164560; WU/CCM-81/1) Avail: NTIS HC A05/MF A01 CSCL 12A

An assessment of the potential impact of adaptive finite element technology on the analysis part of the aircraft structural synthesis process is presented. The main conclusion is that adaptive application of the p-version of the finite element method based on indirect error estimation procedures results in substantial cost reduction and increased reliability of the computed data. Adaptivity based on direct a posteriori error estimation has the potential for additional savings. M.G.

N81-29034*# National Academy of Sciences - National Research Council, Washington, D. C.
NASA'S AERONAUTICS PROGRAM: SYSTEMS TECHNOLOGY AND EXPERIMENTAL PROGRAM Final Report
1980 40 p
(Contract NASw-2342)
(NASA-CR-164642) Avail: NTIS HC A03/MF A01 CSCL 05A

The appropriateness of the division of effort between the directed to the solution of near-term problems and that directed to long-term technical advances in the program is addressed. Comparisons between in-house work and out-of-house work are presented. Programs include those in: general aviation; propulsive lift; rotorcraft; avionics and flight controls; small transport aircraft; and human/vehicle systems. T.M.

N81-29063*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AEROSPACE IN THE FUTURE
John F. McCarthy, Jr. May 1980 34 p Presented at CECON, Cleveland, 20-21 May 1980
(NASA-TM-82664; E-575) Avail: NTIS HC A03/MF A01 CSCL 05A

National research and technology trends are introduced in the environment of accelerating change. NASA and the federal budget are discussed. The U.S. energy dependence on foreign oil, the increasing oil costs, and the U.S. petroleum use by class are presented. The $10 billion aerospace industry positive contribution to the U.S. balance of trade of 1979 is given as an indicator of the positive contribution of NASA in research to industry. The research work of the NASA Lewis Research Center in the areas of space, aeronautics, and energy is discussed as a team effort of government, the areas of space, aeronautics, and energy is discussed as a team effort of government, industry, universities, and business to maintain U.S. world leadership in advanced technology. A.R.H.

N81-29066# Armament Development and Test Center, Eglin AFB, Fla.
TACTICAL NAVIGATION SYSTEM TESTING
Douglas M. Carlson *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 13 p

Avail: NTIS HC A14/MF A01
Three systems, the AN/ARN-101 Digital Modular Avionics System, the AN/AVQ-26 Pave Tack, and the Stores Management System are described along with the instrumentation used. A discussion of the simulation and integration efforts in these programs is presented. T.M.

N81-29067# British Aerospace Aircraft Group, Woodford (England).
FLIGHT TESTING AND INSTRUMENTATION OF AIRCRAFT NAVIGATION SYSTEMS
M. J. Taylor *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 17 p refs

Avail: NTIS HC A14/MF A01
Experience gained in developing navigation systems for the 'Nimrod' series of aircraft over the past thirteen years led to the derivation and establishment of test methods which meet the needs of the job. An account of the way in which flight trials on Nimrod Mk.1, Mk.2 and Mk.3 aircraft were formulated to meet the different operational patterns expected in service is presented along with the various choices of navigation system modes and the constraints imposed by test facility and air traffic limitations. The instrumentation of the aircraft, its navigation system and the navigation reference system are covered, together with the data analysis methods used. The philosophy of flight trials is discussed as influenced by all the above factors. T.M.

N81-29068# Centre d'Essais en Vol, Bretigny-sur-Orge (France).
SYSTEMS INTEGRATION OF AUTOMATIC FLIGHT CONTROL, NAVIGATIONAL CALCULATIONS, AND VISUAL CONTROL (CARAVELLE ALIS) [ESSAI D'UN SYSTEME INTEGRE DE PILOTAGE, NAVIGATION ET VISUALISATION (CARAVELLE ALLIS)]
Alain Klopfstein *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 11 p refs In FRENCH

Avail: NTIS HC A14/MF A01
The complexity of aircraft equipment has made it necessary to utilize onboard systems integration. An experimental integration system was installed in a Caravelle aircraft. It assures the integration of information from the automatic flight command system, the visual information gathered by the pilot, and the navigation and guidance calculations. Transl. by T.M.

N81-29069# Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).
ONBOARD AND GROUND TEST OF AN AUTONOMOUS NAVIGATION SYSTEM BASED ON TERRAIN CORRELATION
Horst Dieter Lerche *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 11 p

Avail: NTIS HC A14/MF A01
The progress in microprocessor technology and digital data processing has caused a trend towards high sophisticated avionic systems with decentralized system architecture. The experience gained in developing and testing of a navigation system based upon terrain correlation is discussed. A dedicated ground based data management system and special test methods were developed to perform flight tests. Typical flight experiments are discussed. T.M.

N81-29070# Dornier-Werke G.m.b.H., Oberpfaffenhofen (West Germany).
ALIGNMENT OF A NAVIGATION AND ATTACK SYSTEM FOR THE ALPHA JET AIRCRAFT [MISE AU POINT DU SYSTEME DE NAVIGATION ET D'ATTAQUE DE L'AVION ALPHA-JET]
Juergen Lang *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 9 p In FRENCH

Avail: NTIS HC A14/MF A01
A description of a navigation and attack system is presented along with its aims and operational principles. Test equipment is discussed which assure the desired flexibility for the flight tests. The principle task of alignment as well as ground support operations are outlined. Transl. by T.M.

N81-29072# National Aerospace Lab., Amsterdam (Netherlands).
DATA ACQUISITION AND ANALYSIS SYSTEM AS A TRAINING DEVICE FOR SIMULATED CONVENTIONAL WEAPON DELIVERY
C. F. G. M. Hofman and J. Batenburg (Royal Netherlands Air Force) *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 10 p refs

Avail: NTIS HC A14/MF A01
A system, called Delivery and Impact Analysis System (DIAS) was developed and tested. This system, based on a photogrammetric method, yields release conditions, the nominal weapon impact position and the weapon time of flight. Simulated attacks on a great variety of realistic targets can be evaluated and validated as there is no need to drop training weapons. Furthermore no ground based instrumentation in the target area is needed. The system consisting of an airborne data acquisition system installed in the aircraft and a ground based processing and analysis system at the airbase allows a debriefing of the pilot within half an hour after completion of the mission. DOE

N81-29073# Air Force Flight Test Center, Edwards AFB, Calif.
AIR-TO-AIR GUNNERY SYSTEMS TEST AND EVALUATION
John A. Wiles *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 16 p refs

Avail: NTIS HC A14/MF A01
The system is theoretically capable of evaluating any gunnery system installed on an instrumented aircraft. It was developed and tested using a scorable tow target system, an analysis software package, and three independent flight evaluations of current fighter aircraft. Use of this flight test system over a two-year period led to the preliminary conclusion that the combination of ballistic prediction software and tow targets with miss distance measurement capability can provide analysis results accurate to within three milliradians. The system has operational test and evaluation application as well as use for developmental testing. T.M.

N81-29074# Royal Aircraft Establishment, Farnborough (England). Instrumentation and Trials Dept.
GUN HARMONISATION USING THE SECTOR ACOUSTIC MISS DISTANCE INDICATOR
T. W. Chubb *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 8 p refs

Avail: NTIS HC A14/MF A01
The operating principles of the indicator are described and the performance limitations which determine the accuracy in both range measurement and quadrant determination are indicated. The application to air-to-air gun harmonization trials using this target system is described. T.M.

N81-29076# Aeritalia S.p.A., Torino (Italy). Combat Aircraft Group.
FUEL SYSTEM TESTING AND TEST INSTRUMENTATION

Renato Aimo *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 19 p

Avail: NTIS HC A14/MF A01
Several aspects related to fuel system design requirements

for high performance aircraft are discussed. Major emphasis is placed on safety, quality assurance, and performance factors. R.C.T.

N81-29077# Boeing Military Airplane Development, Seattle, Wash. Advanced Airplane Branch.
ADVANCES IN LANDING GEAR SYSTEMS
N. S. Attri and R. L. Amberg (Boeing Commercial Airplane Co., Seattle) *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 20 p
Avail: NTIS HC A14/MF A01

A status of the development for some of the hardware components of landing gear is provided. Methods of system evaluation are discussed as well as the problems associated with validating expected performance. The relationship between functional landing gear subsystem and hardware components is also illustrated. R.C.T.

N81-29078# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
RESEARCH ON THE FUNCTIONAL LIMITS OF A HELICOPTER ROTOR: SPEED AND LOAD FACTOR [RECHERCHE DES LIMITES DE FUNCTIONNEMENT D'UN ROTOR D'HELICOPTERE EN VITESSE ET FACTEUR DE CHARGE]

B. Certain and J. M. Besse *In its* Subsystem Testing and Flight Test Instr. Apr. 1981 13 p In FRENCH

Avail: NTIS HC A14/MF A01

Methods of testing the rotor aerodynamics are discussed and include in-flight monitoring and ground tests. Strain gages were utilized in the in-flight monitoring. Wind tunnel tests offered simulation of various aerodynamic loads. Of special interest was aerodynamic stalling and flutter. The data processing techniques are discussed in detail. Transl. by T.M.

N81-29079# Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
ELECTRO-MAGNETIC COMPATIBILITY: THE DETERMINATION OF SAFETY FOR CRITICAL SYSTEMS
G. M. Smith *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 6 p *refs*

Avail: NTIS HC A14/MF A01

The problems of certification of the fitness of military aircraft to enter service have increased significantly with the introduction of electronic equipments into areas of the aircraft which directly relate to primary flight safety. The effects of self generated interference as well as effects due to the external environment are considered. The establishment of adequate margins of safety for these systems requires changes to equipment test methods and procurement procedures. The problems are reviewed and alternative approaches described. R.C.T.

N81-29082# Westland Helicopters Ltd., Yeovil (England).
DEVELOPMENT FOR HELICOPTER FLIGHT IN ICING CONDITIONS
David Gibbings *In* AGARD Subsystem Testing and Flight Instr. Apr. 1981 12 p
Avail: NTIS HC A14/MF A01

The requirement for airframe, intake and rotor deicing systems and the instrumentation considered necessary for safe flight development are discussed. The problems involved in carrying out icing and snow flight development as part of a full prototype development program are considered and some of the favored icing simulation test methods are addressed. R.C.T.

N81-29083# Centre d'Essais en Vol, Bretigny-sur-Orge (France).
METHODS OF TESTING AIRCRAFT PERFORMANCE UNDER ICING CONDITIONS AND ICE TECTION SYSTEMS [*METHODES D'ESSAI DU COMPORTEMENT DES AERONEFS EN CONDITIONS GGIVRANTES ET DES SYSTEMES DE PROTECTION CONTRE LE GAVRAGE*]
Martin Friendlander *In* AGARD Submystem Testing and Flight Test Instr Apr 1981 9 p

Avail: NTIS HC A14/MF A01

The aerodynamic effects on flight control were reviewed. Parameters that influence ice formation are discussed and include: the temperature of turbulent air; the water tension in each droplet; and the aerodynamic speed. The advantages and disadvantages of ground tests that simulate icing conditions are summarized and compared to inflight testing. Focus is placed on ice prevention systems for aircraft, especially helicopters. Transl. by T.M.

N81-29084# Centre d'Essais en Vol, Bretigny-sur-Orge (France).
THE INTERFACE ARRANGEMENT OF DIGIBAS SYSTEMS [L'INERFACE MESURE DES SYSTEMES DIGIBUS]
C. Rat *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 9 p
Avail: NTIS HC A14/MF A01

The use of the digibus throughout the Mirage 2000 program is discussed, in particular the important role that it plays in the weapons system of that aircraft. In order to use the large operational capacities of the aircraft, an important integration effort was made at the navigation room level in an effort to get the best compromise in presenting system parameters and commands to the pilot. These include heads-up high visualizations adapted to each phase of flight, multiplexed controls, and synthetic presentations of tactical situations. The use of a numerical bus is absolutely necessary in carrying such a program to completion. Topics covered include avionics and the numerical bus; technical aspects of the digibus; and the programmable numerical bus-visualization relation. Transl. by A.R.H.

N81-29085# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
PROGRAMMABLE MULTIPURPOSE FLIGHT TEST INSTRUMENTATION SYSTEM
Ruediger Karmann *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 13 p refs

Avail: NTIS HC A14/MF A01

As a result of the increased use of flight control and stability augmentation systems, higher frequency contents of the control loops together with an increased amount of information provided by additional sensors have placed several demands on the flight test instrumentation. In order to achieve a reasonable relationship between costs and benefits a computer controlled flight test instrumentation system was developed. Through the modular construction of this device a wide field of applications is achieved. E.D.K.

N81-29087# Royal Aircraft Establishment, Farnborough (England).
AN INVESTIGATION OF THE LINEAR AND ANGULAR VIBRATION ENVIRONMENTS OF TRIALS AIRCRAFT
G. L. Wray and D. J. Flynn *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 28 p

Avail: NTIS HC A14/MF A01

An investigation of the dynamic environment of trials aircraft based on the measurement of linear acceleration and angular velocity along and about the three principal airframe axes is described. The results, expressed in the form of power and cross spectral densities, are used to set up an empirical mathematical model of the dynamic environment of an aircraft for use in computer simulations of a strapdown inertial navigator. The application of the model to the simulation of strapdown system alignment in a nominally stationary vehicle is discussed. E.D.K.

N81-29088# National Aerospace Lab., Amsterdam (Netherlands).
A METHOD FOR MEASURING TAKE-OFF AND LANDING PERFORMANCE OF AIRCRAFT, USING AN INERTIAL SENSING SYSTEM
A. Pool, J. L. Simons, G. J. H. Wensink, and A. J. L. Willekens *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 7 p refs
Avail: NTIS HC A14/MF A01

The start and landing with an inertial system (STALINS) method for measuring takeoff and landing trajectories is described and results of flight tests made in 1978 to 1980 are discussed. The method meets the requirements to which it was designed and a few improvements in the hardware and software are being finalized. The method is expected to be ready for operational use in the course of 1981. E.D.K.

N81-29089# Boeing Co., Seattle, Wash.
MICROWAVE SYSTEM FOR REAL TIME SPACE POSITION

MEASUREMENT
W. J. Irwin *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 7 p

Avail: NTIS HC A14/MF A01

A microwave airplane position system (maps) for measuring the space position of a flight test airplane and time correlating this position with other varying test parameters is discussed. Operational range is normally within 10 km of the test range of runway. A number of microwave transmitter/receiver (T/R) units are located at surveyed coordinates in an optimum ground pattern. Airborne equipment includes an interrogator, digital processor, data storage units, pilot's guidance indicators, and a quick look engineering station. The airborne system interrogates each ground T/R in serial fashion and computes slant range and range rate from the response. The computer performs position calculations in real time using a high speed Kalman filtering algorithm. Data are tape recorded, displayed to test engineers, and used to drive panel instruments which allow the pilot to follow a specific flight profile. E.D.K.

N81-29090*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
PRACTICAL ASPECTS OF INSTRUMENTATION INSTALLATION IN SUPPORT OF SUBSYSTEM TESTING
Robert W. Borek *In* AGARD Subsystem Testing and Flight Test Instr. Apr. 1981 16 p refs

Avail: NTIS HC A14/MF A01

Some of the problems associated with using military specification MIL-W-5088H as a guideline for wire gage selection are discussed. Examples of proper use of this specification as a criterion for interfacting wire bundles and connectors are provided. The quantitative results of 22 projects that have used the technique known as sneak analysis are reviewed and examples are given. E.D.K.

N81-29093*# Boeing Military Airplane Development, Seattle, Wash.
STATIC TEST OF A FAN-POWERED CHIN NOZZLE FOR V/STOL APPLICATIONS Final Report
Victor Salemann Apr. 1981 37 p ref
(Contract NAS3-22165)
(NASA-CR-165361; D180-26446-1) Avail: NTIS HC A03/MF A01 CSCL 01A

The performance of a 'chin' nozzle which diverts flow in a downward direction immediately downstream of a fan typical of designs suitable for V/STOL A applications was evaluated. Back pressure distortion to the fan and fan discharge pressure distortion were also measured. Results show that the distortion is significant at the closest spacing between the fan exit and cascade entrance tested, and that the chin nozzle performance deteriorates with increased flow diversion to the chin nozzle. Color oil flow visualization on video tape and still photos were also obtained. Tests were conducted behind a 12' model fan in the NASA-Lewis fan calibration facility. A.R.H.

N81-29107*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EXPLOSIVELY ACTIVATED EGRESS AREA Patent Application
Laurence J. Bement and James W. Bailey, inventors (to NASA) (LTV Corp., Hampton, Va.) Filed 30 Apr. 1981 19 p
(NASA-Case-LAR-12624-1; US-Patent-Appl-SN-259209) Avail: NTIS HC A02/MF A01 CSCL 01C

A lightweight, add-on structure which smoothly cuts general aviation airframes along an egress area periphery, jettisoning the severed portion for rapid pilot egress is described. Flexible charges held against the airframe's interior cut the airframe while reaction surfaces, attached to the airframe's exterior within the periphery, restrict deformation of the skin. The reaction surfaces envelop an external containment cell which provides adequate space for cutting to occur; changing the volume and shape of the external containment cell alters the roughness of the cut. The reaction surfaces also receive impulse forces from the charge to jettison the severed portion of the airframe. Sealing walls and retention surfaces shield the airframe's interior from explosive forces. The pilot initiates the charges by rotating a bellcrank assembly which activates a lanyard-detonator. Safe pilot egress is improved by reducing the roughness of the egress area periphery, and increasing the distance which the severed portion is jettisoned. NASA

N81-29108*# Battelle Columbus Labs., Ohio.
AN INVESTIGATION OF REPORTS OF CONTROLLED FLIGHT TOWARD TERRAIN (CFTT) Interim Report
Richard F. Porter and James P. Loomis 6 Apr. 1981 68 p refs
(Contract NAS2-10060)
(NASA-CR-166230) Avail: NTIS HC A04/MF A01 CSCL 01C

Some 258 reports from more than 23,000 documents in the files of the Aviation Safety Reporting System (ASRS) were found to be to the hazard of flight into terrain with no prior awareness by the crew of impending disaster. Examination of the reports indicate that human error was a casual factor in 64% of the incidents in which some threat of terrain conflict was experienced. Approximately two-thirds of the human errors were attributed to controllers, the most common discrepancy being a radar vector below the Minimum Vector Altitude (MVA). Errors by pilots were of a much diverse nature and include a few instances of gross deviations from their assigned altitudes. The ground proximity warning system and the minimum safe altitude warning equipment were the initial recovery factor in some 18 serious incidents and were apparently the sole warning in six reported instances which otherwise would most probably have ended in disaster. A.R.H.

N81-29109*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECT OF DISPLAY SIZE ON UTILIZATION OF TRAFFIC SITUATION DISPLAY FOR SELF-SPACING TASK
Terence S. Abbott and Gene C. Moen (Army-Aviation Research and Development Command, Hampton, Va.) Aug. 1981 30 p refs
(DA Proj. 1L2-62209-AH-76)
(NASA-TP-1885; L-14418; AVRADCOM-TR-81-B-4) Avail: NTIS HC A03/MF A01 CSCL 17G

The weather radar cathode ray tube (CRT) is the prime candidate for presenting cockpit display of traffic information (CDTI) in current, conventionally equipped transport aircraft. Problems may result from this, since the CRT size is not optimized for CDTI applications and the CRT is not in the pilot's primary visual scan area. The impact of display size on the ability of pilots to utilize the traffic information to maintain a specified spacing interval behind a lead aircraft during an approach task was studied. The five display sizes considered are representative of the display hardware configurations of airborne weather radar systems. From a pilot's subjective workload viewpoint, even the smaliest display size was usable for performing the self spacing task. From a performane viewpoint, the mean spacing values, which are indicative of how well the pilots were able to perform the task, exhibit the same trends, irrespective of display size; however, the standard deviation of the spacing intervals decreased (performance improves) as the display size increased. Display size, therefore, does have significant effect on pilot performance. A.R.H.

N81-29110*# Battelle Columbus Labs., Ohio.
ATC CONTINGENCY OPERATIONS IN THE EN-ROUTE FLIGHT REGIME Interim Report
E. Gene Lyman 15 Apr. 1981 24 p refs
(Contract NAS2-10060)
(NASA-CR-166231) Avail: NTIS HC A02/MF A01 CSCL 17G

Air traffic control (ATC) operations were examined to learn what factors of controller performance should be given consideration in the design and development of future automation systems enhancing ATC. Contingencies were of two types: those constraining airspace usage or traffic flow (i.e., weather); and those related to system and equipment usage (i.e., radar/radio status). Examination of controller response to contingencies and workload pressures showed differing effects on controller allocations of effort among the three primary function of planning, monitoring, and information transfer. Automation advancements oriented towards aiding the controller in performing monitoring tasks may offer the most substantial safety benefit. S.F.

N81-29111*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EVALUATION OF MICROWAVE LANDING SYSTEM (MLS) EFFECT ON THE DELIVERY PERFORMANCE OF A FIXED-

PATH METERING AND SPACING SYSTEM
Leonard Credeur, Christine M. Davis (Research Triangle Inst., Research Triangle Park, N.C.), and William R. Capron (Kentron International, Inc., Hampton, Va.) Aug. 1981 132 p refs
(NASA-TP-1844; L-14069) Avail: NTIS HC A07/MF A01 CSCL 17G

Metering and spacing (M & S) system's algorithms described assume an aircraft two dimensional are navigation capability. The three navigation systems compared were: very high frequency omnidirectional range/distance measuring equipment (VOR/DME) and ILS, VOR/DME and + or - 40 MLS, and VOR/DME and + or - 60 MLS. Other factors studied were M & S tentative schedule point location, route geometry effects, and approach gate location effects. Summarized results are: the MLS offers some improvement over VOR/DME and ILS if all approach routes contain computer assisted turns; pilot reaction to moving the gate closer to the runway threshold may adversely affect M & S performance; and coupling en route metering to terminal scheduling transfers most of the terminal holding to more full efficient, higher altitude en route delay. T.M.

N81-29112# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADAR BEACON TRANSPONDER (RBX) FUNCTIONAL DESCRIPTION
Ronald G. Sandholm 18 Feb. 1981 31 p refs
(Contracts F19628-80-C-0002; DOT-FA77WAI-817)
(AD-A100665; ATC-104; FRA-RD-80-135) Avail: NTIS CSCL 17/9

The Radar Beacon Transponder (RBX) is a ground-based transponder used to control the threat detection sensitivity level of BCAS aircraft operating in high density terminal airspace. The RBX is also used to deliver displayed resolution advisories from BCAS to the ATC facility. The normal DABS interrogation waveforms and message formats are used for communication between the RBX and BCAS aircraft. The appropriate BCAS sensitivity level is selected by comparing the BCAS aircraft position with an internally stored sensitivity level map of the surrounding airspace volume. This document provides a functional description of the RBX and shows that reliable performance is achievable in the presence of interference from ATCRBS and BCAS air-to-air interrogations. Author (GRA)

N81-29113# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADAR BEACON TRANSPONDER (RBX) INSTALLATION AND SITING CRITERIA
Ronald G. Sandholm 13 Mar. 1981 21 p refs
(Contracts F19628-80-C-0002; DOT-FA77WAI-817)
(AD-A100666; ATC-106) Avail: NTIS HC A02/MF A01 CSCL 17/9

The Radar Beacon Transponder (RBX) is a ground-based facility used in conjunction with other elements of the Active Beacon Collision Avoidance System (BCAS) to control the threat detection sensitivity level of BCAS aircraft and to convey displayed Resolution Advisories from the BCAS aircraft to the local ATC terminal facility. This paper describes the mechanisms of specular multipath reflection and signal shadowing, and discusses their impact on the RBX link power budget. Criteria for choice of RBX antenna height and location are presented. Author (GRA)

N81-29116# National Aeronautical Establishment, Ottawa (Ontario).
A KALMAN FILTER APPROACH TO NAVIGATION ON THE NAE CONVAIR 580 AEROMAGNETICS RESEARCH AIRCRAFT
B. W. Leach Feb. 1981 106 p refs
(AD-A100836; NAE-LR-604; NRC-19271) Avail: NTIS HC A06/MF A01 CSCL 17/7

Doppler radar, compass heading, and VLF communications station phase difference information are combined in an optimal fashion to form an ten-state Doppler/VLF Kalman filter navigation algorithm is designed for use onboard the NAE Convair 580 aeromagnetics research aircraft, with simulation studies conducted using computer programs written in FORTRAN for the IBM 3032 TSS operating environment. Results from the studies show the unique features of a Kalman filtering approach to the navigation task. Various contingencies, or anomalous situations, that can arise when handling the VLF data are considered, and solutions are offered in the context of the Kalman filter approach being used. A comparison study involving simulated navigation data demonstrates the superiority of the Kalman filter navigator compared to simpler navigation algorithms, especially when significant bias errors occur in the basic quantities being measured. A further comparison study based on navigation data collected onboard the Convair verifies that the proposed Kalman filter navigation algorithm operates properly when using typical 'real world' data. Author (GRA)

N81-29118*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONCEPTUAL/PRELIMINARY DESIGN STUDY OF SUBSONIC V/STOL AND STOVL AIRCRAFT DERIVATIVES OF THE S-3A
George H. Kidwell, Jr. Jul. 1981 64 p refs
(NASA-TM-81310; A-8665) Avail: NTIS HC A04/MF A01 CSCL 01C

A computerized aircraft synthesis program was used to examine the feasibility and capability of a V/STOL aircraft based on the Navy S-3A aircraft. Two major airframe modifications are considered: replacement of the wing, and substitution of deflected thrust turbofan engines similar to the Pegasus engine. Three planform configurations for the all composite wing were investigated: an unconstrained span design, a design with the span constrained to 64 feet, and an unconstrained span oblique wing design. Each design was optimized using the same design variables, and performance and control analyses were performed. The oblique wing configuration was found to have the greatest potential in this application. The mission performance of these V/STOL aircraft compares favorably with that of the CTOL S-3A. J.D.H.

N81-29119*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
US AND USSR MILITARY AIRCRAFT AND MISSILE AERODYNAMICS 1970-1980. A SELECTED, ANNOTATED BIBLIOGRAPHY, VOLUME 1
Marie H. Tuttle and Dal V. Maddalon Aug. 1981 71 p
(NASA-TM-81951; L-14392) Avail: NTIS HC A04/MF A01 CSCL 01B

The purpose of this selected bibliography (281 citations) is to list available, unclassified, unlimited publications which provide aerodynamic data on major aircraft and missiles currently used by the military forces of the United States of America and the Union of Soviet Socialist Republics. Technical disciplines surveyed include aerodynamic performance, static and dynamic stability, stall-spin, flutter, buffet, inlets nozzles, flap performance, and flying qualities. Concentration is on specific aircraft including fighters, bombers, helicopters, missiles, and some work on transports, which are or could be used for military purposes. The bibliography is limited to material published from 1970 to 1980. The publications herein illustrate many of the types of aerodynamic data obtained in the course of aircraft development programs and may therefore provide some guidance in identifying problems to be expected in the conduct of such work. As such, this information may be useful in planning future research programs. Author

N81-29120# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Graduate Strategic and Tactical Sciences.
SURVIVABILITY STUDY OF A FLIR EQUIPMENT FIGHTER ON A NIGHT PENETRATION OF A SOVIET ARMY M.S. Thesis
Warren J. Leek and Richard W. Schmitt Mar. 1981 161 p refs
(AD-A101186; AFIT/GST/OS/81-M-9) Avail: NTIS HC A08/MF A01 CSCL 01/3

The LANTIRN system provides the fighter pilot with a forward looking infrared (FLIR) system, which allows him to fly the aircraft lower and faster than he would otherwise be able to fly. The objective of this research effort was to determine whether this increased capability will significantly improve the fighter's survivability in the night interdiction role. The problem was studied in the context of the threats and terrain found in the central region of West Germany. A model of the terrain features and threat scenario was constructed using the SLAM computer simulation language. The Soviet defensive systems can be moved around as desired, and aircraft can enter the system at a variety of arrival intervals, airspeeds, and altitudes. Defensive systems that are within range of the aircraft will shoot at it, provided they are not tied up with a previous aircraft, blocked by terrain, or prevented from shooting because of a low probability of kill. The capability to fly faster did not significantly increase the fighter's survivability. A decrease in altitude from

1000 feet to 500 feet increased survivability to a minor degree, while a further decrease to 250 geet improved survivability significantly. These findings led to the conclusion that a strong effort should be made to develop a FLIR of high enough resolution to allow the pilot to fly the mission at an altitude of 250 feet or below. Author (GRA)

N81-29121# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

AH-1S(PROD) AIRWORTHINESS AND FLIGHT CHARACTERISTICS FOR INSTRUMENT FLIGHT Final Report, May - Aug. 1980

John S. Tulloch, John D. Ottomeyer, Charles E. Frankenberger, Jr., and Bartholomew D. Picasso, III Nov. 1980 47 p refs
(AD-A100946; USAAEFA-79-08) Avail: NTIS HC A03/MF A01 CSCL 01/2

The United States Army Aviation Engineering Flight Activity conducted an Airworthiness and Instrument Flight Characteristics evaluation of a Production AH-1S (Prod) to determine potential for the AH-1S with Enhanced Cobra Armament System (ECAS) to meet instrument meteorological conditions qualification criteria. The test aircraft was configured with two tube launched, optically tracked, wireguided (TOW) missile launchers on each outboard wing stores station and a 7-tube lightweight launcher on each inboard wing stores station. The test consisted of 16.3 flight hours which were flown during 12 test flights. Four deficiencies and seven shortcomings associated with flying the AH-1S in instrument flight conditions, were identified. The deficiencies identified were: (1) unsatisfactory cyclic control system mechanical characteristics; (2) large pitot-static system airspeed errors in climb and descent; (3) easily excited lateral gust response; (4) vertigo-inducing location of radio control panels. Five specification noncompliances were noted. The AH-1S (Prod) is not suitable for flight in instrument meteorological conditions, which infers that the AH-1S (ECAS) will also not be suitable. Author (GRA)

N81-29122# Michigan Univ., Ann Arbor. Aircraft Research Lab.

INVESTIGATION OF AERODYNAMIC STALL ALLEVIATION ON A SWEPT PLANFORM WING USING LEADING EDGE MODIFICATIONS Final Report, 10 Apr. 1980 - 5 Jan. 1981

Roger W. VanGunst, Shreekant Agrawal, and Brian Meyer May 1981 68 p refs
(Contract N00167-80-C-0058)
(AD-A101239; UMICH-018209-3-F) Avail: NTIS HC A04/MF A01 CSCL 20/4

A wind tunnel investigation was conducted to determine the effect of leading edge modifications on the stall characteristics of a swept planform wing. The modifications consisted of openings in the leading edge which generated a vortex pattern over the wing surface. The force/moment results showed that a 33 percent increase in stall angle of attack could be achieved with the leading edge modifications. A maximum lift coefficient comparable to that of the baseline wing was also achieved with the modifications. Evidence of interference between the modification-generated flow field and the wind tunnel upper surface indicated that these high angle of attack results are a conservative evaluation of the modification's lift enhancement potential. The nose up pitching moment at stall was moderated by the leading edge modifications and no increase in drag occurred below 19 degrees angle of attack. Preliminary flow visualization results indicate that these force/moment characteristics associated with the leading edge modifications are caused by vortices formed on each side of the modification opening. The test results indicate that the leading edge modifications have the potential for increasing the maneuvering capability and stall margin of airplane flight operations. Author (GRA)

N81-29123# Air Force Flight Test Center, Edwards AFB, Calif.

AIRCRAFT BRAKE SYSTEMS TESTING HANDBOOK Final Report

Larry D. Plews and Gregory A. Mandt May 1981 72 p refs
(AD-A101516; AFFTC-TIH-81-1) Avail: NTIS HC A04/MF A01 CSCL 01/3

This handbook was written to provide AFFTC engineers with guidelines for the testing of aircraft brake systems. Future technological advances, characteristics of individual test programs, and cost constraints may necessitate other methods being used in some cases. A background on brake systems, test conduct, and documentation of computer software for calculation of brake energies is presented. Author (GRA)

N81-29124# United Technologies Corp., Stratford, Conn. Aircraft Div.

CH-53E EMERGENCY FLOTATION SYSTEM DESIGN STUDY Final Report

Knute C. Hansen and Thomas H. Lawrence 10 Jun. 1981 140 p refs
(Contract N62269-80-C-0210)
(AD-A101640; SER-13452; NADC-79256-60) Avail: NTIS HC A07/MF A01 CSCL 13/12

A study has been conducted to design an auxiliary flotation/stability system for the CH-53E helicopter which will keep the aircraft upright and afloat (with the cabin flooded) long enough to allow the evacuation of a full complement of combat troops. Configurations were made to be compatible with the proposed MH-53E helicopter and MCM equipment as well. The study showed that inflatable flotation bags provided the best design solution. Three such systems were designed in detail, one each for sea states 2, 4, and 5. Increasing system capability from sea state 2 to 5 results in only a slight increase in cost. The final systems should have acceptable reliability and maintainability characteristics, minimal impact on performance, and only cause a small weight penalty. In addition, a 1/10 Froude scaled model of the CH-53E and the auxiliary flotation systems has been designed and constructed. This model will be provided to the U.S. Navy for hydrodynamic testing. Author (GRA)

N81-29125# Strategic Air Command, Offutt AFB, Nebr. Aircraft Engineering Div.

OPTIMAL NUCLEAR RADIATION CRITERIA FOR AERONAUTICAL SYSTEMS Final Report

Rayford P. Patrick 15 May 1981 19 p refs
(AD-A101651; SAC/LGME-S-110) Avail: NTIS HC A02/MF A01 CSCL 15/6

Common nuclear radiation hardness criteria are developed and recommended for Air Force wide adoption. The criteria are based upon human 'mission kill' doses, technical capability to harden, and representative missions of manned penetrators. The criteria levels should provide balanced and cost effective life cycle hardness values. They also provide well defined keep out ranges/lethal volumes needed as input for future bomber defense systems. More importantly, the common criteria would decrease logistic support costs, increase the useability and interoperability of electronic equipment, and support the development of integrated hardness maintenance programs. Author (GRA)

N81-29126# Spectron Development Labs., Inc., Costa Mesa, Calif.

A STUDY IN FLOW CONTROL AND SCREENING METHODS FOR AIRCRAFT LASER TURRETS Final Report

James E. Craig Kirtland AFB, N. Mex. AFWL Apr. 1981 64 p refs
(Contracts F29601-80-C-0022; MIPR-FY3592-80-10039)
(AD-A101723; AFWL-TR-80-119) Avail: NTIS HC A04/MF A01 CSCL 01/3

Technical issues regarding the aerodynamics and optics of aircraft turrets are of critical importance to the Air Force Weapons Laboratory. Of specific interest are the optical properties of the separated flow over aircraft turrets. Turbulence generated by flow separation imparts significant distortion on laser beams. Control of flow separation from the turret and the resultant development of the turret wake will result in improved energy propagation at aft targets. The paper describes a survey of high-lift airfoil flow-control technology and its application to separation control on aircraft turrets. A flow-control concept screening methodology is developed and applied to conceptual designs. The effectiveness of wind and water tunnel testing for screening flow-control concepts has been evaluated. Flow parameters have been bracketed and the simulation quality of the mechanisms of flow control established for each facility. Water channels are recommended for screening tests for many of the conceptual designs. Author (GRA)

N81-29127*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EFFECT OF DISPLAY UPDATE INTERVAL, UPDATE TYPE, AND BACKGROUND ON PERCEPTION OF AIRCRAFT SEPARATION ON A COCKPIT DISPLAY ON TRAFFIC

INFORMATION
Sharon Jago (San Jose State Univ., Calif.), Daniel Baty (San Jose State Univ., Calif.), Sharon OConnor, and Everett Palmer Jun. 1981 12 p refs
(NASA-TM-81171; A-8070) Avail: NTIS HC A02/MF A01 CSCL 01D

The concept of a cockpit display of traffic information (CDTI) includes the integration of air traffic, navigation, and other pertinent information in a single electronic display in the cockpit. Concise display symbology was developed for use in later full-mission simulator evaluations of the CDTI concept. Experimental variables used included the update interval motion of the aircraft, the update type, (that is, whether the two aircraft were updated at the same update interval or not), the background (grid pattern or no background), and encounter type (straight or curved). Only the type of encounter affected performance. S.F.

N81-29129* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUPERCRITICAL FUEL INJECTION SYSTEM Patent
Cecil J. Marek and Larry P. Cooper, inventors (to NASA) Issued 26 Feb. 1980 4 p Filed 19 Jun. 1978 Supersedes N78-27122 (16 - 18, p 2353)
(NASA-Case-LEW-12990-1; US-Patent-4,189,914; US-Patent-Appl-SN-916654; US-Patent-Class-60-726; US-Patent-Class-60-39.06; US-Patent-Class-261-28; US-Patent-Class-431-2; US-Patent-Class-60-737) Avail: US Patent and Trademark Office CSCL 21E

A fuel injection system for gas turbines is described including a pair of high pressure pumps. The pumps provide fuel and a carrier fluid such as air at pressures above the critical pressure of the fuel. A supercritical mixing chamber mixes the fuel and carrier fluid and the mixture is sprayed into a combustion chamber. The use of fuel and a carrier fluid at supercritical pressures promotes rapid mixing of the fuel in the combustion chamber so as to reduce the formation of pollutants and promote cleaner burning.Official Gazette of the U.S. Patent and Trademark Office

N81-29130*# United Technologies Research Center, East Hartford, Conn.
TURBOJET ENGINE BLADE DAMPING Final Report
A. V. Srinivasan, D. G. Cutts, and S. Sridhar Jul. 1981 182 p refs
(Contract NAS3-21708)
(NASA-CR-165406; Rept-R81-91441031) Avail: NTIS HC A09/MF A01 CSCL 21E

The potentials of various sources of nonaerodynamic damping in engine blading are evaluated through a combination of advanced analysis and testing. The sources studied include material hysteresis, dry friction at shroud and root disk interfaces as well as at platform type external dampers. A limited seris of tests was conducted to evaluate damping capacities of composite materials (B/AL, B/AL/Ti) and thermal barrier coatings. Further, basic experiments were performed on titanium spcimens to establish the characteristics of sliding friction and to determine material damping constants J and n. All the tests were conducted on single blades. Mathematical models were develthe several mechanisms of damping. Procedures to apply this data to predict damping levels in an assembly of blades are developed and discussed. M.G.

N81-29131# Naval Postgraduate School, Monterey, Calif.
COMPUTER EVALUATION OF THE ON-AND-OFF DESIGN OF AN AXIAL AIR TURBINE M.S. Thesis
Robert Cirone Mar. 1981 269 p refs
(AD-A101102) Avail: NTIS HC A12/MF A01 CSCL 09/2

An existing code for calculating axial turbine performance using multiple stream surfaces was modified and made to run on the equivalent of an HP-1000 computer system. Calculations were made for the geometry of a 485 horsepower dual-discharge air-drive turbine for both on and off-design conditions. The results were compared with available data obtained at off-design speeds. Agreement of the flow rate and horsepower to within 5% was obtained. Author (GRA)

N81-29132*# Youngstown State Univ., Ohio.
CONTROL AUGMENTATION FOR LATERAL CONTROL WHEEL STEERING Final Report
Robert H. Foulkes, Jr. 13 Aug. 1981 71 p refs
(Grant NAG1-88)
(NASA-CR-164664) Avail: NTIS HC A04/MF A01 CSCL 01C

Flight control system design for lateral control wheel steering is discussed. Two alternate designs are presented. The first design is a roll-rate command, bank-angle hold system with a wings-level track-hold submode. The second is a curved-track-hold system. Design details and real-time flight simulator results are included. Author

N81-29133*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MINIMUM FUEL HORIZONTAL FLIGHTPATHS IN THE TERMINAL AREA
Eliezer Kreindler (Technion - Israel Inst. of Tech.) and Frank Neuman Aug. 1981 40 p refs
(NASA-TM-81313; A-8676) Avail: NTIS HC A03/MF A01 CSCL 17G

The problem of minimum fuel airplane trajectories from arbitrary initial states to be fixed final state is considered. There are four state variables (two position coordinates, heading, and constrained velocity) and two constrained controls (thrust and bank angle). The fuel optimality of circular and straight line flightpaths is examined. Representative extremals (trajectories satisfying the necessary conditions of the minimum principle) of various types are computed and used to evaluate trajectories generated by an on line algorithm. Attention is paid to the existence of Darboux points (beyond which an extremal ceases to be globally optimal). One fuel flow rate model includes a term quadratic in thrust; hence, the optimal thrust is continuous and nonsingular. The other fuel flow rate model is linear in thrust, and consequently the optimal thrust is discontinuous and singular. M.G.

N81-29134*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
ALLEVIATION OF HELICOPTER FUSELAGE-INDUCED ROTOR UNSTEADY LOADS THROUGH DETERMINISTIC VARIATION OF THE INDIVIDUAL BLADE PITCH
Mohammad A. Rahnema May 1981 72 p refs
(Contract NsG-2266)
(NASA-CR-166234; ASRL-TR-196-2) Avail: NTIS HC A04/MF A01 CSCL 01C

The effect of fuselage-induced upwash on the flapwise motion of a hinged rotor blade is considered. The typical upwash field is simulated through the flow produced by a moving point source. The resulting blade response is then approximated by its rigid flapping and first bending mode. The perturbation blade pitch variation required to alleviate its response to the upwash in the sense of either reducing the increased hub shear or minimization of the blade overall time averaged deflection, is determined. Calculations are carried out for a model rotor and for the case with increased Lock number. The results are presented in graph form. It is found that the minimum blade deflection criteria suppress the rigid flapping by a large amount and reduce the peak-to-peak value of the blade hub shear by at least 50 percent without causing an additional increase in blade stresses. Author

N81-29135*# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
TESTING AND EVALUATION OF A STALL-FLUTTER-SUPPRESSION SYSTEM FOR HELICOPTER ROTORS USING INDIVIDUAL-BLADE-CONTROL
Todd R. Quackenbush Aug. 1981 82 p refs
(Grant NsG-2266)
(NASA-CR-166233; ASRL-TR-196-3) Avail: NTIS HC A05/MF A01 CSCL 01C

The development and testing of a feedback system designed to alleviate the violent blade first torsion mode oscillations associated with stall flutter are described. The system, based on previously developed M.I.T. Individual-Blade-Control hardware, employs blade-mounted accelerometers to sense torsional oscillations and feeds back rate informaton to increase the damping of the first torsion mode. A linear model of the blade and control system dynamics is developed and is used to give qualitative and quantitative guidance in the design process as well as to aid in analysis of experimental results. System performance in wind tunnel tests, both in hover and forward flight, is described, and evidence is given of the system's ability to provide substantial additional damping to stall-induced blade oscillations. Author

N81-29136# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

DIRECT DIGITAL DESIGN METHOD FOR RECONFIGURABLE MULTIVARIABLE CONTROL LAWS FOR THE A-7D DIGITAL 2 AIRCRAFT M.S. Thesis

David W. Potts Dec. 1980 145 p refs
(AD-A100794; AFIT/GE/EE/80D-36) Avail: NTIS HC A07/MF A01 CSCL 01/3

This thesis investigates control of an aircraft when there is a primary control surface failure. The object of this study is to reconfigure the remaining control surfaces to compensate for the additional forces and moments generated by the inoperative control surface. To study this flight control problem, a comprehensive aircraft model is required which considers each control surface operating individually. A six degree-of-freedom aircraft model is developed, including all the individual control surfaces. A control surface input can produce both a lateral and/or a longitudinal response. Thus, the equations of motion cannot be decoupled for the design of the control laws. The coupling between the axes requires the derivation of several new non-dimensional control derivatives. Using the geometrical properties of the aircraft and the Digital Datcom computer program, the needed control derivatives are derived. The entire eigenstructure assignment method is used to assign both the eigenvalues and the eigenvectors to the closed-loop plant matrix. This method is used for the direct digital design of a multivariable discrete regulator and tracker control law. The effect of increasing the number of control inputs on the relative degree of controllability of the states was determined by singular value decomposition. GRA

N81-29137*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CONSIDERATIONS FOR THE INSTALLATION OF HONEYCOMB AND SCREENS TO REDUCE WIND-TUNNEL TURBULENCE

James Scheiman Aug. 1981 53 p refs
(NASA-TM-81868; L-14109) Avail: NTIS HC A04/MF A01 CSCL 14B

Tests were conducted on a half-scale model representing a 0.914-m (3.0-ft) square stream tube of the flow through the fourth corner and settling chamber of the Langley 8-Foot Transonic Pressure Tunnel. The model included the tube cooler 45 degree turning vanes, and the turbulence reduction screens and honeycomb, which were the subject of the tests. Hot-wire measurements of the turbulence reduction for various combinations of screens and honeycomb were made at various duct speeds. Of the four sizes of honeycomb cells tested, none were found to have a superior performance advantage. The effectiveness of screens and honeycomb in reducing turbulence is greatly affected by relatively minor physical damage; therefore, extreme care must be exercised in installing and maintaining honeycomb or screens if the turbulence reduction performance is to be maintained. Author

N81-29138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A RECTANGULAR ROD-WALL SOUND SHIELD Patent Application

Theodore R. Creel, Jr. and Ivan E. Beckwith, inventors (to NASA) Filed 28 May 1981 12 p
(NASA-Case-LAR-12883-1; US-Patent-Appl-SN-267935) Avail: NTIS HC A02/MF A01 CSCL 14B

A test section for a supersonic or hypersonic wind tunnel is described. The section is shielded from the noise normally radiated by the turbulent tunnel wall boundary layer. A vacuum plenum surrounds spaced rod elements making up the test chamber. Some of the boundary layer formed along the rod elements during a test is thereby extracted to delay the tendency of the rod boundary layers to become turbulent. Novel rod construction involves bending. Each rod is bent prior to machining, providing a flat segment on each rod for connection with the flat entrance fairing. Rods and fairing are secured to provide a test chamber incline on the order of 1 deg outward from the noise shield centerline to produce up to a 65% reduction of the root-mean-square (rms) pressure over previously employed wind tunnel test sections at equivalent Reynolds numbers. NASA

N81-29139*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

GUIDE FOR USERS OF THE NATIONAL TRANSONIC FACILITY

Dennis E. Fuller, Blair B. Gloss, and Donna Nystrom Jul. 1981 41 p refs
(NASA-TM-83124; L-14077) Avail: NTIS HC A03/MF A01 CSCL 14B

The National Transonic Facility (NTF) is a fan-driven, closed-circuit, continuous flow, pressurized wind tunnel. The test section is 2.5 m x 2.5 m and 7.62 m long with a slotted-wall configuration. The NTF will have a Mach number range from 0.2 to 1.2, with Reynolds number up to 120 10 to the sixth power at Mach 1 (based on a reference length of 0.25 m). The pressure range for the facility will be from 1 to about 9 bars (1 ban = 100 kPa), and the temperature can be varied from 340 to 78 K. This report provides potential users of the NTF with the information required for preliminary planning to test programs and for preliminary layout of models and model supports which may be used in such programs. Author

N81-29140# Sanders and Thomas, Inc., Pottstown, Pa.

APPLICATION OF AN IN-LINE CONTAMINATION MONITORING UNIT TO THE AHT-64 HYDRAULIC TEST STAND Final Report, 13 Mar. 1978 - 30 Sep. 1980

P. M. ODonnell (Naval Air Engineering Center, Lakehurst, N.J.) and E. W. Roberts 4 Jun. 1981 115 p refs
(Contract N00014-80-C-0053; WF41461400)
(AD-A100696; NAEC-92-146) Avail: NTIS HC A06/MF A01 CSCL 14/2

This report documents a support engineering analysis establishing parameters, including vibration environment, for development and application of an in-line contamination monitor on the Portable Hydraulic Test Stand AHT-64 to indicate attained degree of particulate decontamination of return hydraulic fluid. Approaches are evaluated, concepts presented, and recommendations made. Author (GRA)

N81-29165*# Boeing Commercial Airplane Co., Seattle, Wash.

ENVIRONMENTAL EXPOSURE EFFECTS ON COMPOSITE MATERIALS FOR COMMERCIAL AIRCRAFT Quarterly Progress Report, 1 Dec. 1980 - 28 Feb. 1981

Daniel J. Hoffman Mar. 1981 39 p refs
(Contract NAS1-15148)
(NASA-CR-165765; D6-44815-10; QPR-10) Avail: NTIS HC A03/MF A01 CSCL 11D

This period's activities were highlighted by continued long term and accelerated lab exposure testing, and by completion of all fabrication tasks on the optional material systems, AS1/3501-6 and Kevlar 49/F161-188. Initial baseline testing was performed on the two optional material systems. Long term exposure specimens were returned from three of the four ground rack sites and from two of the three aircraft locations. Test data from specimens returned from Dryden after 2 years exposure do not indicate continuing trends of strength reduction from the 1 year data. Test data from specimens returned from the Wellington, New Zealand ground rack and on Air New Zealand aircraft after 1 year exposure show strength changes fairly typical of other locations. Author

N81-29167# National Mechanical Engineering Research Inst., Pretoria (South Africa).

USE OF COMPOSITE MATERIALS FOR HELICOPTER ROTOR BLADES

M. S. Hunt Oct. 1980 31 p refs Presented at Ann. Conf. of the Plastics Inst. of South Africa, Durban, South Africa, 22 May 1980
(CSIR-ME-1674; ISBN-0-7988-1470-5) Avail: NTIS HC A03/MF A01

The availability of locally produced glass fiber and epoxy resin, the unlimited fatigue life, and the low cost of the composite blade in comparison with an equivalent imported all-metal blade are arguments favoring the developing of a South African helicopter industry. Manufacturing techniques and some results obtained in the structural testing of rotor blades are discussed. A.R.H.

N81-29205*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NASA'S ACTIVITIES IN THE CONSERVATION OF STRATEGIC AEROSPACE MATERIALS

Joseph R. Stephens 1980 24 p refs
(NASA-TM-81617; E-623) Avail: NTIS HC A02/MF A01 CSCL 11F

The primary objective of the Conservation of Strategic Aerospace Materials (COSAM) Program is to help reduce the

dependence of the United States aerospace industry on strategic metals by providing the materials technology needed to minimize the strategic metal content of critical aerospace components with prime emphasis on components for gas turbine engines. Initial emphasis was placed in the area of strategic element substinction. Specifically, the role of cobalt in nickel base and cobalt base superalloys vital to the aerospace industry is being examined in great detail by means of cooperative university-industry-government research efforts. Investigations are underway in the area of 'new classes' of alloys. Specifically, a study was undertaken to investigate the mechanical and physical properties of intermetallics that contain a minimum of the strategic metals. Current plans for the much larger COSAM Program are also presented. E.D.K.

N81-29206*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COBALT: A VITAL ELEMENT IN THE AIRCRAFT ENGINE INDUSTRY
Joseph R. Stephens 1981 15 p refs Presented at the Workshop Conserv. Technol. for Critical Mater., 15-17 Jun. 1981; sponsored by Dept. of Commerce
(NASA-TM-82662; E-934) Avail: NTIS HC A02/MF A01 CSCL 11F

Recent trends in the United States consumption of cobalt indicate that superalloys for aircraft engine manufacture require increasing amounts of this strategic element. Superalloys consume a lion's share of total U.S. cobalt usage which was about 16 million pounds in 1980. In excess of 90 percent of the cobalt used in this country was imported, principally from the African countries of Zaire and Zambia. Early studies on the roles of cobalt as an alloying element in high temperature alloys concentrated on the simple Ni-Cr and Nimonic alloy series. The role of cobalt in current complex nickel base superalloys is not well defined and indeed, the need for the high concentration of cobalt in widely used nickel base superalloys is not firmly established. The current cobalt situation is reviewed as it applies to superalloys and the opportunities for research to reduce the consumption of cobalt in the aircraft engine industry are described. E.D.K.

N81-29247# General Technology Applications, Inc., Arlington, Va.
APPLICATION OF GENERAL TECHNOLOGY APPLICATIONS, INCORPORATED (GTA) BLENDING PROCESS TO ANTIMISTING FUEL ADDITIVES Final Report, Aug. 1980 - May 1981
J. C. Trippe, Paul Waters, and Albert Hadermann May 1981 28 p refs
(Contract DTFA-03-80-C-00070)
(AD-A100692; FAA-CT-81-51) Avail: NTIS HC A03/MF A01 CSCL 21/4

This program examines the applicability of a proprietary blending process to blending antimisting additives in JET A aviation fuel. The first phase of the program covers use of the process with a high molecular weight polyisobutylene. The second phase covers the use of the process with Imperial Chemical Industries, Ltd's proprietary polymer, FM-9. The results of the program indicate that high molecular weight polyisobutylene can be blended rapidly with JET A using the proprietary process and that the resulting blend demonstrates antimisting behavior within minutes. There was no evidence that the proprietary process is effective in the blending of FM-9 in JET A. Author (GRA)

N81-29260# Department of Energy, Laramie, Wyo. Energy Technology Center.
HYDROCARBON TYPE ANALYSIS OF JET FUELS BY H-1 AND C-13 NMR
D. A. Netzel and P. M. Hunter May 1981 83 p refs Prepared in cooperation with Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio
(Contract MIPR-FY1455-80-00621)
(DOE/LETC/RI-81/1) Avail: NTIS HC A05/MF A01

The application of NMR spectroscopy to the chemical characterization without prior chromatographic separation of jet fuels and various fuel blends containing varying amounts of paraffinic and aromatic constituents is described. Equations are derived by which the total percent paraffins and aromatics as well as percent monoaromaics and diaromatics can be calculated. Computer programs for the various calculations are included. The results obtained by NMR are compared to those obtained by MS. DOE

N81-29281# Baisch Engineering Proprietary Ltd. (South Africa).
METALSPINNING, SHEAR- AND FLOWFORMING
H. P. Baisch *In* CSIR The 2nd Seminar on Efficient Metal Forming and Machining 18 Nov. 1980 14 p

Avail: NTIS HC A12/MF A01

The fundamentals of metalspinning, shearforming, and flowforming techniques are discussed. Application of the metalforming techniques in the production of rotationally symmetrical components is addressed. J.M.S.

N81-29294# Council for Scientific and Industrial Research, Pretoria (South Africa). Machining Technology Section.
COLD-FORMING OF INTERNAL THREADS
P. H. H. Trendler *In its* the 2nd Seminar on Efficient Metal Forming and Machining 18 Nov. 1980 15 p

Avail: NTIS HC A12/MF A01

A test program aimed at evaluating the comperative performance of conventional thread-cutting taps and a variety of thread-forming taps is described. A case history which illustrates the economic advantages of cold form tapping is also given. J.M.S.

N81-29317# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
MULTIPLE ARRESTED SYNTHETIC APERTURE RADAR Ph.D. Thesis
Jerrold S. Shuster May 1981 299 p refs
(AF Proj. 2305)
(AD-A101143; AFIT/DS/EE/81-1) Avail: NTIS HC A13/MF A01 CSCL 17/9

This report contains the formulation and analysis of an airborne synthetic aperture rate scheme which employs a multiplicity of antennas with the displaced phase center antenna technique to detect slowly moving targets embedded in a severe clutter environment. The radar is evaluated using the target to clutter power ratio as the measure of performance. Noise is ignored in the analysis. An optimization scheme which maximizes this ratio is employed to obtain the optimum processor weighting. The performance of the MASAR processor with optimum weights is compared against that using target weights (composed of the target signal) and that using binomial weights (which, effectively, form an n-pulse canceller). Both the target and the clutter are modeled with the electric field backscattering coefficient. The target is modeled simply as a deterministically moving point scatterer with the same albedo as a point of clutter. The clutter is modeled as a homogeneous, isotropic, two dimensional, spatiotemporal random field for which only the correlation properties are required. The analysis shows that this radar, with its optimum weighting scheme, is a promising synthetic aperture concept for the detection of slowly moving targets immersed in strong clutter environments. Author (GRA)

N81-29323# Utah Univ., Salt Lake City. Dept. of Computer Science.
NOISE SUPPRESSION METHODS FOR ROBUST SPEECH PROCESSING Final Technical Report, 1 Oct. 1978 - 31 Mar. 1981
Steven F. Boll, James Kajiya, James Youngberg, Tracy Lind Petersen, H. Ravindra, William Done, B. V. Cox, and Elaine Cohen Apr. 1981 53 p refs
(Contract N0017370-C-0045; ARPA Order 3301)
(AD-A100629; UTEC-CSC-81-020) Avail: NTIS HC A04/MF A01 CSCL 17/2

Robust speech processing in practical operating environments requires effective environmental and processor noise suppression. This report describes the technical findings and accomplishments during the reporting period for the research program funded to develop real-time, compressed speech analysis-synthesis algorithms whose performance is invariant under signal contamination. Fulfillment of this requirement is necessary to insure reliable secure compressed speech transmission within realistic military command and control environments. Overall contributions resulting from this research program include the understanding of how environmental noise degrades narrow band, coded speech, development of appropriate real-time noise suppression algorithms,

and development of speech parameter identification methods that consider signal contamination as a fundmental element in the estimation process. This report describes the research and results in the areas of noise suppression using the dual input adaptive noise cancellation articulation rate change techniques, spectral subtraction and a description of an experiment which demonstrated that the spectral substraction noise suppression algorithm can improve the intelligibility of 2400 bps, LPC-10 coded, helicopter speech by 10.6 points. In addition summaries are included of prior studies in Constant-Q signal analysis and synthesis, perceptual modelling, speech activity detection, and pole-zero modelling of noisy signals. Three recent studies in speech modelling using the critical band analysis-synthesis transform and using splines are then presented. Finally a list of major publications generated under this contract is given.
Author (GRA)

N81-29354# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
COMPUTER ANALYSIS OF 400 HZ AIRCRAFT ELECTRICAL GENERATOR TEST DATA M.S. Thesis
Philip Glen Gaberdiel Jun. 1980 167 p refs
(AD-A100785; AFIT/GCS/EE/80-1) Avail: NTIS HC A08/MF A01 CSCL 14/2

A software system was specified which would derive the performance measures of MIL-STD-704B from the test data provided by the Generator Test Facility. This analysis software system was then designed and implemented. Accuracy tests on the system demonstrated that very precise measurements of generator performance can be obtained. A software system was also designed and implemented to display the analysis results to the user. The display system employs a Tektronix 4010 terminal in an interactive mode to present the data. The user, therefore, selects the particular display and time range to be presented.
Author (GRA)

N81-29362# Clemson Univ., S.C. Dept. of Electrical and Computer Engineering.
DYNAMIC SIMULATION OF AIRBORNE HIGH POWER SYSTEMS Interim Technical Report, 15 Aug. 1979 - 30 Aug. 1980
R. W. Gilchrist, Haren Almaula, Charles J. Alajajian, G. Frank Bell, Fred C. Lee, G. Y. Chen, R. L. Avant, and R. Ramanathan Mar. 1981 112 p refs Prepared in cooperation with Virginia Polytechnic Inst. and State Univ., Blacksburg
(Contract F33615-79-C-2047; AF Proj. 3145)
(AD-A101316; AFWAL-TR-80-2115) Avail: NTIS HC A06/MF A01 CSCL 10/2

This interim report describes the progress in model development for three phase ac generator, three phase transformers, SCR's and resonant charging circuits. The generator and transformer models include nonlinear effects due to magnetic field saturation. The SCR's and the resonant charging circuit and modeled in sufficient detail to include switching transients during turn-on and turn-off intervals. The component models are to be assembled into a system to simulate ac and dc resonant charging applications. Use of SCEPTRE is elected as the method for solving the problem of assembling the components into a system model and for solving the problems arising from the 'stiff' differential equations of the composite systems.
Author (GRA)

N81-29536# Rockwell International Corp., Anaheim, Calif. Autonetics Strategic Systems Div.
HIGH CURRENT POWER CONTROLLER Final Report, Sep. 1978 - Dec. 1980
P. E. McCollum Apr. 1981 138 p
(Contract F33615-78-C-2202; AF Proj. 3146)
(AD-A101643; C80-904/201; AFWAL-TR-81-2016) Avail: NTIS HC A07/MF A01 CSCL 10/2

This report documents the design, development, and test of High Current Power Controllers (HCPCs) by Rockwell International. HCPCs are a combination of solid state and electromechanical technologies, combined for reduction of high power dissipation/voltage drop experienced in present Solid State Power Controllers (SSPCs) in the high current (10 ampere to 400 ampere) area. In addition, solid state advantages over the conventional electromechanical configuration, such as EMI reduction, longer life, etc., are retained. This report includes results of tests conducted during the study. Author (GRA)

N81-29661# Federal Aviation Agency, Washington, D.C. Office of Environment and Energy.
HELICOPTER NOISE EXPOSURE LEVEL DATA: VARIATIONS WITH TEST TARGET, INDICATED AIRSPEED, DISTANCE, MAIN ROTOR RPM AND TAKEOFF POWER
J. Steven Newman 10 Jul. 1980 39 p refs
(AD-A100691; FAA-AEE-80-34) Avail: NTIS HC A03/MF A01 CSCL 01/2

This report provides uncorrected noise exposure level data measured using an integrating sound level meter at a single measurement location during the recently completed, week long, FAA helicopter noise test. In addition to the measurements reported, primary acoustical measurements were conducted. This acoustical data (acquired for nine microphones) will be combined with flight path track data processed at the FAA, Dulles Noise Laboratory by D. W. Ford. Meteorological data acquired from surface readings and radiosondes will be processed by U.S. Weather Service personnel. GRA

N81-29722# National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.
AIRCRAFT SENSOR QUALITY IN SESAME 1979: RESULTS OF TOWER FLY-BYS AND AIRCRAFT INTERCOMPARISON
Diane E. Ziegler and John McCarthy Oct. 1980 42 p refs
(PB81-176596; NOAA-81020304) Avail: NTIS HC A03/MF A01 CSCL 04B

Instrumented research aircraft data quality during Project SESAME '79 is examined in a series of tower fly-bys, designed to compare temperature and static pressure measurements with reference values obtained from sensors located on the towers. Aircraft studied included a NCAR Queen Air and Sabreliner, and the South Dakota T-28. Measurements indicate that the quality of data was within acceptable limits. GRA

N81-29782*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
APPLICATION OF COMPUTER GENERATED COLOR GRAPHIC TECHNIQUES TO THE PROCESSING AND DISPLAY OF THREE DIMENSIONAL FLUID DYNAMIC DATA
Bernhard H. Anderson, C. W. Putt, and C. C. Giamati 1981 15 p refs Presented at Winter Ann. Meeting of the AM. Soc. of Mech. Engr., Washington, D.C., 15-20 Nov. 1981
(NASA-TM-82658; E-926) Avail: NTIS HC A02/MF A01 CSCL 20D

Color coding techniques used in the processing of remote sensing imagery were adapted and applied to the fluid dynamics problems associated with turbofan mixer nozzles. The computer generated color graphics were found to be useful in reconstructing the measured flow field from low resolution experimental data to give more physical meaning to this information and in scaning and interpreting the large volume of computer generated data from the three dimensional viscous computer code used in the analysis. M.G.

N81-29924# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
A STUDY OF THE PERFORMANCE OF AN OLSON TYPE ACTIVE NOISE CONTROLLER AND THE POSSIBILITY OF THE REDUCTION OF CABIN NOISE
S. E. Keith and H. S. B. Scholaert Mar. 1981 26 p refs
(UTIAS-TN-228; ISSN-0082-5263) Avail: NTIS HC A03/MF A01

Designed to reduce sound levels by means of an electronic transducing system, the active noise controller is a basic feedback control system composed of a speaker, microphone, amplifier and control unit. Because the scheme can be effective in reducing low frequency noise, it is of particular interest to aircraft manufacturers since attenuation of low frequency noise to increase passenger comfort can be at once costly and cumbersome when conventional sound absorption methods are employed. Olson and May's pioneering work in the 1950's in developing an electronic sound absorber which appeared to be successful over small volumes in a unidirectional sound field is re-examined as well as more recent developments in an effort to test their suitability to the aircraft industry. The results suggest only limited possible use for all systems studied. A.R.H.

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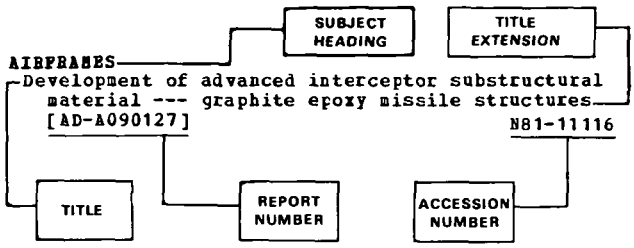

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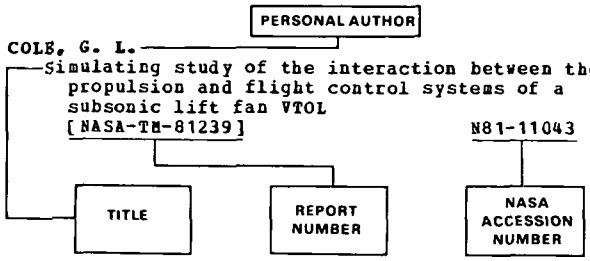

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