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Aeronautical Engineering

Pages 443-503

October 1980



# AERONAUTICAL ENGINEERING

## A Continuing Bibliography

### Supplement 127

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in September 1980 in

- *Scientific and Technical Aerospace Reports (STAR)*
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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 431 reports, journal articles, and other documents originally announced in September 1980 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.

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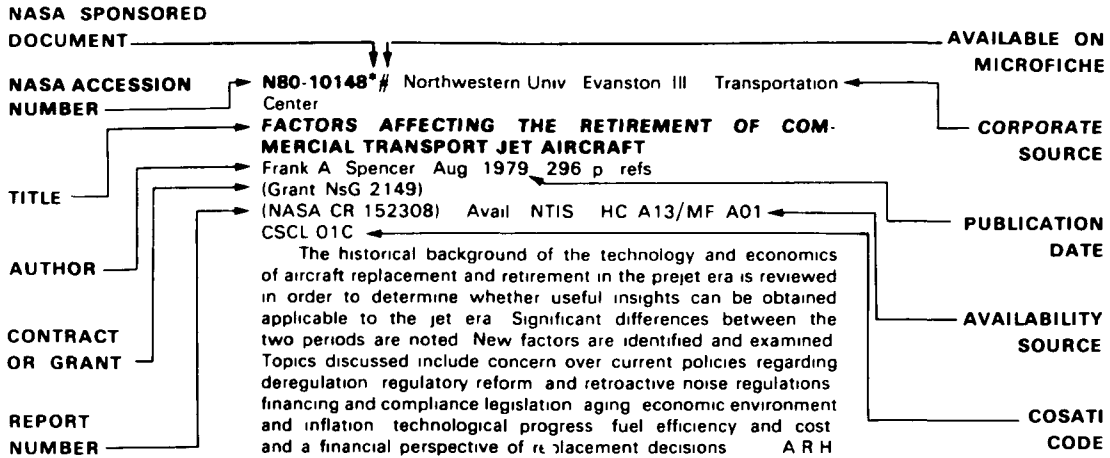
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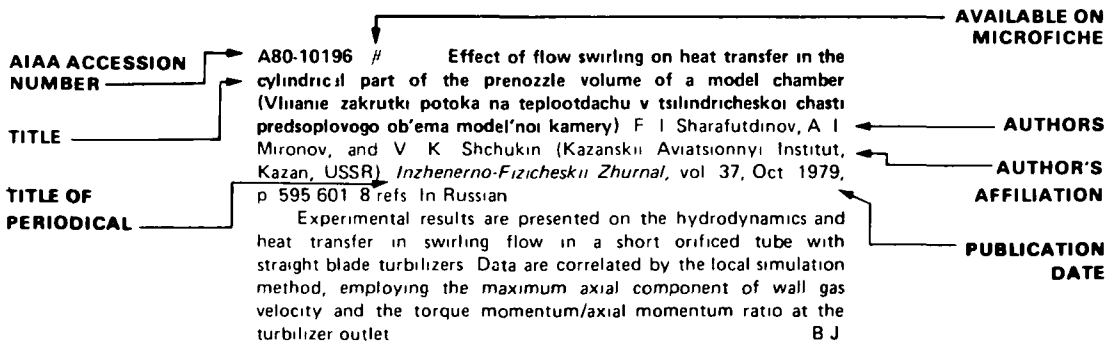
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## TYPICAL CITATION AND ABSTRACT FROM IAA



# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 127)*

OCTOBER 1980

## IAA ENTRIES

**A80-40707** Ozone measurements in cabin air of Concorde  
J F Leach (British Aerospace, Bristol, England) and F J Sandalls (Atomic Energy Research Establishment, Environmental and Medical Sciences Div., Harwell, Oxon, England) (*International Academy of Aviation and Space Medicine, International Congress of Aviation and Space Medicine, 26th, Royal College of Surgeons, London, England, Sept 4-8, 1978*) *Atmospheric Environment*, vol 14, no 6, 1980, p 705-710 8 refs Research supported by the Department of Transport/Department of the Environment and Department of Industry of England

In two flights of the Concorde used for development purposes (G-BBDG) measurements of both ozone in ambient air and ozone in the air supplied to the cabin were obtained simultaneously. The measurements show that the concentration of ozone in the air at its point of entry into the cabin did not exceed 1% of the ambient concentration during high altitude Mach 2 cruise. However, when the aircraft commenced its descent, engine air bleed temperatures fell rapidly giving a corresponding reduction in the rate of ozone destruction while the aircraft was still at high altitude. Under these transient conditions, short-term excursions of the ozone level occurred in the fresh air entering the cabin, rising to a maximum of 0.14 ppmv. The measurements suggest that in cruise, the cabin ozone level is unlikely to exceed 0.01 ppmv, but in the descent phase there may be a brief period when the level could peak at higher values.

(Author)

**A80-40730** Non-linear dynamic analysis of rotors by finite element method  
A V Krishna Murty and A Raman (Indian Institute of Science, Bangalore, India) *Journal of Sound and Vibration*, vol 69, Apr 22, 1980, p 559-568 8 refs

Nonlinear natural vibration characteristics and the dynamic response of hingeless and fully articulated rotors of rectangular cross-section are studied by using the finite element method. In the formulation of response problems, the global variables are augmented with appropriate additional variables, facilitating direct determination of subharmonic response. Numerical results are given showing the effect of the geometric nonlinearity on the first three natural frequencies. Response analysis of typical rotors indicates a possibility of substantial subharmonic response especially in the fully articulated rotors widely adopted in helicopters.

(Author)

**A80-40731** Aircraft noise annoyance contours. Importance of overflight frequency and noise level  
R Rylander, M Bjorkman, U Ahrlin (Goteborg, Universitet, Goteborg, Sweden), S Sorensen, and K Berglund (Statens Naturvardsverk, Stockholm, Sweden) *Journal of Sound and Vibration*, vol 69, Apr 22, 1980, p 583-595 24 refs Research supported by the Statens Naturvardsverk

The social survey studies to assess general annoyance and activity disturbances made in 38 areas around nine airports are presented. The noise exposure was expressed as the number of overflights/24 hr and dB(A) level from the noisiest aircraft type. An increase in the number of overflights increased the extent of annoyance and activity disturbances up to the level of 50 overflights. The results indicate that the number of events is of limited value in

describing the annoyance caused by aircraft noise exposure, and that the noise levels of aircraft are more important. The data suggest that a more accurate description and prediction of the extent of annoyance in a population can be obtained by using the dose-response relationships developed in this study. A T

**A80-40746 \* #** Active controls for flutter suppression and gust alleviation in supersonic aircraft  
E Nissim and I Lottati (Technion - Israel Institute of Technology, Haifa, Israel) (*American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Structures and Structural Dynamics Conference, 20th, St Louis, Mo., Apr 4-6, 1979, AIAA Paper 79 0792*) *Journal of Guidance and Control*, vol 3, July-Aug 1980, p 345-351 9 refs Grant No N5G-7373

Application is made in the present paper of the recently developed relaxed aerodynamic energy concept and synthesis techniques to the definition of appropriate active control systems for the low-speed flutter model of the B-2707-300 supersonic cruise airplane. The effectiveness of the resulting activated systems is analytically tested for flutter suppression, wing root bending moment alleviation, and ride control (fuselage accelerations). The results obtained indicate that considerable increase in flutter speeds can be obtained by the various control systems, using a single trailing-edge control. In all cases, the flutter suppression control system led to a substantial reduction in both wing root bending moments and in fuselage and wing accelerations. (Author)

**A80-40793** Neutron radiography for nondestructive testing  
J John (IRT Corp., San Diego, Calif.) In *Nondestructive Evaluation of Materials* New York, Plenum Press, 1979, p 151-182 12 refs

Neutron radiography is similar to X-ray inspection in that both depend upon use of radiation that penetrates some materials and is absorbed by others to provide a contrast image of conditions not readily available for visual inspection. X-rays are absorbed by dense materials, such as metals, whereas neutrons readily penetrate metals, but are absorbed by materials containing hydrogen. The neutron radiography has been successfully applied to a number of inspection situations. These include the inspection of explosives, advanced composites, adhesively bonded structures and a number of aircraft engine components. With the availability of Californium 252, it has become feasible to construct mobile neutron radiography systems suitable for field use. Such systems have been used for in-situ inspection of flight line aircraft, particularly to locate and measure hidden corrosion. (Author)

**A80-40803 #** Experimental study of the interaction between a rapid subsonic aircraft wing and an engine nacelle at high dilution rate  
(Etude expérimentale de l'interaction entre une voilure d'avion subsonique rapide et une nacelle de moteur à haut taux de dilution)  
P Levart (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (*NATO, AGARD, Symposium on Subsonic/Transonic Configuration Aerodynamics, Munich, West Germany, May 5-7, 1980*) ONERA, TP no 1980-35, 1980 12 p 16 refs In French

An experimental wind tunnel study of wing-nacelle-jet-pylon interference in transonic flow has been conducted. The nacelle models represent a turbofan by means of two compressed air jets,

and the wing is located between the sidewalls of the test section, the drag coefficient of the wing was obtained by a wake survey. The following parameters were studied: wing/nacelle position, upstream Mach number (from 0.3 to 0.8), jet pressure ratio, the presence or absence of the pylon, and the type of nacelle. It is found that wing-nacelle interference can be studied by means of total thrust drag analysis as a function of various parameters. J P B

**A80-40804 #** Expected improvements from wind tunnel model testing at high angle of attack (Améliorations envisagées pour résoudre les problèmes rencontrés au cours d'essais à grande incidence de maquettes en soufflerie) X Vaucheret (ONERA, Châtillon-sous-Bagneux, Hauts de Seine, France) (NATO, AGARD, Symposium on Subsonic/Transonic Configuration Aerodynamics, Munich, West Germany, May 5-7, 1980) ONERA, TP no 1980-36, 1980 23 p 18 refs In French

Several problems were encountered during tests at high angle of attack in wind tunnels. Three are selected here: wall interference, sting interference and vibrations beyond the stall. The state of the art on wall interference, systematically applied to the development tests, is shown with several comparisons between wind tunnels or between flight and tunnel tests. The models used in unconfined flow point out some deficiencies as regards apex vortex and active jets. Other correction methods have developed to palliate the assumptions and limits of the classical method. Thus AMD RA works on the vortex lattice method and ONERA on the model signatures on the test section walls. This method, already used in 2D flow for development tests with ventilated cylindrical test sections, is extended to the 3D case as a first stage for distorted but non streamlined walls. (Author)

**A80-40805 #** A fast method to control tackiness of fiber resin prepregs J P Favre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (Society for the Advancement of Material and Process Engineering, Symposium, 25th, San Diego, Calif., May 6-8, 1980) ONERA, TP no 1980-37, 1980 13 p 6 refs. Research supported by the Delegation Generale a la Recherche Scientifique et Technique

Tackiness of prepregs has been demonstrated to be related very closely to the area of contact between the material to be tested and a glass prism pressed against it. Using an optical mechanical tack tester a series of commercial and specifically prepared materials have been tested. The method has been established as the most convenient means to compare materials in terms of tackiness. (Author)

**A80-40808 #** Influence of the heterogeneity of flow at the rotor outlet on the performance of the diffuser of a centrifugal compressor (Influence de l'hétérogénéité de l'écoulement à la sortie du rotor sur les performances du diffuseur d'un compresseur centrifuge) H Hus (Societe Hispano Suiza, Saint Cloud, Hauts-de-Seine, France) and C Fradin (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Meeting on Centrifugal Compressors, Flow Phenomena and Performance, 5th, Brussels, Belgium, May 7, 8, 1980) ONERA, TP no 1980-40, 1980 13 p 6 refs In French

The performance of the diffuser of a centrifugal compressor is analyzed for the case of nonuniform inlet flow. Pressure transducers and hot-wire anemometers are used to measure instantaneous pressure and velocity. The detailed structure of the flow field is thus provided, and the effect on diffuser performance of nonuniformities is estimated. It is shown that the pressure losses are directly related to the nonuniformities. Also found was the insufficiency of the honeycombs to give a homogeneous flow at the outlet of the rotor above all with regard to the flow velocity. J P B

**A80-40819 #** Flight tests for the study of radioelectric perturbations of electrostatic origin (Essais en vol pour l'étude des perturbations radioélectriques d'origine électrostatique) P Laroche (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), R Weber (Société Nationale Industrielle Aérospatiale, Suresnes, Hauts-de-Seine, France), and D Gall (Toulouse, Centre d'Essais Aéro-

nautiques, Toulouse, France) (NATO, AGARD, Technical Meeting on Electromagnetic Effects of /Carbon/ Composite Materials upon Avionics Systems, 39th, Lisbon, Portugal, June 16-19, 1980.) ONERA, TP no 1980-58, 1980 12 p 8 refs In French

Flight tests on a Meteor NF11 aircraft for the investigation of radioelectric perturbations due to electrostatic aircraft charging are presented. Following a review of the types of electrostatic phenomena (arc discharges, rampant discharges, corona discharges) giving rise to charging and antistatic treatments for the dielectric and conducting regions of aircraft surfaces, the objectives and principles of the flight testing program are discussed. Instruments used in the measurement of aircraft electric potential, the evaluation of triboelectric charge current and the measurement of parasitic radio noise, static discharger currents and the surface potentials and currents over dielectric surfaces are presented. Results of preliminary ground tests on the high-voltage polarization of the aircraft, and initial flight test results indicating the significance of electrostatically induced radioelectric perturbations, the frequencies most affected, the effectiveness of static dischargers and the presence of rampant discharges over dielectric surfaces are presented. A L W

**A80-40820 #** French inflight program of study on the electromagnetic effects of lightning (Programme Français d'essais en vol sur les effets électromagnétiques de la foudre) J-C Alliot (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and D Gall (Toulouse, Centre d'Essais Aeronautiques, Toulouse, France) (NATO, AGARD, Technical Meeting on Electromagnetic Effects of /Carbon/ Composite Materials upon Avionics Systems, 39th, Lisbon, Portugal, June 16-19, 1980) ONERA, TP no 1980-59, 1980 11 p 7 refs In French

An inflight program was undertaken to detect phenomena associated with or near the lightning. These include the lightning current, skin currents at different points of the structure, external and internal electromagnetic fields, overvoltages on various onboard equipment and circuits, and various sensors allowing the characterization of the electric state of the aircraft during the lightning. In addition, the behavior of the composite material structure panels with regard to electromagnetic radiation was studied in order to define protection systems. J P B

**A80-40892** Force equilibrium and performance balance of aircraft longitudinal motion graphically presented in the Korhammer diagram (Kraftgleichgewicht und Leistungsbilanz der Flugzeuglangsbewegung grafisch dargestellt im Korhammer-Diagramm) R Brockhaus and G Schanzer (Braunschweig, Technische Universität, Braunschweig, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol 4, May/June 1980, p 128-136 11 refs In German

A graphic representation showing the solution of the nonlinear equations of motion of an aircraft is presented, in which the vector polygon of longitudinal forces is linked with the Lilienthal polar. The addition of the triangle of velocity vectors as well as of rectangles representing the balance of power gain and power deficit leads to a very comprehensive representation of the physical relations not only in stationary but also in accelerated flight in the moving atmosphere. It is shown how the equilibrium of aircraft energy as well as the energy transfer from the surrounding air to the aircraft (gliding flight, windshear effects) is connected to the forces and variables which characterize the aircraft motion, especially with the measurable variables load factor and potential flight path angle ('energy angle'). The clearness of the graphs called 'Korhammer diagram' is demonstrated through some typical examples of actual interest. (Author)

**A80-40895** Optimization of the relaxation drag of slender profile arrangements in steady subsonic flow I - Single profile (Optimierung des Relaxationswiderstands schlanker Profilanordnungen in stationärer Unterschallströmung I - Einzelprofil) H Schilling (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol 4, May-June 1980, p 148-157 17 refs In German

Starting with a well known theorem by Oswatitsch, a formula for the relaxation drag of a body in a relaxing gas flow is developed, and the relaxation drag of a single profile for arbitrary Damkohler numbers is studied. Since very small and very large Damkohler numbers can be found for the limiting cases, the transition between these cases is of interest. Profiles are found which have an optimum shape minimizing the relaxation drag, and two examples are given. Finally, by means of a numerical calculation it is shown that because of the possible order of magnitude of the relaxation drag an optimization can be of importance for applications. M E P

**A80-40897**      The influence of the thrust direction on the level flight of light airplanes (Der Einfluss der Schubrichtung auf den Horizontalflug von Leichtflugzeugen) O Wagner (Munich, Technische Universität, Munich, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol 4, May-June 1980, p. 162-168 5 refs In German

The flight performance of an aircraft depends on the direction of the installed thrust. For light aircraft with reciprocating piston engines driving propellers and with a flight envelope which is independent of Mach number, the effects of the installed thrust angle are explored theoretically for range and endurance. A parabolic polar drag curve with the Mach number independent coefficients  $C_{sub WO}$  and  $k$  as well as constant specific fuel consumption and constant propeller efficiency at normal flow are assumed. The results are demonstrated with a sample aircraft. M E P.

**A80-40909** #      Calculation of transonic viscous flows past wing profiles (Berechnung transonischer, reibungsbehafteter Profilstromungen) D Hanel *Rheinisch-Westfälische Technische Hochschule, Aerodynamisches Institut, Abhandlungen*, no 24, 1980, p 50-55 6 refs In German

In the present paper, the transonic viscous flow past wing profiles is calculated by obtaining finite-difference solutions of the potential equation and the boundary layer equations. The accuracy of the solutions is assessed by comparing a solution of a simplified potential equation by Murman's (1973) method with a solution of the exact potential equation by Jameson's (1976) method. An implicit algorithm is applied to the boundary layer equations, and the solutions are joined through the boundary conditions. V P

**A80-40913** #      Calculation of compressible inlet flows (Berechnung kompressibler Einlaufströmungen) U Giese *Rheinisch-Westfälische Technische Hochschule, Aerodynamisches Institut, Abhandlungen*, no 25, 1980, p 52, 53 6 refs In German

It is noted that experimental investigations of the flow in the inlet of safety valves have shown that under certain conditions adverse inlet configuration can lead to operating difficulties. As a result of flow separation, the flow in the inlet can be accelerated to supersonic speeds, which results in static pressure losses and, under certain conditions, in shock oscillations. A study is presented in which the wall pressure distribution is determined for a given inlet contour. In addition, the most gradual curve radius which the flow will follow is determined. M E P

**A80-40944** #      The energy problem - Its effect on aircraft design IV - The unforecastable future W Tye *Aircraft Engineering*, vol 52, June 1980, p 2-4

Future supplies of energy for aviation and their affect on aircraft design are considered. Attention is given to proven and ultimately recoverable reserves of oil and gas and to the use of coal for fuel oil. Also discussed are advanced aircraft concepts, including laminar flow and the associated requirements of the porous surfaced wing and the suction system. In addition, the use of liquid hydrogen and of multibladed turbo-propellers with large blade chords, small thickness and high tip speeds, efficient up to a Mach number of 0.8, is considered. J P B

**A80-40945** #      Fuel economy in the airlines T Ford *Aircraft Engineering*, vol 52, June 1980, p 5-8

Fuel savings during flight procedures are examined with regard to takeoff, climb optimization and automatic flight management using autopilot and autothrottle systems. The importance of the leading edge to the flow characteristics is also considered, along with engine design, development and maintenance. Research into terminal area capacity and efficiency, the improvement of approach and landing capability in adverse weather and the reduction of noise impact through operating procedures is discussed. In addition, the improvement of aircraft fuel efficiency by recovering deterioration losses and by incorporating drag reduction/engine fuel saving modifications is considered. J P B

**A80-40946** #      Aircraft noise monitoring at airports K Bauermeister and U Donner *Aircraft Engineering*, vol 52, June 1980, p 16-18

A Siemens aircraft noise monitor is described, which consists of a sound measuring device as well as data transmission, processing, printout and analysis. Attention is given to the requirements of the monitor microphones, the digital transmission system and the use of a microcomputer. It is noted that an individual reference level can be set in for every measurement point, and that a takeoff/landing evaluation can be carried out from the time sequences of the noise events. J P B

**A80-40966**      Contract research on aerodynamic problems of turbomachinery vanes (Auftragsforschung an aerodynamischen Problemen von Turbomaschinenbeschaufelungen) H Hoheisel and R Kiock (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Entwurfs-Aerodynamik, Braunschweig, West Germany) *DFVLR-Nachrichten*, June 1980, p 3-7 In German

A survey of some of the research performed by the DFVLR under contract to the aerospace industry is presented. It is shown that the characteristics of the test site employed, the high velocity grid wind tunnel in Braunschweig, enable the study of the physics of vane grid flow in axial turbomachinery and thus the pursuit of basic technological research. Such investigations are discussed and examples of new investigations of highly loaded turbine and compressor grids are given. M E P

**A80-40967**      On film-cooling of turbine blades (Zur Filmkühlung von Turbinenschaufeln) H Kruse (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Antriebs-technik, Cologne, West Germany) *DFVLR Nachrichten*, June 1980, p 8-11 In German

The demand for improved economy and performance of gas turbines in aircraft powerplants as well as stationary installations has led to higher combustion temperatures and to higher pressures. Attention is given to the fact that the substantial success in recent years has been accomplished in this manner. It is shown that this has been made possible for the most part by improved cooling of all parts exposed to hot gases, especially the high pressure turbine vanes. The improvement of current cooling techniques as well as the development of new cooling technology is described. M E P

**A80-40972**      Aircraft turbine oils - Problems and future aspects (Flugturbinenöle - Probleme und Zukunftspunkte) E Jantzen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Technische Physik, Stuttgart, West Germany) *DFVLR-Nachrichten*, June 1980, p 32, 33 In German

The energy situation and the demands from the defense sector will, with regard to the development of gas turbine engines, lead to higher combustion chamber temperatures. As a result, higher temperatures must be anticipated in the oil lubrication system. Attention is given to the problem that the oils presently employed have only a limited thermal and oxidation stability. Aspects discussed include engine temperatures and the effects on lubricating oils, consequences and measures, laboratory and test stand investigations. Also examined are design measures to reduce the demands on

oils, improvements in aircraft turbine oils and future aircraft turbine oils  
M E P

**A80-40973** Experiments with transonic profiles (Transsonische Profile im Experiment) E Stanewsky (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Experimentelle Stromungsmechanik, Göttingen, West Germany) *DFVLR-Nachrichten*, June 1980, p 34-40 In German

Information is presented on the continuing need for wind tunnel testing of transonic wing profiles and solutions to the problems experienced. It is shown that such consideration can be extended for complete aircraft models. The discussion covers the need for wind tunnel testing, noting the importance of measuring maximum lift, the onset of transonic resistance increase, and the onset of wing oscillation. Consideration is given to general and expanded wind tunnel testing including examples of actual testing. Finally, problems of wind tunnel testing and the future outlook are discussed. M E P

**A80-40976** Design for the future B Adderley (Software Sciences, Ltd, Farnborough, Hants, England) *The Controller*, vol 19, June 1980, p 5-7, 9, 10

A technique of system architecture for air traffic control is described which seeks the correct balance between user requirements, technological capability, financial constraints, compatibility with other systems and human resources. The use of computer based fast time simulation techniques for testing and optimizing the route structures and procedures is considered with regard to radar coverage and communications. Attention is also given to the problems of translating operational to technical requirements. J P B

**A80-40977** The design of an air navigation services system F W Fischer (Studiengemeinschaft für Flugsicherung, Westerngrund, West Germany) and H Fischer *The Controller*, vol 19, June 1980, p 17-21

The conditioning factors for the design of an air navigation services (ANS) system related to its safety, capacity and capability are presented, with attention given to the modernization and upgrading of present ANS systems. Compatibility of the ANS system with the adjacent systems in neighboring countries and with their system functions is considered along with national air traffic safety. Also discussed are operational philosophy and general communications considerations with respect to government decisions regarding ANS. J P B

**A80-41001 #** Condition evaluation of jointed concrete air-field pavement M Y Shahin (U S Army, Construction Engineering Research Laboratory, Champaign, Ill), M I Darter (Illinois, University, Urbana, Ill), and S D Kohn (Michigan, University, Ann Arbor, Mich) *ASCE, Transportation Engineering Journal*, vol 106, July 1980, p 381-399 13 refs

The paper describes the newly developed Air Force Pavement Condition Index (PCI) and the overall procedures for its field utilization. The basic objectives of the PCI are to (1) provide a standard measure of pavement condition in terms of both structural integrity and surface operational condition, (2) provide the pavement engineer with an objective and rational basis for determining maintenance and repair needs and priorities, and (3) provide a warning system for early identification of major repair requirements. B J

**A80-41004** HiMAT technical description G Warwick *Flight International*, vol 118, July 5, 1980, p 34-36, 41, 42

The paper describes HiMAT, a highly maneuverable research vehicle designed for 1990's fighters capable of a sustained 8g turn at Mach 0.9, at 30,000 ft. It utilizes a close coupled canard, vortex strakes, a variable-camber wing, drag modulation, cambered fuselage, and integrated propulsion and flight controls. HiMAT has five pairs of control surfaces: ailerons, elevons, elevators, canard flaps, and fins, the elevons, elevators, and canard flaps provide pitch and direct-lift control, and the canard flaps and fins generate direct

sideforce. Composites make up 30% of HiMAT's structural weight, aeroelastically tailored surfaces are carbon-fiber with a composite honeycomb filler. With a 3370 lb launch weight, HiMAT offers 3.7 minutes at Mach 1.4 at 40,000 ft, rising to the 22 minute test time at Mach 1.9 at 40,000 ft, it is carried aloft under the wing of a B-52 and released at Mach 0.7 at 40,000 to 45,000 ft. It has an endurance of over an hour, although most test flights will last about 30 minutes. A T

**A80-41005** Mirage 2000 update *Flight International*, vol 118, July 5, 1980, p 45-48

The paper updates the Mirage 2000 program which changed its main radar for the primary interception, the Radar Doppler Impulsions (RDI) to the Radar Doppler Multifunctions (RDM). RDM is better suited to ground attack, but retains good air-to-air performance in clear conditions. Automatic terrain-following penetration in all weathers will be possible for the third Mirage role which is now flying in a Votour used for ground mapping research. Mirage 2000 has built-in active and passive ECM systems including radar receiver, with aerials in the fin and forward-facing aerials in the wing-tips, it is limited to Mach 2.1 by its structural materials, although it can briefly surge to 2.3. The basis of Mirage 2000 avionics system is the EMD-Sagem 2084 central computer, plus the Digibus digital data highway linking all on-board avionic systems. A T

**A80-41033** Sailing Darrieus rotors P S Revell and K W Everitt (Warwick, University, Coventry, England) *Wind Engineering*, vol 4, no 1, 1980, p 11-31 10 refs

Recently published data for a number of simply constructed sailings has been used in a numerical analysis of the performance of flexible bladed Darrieus rotors. To facilitate comparisons, the analysis has been repeated using data for a solid aerofoil. An improved understanding of the operation of sailing rotors has been gained and some criteria for their design are reached. It is concluded that such rotors can reliably self start and achieve a higher power coefficient than so far reported, although still rather lower than can be obtained with solid blades, but that their full potential will not be realized in very small scale applications. (Author)

**A80-41146 \* #** Review - Axial compressor stall phenomena E M Greitzer (MIT, Cambridge, Mass) *ASME, Transactions, Journal of Fluids Engineering*, vol 102, June 1980, p 134-151 80 refs Grant No NsG 3208

Stall in compressors can be associated with the initiation of several types of fluid dynamic instabilities. These instabilities and the different phenomena, surge and rotating stall, which result from them, are discussed in this paper. Assessment is made of the various methods of predicting the onset of compressor and/or compression system instability, such as empirical correlations, linearized stability analyses, and numerical unsteady flow calculation procedures. Factors which affect the compressor stall point, in particular inlet flow distortion, are reviewed, and the techniques which are used to predict the loss in stall margin due to these factors are described. The influence of rotor casing treatment (grooves) on increasing compressor flow range is examined. Compressor and compression system behavior subsequent to the onset of stall is surveyed, with particular reference to the problem of engine recovery from a stalled condition. The distinction between surge and rotating stall is emphasized because of the very different consequences on recoverability. The structure of the compressor flow field during rotating stall is examined, and the prediction of compressor performance in rotating stall, including stall/unstall hysteresis, is described. (Author)

**A80-41151 #** The effect of blade wakes on the performance of short dump-diffuser type combustor inlets A Klein, P Pucher, and M Rohiffs (Motoren und Turbinen-Union München GmbH, Munich, West Germany) *ASME, Transactions, Journal of Fluids Engineering*, vol 102, June 1980, p 236-241 9 refs Research sponsored by the Bundesministerium der Verteidigung

Experimental results are presented of the effects of flow distortions, generated by a compressor cascade, on the performance of a short annular dump-diffuser type combustor inlet. The distance between the cascade and the diffuser entrance plane was varied. The losses increase substantially when this distance becomes small. In most of the tests the losses turned out to be minimum at a distance of about two blade-chord lengths. When the cascade was removed, the losses were higher than this minimum value. Evidence is presented that the radial blockage factor rather than the total blockage factor determines the magnitude of the losses. (Author)

**A80-41158 # Aircraft configuration optimization for ground attack mission** P Ramamoorthy and A K Sinha (National Aeronautical Laboratory, Bangalore, India) *Journal of Aircraft*, vol 17, July 1980, p 538-542

The optimum aircraft wing configuration for a low-level ground attack mission is investigated. Wing planform variables, wing thickness ratio and wing loading were optimized to achieve the maximum radius of action for a given amount of fuel and armament, assuming fuselage and empennage geometry and engine to be frozen, using a modular interactive computer program. The iterative program is designed to estimate wing geometrical quantities from configuration variables, evaluate wing aerodynamic characteristics, estimate structural weight, compute point performance parameters and adjust design parameters until an optimum is reached. For a given starting configuration, the program is found to provide an optimal configuration which increases the radius of action by 5 nautical miles without violating preset constraints on design variables, take-off distance or all-up weight. The inclusion of design variables characterizing the fuselage and empennage and further constraints into the procedure are under investigation. A L W

**A80-41159 # Effect of adding structural damping on a wing/nacelle hump type flutter mode** D Gimmestad (Boeing Military Airplane Co., Seattle, Wash.) *Journal of Aircraft*, vol 17, July 1980, p 542, 543

The effect of adding structural damping to nacelle strut side bending on a wing/nacelle hump type flutter mode is demonstrated. A flutter analysis is performed for a twin engine aircraft design with high-bypass fan engines strut mounted on the wing with damping added to modify the behavior of the nacelle strut from that of a tuned mass damper to that of a tuned viscoelastic damper. It is found that the addition of damping increases the bandwidth of the nacelle side bending frequency in which the nacelle tuning suppresses flutter, while increasing flutter speed at some of the other nacelle side bending natural frequencies. It is recommended that structural damping be considered for designs requiring the suppression of chimney type flutter modes, and that the effects of structural damping be included in dynamic gust, fatigue and flutter calculations. A L W

**A80-41176 # Planning technology development to achieve consistent component technology and flexibility of application** A E Fanning (USAF, Frank J Seiler Research Laboratory, Colorado Springs, Colo.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1081* 8 p

Planning the development of technology applicable to military airbreathing propulsion systems is dominated by unknowns. Most significant among these unknowns is the uncertainty regarding desired characteristics of future systems. Effective planning must recognize these uncertainties and efficient use of development resources demands that technical goals established for the development of component technologies be consistent with maximum exploitation of advancing technology, while maintaining flexibility. A systematic method of identifying sets of consistent component technology goals, which maximize exploitation of advancing technology and maintain flexibility of application is discussed. (Author)

**A80-41177 # Life and utilization criteria in design for balanced life and performance** J Osmer (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) and G Blevins (USAF, Wright Aeronautical Laboratories, Wright Patterson AFB, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1082* 7 p USAF-sponsored research

The implementation of an aircraft gas turbine conceptual design procedure currently being developed under Air Force (AFWAL) sponsorship will result in improved aircraft gas turbine designs with which to proceed to preliminary design. While gas turbine performance and weight sensitivities to changes in life are generally not large (due to the logarithmic relationship of life to stress), past conceptual efforts have not quantified these trades. A methodology is developed which will quantify these life/performance trades cost effectively via computerized design procedures. Critical to the methodology is an accurate detailed engine utilization definition, which was not known in past efforts. Future conceptual efforts will be enhanced by the addition of life analyses of critical rotating components in the traditional solution of the aircraft and engine interactive design problem. (Author)

**A80-41178 # Installation trades for axisymmetric and non-axisymmetric nozzles** R J Glidewell (USAF, Aero Propulsion Laboratory, Wright Patterson AFB, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1084* 11 p 9 refs

Recent developments in several technology areas related to turbine engine exhaust nozzles indicate the potential for significant advancements in the state-of-the-art. These technology areas include nonaxisymmetric nozzles, high temperature composite materials, thrust reversing, and thrust vectoring. Trade studies have been performed to determine the impact of these developments on the installed performance of an advanced tactical aircraft. Results of these studies are presented and recommendations are made with regard to future directions of advanced development and demonstration. Significant improvements in both installed performance and design flexibility can be expected with the introduction of high temperature composites into the exhaust nozzle. (Author)

**A80-41180 # Performance variations in high aspect ratio subsonic diffusers due to geometric constraints in supersonic tactical aircraft inlet installations** J Syberg, J Koncsek (Boeing Military Airplane Co., Seattle, Wash.), and L Surber (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1106* 11 p

Performance data have been obtained on several subsonic diffusers designed for supersonic tactical fighter aircraft. Three of the diffusers were designed for high aspect ratio inlets having throat aspect ratios greater than seven. A fourth diffuser design incorporated a low throat aspect ratio. Two of the high aspect ratio inlets and the low aspect ratio inlet incorporated duct bends required by substantial offset from the engine centerline. The high aspect ratio diffusers produced high total pressure recovery coupled with relatively low flow distortion, supporting their use as a viable design option in future aircraft designs. The use of longitudinal vanes in one high aspect ratio diffuser provided significant improvements in flow uniformity with very little performance degradation. (Author)

**A80-41181 # An analog editing system for inlet dynamic flow distortion** DYNADec - Past, present and future J J Marous (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and D Sedlock (USAF, Wright Aeronautical Laboratories, Wright Patterson AFB, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1108* 10 p 5 refs

An analog/digital (hybrid) editing system DYNADec (Dynamic Data Editing and Computing) used to screen inlet dynamic pressure distortion data is described. An overall configuration is presented,



some of the improvements that have been made over the past decade are pointed out, and some future changes and uses of the system are discussed V T

**A80-41182 # Evaluation of a statistical method for determining peak inlet flow distortion using F-15 and F-18 data** C H Stevens, R C Oliphant, and E D Spong (McDonnell Aircraft Co., St Louis, Mo) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1109* 11 p 6 refs

Methods have been developed for significantly reducing the cost of determining inlet peak dynamic distortion values for advanced design purposes. These methods are not intended to replace the data acquisition and reduction systems required for final assessments of inlet/engine compatibility on aircraft development programs. However, they do satisfy the critical need for a prediction procedure for advanced design investigations that enables us to predict peak distortion levels using small scale models in small wind tunnels. Cost reductions are achieved by taking advantage of the statistical characteristics of the dynamic pressure and distortion data. Comparisons with measured distortion data show good agreement, thereby validating the statistical approach (Author)

**A80-41183 # Effect of aircraft power plant usage on turbine engine relative durability/life** R G Stabrylla (General Electric Co., Evendale, Ohio) and W A Troha (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1115* 28 p

A study to identify the causes of durability problems of gas turbine engines of recently developed fighter aircraft systems is reported. The differences between engine design usage and actual flight usage were evaluated, as were their effect on the relative durability/life of engine turbine components, and the effects of engine application and mission content on the relative cyclic and steady state durability of these components. Results have shown that military transport engine usage is more severe than commercial aircraft engine usage and that fighter aircraft usage is more severe than bomber aircraft usage for the specific engines tested. In both cases, the increased severity is due to higher cyclic usage content. In addition, aircraft training missions were found more severe than combat missions J P B

**A80-41187 # Flight test of all-electronic propulsion control system** J Kuhlberg (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn) and W Zimmerman (Boeing Commercial Airplane Co., Seattle, Wash) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1147* 18 p 6 refs

The paper describes the JT9D-7/747 flight test program for an all-electronic propulsion control system. Consideration is given to pilot controls and displays, an electronic engine control system, engine performance, and maintenance V T

**A80-41188 # Accelerating reliability growth of electronic propulsion controls in the 1980's** W C Peck (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1148* 9 p

The paper deals with Combined Environmental Reliability Test (CERT), a system of real-time, end-assembly, electronic hardware tests. Objectives of CERT testing are explained along with technical approach and pictures of physical facilities. Attention is given to computer controls, safety features, and performance envelopes V T

**A80-41189 # Evaluating potential VCE control modes with respect to performance, stability, and engine life utilization** R C Boyer (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind) *AIAA, SAE, and ASME, Joint Propulsion Conference,*

*16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1150* 7 p Contract No F33615-78 C 2021

The modern Variable Cycle Engine permits the control designer great latitude in the development of engine control modes. A method of evaluating potential control modes with the respect to mission performance, engine life, and engine stability during the preliminary design phase of the engine is presented. Control optimization criteria are evaluated with a steady-state engine simulation. Potential control schedules are used to generate steady-state data throughout the flight envelope. Missions are then simulated with the steady state data and mission time histories are analyzed to determine mechanical and thermal low cycle fatigue and stress rupture effects on critical engine components (Author)

**A80-41190 \* # Investigation of advanced thrust vectoring exhaust systems for high speed propulsive lift** R A Hutchison, J E Petit (Boeing Military Airplane Co., Seattle, Wash), F J Capone (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va), and R W Whittaker (General Electric Co., Evendale, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1159* 15 p 13 refs

The paper presents the results of a wind tunnel investigation conducted at the NASA-Langley research center to determine thrust vectoring/induced lift characteristics of advanced exhaust nozzle concepts installed on a supersonic tactical airplane model. Specific test objectives include (1) basic aerodynamics of a wing body configuration, (2) investigation of induced lift effects, (3) evaluation of static and forward speed performance, and (4) the effectiveness of a canard surface to trim thrust vectoring/induced lift forces and moments V T

**A80-41191 # A comparison of jet temperature effects on afterbody drag with those from jet molecular weight and nozzle area ratio variations** W L Peters (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1161* 12 p 7 refs

Experiments have been conducted to further assist in developing a wind tunnel test technique to allow simulation of or correction for jet exhaust temperature effects on afterbody drag. Integrated afterbody pressure drag data were acquired on a strut-mounted model at free stream Mach numbers from 0.6 to 1.2 with nozzle area ratio and jet molecular weight as variables. A method for estimating temperature effects on afterbody drag has been developed (Author)

**A80-41193 \* # Development of a Kevlar/PMR-15 reduced drag DC-9 nacelle fairing** R T Kawai (Douglas Aircraft Co., Long Beach, Calif) and F J Hrach (NASA, Lewis Research Center, Engine Component Improvement Office, Cleveland, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1194* 9 p 5 refs

The paper describes an advanced composite fairing designed to reduce drag on DC-9 nacelles as a part of the NASA Engine Component Improvement Program. This fairing is the aft enclosure for the thrust reverser actuator system on JT8D engine nacelles and is subjected to a 500 F exhaust flow during the reverse thrust. A reduced drag configuration was developed by using in-flight tuft surveys for flow visualization in order to identify areas with low-quality flow, and then modifying the aerodynamic lines to improve the flow. A fabrication method for molding the part in an autoclave was developed, this material system is suitable for 500 F. The resultant composite fairing reduces the overall aircraft drag 1% with a weight reduction of 40% when compared with a metal component A T

**A80-41194 \* # Reduced bleed air extraction for DC-10 cabin air conditioning** W H Newman, M R Viele (Douglas Aircraft Co., Long Beach, Calif), and F J Hrach (NASA, Lewis Research Center, Cleveland, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Confer*

ence, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1197 8 p

It is noted that a significant fuel savings can be achieved by reducing bleed air used for cabin air conditioning. Air in the cabin can be recirculated to maintain comfortable ventilation rates but the quality of the air tends to decrease due to entrainment of smoke and odors. Attention is given to a development system designed and fabricated under the NASA Engine Component Improvement Program to define the recirculation limit for the DC-10. It is shown that with the system, a wide range of bleed air reductions and recirculation rates is possible. A goal of 0.8% fuel savings has been achieved which results from a 50% reduction in bleed extraction from the engine. M E P

**A80-41203 \* # Zero-length, slotted-lip inlet for subsonic military aircraft.** E R Glasgow, W E Beck (Lockheed-California Co, Burbank, Calif), and R R Woollett (NASA, Lewis Research Center, Cleveland, Ohio). AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1245 13 p 24 refs. Contract No NAS3-21461

Zero-length, slotted-lip inlet performance and associated fan blade stresses were determined during model tests using a 20-inch diameter fan simulator in the NASA-LeRC 9 by 15-foot low-speed wind tunnel. The model configuration variables consisted of inlet contraction ratio, slot width, circumferential extent of slot fillers, and length of a constant area section between the inlet throat and fan face. Inlet configurations having contraction ratios of 1.2 and 1.3 satisfied all critical low-speed inlet operating requirements for a fixed horizontal nacelle and tilt-nacelle type subsonic V/STOL aircraft, respectively. Relative to a conventional axisymmetric tilt nacelle inlet, the zero-length, slotted-lip inlet has a 27-percent smaller inlet lip contraction ratio, an 83-percent shorter total length, and a 5-percent smaller maximum cowl diameter. (Author)

**A80-41204 # Stability analysis of the YF401 engine in the XFV-12A aircraft.** W A Walter (United Technologies Corp, Pratt and Whitney Aircraft Group, West Palm Beach, Fla) and J T DeLany (Rockwell International Corp, North American Aircraft Div, Columbus, Ohio). AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1246 8 p 7 refs

This paper presents the results of stability analyses of the YF401 engine in the XFV 12A V/STOL aircraft. A description of scale inlet model tests, including instrumentation and the test program, is presented. The method of screening the inlet model data on-line with an analog distortion factor calculator is reviewed. XFV-12A aircraft tests are then described including the instrumentation used to establish thermal reingestion levels. YF401 stability predictions are presented for selected operating conditions throughout the XFV-12A flight envelope. Temperature distortion during hover operation is shown to be a significant stability consideration, although less severe than pressure distortion. Study results predict compatible engine aircraft operation throughout the flight envelope. Predictions of compatible sea-level static operation have been confirmed by XFV-12A experience to date. (Author)

**A80-41205 # Navy operational and support cost model.** L T Finizie and M J Caddy (U S Naval Material Command, Naval Air Development Center, Warminster, Pa). AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1249 5 p

A Navy engine maintenance model (NAVEMM) developed to simulate the maintenance history of Naval aircraft engines is described. The NAVEMM is a Monte Carlo simulation model that tracks the events during the maintenance life of Naval aircraft engines. V T

**A80-41207 # Analysis of mixing and combustion in a scramjet combustor with a co-axial fuel jet.** J A Schetz (Virginia Polytechnic Institute and State University, Blacksburg, Va), F S

Billig, and S Favin (Johns Hopkins University, Laurel, Md). AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1256 8 p 12 refs. Navy supported research

A complete calculation procedure for predicting turbulent mixing and burning 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 modeled, including for the first time the upstream influence of heat release in the duct. Calculations for a representative engine with Shell-dyne 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. (Author)

**A80-41213 # Gas turbine combustor design challenges for the 1980's.** G J Sturgess (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hartford, Conn). AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1285 20 p 45 refs

The challenges in combustion, facing the industry at the beginning of this decade are discussed, including improved combustor durability, broad-based and synthetic fuels, and the design and development process itself. Their origins and salient features are briefly described, and areas where more knowledge is required are highlighted. V T

**A80-41366 # Nonlinear aeroelastic vibration of interfering surfaces.** Z Kopriva (Vojenska Akademie, Brno, Czechoslovakia). In International Conference on Nonlinear Oscillations, 8th, Prague, Czechoslovakia, September 11-15, 1978, Proceedings Volume 1. Prague, Academia, 1979, p 403-408 5 refs

The manner of arriving at the nonlinear aeroelastic characteristics of the system consisting of a supporting surface, control and auxiliary tab is outlined. The nonlinearity of the system is caused by flat spots in the hinges. The domain of unstable aeroelastic vibrations (flutter) is investigated. Theoretical analysis was made by an analog computer and simultaneously an experiment on an elastic model in aerodynamic tube was elaborated. The quantitative evaluation of the research shows a dangerous decrease of critical velocities of aeroelastic phenomena in such a configuration where nonlinearities are present. (Author)

**A80-41369 # A glider in 2-dimensional gusts.** L Laudanski and J Kaniowski (Rzeszow, Politechnika, Rzeszow, Poland). In International Conference on Nonlinear Oscillations, 8th, Prague, Czechoslovakia, September 11-15, 1978, Proceedings Volume 1. Prague, Academia, 1979, p 423-428 8 refs

New numerical results giving a picture of the behavior of a sailplane under action of vertical atmospheric gusts in a horizontal steady flight have been obtained for the Zefir 3 glider. The response has been represented by the rms, the gust alleviation factor and other averages describing samples of accelerations of five chosen points on the glider. The integral scale of turbulence has been the main model parameter. The results show the span-wise variations of gusts and their implications on the gust response. (Author)

**A80-41421 # Conditions for exciting natural vibrations in a tricycle rolling along a straight line.** (Uslowia vobuzhdeniia avtokolebanii pri priamolineinom kacheniitritsiklika) L G Lobas (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR). In International Conference on Nonlinear Oscillations, 8th, Prague, Czechoslovakia, September 11-15, 1978, Proceedings Volume 2. Prague, Academia, 1979, p 949-954 9 refs. In Russian

A major problem in the analysis of the motion of a tricycle is correct representation of the interaction of the wheels and the road surface. In the present paper, the problem is attacked using several approaches. One is based on the assumption of classical nonholonomic rolling constraints, another approach is based on a wheel drift

## A80-41474

hypothesis, while in the third approach, the problem is analyzed within the framework of Keldysh's theory. The results are of interest to aircraft takeoff problems. V P

**A80-41474 # Heat pipe avionic thermal control** K H Token, E C Garner, R S Cook, and J E Stone (McDonnell Aircraft Co., St Louis, Mo) *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 15th, Snowmass, Colo., July 14-16, 1980, Paper 80-1511* 13 p 6 refs Contracts No N00019 77 C-0351, No N00163 78 C-0331, No N00164 79-C-0211 No F33615-77 C-2075

This paper summarizes recent heat pipe avionic thermal control hardware developments and system studies. Concepts which integrate heat pipe avionic thermal designs with accepted avionic packaging approaches are described and compared to current designs. Prototype heat pipes, their measured thermal performance, and their integration into avionic packaging concepts are described. Results of studies which define aircraft benefits for heat pipe avionic thermal control systems are presented. These avionic thermal control systems include heat pipes, liquid coolants, and closed cycle environmental control system. Substantial increases in avionic reliability and reductions in aircraft mass, fuel requirements, and life cycle costs are demonstrated for these systems. (Author)

**A80-41506 \* # Fuel conservation through active control of rotor clearances** R S Beitler, A A Saunders, and R P Wanger (General Electric Co., Aircraft Engine Group, Evendale, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1087* 8 p Contract No NAS3 20643

Under the NASA-sponsored Energy Efficient Engine (EEE) Project, technology is being developed which will significantly reduce the fuel consumption of turbofan engines for subsonic transport aircraft. One technology concept being pursued is active control of rotor tip clearances. Attention is given to rotor tip clearance considerations and an overview of preliminary study results as well as the General Electric EEE clearance control approach is presented. Finally, potential fuel savings with active control of rotor clearances for a typical EEE mission are predicted. M E P

**A80-41508 # Investigation of infrared characteristics of three generic nozzle concepts** G J Banken, W M Cornette (Boeing Military Airplane Co., Seattle, Wash.), and K M Gleason (Boeing Aerospace Co., Seattle, Wash.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1160* 12 p

The infrared characteristics of three exhaust nozzles were investigated. The nozzles tested included a single axisymmetric convergent nozzle, a twin axisymmetric convergent/divergent nozzle, and a twin 2 D wedge nozzle. Each nozzle was tested using turbojet engine simulators over a range in total gas temperature from 617 to 1033 K, and for nozzle pressures from 2.0 to 5.0. In addition, limited infrared measurements were made for several nozzle/mixer combinations examined with a turbofan engine simulator. It was shown that (1) the facility is a convenient tool for obtaining model infrared signature data, (2) the presence of shocks in the flow has secondary effects on the infrared signature, and (3) no appreciable differences existed in the plume signatures for the three nozzle concepts. Analysis of the nozzle/mixer data showed that reductions in plume infrared signature of up to 80% are possible. A T

**A80-41510 # Development of a long-life 125 lb/f/ hydrazine thruster** C A Poythress and H C Conkey, III (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1170* 7 p

A flightweight 125 lb(f) REA 20-4 monopropellant hydrazine thruster has been developed for applications requiring high total impulse with unlimited duty cycle operation. The catalytic engine has demonstrated more than 1,000,000 lb(f)-sec total impulse with a propellant throughput of over 4350 lb(m). It was designed to operate

over a thrust range of 125 to 40 lb(f), corresponding to inlet pressures of 400 to 100 psia. Engine thrust was measured over the blowdown range, and resulted in demonstrated specific impulse of 237 to 232 sec over the thrust range. The paper describes the engine configuration and the development test program. (Author)

**A80-41511 # Muzzle blast from canister launched missiles** G L Romine and C T Edquist (Martin Marietta Aerospace, Denver, Colo.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1187* 13 p 19 refs Research supported by the Martin Marietta Aerospace, Contract No F04704 78 C-0016

Two approaches have been used to define the muzzle blast flow field that occurs during exit of a missile from a canister. The first utilized an existing time dependent finite difference technique and the second was to develop an approximate solution based on similarity considerations. In contrast to rifle and cannon muzzle blasts where the primary flow direction is axial, the muzzle blast resulting from missile launch is directed radially outward. The flow is strongly influenced by the missile base and canister exit geometry. The graphical results provided in this report clearly show this trend. Good correlation is shown between the two methods for the pressure pulse that travels along the missile surface. The analytical results also showed good agreement when compared to scale interceptor missile test results. (Author)

**A80-41512 # Modeling techniques for the analysis of ramjet combustion processes** R B Edelman, P T Harsha (Science Applications, Inc., Canoga Park, Calif.), and S N Schmotolocha (United Technologies Corp., Chemical Systems Div., Sunnyvale, Calif.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1190* 14 p 24 refs Contracts No F49620 77 C-0044, No F33615-77 C-2062

Increased demand for higher performance from airbreathing propulsion systems in general, and ramjet devices in particular, has resulted in the need to upgrade existing technologies to meet the emergence of more stringent design requirements. Criteria for higher performance includes reduced volume and weight and ways to achieve this involve the use of shorter combustors and high energy, high density fuels. Furthermore, systems constraints have dictated the use of sudden expansion (dump) combustors capable of operating effectively at high combustion intensities over wide ranges of conditions. Problems of flame stabilization, flame propagation and spray combustion have been encountered. This paper describes how the development and application of modeling techniques can be used to interpret the observations and to assist in the design of combustors and combustor components. (Author)

**A80-41513 # Exhaust system performance improvement for a long-duct nacelle installation for the DC-10** J G McComb, S V Parsons, and J A Wilson (Douglas Aircraft Co., Long Beach, Calif.) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1195* 13 p 6 refs

The paper describes a scale model configuration development test conducted to produce a high performance mixed flow exhaust system for a high bypass ratio engine for the DC-10 aircraft. A series of 12-lobe and 19-lobe mixer nozzles were fabricated, three-dimensional potential flow and boundary layer analyses were used to provide test configurations that contained no predicted flow separations. The geometric design variables covered were the number of lobes, the lobe shape contour, the mixer nozzle length, and the lobe-valley angle. Test results indicated that a substantial exhaust system performance improvement can be achieved for a high bypass ratio engine installed in a long-duct nacelle. A T

**A80-41514 \* # CF6-50 Short Core Exhaust Nozzle** D J Dusa (General Electric Co., Cincinnati, Ohio) and F J Hrach (NASA, Lewis Research Center, Engine Component Improvement Office,

Cleveland, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1196* 6 p

The General Electric CF6-50 engine nacelle was originally equipped with both fan nozzle and core nozzle thrust reversers. Many airline operators later deactivated the core reverser. Elimination of the core reverser enabled design changes to be made to help improve performance. A reduction in core nozzle length of approximately two feet was possible. This concept, defined as the Short Core Exhaust Nozzle, was evaluated in engine ground tests, including performance, acoustic, and endurance tests under the NASA/Lewis Engine Component Improvement Program. The test results verified the performance predictions from scale model tests. The Short Core Exhaust Nozzle provides an internal cruise SFC reduction of 0.9% without an increase in engine noise. The nozzle hardware successfully completed 1000 flight cycles of endurance testing with no signs of distress. (Author)

**A80-41515 \* #** Influence of pressure driven secondary flows on the behavior of turbofan forced mixers. B. Anderson, L. Povinelli, and W. Gerstenmaier (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1198* 27 p 12 refs

An analytical and experimental study was performed to determine the influence of pressure driven secondary flows on the behavior of turbofan forced mixer nozzles. The basic secondary flow structure entering the nozzle was identified experimentally and was composed of a strong vortex system aligned with the radial interface between the fan and core streams. A generic secondary flow vortex structure was constructed for input to the analysis to represent the large scale structure of this inflow condition. Comparison between experiment and analysis at five axial stations showed very good agreement and indicated that this vortex system was convected downstream and dominated the mixing process. (Author)

**A80-41516 \* #** Analytical and experimental evaluations of the effect of broad property fuels on combustors for commercial aircraft gas turbine engines. A. L. Smith (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1204* 19 p 9 refs. NASA-supported research

Analytical and experimental studies were conducted in three contract activities funded by the National Aeronautics and Space Administration, Lewis Research Center, to assess the impacts of broad property fuels on the design, performance, durability, emissions and operational characteristics of current and advanced combustors for commercial aircraft gas turbine engines. The effect of fuel thermal stability on engine and airframe fuel system was evaluated. Trade offs between fuel properties, exhaust emissions and combustor life were also investigated. Results indicate major impacts of broad property fuels on allowable metal temperatures in fuel manifolds and injector support, combustor cyclic durability and somewhat lesser impacts on starting characteristics, lightoff, emissions and smoke. (Author)

**A80-41523 \* #** Influence of antimisting polymer on aviation fuel breakup. V. Sarohia and R. F. Landel (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn, June 30-July 2, 1980, AIAA Paper 80-1287* 10 p 13 refs. Contract No. NAS7-100

Experiments have been performed to determine the influence of a moving airstream on jet and drop breakup of fuel containing small concentrations of antimisting polymers. This study was motivated by the needs to inhibit the ignition of fuel during a survivable aircraft crash landing. High speed motion pictures of initial deformation rates and instant pictures of initial deformation rates and instant pictures of the drop breakup suggest that the enormous resistance to the sudden deformation of fuel containing antimisting polymer is related to the development of high tensile viscosity, even though the shear

viscosity is not markedly affected. Study of a pendant drop fiber was undertaken to determine this tensile viscosity of antimisting fuel as a function of temperature and of polymer concentration. (Author)

**A80-41536** Laser beacon system for aircraft collision hazard determination. R. B. Miles (Princeton University, Princeton, N.J.). *Applied Optics*, vol. 19, July 1, 1980, p. 2098-2108. 13 refs. Research supported by Princeton University.

A laser beacon collision hazard determination system is capable of simultaneously determining range, bearing, and heading of threat aircraft. Calculations demonstrate that threat aircraft may be observed at greater than 10 km under good visibility conditions. When the visibility is limited to 5.6 km (3 nautical miles), the shortest possible warning time for aircraft below 3000 m can be greater than 15 sec. A wide variety of detection systems may be chosen based on cost, detection range, and sophistication. Traffic saturation is not a problem since closer aircraft produce easily distinguishable signals so traffic may be prioritized. Preliminary tests demonstrate that accurate range measurements are possible under daylight conditions. (Author)

**A80-41562 \* #** Careful numerical study of flowfields about asymmetric external conical corners. M. D. Salas (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1329* 13 p 11 refs.

A numerical study of the flowfield about asymmetrical external axial corners formed by the juncture of swept compressive wedges is presented. The geometrical configuration allows a unified treatment of external corners typical of delta wings and rectangular inlets. The study investigates how the flow transitions from a symmetrical flowfield with a cross-flow stagnation point at the corner to an asymmetrical flowfield for which the flow spills over the corner. The effects of leading-edge sweep, wedge compression, and corner radius are investigated. (Author)

**A80-41574 \* #** Numerical solution of the Navier-Stokes equations for a family of three-dimensional corner geometries. R. E. Smith (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1349* 15 p 22 refs.

Three-dimensional corners occur in many aerodynamic engineering situations. Supersonic flow about such geometries is characterized by strong inviscid-viscid interactions which are analyzed adequately only through the solution of the Navier-Stokes equations. In this paper numerical solution for the laminar compressible Navier-Stokes equations are presented for a family of three-dimensional corners consisting of wedge-plate and wedge-cylinder intersecting boundaries. The equations of motion are transformed to a uniform rectangular computational domain. The computational technique is the MacCormack time-split algorithm vectorized and programmed to run on the CDC CYBER 203 computer. The metric data for the transformation is obtained from the 'two-boundary technique'. (Author)

**A80-41576 \* #** Complete viscous flowfield solutions about a blunt parabolic body in a supersonic stream. K. J. Weilmuenster and R. A. Graves, Jr. (NASA, Langley Research Center, Space Systems Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1351* 9 p 16 refs.

A hybrid computational technique which splits the flowfield into inviscid and viscous regions is used to investigate the complete flowfield about axisymmetric parabolic blunt bodies in a supersonic stream. The solutions are carried out on the CDC CYBER 203 computer which, with its extensive memory, allows for the use of a large number of finite-difference mesh points, allowing resolution of important flowfield features. A range of freestream Mach number of 2.5 and a range of Re number based on nose radius of 500-125,000 was run for a sonic corner body. Contour plots of density, pressure,

and Mach number, velocity vector plots, and surface distributions of pressure, heat transfer, and shear stress are presented. Also, correlations of the downstream extent of the base recirculation region with Re number based on nose radius are given (Author)

**A80-41588 \* # Comparison of methods for prediction of transition by stability analysis** M R Malik (Systems and Applied Sciences Corp, Hampton, Va) and S A Orszag (MIT, Cambridge, Mass) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1375* 7 p 8 refs Contracts No NAS1-15604, No NAS1-15894

The paper compares several methods of transition prediction of linear stability analysis. The spectral stability analysis code SALLY is used to analyze flows over laminar flow control wings. It is shown that transition prediction by the envelope method and a new modified wave packet method are comparable in reliability, but that the envelope method is more efficient computationally. This is based on the results which show that the wave packet method provides N factors which are at best as consistent as those of the envelope method, since the wave packet method is at least 3 times as expensive as the envelope method, the latter is recommended for engineering design calculations. A T

**A80-41598 \* # Analysis of nonlifting and lifting airfoils in transonic flow by parametric differentiation** W Whitlow, Jr (NASA, Langley Research Center, Structures and Dynamics Div, Hampton, Va) and W L Harris (MIT, Cambridge, Mass) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1394* 11 p 20 refs Grant No NsG-1219

A method is presented which allows one to solve nonlinear transonic flow problems by analyzing a sequence of linear equations. The small disturbance formulation of steady transonic flow over airfoils is linearized by considering the perturbations due to small changes in airfoil thickness ratio and angle of attack. Repeatedly incrementing those parameters results in a series of nonlinear solutions and cumulatively determines the effects of large changes in airfoil geometry. Successive line overrelaxation is used to solve the associated linear equations and is coupled with predictor-corrector methods to yield series of nonlinear solutions. Computed pressure distributions on biconvex airfoils show good agreement with experimental data and other transonic prediction methods. Possible extensions to unsteady and/or three-dimensional transonic flow problems are briefly discussed (Author)

**A80-41599 \* # Prediction and measurement of turbulent aerodynamic trailing edge flows** A J Baker (Tennessee, University, Knoxville, Tenn), J C Yu, T B Gatski (NASA, Langley Research Center, Hampton, Va), and J A Orzechowski (Computational Mechanics Consultants, Inc, Knoxville, Tenn) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1395* 15 p 14 refs Contracts No NAS1-14855, No NAS1-15105

A viscous-inviscid interaction algorithm is developed for prediction of two-dimensional mean and fluctuating velocity distributions in the wake immediately downstream of an airfoil trailing edge. A composite pressure field is defined, and a Poisson equation solved for transverse pressure variations. A parabolized form of the time-averaged steady Navier-Stokes equations are solved in conjunction with a viscous augmented two-dimensional inviscid potential flow analysis. A tensor constitutive equation is employed to predict Reynolds stress distributions from solutions of a turbulence kinetic energy two equation closure model. Numerical predictions compared favorably with detailed experimental data for mean and fluctuating velocities, and Reynolds shear stress distributions, in the trailing edge region of a NACA 63-012 airfoil (Author)

**A80-41612 # Aerodynamics of wings in subsonic shear flow** A Barsony-Nagy and M Hanin (Technion - Israel Institute of

Technology, Haifa, Israel) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1418* 8 p 10 refs

Lifting surface and lifting line theories are developed for wings in nonuniform subsonic parallel stream whose velocity and density vary in the vertical direction. Solutions and numerical results are obtained, giving the lift and induced drag of elliptic wings in a jet stream, a wake stream, and in monotonic sheared stream (Author)

**A80-41614 # Non-equilibrium flow over delta wings with detached shock waves** R J Stalker (Queensland, University, Brisbane, Australia) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1424* 11 p 9 refs Research supported by the Australian Research Grants Committee

An analysis is made of the effect of streamwise density changes, due to chemical relaxation, on the flow in the shock layer of a medium to low aspect ratio delta wing at angles of incidence such that the shock wave is detached from the leading edges. It is shown that, at least near the midspan of the wing, the flow retains the conical character which is associated with flow in the absence of density changes. The density changes displace the shock wave towards the wing surface, but do not alter the shock shape. Unless strong crossflows are present, the crossflow pattern can be obtained from that for the appropriate constant density solution by suitable linear contraction of the ordinates normal to the wing surface. The displacement effect predicted by the analysis is confirmed by experiments in a high enthalpy shock tunnel (Author)

**A80-41615 \* # A simplified shock-fitting solution to a supersonic internal corner flowfield** J A Martin (NASA, Langley Research Center, Space Systems Div, Hampton, Va) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1425* 7 p 9 refs

A simplified shock-fitting method is developed and applied to a supersonic internal corner flowfield. An analytical approach is discussed, and results for a case with a free stream Mach number of 2.47 and wedge angles of 12.2 deg are shown. V T

**A80-41616 # A Navier-Stokes solution for laminar and turbulent flow through a cascade of airfoils** S J Shamroth, H J Gibeling, and H McDonald (Scientific Research Associates, Inc, Glastonbury, Conn) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1426* 14 p 35 refs Contract No N00019-78-C-0543

A numerical solution of the compressible time-dependent Navier-Stokes equations, including a transition-turbulence model, is obtained for a cascade of airfoils utilizing a nonorthogonal body fitted coordinate system. The equations are solved by a consistently split linearized block implicit scheme due to Briley and McDonald. Boundary conditions are formulated so as to allow placement of the outer boundary relatively close to the cascade without imposing physically unrealistic constraints. The transition-turbulence model is based upon the turbulence kinetic energy equation and an algebraic length scale equation. Results are presented for both laminar and turbulent flow through a cascade of uncambered NACA 0012 airfoils at zero incidence, and for laminar flow through the same cascade at six degrees incidence. The predicted flow field is consistent with experimental observation (Author)

**A80-41617 \* # Investigation of transonic flow in a cascade using an adaptive mesh** A Ecer and H U Akay (Purdue University, Indianapolis, Ind) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo, July 14-16, 1980, Paper 80-1430* 12 p 19 refs Grant No NsG-3294

The solution of two-dimensional full potential equation for the analysis of steady transonic flow through cascades is investigated. Finite element method is employed in the analysis. Accuracy and

efficiency of the obtained numerical solutions are discussed in terms of the employed computational grid. Accurate modeling of subsonic and supersonic flow regions together with the shock is discussed. The choice of artificial viscosity and relaxation factors are examined and related to the design of a computational grid. Shock capturing and shock fitting procedures are compared for improved accuracy and efficiency. Numerical results include cascades of Gostelow and NACA 0012 airfoils. (Author)

**A80-41622 \* #** Experimental studies of the laminar separation bubble on a two-dimensional airfoil at low Reynolds numbers. T J Mueller and S M Batill (Notre Dame, University, Notre Dame, Ind.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1440* 13 p 32 refs Grant No NsG 1419

The laminar separation, transition and turbulent reattachment near the leading edge of a two-dimensional NACA 663-018 airfoil were investigated using a low speed, smoke visualization wind tunnel. Lift and drag force measurements were made using an external strain gauge balance for a chord Reynolds number range of 40,000 to 400,000. An extensive flow visualization study was performed and correlated with the force measurements. Experiments were also conducted with distributed surface roughness at the leading edge and external acoustic excitation to influence the development of the airfoil boundary layer. This study delineates the effects of angle of attack and chord Reynolds number on the separation bubble characteristics and airfoil performance. (Author)

**A80-41623 #** Numerical study of separated turbulent flow over airfoils. A Sugavanam and J C Wu (Georgia Institute of Technology, Atlanta, Ga.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1441* 11 p 27 refs Grant No DAAG29-75-G-0147

A numerical scheme for the solution of two dimensional turbulent incompressible time-dependent Reynolds equations is developed with special emphasis on flow past airfoils. The turbulence models used are the two equation k-epsilon model with the turbulent kinetic energy, k, and the turbulent energy dissipation rate, epsilon, as the model variables, and the mixing length model. An explicit integral representation is used for the kinematics of the problem. Results are presented for the study of a 12% thick Joukowski airfoil at 15 deg angle of attack at a Reynolds number of 3,630,000. (Author)

**A80-41625 #** Airfoil design and analysis using an information systems approach. J C Narramore and R D Yeary (Bell Helicopter Textron, Fort Worth, Tex.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1444* 11 p 21 refs

Aerodynamic design problems become more complex as demands on aircraft performance and efficiency increase. Therefore, the use of sophisticated analytical methods that allow evaluation of designs with a greater technical depth are required. This has only become possible with the advent of modern high-speed computers. The aerodynamic design process can be significantly improved with the use of modern information system theories. Airfoil design and analysis methodology (ADAM) is a data processing system that has made major improvements in engineering productivity. (Author)

**A80-41626 #** Unsteady wake of a plunging airfoil. C M Ho and S H Chen (Southern California, University, Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1446* 8 p 15 refs Grant No DAAG29-78-G-0073

The velocity field in the near wake of a plunging airfoil was surveyed with a hot-wire rake containing five x-wires. Both the mean streamwise and the mean transverse velocity profiles indicate that the

wake consists of two parts, one part is the thin viscous wake formed by the two boundary layers on the airfoil. Another part is the inviscid wake of the airfoil. The inviscid wake extends about one chord length above and below the trailing edge. The simultaneous measured velocity traces by the rake across the wake revealed that the turbulent structures are asymmetric in the viscous wake. The upper portion and the lower portion of the wake approach a self-preserving state with different rates. (Author)

**A80-41628 #** A linearised theory for swirling supersonic jets and its application to shock-cell noise. P W Carpenter (Exeter, University, Exeter, England) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1449* 10 p 11 refs

A linearized theory is developed for underexpanded inviscid supersonic jets with arbitrary initial swirl. The radial displacement of a given stream line from its position at nozzle exit is used as the dependent variable. The governing equation is fairly complicated and has to be solved numerically by the method of characteristics. A simple expression for the wavelength of the primary shock cell is derived. The linearized theory is used to extend some of Howe and Ffowcs Williams theoretical results for shock-associated noise to swirling supersonic jets. In this way estimates are made of the effect of swirl on the total radiated sound power of shock-associated noise. It is found that for a certain type of swirl the shock-associated noise could be greatly reduced, or even eliminated, for sufficiently high swirl levels. This could be achieved at the expense of a very small thrust loss. (Author)

**A80-41647** Theoretical and experimental determination of the aerodynamic characteristics of a helicopter rotor. S D'Angelo (Torino, Politecnico, Turin, Italy) and R Malvano (CNR, Centro di Studio per la Dinamica dei Fluidi, Turin, Italy) *Meccanica*, vol 14, Mar 1979, p 26-33 7 refs. Research supported by the Consiglio Nazionale delle Ricerche

A simple theory for a hingeless rotor with stiff blades is extended to freely hinged rotors. The theory is based on the blade element theory and on energy, momentum, and angular momentum theorems; it can determine the aerodynamic characteristics of a freely hinged rotor in any condition of forward flight. A numerical model has been developed and results compared with real-flight data and data from tests of a helicopter model in a three meter diameter subsonic wind tunnel. The agreement is reasonably good. The numerical program makes it possible to consider the effects of the inverse flow area, tip losses, retreating blade stall, and twisting the blades for any forward steady flight with an advance ratio of 0.0 to 0.7, as well as to determine the global coefficient of lift, thrust, side force, and torque of the rotor. It is also possible to compute the speed increase at the disk and the local distribution of the aerodynamic incidence angle, lift, and thrust coefficient. V L

**A80-41708 #** Major results of the asymptotic theory of a low-flying wing - Method of matched asymptotic expansions (Osnovnye rezul'taty asimptoticheskoi teorii nizkoletishchego kryla - Metod srashchivaemykh razlozhenii). K V Rozhdestvenskii (Leningradskii Korablestroitel'nyi Institut, Leningrad, USSR) *Gidromekhanika*, no 41, 1980, p 18-28 11 refs. In Russian

Some asymptotic results are presented for a wing in ground effect. Formulas for calculating the hydrodynamic characteristics of rectangular wings in steady and unsteady flows are derived, and the problem of the optimal wing in ground effect is examined. An asymptotic theory that is well suited for evaluating the wing characteristics in ground effect over a wide range of Strouhal numbers, aspect ratios, and other parameters is examined. V P

**A80-41780** Variable camber airfoils. J E Chacksfield (Short Brothers, Ltd, Belfast, Northern Ireland) *Aeronautical Journal*, vol 84, May 1980, p 131-139 11 refs

The use of variable camber (VC) on combat aircraft is considered for thin, relatively low aspect ratio wings. Aerodynamic

features of leading and trailing edge VC are discussed along with performance gains and losses, direct lift control, gust load alleviation and battle damage. Provisional analysis of available data on VC airfoil applications indicates that both leading and trailing edge systems are necessary to minimize trimming requirements and optimize pressure distributions. In addition, the main improvement on combat aircraft appears to be the sustained maneuver phase of flight, with improvement in achievable turn radius. J P B

**A80-41790** **Newer users of older aircraft** R H Jones (Eastern Air Lines, Inc., Washington, D C., Lewis, Wilson, Lewis and Jones, Arlington, Va.) (*Flight Safety Foundation International Air Safety Seminar, 32nd, London, England, Oct 8-11, 1979*) *Air Law*, vol 5, no 2, 1980, p 66-75

The roles of airline deregulation, a large number of inexperienced operators and an increased number of newer users of older aircraft are explored with regard to a possible increase in aircraft accidents. Instances of inexperienced pilots and improperly loaded cargo in accidents are reported along with an analysis of accidents showing that as the pilots' total flight time exceeds 10,000 hours, there is a peak of accidents. Emphasis is placed on accidents caused by the manufacturer's negligence, the concept of strict liability and breach of warranty by the manufacturer, as well as the statute of limitations regarding air accidents and the age of the aircraft and its parts. J P B

**A80-41871 #** **Energy and civil aviation (Energia ed aviazione civile)** G Nicosia (Alitalia, Rome, Italy) *Istituto Italiano di Navigazione, Atti*, Jan-Mar 1980, p 5-16. In Italian

Repercussions of the energy crisis on air transport are examined, considering available resources of oil, natural gas, coal, sands and bituminous shales. Attention is given to the utilization of nuclear energy and of hydrogen, the synthesizing of fuel, and the amount of fuel used in air transport. The relationships between energy, economics and demand are also addressed, and a comparison is presented between the amount of fuel used by a Boeing 747 and the supersonic Concorde making the same Paris-New York flight. J P B

**A80-41872 #** **Men, aircraft and systems of navigation - An evaluation for the 1980s (Uomini velivoli e sistemi di navigazione - Una valutazione per gli anni 80)** F Squerri (*Institute of Navigation, International Congress on Man and Navigation, Brighton, England, Sept 10-14, 1979*) *Istituto Italiano di Navigazione, Atti*, Jan-Mar 1980, p 41-47. In Italian

Technological advances in the 1980s are described for both civil and military aircraft, including advances in aeronautical sciences, microelectronics and space sciences, and having the objectives of optimizing and automating air operations. Attention is given to the use of microelectronics in the 'flight management system' which includes an automatic flight control system and a navigation/attitude system. Also discussed are digitalized flight, integrated flight decks, the use of the global positioning system/NAVSTAR and within it, the time division multiple access concept. J P B

**A80-41878** **UNIGEN - Universal language of aviation** W

R Franks, P Allen (Canadian Society of Aviation Medicine, Aerospace Linguistic Foundation, Toronto, Canada), J Soutendam (Canadian Society of Aviation Medicine, Aerospace Linguistic Foundation, School of Operational and Aerospace Medicine, Toronto, Canada), and I Taylor (Canadian Society of Aviation Medicine, Aerospace Linguistic Foundation, Toronto, University, Toronto, Canada) (*Aerospace Medical Association, Annual Meeting, 50th, Washington, D C., May 14-17, 1979*) *Aviation, Space, and Environmental Medicine*, vol 51, Apr 1980, p 339-343. 27 refs

In 1978, 12 million flights arose from nations where English is a foreign language. From these, crash-deaths averaged 200 per million flights. The Aerospace Linguistic Foundation is incorporated to further cooperative evolution of a suitable speech for universal air use as envisaged by ICAO. The language is called UNIGEN, an acronym from Genesis 11:1. It reflects the pragmatic monitoring of

collective air communications and universal linguistic developments. The foundation underwrites investigations by existing communication faculties of linguistic problems identified from accidents, etc. (e.g. Tenerife shows English phonemes 'th' and 'wh' are not internationally suitable). Optimum expressions may derive from the world languages. Phonetics may also be selected to monitor the human factor, e.g. plosives to spot hyperventilation or arousals for sleep. Future air communications must exploit hearing and sight concurrently to assure the million-to-one reliability required for perception transfer. (Author)

**A80-41889** **Hypoxia-induced fatal aircraft accident revealed by voice analysis** I Saito, O Fujiwara, N Utsuki, C Mizumoto, and T Arimori (Japan Air Self-Defense Force, Aeromedical Laboratory, Tachikawa, Japan) *Aviation, Space, and Environmental Medicine*, vol 51, Apr 1980, p 402-406. 6 refs

The voice communication was the only clue of the fatal F-1043 accident encountered during high-altitude intercept procedures, and it was analyzed to prove the presence of hypoxia as a causal factor. A simulated low-pressure chamber flight was undertaken, and the subject's voice, saying the same words as the pilot, was analyzed in the same way. Comparison of these two voices revealed a similarity in characteristic changes of the sound spectrum and time course. The blurred formation of formant, fundamental, and harmonic frequencies, as well as the obscured gap in pre-vocal cord opening time (VOT) of the sound spectrogram, were thought to be the effects of hypoxia. Lowered fundamental frequency of the pilot's voice, even at the stressful period of attack, has strongly suggested decreased vigilance due to hypoxia. Through these findings, it was concluded that the cause of the accident was probably hypoxia in the pilot. (Author)

**A80-41899 #** **The influence of compressibility on the simulation of the separation behavior of external stores from a carrier (Der Einfluss der Kompressibilität zur Simulation des Abgangsverhaltens von Aussenlasten vom Trager)** K Thomas (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-094*. 22 p. In German

In the simulation of release behavior with the MBB-trajectory program, the MBB-panel method is used for determining the outer field around the paneled carrier aircraft and for the calculation of the pressure distribution on the upper surface of the paneled external stores. In this manner the influence of the compressibility on the external load-pressure distribution can be described relatively well through application of the Gothert-law. However, this law is not valid in the external field around the carrier aircraft. In order to approximate the compressibility influence, an outer field model based on the Gothert law and suited to the panel method is presented. By means of a calculated example, the influence of compressibility on an external store trajectory is shown. A measured flowfield is used for this calculation. In addition, the results of calculation with an outer field model are given. M E P

**A80-41900 #** **A theoretical method for the simulation of the separation behavior of external stores from a carrier (Ein theoretisches Verfahren zur Simulation des Abgangsverhaltens von Aussenlasten vom Trager)** R Deslandes (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-091*. 17 p. 10 refs. In German

An interference model is presented that is based on the 'flow-angularity method'. In this manner the interference in the aircraft near field is determined in the form of induced up and side drafts. Forces and moments are obtained from the superposition of sectional load gradients of the external stores with aircraft flow. Nonlinear effects are considered by means of the crossflow drag analogy since the flow and the sectional load are determined by the

linear functioning panel method. Finally, experimental and theoretical results are compared. M E P

**A80-41901 #** Some vertical and horizontal ejection problems (Problematik des Vertikalen und Horizontalen Ausstosses von Korpfern) A Foysi (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79 101* 17 p In German

A Monte Carlo simulation is proposed for evaluating the effectiveness of weapons ejected vertically from an aircraft with allowance for the influence of external factors (winds) and errors in the coordination of aircraft velocity with the ejection velocity and ejection angle. A mathematical model for horizontal ejection is proposed, and the problem of avoiding collisions among the ejected bodies is discussed. V P

**A80-41902 #** Theoretical investigations of the release and trajectories of aircraft stores (Theoretische Untersuchungen zum Abgang und zur Flugbahn von Aussenlasten) W Benner and W Fritz (Dornier GmbH, Friedrichshafen, West Germany) *Deutsche Gesellschaft fur Luft und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79 093* 16 p 16 refs In German

The paper deals with the complex aerodynamic and dynamic effects and interactions accompanying the release of aircraft stores. A mathematical basis is developed for treating the 'aircraft-release hit' problem and determining its influence parameters. For illustration, the calculation of store release influence parameters is carried out for the alpha-jet. V P

**A80-41903 #** Wind tunnel investigations of the release behavior of aircraft stores at low and high velocities (Windkanaluntersuchungen zur Ermittlung des Abgangsverhaltens von Aussenlasten im Nieder- und Hochgeschwindigkeitsbereich) P Esch and T Windeck (Dornier GmbH, Friedrichshafen, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-096* 13 p In German

Wind-tunnel store release data obtained by the Froude method, the heavy model method, and the light model method are diagrammed and discussed. The influence of the various parameters is demonstrated. The simulated releases are compared with the experiment. V P

**A80-41904 #** Release experiments in DFVLR wind tunnels (Abwurfversuche in DFVLR Windkanalen) K Wichmann (Deutsche Forschungs- und Versuchsanstalt fur Luft und Raumfahrt, Cologne, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-097* 20 p In German

The paper deals with wind tunnel investigations of the release behavior of aircraft stores. Some systems developed for controlling the model releases and recording the test data are described, and high-speed photographs of the release process are presented. V P

**A80-41905** External stores technology in subsonic wind tunnels (Aussenlasttechniken in Unterschall-Windkanalen) R Leister (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79 098* 38 p 5 refs In German

The use of the 3 m subsonic tunnel in Cologne for the testing of the separation characteristics of external stores is described. Attention is given to the significance of such investigations for the theoretical calculation of external store trajectories and the technical

prerequisites for their utilization in the subsonic wind tunnel. In addition, the necessary and desirable improvements are suggested and special auxiliary devices are recommended. M E P

**A80-41906 #** Importance of simulations of weapon and load drops in the testing of attack aircraft (Die Bedeutung von Simulationen des Abgangs von Waffen und Lasten bei der Erprobung von Kampfflugzeugen) J Rohmer *Deutsche Gesellschaft fur Luft- und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-100* 14 p In German

Progress in the simulation of load releases and the ballistics of single and stick bombing is reviewed. The savings resulting from simulation are compared with the costs of procuring very precise input data required for effective simulation. The need to carefully examine the extent to which simulation and actual testing should be used to arrive at a cost effective solution is indicated. V P

**A80-41907 #** Aircraft model store trajectory testing at A R A R H Landon (Aircraft Research Association, Ltd, Bedford, England) *Deutsche Gesellschaft fur Luft und Raumfahrt, Symposium uber Abgang von Lasten und Waffen vom Trager, Bad Neuenahr, West Germany, Nov 26, 27, 1979, Paper 79-099* 36 p 6 refs

Store release tests are described with particular reference given to a light body free flight wind tunnel trajectory testing. The test philosophy and ejector gun development to the present twin ram is discussed. Examples of specific model ERUs illustrating the application of design principles established are presented. V T

**A80-42009** A comparison of underwater helicopter-escape lights S M Luria, B L Ryack, and D Temple (US Naval Material Command, Naval Submarine Medical Research Laboratory, Groton, Conn.) *Aviation, Space, and Environmental Medicine*, vol 51, July 1980, p 674-679

The effectiveness of two types of steady and flashing lights as escape hatch indicators for submerged helicopters was compared. Measurements were taken in moderately and highly turbid water. Response time was faster to the steady lights, and they were more accurately localized. Pairs of steady lights appeared to have some advantage over single lights, but this was not true for flashing lights. Subjects found it very difficult to discern how many different locations were being illuminated. (Author)

**A80-42054 #** Compressor response to spatially repetitive and non-repetitive transients R E Peacock and O C Eralp (Cranfield Institute of Technology, Cranfield, Beds, England) *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9 11, 1979, Paper 79-GT/Isr 14* 12 p 7 refs Members, \$1 50, nonmembers, \$3 00

The problem of compressor inflow with superimposed wave propagation is addressed and solutions are offered using two separate time dependent mathematical models. In the actuator disc model the work input to the stage is achieved in an infinitesimally short axial length, the flow returning to the axial direction between stages. The simultaneous solution of the continuity and energy equation across the actuator disc is involved in this approach. The continuous flow model assumes a continuous work input axially along the compressor which consists of an infinite number of infinitesimally small stacked stages, every stage behaving quasi-steadily under transient flow conditions. This method involves the simultaneous solution of the continuity, tangential momentum and energy equations in non-homentropic circumstances. In both models, the method of characteristics is used to solve the partial differential equations of wave propagation through the system. A compressor of known geometry and steady state operating characteristics is embedded in a ductwork. The system is analyzed under superimposed conditions of repetitive (sinusoidal) and impulse type steps of pressure fluctuation. The effect of frequency, and amplitude of pulse is investigated and the onset of instability is predicted. (Author)



**A80-42055 # Compressor rotating stall in uniform and non-uniform flow** B F J Cossar (Royal Military College of Canada, Kingston, Ontario, Canada), R E Peacock (Cranfield Institute of Technology, Cranfield, Beds, England), and W C Moffatt *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-18* 10 p 7 refs Members, \$1 50, nonmembers, \$3 00 Defence Research Board of Canada Grant No 3610-147, Grant No AF-AFOSR-77-3305

The paper describes a series of experiments in which a single-stage, lightly loaded compressor operated under stall-free conditions and with rotating stall, both with uniform inlet flow and with distortions generated by an upstream screen of uniform porosity. The distribution of static pressure along rotor blade surfaces is discussed. V T

**A80-42056 # Reliability prediction techniques for second generation marine and industrial gas turbines** R B Spector (General Electric Co, Marine and Industrial Projects Dept, Evendale, Ohio) *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-3* 9 p 6 refs Members, \$1 50, nonmembers, \$3 00

The paper discusses reliability prediction techniques for second generation marine and industrial gas turbines. A technique to provide an 'early look' at the reliability of equipment and a means of projecting its reliability growth used for the LM2500 gas turbine is examined, this technique, employing a 'family concept' to reliability growth supplements the Failure Mode, Effect and Criticality Analysis (FMECA), providing a tool for earlier assessments of the reliability potential. This new prediction technique can also be applied to the selection of the most reliable power plant and to identifying the condition when a gas turbine is sufficiently mature for release. The paper compares the features of these two methods as they were applied to the LM2500 turbine. A T

**A80-42057 # Design of air-cooled jet engine testing facilities** F M Oran and M I Schiff (Industrial Acoustics Co, Inc, Bronx, N Y) *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-5* 8 p Members, \$1 50, nonmembers, \$3 00

The analytical procedures used to design jet engine test facilities suitable for afterburner operation using air as a coolant for the discharge gases rather than the conventional use of water are presented. The application of these procedures in the design of a test facility is outlined. Furthermore, the effects of air cooling a test cell with specific implications regarding environmental and engineering economy considerations are reviewed. (Author)

**A80-42058 # Matching of turbocomponents described by the example of impeller and diffuser in a centrifugal compressor I - Aerothermodynamic coupling of impeller and diffuser II - Optimized stage efficiency of a centrifugal compressor** K Bammert, M Rautenberg (Hannover, Universitat, Hanover, West Germany), and W Wittekindt (Klein, Schanzlin und Becker AG, Saarbrucken, West Germany) *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-9* 7 p 14 refs Members, \$1 50, nonmembers, \$3 00

An important task in the design of turbo machinery is the determination of the aerothermodynamic parameters necessary to assure optimum matching of the individual compressor components. With centrifugal compressors, the problem is to design impeller and diffuser such that a maximum overall efficiency is achieved for the desired design point. For this purpose, a mathematical model is developed coupling the individual component efficiencies. In the first part of this paper, the aerothermodynamic bases are derived and the coupling equation is illustrated. In the second part, a solution is displayed for the complex problem of matching the impeller and the vaneless diffuser of a centrifugal compressor. The solution is

obtained by means of a stochastic-mathematical optimization procedure based on the biological evolution strategy. (Author)

**A80-42060 # Conceptual examination of gas phase particulate formation in gas turbine combustors** A S Kesten, J J Sangiovanni (United Technologies Research Center, East Hartford, Conn), and P Goldberg (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hartford, Conn) *American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-12* 9 p 14 refs Members, \$1 50, nonmembers, \$3 00

Recent laboratory studies of droplet combustion indicate the potential for substantial gas phase particulate formation even with single component hydrocarbon fuels. Formation of large particles has been observed in the neighborhood of burning droplet arrays, particularly when the droplets are closely spaced. To provide insight into the potential for particulate formation during the combustion of fuel droplet sprays in gas turbine combustors, a mathematical framework is developed for examining the formation of soot nuclei in droplet combustion. A simplified model of the chemistry of fuel pyrolysis and nuclei formation is used and a series of calculations is made to explore the sensitivity of soot nuclei formation to conditions typical of gas turbine combustion systems. (Author)

**A80-42147 \* # Experimental study of low aspect ratio compressor blading** L Reid and R D Moore (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-6* 8 p Members, \$1 50, nonmembers, \$3 00

The paper presents a study of low aspect blading for the inlet stages of a high pressure ratio, high speed core compressor. The basic overall design variables were stage pressure ratio and blade aspect ratio, these four stages represent two levels of total pressure ratio, two levels of rotor blade aspect ratio, and two levels of stator vane aspect ratios. Comparisons of the overall performance, radial distributions of performance parameters, diffusion factors at the near stall conditions, blade element data, and the axial distribution of rotor tip static pressures yielded the following results: (1) higher peak pressure ratio, high stage and rotor efficiencies, and greater stall margin were obtained with the lower aspect ratio blading, (2) the lower aspect ratio blading showed improved performance over the entire blade span, and (3) the lower aspect ratio rotors operated at higher diffusion factors and higher incidence angles over the entire blade span. A T

**A80-42154 \* # Performance of annular prediffuser-combustor systems** W B Wagner, S Tanrikut (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hartford, Conn), and D E Sokolowski (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-15* 12 p 19 refs Members, \$1 50, nonmembers, \$3 00

Results of an experimental investigation of the aerodynamic performance of several annular prediffuser combustor systems are presented. Three curved wall, dump prediffusers of different length, area ratio, and turning angle were tested with and without a simulated combustor located downstream of the prediffuser. Performance was significantly influenced by the presence of the combustor. Pressure recovery and flow losses were determined as a function of prediffuser inlet velocity profile, flow extraction at the prediffuser inlet, axial and radial location of the combustor front end, and distribution of the flow in the combustor. Axial location of the combustor was found to be the most significant parameter influencing system performance. (Author)

**A80-42155 # Tests of an improved rotating stall control system on a J-85 turbojet engine** G R Ludwig and J P Nenni (Calspan Advanced Technology Center, Buffalo, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper*

80-GT-17 9 p Members, \$1 50, nonmembers, \$3 00 Contract No F33615-76-C 2092

An improved version of a rotating stall control system has been tested successfully on a J 85 turbojet engine. Past tests had pointed out the desirability of increasing the response speed of the control. In this study, the installation of the stall control on the J 85 was modified so as to decrease the response time of the control by a factor of ten over that attained in the past tests. The modified control was tested to see if the decreased response time improved the ability to clear rotating stall once it has started, and also to see if rotating stall could be anticipated and prevented by proper selection of the variables in the stall control detection system. The performance of the stall control was tested by closing the bleed doors on the engine until rotating stall occurred or until the control anticipated stall and held the bleed doors open. The tests showed that the control is capable of anticipating stall before it occurs and keeping the engine completely clear of stall at speeds up to 80 percent of design speed. No tests were performed above 80 percent of design speed because opening the bleed doors at such speeds might aggravate the stall rather than clear it. (Author)

**A80-42163 # Simplifying the development of programs for digital engine controllers** D A Rutherford (Ultra Electronic Controls, Ltd, London, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-29* 9 p Members, \$1 50, nonmembers, \$3 00

The paper describes a method of simplifying the preparation and development of control programs for microprocessor-based engine control systems. The system described employs a video display unit, VDU, connected to the digital controller. Programs are prepared in a simple high level language tailored to the requirements of engine control schemes. The paper also describes the internal software structure and features that are provided. An example of the procedures used to develop a simple control program illustrates how a user can concentrate on the control scheme rather than on software problems. (Author)

**A80-42164 \* # Atomizing characteristics of swirl can combustor modules with swirl blast fuel injectors** R D Ingebo (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-30* 7 p 8 refs Members, \$1 50, nonmembers, \$3 00

Cold flow atomization tests of several different designs of swirl can combustor modules were conducted in a 7.6 cm diameter duct at airflow rates (per unit area) of 7.3 to 25.7 g/sq cm sec and water flow rates of 6.3 to 18.9 g/sec. The effect of air and water flow rates on the mean drop size of water sprays produced with the swirl blast fuel injectors were determined. Also, from these data it was possible to determine the effect of design modifications on the atomizing performance of various fuel injector and air swirler configurations. The trend in atomizing performance, as based on the mean drop size, was then compared with the trends in the production of nitrogen oxides obtained in combustion studies with the same swirl can combustors. (Author)

**A80-42165 # An aerodynamic method for control and range improvement of rotary compressors** N Kyrtatos and N Watson (Imperial College of Science and Technology, London, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-31* 9 p 25 refs Members, \$1 50, nonmembers, \$3 00

An aerodynamic method is proposed to replace the variable inlet guide vanes used for imparting compressor inlet prewhirl. High pressure jets are injected obliquely into the inflow, from orifices spaced around the periphery of the inlet pipe. A mathematical model of the flow situation was developed, which considers an unbounded axisymmetric jet ejected obliquely at various angles into a cross flow. The solution for the trajectory and growth of the jet was found to be in good agreement with relevant published experimental data.

Prewirl producing jet arrangements were designed and the flow deflection resulting from the combined action of the jets was measured for a range of jet velocities and cross flow velocities.

(Author)

**A80-42166 # Protection and specification of clutches to be used with gas turbine generators** K H Burns and R P Kearsley (EPD Consultants, Ltd, Sidcup, Kent, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-33* 8 p 5 refs Members, \$1 50, nonmembers, \$3 00

The use of self-actuating clutches in gas turbine driven electrical power generators is examined, in relation to operation of the clutch during fault conditions. Clutches are employed in the main shaft between the power turbine and the electrical generator, to enable the unit to operate as a synchronous compensator. Five particular fault conditions are identified which could cause overstressing of the clutch. Protection is not universally provided to protect the clutch under all five conditions, and methods of providing protection are suggested. Analysis of the fault conditions is developed to identify the differential acceleration requirement for the clutch. The analysis is extended to demonstrate the limited capability of a gas turbine generator, when operating as a synchronous compensator, to provide spinning reserve capacity for an electrical system. (Author)

**A80-42168 # Time between overhaul vs premature removal rates as turbine design considerations** C E Curry and A C Wei (General Motors Co, Detroit Diesel Allison Div, Indianapolis, Ind) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-35* 6 p Members, \$1 50, nonmembers, \$3 00

A general knowledge of aviation practices constituted the background for the identification of three distinct variables as the major drivers for engine removals in the operation of an aircraft. This study provides an insight into the interrelationships of the major drivers which determine engine removals for an aircraft: utilization rate (U), time between overhaul (TBO), and premature removal rate (PRR). Each of these elements is of concern to nearly every aircraft operator. For this study, it was assumed to be the same as aircraft flight hours per month. (Author)

**A80-42170 # Full coverage film-cooled blading in high temperature gas turbines - Cooling effectiveness, profile loss and thermal efficiency** H Hempel, R Friedrich, and S Wittig (Karlsruhe, Universitat, Karlsruhe, West Germany) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-37* 7 p 13 refs Members, \$1 50, nonmembers, \$3 00

Extending data obtained from hot gas cascade measurements on the cooling effectiveness and profile loss coefficients of full coverage film-cooled blading, use is made of similarity considerations to determine the heat transfer characteristics under actual engine conditions. Of primary interest are stationary gas turbines. Calculations are made for a four-stage single shaft gas turbine with air preheat and common component efficiencies. As a representative result it is found that for a pressure ratio of  $p_2/p_1$  equal to 10 a relative cooling air flow of approximately 8 percent will be required in raising the temperature from 1173 to 1573 K. The resulting relative improvement of the thermal efficiency is 24 percent and that of the specific work about 70 percent. (Author)

**A80-42171 # Aerodynamic loss in a gas turbine stage with film cooling** S Ito (Ikutoku Technical University, Atsugi, Kanagawa, Japan), E R G Eckert, and R J Golstein (Minnesota, University, Minneapolis, Minn) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-38* 7 p 8 refs Members, \$1 50, nonmembers, \$3 00 Contract No N00014-76 0246

Experiments have been performed to measure the total pressure loss of the flow through a two-dimensional turbine cascade with 'coolant' injection from a single row of holes on the suction or

pressure side of the blades. The tests were performed in a low speed tunnel. Air and carbon dioxide were used as secondary fluids, the latter to provide a large density difference between the gas in the mainstream and the injected gas. Both gas streams had the same temperature. The measured pressure loss is in good agreement with analytical predictions based on a model introduced by Hartsel. The results thus provide information which can be incorporated in a program which predicts the influence of injection on the aerodynamic efficiency of a gas turbine. (Author)

**A80-42172 #** Investigations of an axial flow compressor with tandem cascades. K Bammert and H Beelte (Hannover, Universitat, Hanover, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-39* 7 p 8 refs. Members, \$1 50, nonmember, \$3 00

In axial flow compressors with high degrees of reaction the transfer of energy can be increased by using suitable tandem cascade arrangements. The application of multistage tandem cascade systems therefore allows savings in constructional length and blading and thus a very compact compressor design. Therefore a four-stage tandem cascade compressor with 100 percent reaction was built. To determine the operating behavior of the machine, the compressor characteristic on speed control was measured. For optimization and further development of this compressor the characteristics on adjustment of all stator blade rows and speed control were measured. To allow the behavior of the stator blade rows and tandem cascade wheels to be assessed, the channel flow in the axial gaps behind selected wheels was measured. The tandem cascade compressor, its layout and the results of experimental investigations are presented and discussed. (Author)

**A80-42174 #** The aerodynamic significance of fillet geometry in turbocompressor blade rows. L L Debruge (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-41* 10 p 14 refs. Members, \$1 50, nonmembers, \$3 00

This paper describes a theoretical investigation of the influence of fillet radius on the aerodynamic behavior of turbocompressors. The fillet is that found at the intersection of an airfoil and a hub or shroud where no relative motion or gap is present. A modified power law velocity is used in conjunction with experimental estimates of the three-dimensional corner boundary layer extent to obtain values of the interference displacement and friction coefficient for the 90 deg corner flow which are in fair agreement with Gersten's experimental results. Likewise, interference displacement and friction coefficient are obtained in the case of a corner flow in a dihedral greater than 50 deg for which experimental data is unavailable but where the low curvature of the stream surfaces allows the three-dimensional boundary layer extent to be calculated from Bertotti's integral momentum equation. The boundary layer characteristics thus obtained are then applied, by means of a polyhedral approximation, in the evaluation of the influence of 90 deg corner fillet on corner flow separation. Some guidelines are provided relating the fillet radius to physical dimensions of the blading. (Author)

**A80-42178 #** Blade trailing edge heat transfer. A Brown (University of Wales Institute of Science and Technology, Cardiff, Wales), B Mandjikas, and J M Mudyiwa. *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-45* 7 p 9 refs. Members, \$1 50, nonmembers, \$3 00. Research supported by GEC Gas Turbines.

Measurements of heat transfer, pressure loss and friction factor inside simulated trailing edges of turbine blades are presented. The trailing edges considered are vented and the internal heat transfer surfaces are extended by means of staggered arrays of pillars interconnecting the blade pressure and suction surfaces. A number of pillar arrays and trailing edge configurations are considered, namely

pillar pitch to diameter ratios nominally of 2, 3, and 4 and trailing edge included angles of 0, 10, 15, and 20 deg. The range of Reynolds numbers covered based on pillar diameter and maximum velocity through a row of pillars is from 10,000 to 200,000. (Author)

**A80-42179 #** Joint technology demonstrator engine - The initial test. B N Rohm (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-47* 8 p. Members, \$1 50, nonmembers, \$3 00

It is noted that the emphasis on aircraft gas turbine engine technology has recently been shifting from attainment of increasing performance goals to a direction that addresses structural durability with the intent of significantly reducing engine life cycle cost. A general description of the Joint Technology Demonstration Engine (JTDE) is presented, and several aspects of the experimental test approach are addressed. The discussion of design performance details and test results are limited in scope because of the classified nature of this program. M E P

**A80-42181 #** An investigation of ingress for a simple shrouded rotating disc system with a radial outflow of coolant. J M Owen and U P Phadke (Sussex, University, Sussex, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-49* 8 p. Members, \$1 50, nonmembers, \$3 00. Research sponsored by GEC Gas Turbines, Ruston Gas Turbines, and Sulzer Brothers.

An investigation is presented of the ingress for a simple shrouded rotating disk system with a radial outflow of coolant. A plane rotating disk and a plane stator with a cylindrical shroud were used to model the more complex geometry of an air cooled gas turbine rotor. 'Cooling air' supplied to the center of the stator leaves radially through the clearance between the rotating disk and a stationary shroud, flow visualization and pressure measurements are used to determine the minimum dimensionless mass flow rate of cooling air necessary to prevent the ingress of external fluid at the periphery of the system. The results are correlated from theoretical considerations for a gap ratio of 0.1, shroud clearance between 0.0025 and 0.04, and the rotational Reynolds number between  $2 \times 10$  to the 5th and  $10$  to the 6th by the formula derived for the minimum dimensionless mass flow rate. A T

**A80-42182 #** Calculation of windmilling characteristics of turbojet engines. Q S Zhao (Peking Institute of Aeronautics and Astronautics, Peking, Communist China). *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-50* 12 p. Members, \$1 50, nonmembers, \$3 00

The operation of a turbojet engine under windmilling conditions was analyzed and the relationship of engine speed and airflow has been derived. Replacing the efficiencies of compressor and turbine by a total pressure loss coefficient, the author was able to obtain the equations for matching the engine components and the universal curve of windmilling turbine characteristic based on theoretical analysis and experimental data. Based on the relations obtained, a simple method for calculating the windmilling characteristic of a turbojet engine was derived. In the absence of compressor and turbine characteristics under windmilling conditions, two approximate calculating methods were developed. The theoretical relations developed have been checked by experimental data. An example of the application of this approximate method is presented in the Appendix and the agreement between the prediction and experimental data is generally good. (Author)

**A80-42186 #** Fuel property effects on life characteristics of aircraft turbine engine combustors. C C Gleason and D W Bahr (General Electric Corp., Aircraft Engine Group, Cincinnati, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference*

and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-55 9 p 8 refs Members, \$1 50, nonmembers, \$3 00 Contracts No F33615-77-C-2042, No F33615 77-C-2043

Results of a program to determine the effects of fuel properties on the life characteristics of two USAF/General Electric aircraft turbine engine combustors are presented Thirteen test fuels were evaluated in an older technology annular combustion system (J79) and in an advanced technology, virtually smokeless, compact, annular combustion system (F101) over wide ranges of simulated engine operating conditions Fuel variables were hydrogen content, aromatic structure, volatility and distillation end point Significant increases in combustor liner temperatures were observed as fuel hydrogen content was decreased With fuel hydrogen contents of 14 5, 14 0, 13 0 and 12 0, the resulting relative combustor liner cyclic life predictions are 1 00, 0 78, 0 52, and 0 35 for the J79 combustor and 1 00, 0 72, 0 52 and 0 47 for the F101 combustor, respectively Based on these findings, it is concluded that improved liner cooling design features will be needed in most current technology combustors to accommodate the projected lower hydrogen contents of future fuels (Author)

**A80-42187 r** Experimental evaluation of catalytic flame stabilization for aircraft afterburners L C Angello (Electric Power Research Institute, Palo Alto, Calif ) and E N Coppola (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-56* 10 p 6 refs Members, \$1 50, nonmembers, \$3 00

Catalytic flame stabilization encompasses the use of a porous catalytic surface to initiate, stabilize, and provide a continuous pilot for flame propagation A preliminary assessment of the feasibility of employing catalytic flame stabilization to the design of flameholders for aircraft afterburners has been completed Initial testing has demonstrated that catalytic flame stabilization in aircraft afterburners can be achieved For the non-optimal catalytic flameholders evaluated, smooth light off and stable operation were obtained, higher combustion efficiencies were measured and higher pressure losses were observed During the course of the experiment a significant number of design aspects were determined to require further investigation These design aspects along with other results of this study are discussed in this paper (Author)

**A80-42188 #** Composition structure of burning sprays of Jet A fuel and its emulsions with water S R Gollahalli and S H Javadi (Oklahoma, University, Norman, Okla) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10 13, 1980, Paper 80-GT-57* 8 p 20 refs Members, \$1 50, nonmembers, \$3 00

This paper presents the axial and radial concentration profiles of various species (O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O, NO, NO<sub>x</sub>, and CnHm) in the burning sprays of Jet A-fuel, its blend with 1 percent surfactant, and its emulsions with 1 percent surfactant and different water contents (5, 10, and 20 percent by volume) The composition structure of the flame studied is in conformity with the temperature, particulate concentration, and radiation profiles studied earlier The results show that the increase of water content of emulsions decreases fuel pyrolysis and oxides of nitrogen, whereas the surfactant alone does not markedly affect the flame structure (Author)

**A80-42193 \* #** Temperature and flow measurements on near-freezing aviation fuels in a wing-tank model R Friedman (NASA, Lewis Research Center, Cleveland, Ohio) and F J Stockemer (Lockheed-California Co., Burbank, Calif) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10 13, 1980, Paper 80-GT-63* 12 p 15 refs Members, \$1 50, nonmembers, \$3 00

Freezing behavior, pumpability, and temperature profiles for aviation turbine fuels were measured in a 190-liter tank, to simulate internal temperature gradients encountered in commercial airplane wing tanks Two low-temperature situations were observed Where

the bulk of the fuel is above the specification freezing point, pumpout of the fuel removes all fuel except a layer adhering to the bottom chilled surfaces, and the unpumpable fraction depends on the fuel temperature near these surfaces Where the bulk of the fuel is at or below the freezing point, pumpout ceases when solids block the pump inlet, and the unpumpable fraction depends on the overall average temperature (Author)

**A80-42195 \* #** NASA Broad-Specification Fuels Combustion Technology Program - Status and description J S Fear (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-65* 10 p 8 refs Members, \$1 50, nonmembers, \$3 00

The use of 'broad-specification' fuels in aircraft gas turbine engines can be a significant factor in offsetting anticipated shortages of current specification jet fuel in the latter part of the century The changes in fuel properties accompanying the use of broad-specification fuels will tend to cause numerous emissions, performance, and durability problems in currently-designed combustion systems The NASA Broad Specification Fuels Combustion Technology Program is a contracted effort to evolve and demonstrate the technology required to utilize broad-specification fuels in current and next generation commercial Conventional Takeoff and Landing (CTOL) aircraft engines, and to verify this technology in full-scale engine tests in 1983 The program consists of three phases Combustor Concept Screening, Combustor Optimization Testing, and Engine Verification Testing (Author)

**A80-42196 #** The development and application of improved combustor wall cooling techniques A B Wassell and J K Bhangu (Rolls-Royce, Ltd, Derby, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-66* 10 p 5 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Ministry of Defence (Procurement Executive)

The continuing emphasis over the past few years on the development of lower sfc, long on wing life and low emission engines for commercial transportation has put a premium on combustor liner cooling techniques employing less cooling flow Rolls-Royce pioneered the fully machined ring and impingement cooling concepts which formed the basis for the RB211 combustor design Further improvement of the impingement cooling technique has led to the development of a laminated, pseudotranspiration material It exploits the high impingement heat transfer coefficients and provides an extended internal surface area for heat transfer Rolls-Royce has developed this material primarily for combustor applications A major milestone has now been achieved with the certification by the CAA of a Spey combustor variant incorporating this material for limited release for commercial operations These combustors are now entering service in the BAe1 11 with a number of UK airlines (Author)

**A80-42199 \* #** Low NO<sub>x</sub>/ heavy fuel combustor program E Lister (US Department of Energy, Germantown, Md), R W Niedzwiecki, and L Nichols (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-69* 10 p Members, \$1 50, nonmembers, \$3 00

The paper deals with the 'Low NO<sub>x</sub>/ Heavy Fuel Combustor Program' Main program objectives are to generate and demonstrate the technology required to develop durable gas turbine combustors for utility and industrial applications, which are capable of sustained, environmentally acceptable operation with minimally processed petroleum residual fuels The program will focus on 'dry' reductions of oxides of nitrogen (NO<sub>x</sub>), improved combustor durability and satisfactory combustion of minimally processed petroleum residual fuels Other technology advancements sought include fuel flexibility for operation with petroleum distillates, blends of petroleum

## A80-42200

distillates and residual fuels, and synfuels (fuel oils derived from coal or shale), acceptable exhaust emissions of carbon monoxide, unburned hydrocarbons, sulfur oxides and smoke, and retrofit capability to existing engines (Author)

**A80-42200 # Fuel character effects on J79 and F101 engine combustor emissions** C C Gleason (General Electric Aircraft Engine Group, Cincinnati, Ohio) and J A Martone (USAF, Engineering and Services Center, Tyndall AFB, Fla) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-70* 8 p 12 refs Members, \$1 50, nonmembers, \$3 00 USAF supported research

Results of a program to determine the effects of fuel properties on the pollutant emissions of two U S Air Force aircraft gas turbine engines are presented Thirteen test fuels, including baseline JP-4 and JP-8, were evaluated in a cannular (J79) and a full annular (F101) combustor The principal fuel variables were hydrogen content, aromatic structure, volatility, and distillation end point Data analysis shows that fuel hydrogen content is a key fuel property, particularly with respect to high power emissions (oxides of nitrogen and smoke), and that low power emissions (carbon monoxide and hydrocarbons) are more dependent on fuel atomization and evaporation characteristics (Author)

**A80-42201 # Probe effects in gas turbine combustor emission measurements** J A Clark and A M Mellor (Purdue University, West Lafayette, Ind) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-71* 7 p 12 refs Members, \$1 50, nonmembers, \$3 00 Contract No F33613-77 C-2069

Four geometrically distinct, stainless steel probes are used to study the concentrations of CO, HC, NO, and NO<sub>x</sub> at several different radial and two different axial positions within a simplified gas turbine combustor The probes are all water cooled but do not employ an aerodynamic quench They are designed to assess the effect of tip shape, tip to body proximity (for right angle configurations), and probe entry point into the flowfield on measured pollutant concentrations Though probe entry point and tip to body proximity are shown to imperceptibly affect the pollutant concentrations, probe tip geometry has a marked impact on the measured pollutant levels Specifically, the tapered-tip probe yields depressed CO and HC, and elevated NO concentrations compared to the other three blunt-tipped probes Regarding reproducibility, the pollutant concentrations measured with one of the blunt tipped probes in this study are compared to pollutant levels measured with the same probe three years ago (Tuttle et al, 1976) (Author)

**A80-42203 # Some aspects on increasing gas turbine combustor exit temperature** B G A Sjoblom (Volvo Flygmotor AB, Trollhattan, Sweden) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-73* 7 p 9 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Styrelsen for Teknisk Utveckling and Swedish Air Material Department

A high turbine inlet temperature promotes the gas turbine overall cycle efficiency Problems arising in the combustion system when increasing the temperature are discussed A high exit temperature aircraft gas turbine combustor was designed by deleting the dilution air in a double recirculation zone combustor Rig tests were carried out and comparisons were made with a reference combustor of conventional design It was found that the overall fuel-air ratio could be increased from 0 0182 to 0 0315 without impairing the emission characteristics or the combustion efficiency at any power setting The exit temperature pattern factor was improved by providing a proper fuel and air mixing (Author)

**A80-42205 # A review of current methods and problems in making gas path measurements in aircraft gas turbine engines** W G Alwang (United Technologies Corp, Commercial Products Div, East Hartford, Conn) *American Society of Mechanical Engineers, Gas*

*Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-75* 6 p 22 refs Members, \$1 50, nonmembers, \$3 00

The gas path of an aircraft gas turbine engine presents some unique measurement problems As part of the development of an engine, it is necessary to verify all of the critical design parameters such as air and metal temperature, dynamic and steady state stresses, pressure distributions and air flow in order to accurately interpret engine performance and endurance tests Although a great deal can be accomplished within the current state-of-the-art, some very significant gaps remain in the needed measurement technology, particularly in the hottest sections of the engine New sensors and measuring techniques are currently under development which promise to overcome many of the current problems (Author)

**A80-42212 # Gas turbine engine emissions measurement technology - An overview** N T Campbell, V A Zaccardi (United Technologies Corp, Commercial Products Div, East Hartford, Conn), and R H Groth *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-86* 7 p 14 refs Members, \$1 50, nonmembers, \$3 00

Current technology and practices at Pratt and Whitney Aircraft Group, Commercial Products Division, for monitoring gas turbine engine emissions as a function of engine operating parameters, fuels, and environmental factors are discussed from sampling procedures through final data reduction Mobile laboratories and fixed systems are used to rapidly measure smoke, hydrocarbons, oxygen, oxides of nitrogen, water, carbon monoxide and carbon dioxide content Calibration gases, traceable to the National Bureau of Standards (NBS), are provided by an in-house calibration laboratory The data collected are fed into a computer to calculate emission factors, concentration levels, and when requested, gas temperature from the measured emissions Problem areas, including an overall assessment of measurement accuracy, are discussed (Author)

**A80-42213 # Demonstration of a unified approach to the balancing of flexible rotors** M S Darlow, A J Smalley (Mechanical Technology, Inc, Latham, N Y), and A G Parkinson (University College, London, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-87* 7 p 12 refs Members, \$1 50, nonmembers, \$3 00

A flexible rotor balancing procedure, which incorporates the advantages and eliminates the disadvantages of the modal and influence coefficient procedures, has been developed and implemented This new procedure, referred to as the Unified Balancing Approach, has been demonstrated on a supercritical power transmission shaft test rig The test rig was successfully balanced through four flexural critical speeds with a substantial reduction in effort as compared with the effort required in modal and influence coefficient balancing procedures A brief discussion of the Unified Balancing Approach and its relationship to the modal and influence coefficient methods is presented A series of tests which were performed to evaluate the effectiveness of various balancing techniques are described The results of the Unified Balancing Approach tests are presented and discussed These results confirm the superiority of this balancing procedure for the supercritical shaft test rig in particular and for multiple-mode balancing in general (Author)

**A80-42214 # Influence of acceleration on the critical speed of a Jeffcott rotor** H L Hassenpflug, R D Flack, and E J Gunter (Virginia University, Charlottesville, Va) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-88* 6 p 5 refs Members, \$1 50, nonmembers, \$3 00 Research sponsored by the University of Virginia, Contract No DE-AC01-79ET 13151

The effects of angular acceleration on a Jeffcott rotor have been examined both theoretically and experimentally The equations of motion were solved via numerical integration The rotor's response to unbalance was predicted for a number of cases of acceleration and

damping Both amplitude and phase responses were studied In addition, techniques were developed for identifying system damping from data taken during accelerated runs The results of the analysis indicate that for high acceleration rates the amplitude response at the critical speed may be reduced by a factor of four or more The speed at which the peak response occurs can also be shifted by 20 percent or more Experimentally, a small lightly damped rotor ( $\zeta = 0.0088$ ) was run for several acceleration rates The peak responses typically agree within six percent of theoretical predictions Also, a beat frequency was observed both theoretically and experimentally after the rotor had passed through the critical speed (Author)

**A80-42216 #** Some effects of using water as a test fluid in fuel nozzle spray analysis H C Simmons and C F Harding (Parker Hannifin Corp., Gas Turbine Fuel Systems Div., Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-90* 6 p Members, \$1 50, nonmembers, \$3 00

A systematic investigation was made of the differences in atomizing performance between water and kerosene fuel for six simplex fuel nozzles of small flow capacity A large number of tests was run using two methods of spray analysis, to determine the effect of nozzle liquid pressure drop on Sauter Mean Diameter (SMD) It was found that there is a clearly defined relationship dependent on both the relative values of surface tension and also on a Weber Number calculated for conditions in the liquid film at the nozzle discharge orifice It is concluded that large errors in estimating SMD for modeling programs are possible if results observed with water are assumed to be representative of behavior with kerosene fuel

(Author)

**A80-42217 #** Interferometric measurements in a turbine cascade using image-plane holography P J Bryanston-Cross, T Lang (Rolls-Royce, Ltd., Advanced Research Laboratories, Derby, England), M L G Oldfield, and R J G Norton (Oxford University, Oxford, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-91* 7 p 13 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Ministry of Defence (Procurement Executive)

A holographic technique used to produce image plane interferograms with white light reconstruction is described This was used to study the transonic flow in a passage of a turbine stator cascade at a typical Reynolds number, Mach number, and free stream to blade surface temperature ratio Both absolute holographic interferograms (fringes of constant flow density) and differential holographic interferograms (changes of density in 100 microsecs) are presented showing fine details in the boundary layer flow, trailing edge shocks, and wake structure By counting the fringes on the interferograms, the free stream and surface Mach numbers and boundary layer temperature gradients can be determined (Author)

**A80-42234 #** Engine condition monitoring using fiberoptic probes R M McCord (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-118* 3 p Members, \$1 50, nonmembers, \$3 00

With the advent of US military aviation changing from the fixed-cycle inspection concept to the On-Condition Maintenance (OCM) concept, it has become readily apparent to the aircraft maintenance people that their existing inspection methods and diagnostic tools are not adequate to keep pace with the new concept Some of those components which required removal and disassembly to facilitate inspection should now be inspected on-the-wing to maintain the inspection flow time Some means of gaining visual access to those components is required A method has been developed to inspect the gas path of a turbine engine with sufficient accuracy to provide the user with the decisive information on whether to continue the engine in service or remove it for repair The genesis of using controlled light and vision for engine internal

inspection is presented and progress from the early days on the flightline to the future is discussed (Author)

**A80-42235 #** Software for flight critical digital engine controls E S Eccles (Smiths Industries, Ltd., Basingstoke, Hants, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-119* 8 p Members, \$1 50, nonmembers, \$3 00

A flight-critical engine control is any engine control system which has the authority to cause large thrust excursions or which can cause engine shut-down in flight Large negative thrust excursions can clearly hazard an aircraft during critical maneuvers of takeoff and approach, or at any other times when the aircraft is operating at low altitude, while uncontrolled positive thrust excursions can lead to structural failure in the engine at any point in the flight The paper reviews the basic issues in achieving software safety in a digital engine control of a level required for certification and discusses the effects of these issues Particular attention is given to specification, design validation and test procedures throughout the life of a given set of control software S D

**A80-42237 #** Digital controls for helicopter engines E S Eccles (Smiths Industries, Ltd., Basingstoke, Hants, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-121* 6 p 6 refs Members, \$1 50, nonmembers, \$3 00

The paper describes a digital electronic engine control system being built by Dowty and Smiths Industries Controls Limited (DSIC) to demonstrate the control features required for the next generation of helicopters and their power plants It is engine mounted, fuel cooled and of lightweight design The paper describes the mechanical design, the installation and the cooling of the system including the choice of the basic packaging concept It also discusses the safety of flight aspects of system operation Finally, the paper discusses how the design can be modulated to increase/reduce the capability of the system and thus, the more effectively to cover a range of requirements (Author)

**A80-42238 #** Digital control for V/STOL powerplants E S Eccles (Smiths Industries, Ltd., Basingstoke, Hants, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-122* 7 p 8 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the UK Ministry of Defence of England

The paper describes the evolution of a digital control approach to the Pegasus engine as applied to a single engine VTOL aircraft The design is based on extensive engine evaluation of different control configuration with electronic and hydromechanical back up system The paper describes the mechanical design, installation on the engine and the cooling of the system including the choice of basic packaging concept It also discusses the rationale for the particular choice of back-up system and the reliability/safety of flight trade-offs involved (Author)

**A80-42246 #** Non-axisymmetric blade row interaction in axial turbomachines N A Mitchell (Cambridge University, Cambridge, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 10-13, 1980, Paper 80-GT-133* 12 p 10 refs Members, \$1 50, nonmembers, \$3 00

A three-dimensional non-axisymmetric theory is presented to analyze the interaction effects due to wakes between two blade rows in an axial turbomachine The relative importance of potential and wake interaction with varying row separations and the contribution to the flow of shed radial and shed streamwise vorticity from the first row are examined Numerical calculations of turbine and compressor stages are presented to illustrate the theory (Author)

**A80-42247 #** The effect of the axial velocity density ratio on the aerodynamic coefficients of compressor cascades J Starke (Braunschweig, Technische Universität, Braunschweig, West Ger-

many) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-134* 14 p 32 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Deutsche Forschungsgemeinschaft

The aerodynamic coefficients of compressor blade sections in two-dimensional flow can easily and very accurately be determined by use of the well-known Lieblein correlations Very often the flow across the compressor blade sections is quasi-two-dimensional with the axial velocity density ratio (AVDR) differing from unity To establish simple correlations for this type of flow as well, the AVDR effect on the aerodynamic coefficients of compressor cascades is theoretically and experimentally investigated This results in simple but accurate formulas for the calculation of the AVDR effect on the turning angle, the reference minimum-loss inlet angle, and the losses in terms of the wake momentum thickness and the diffusion ratio

(Author)

**A80-42249 # The hybrid diffuser** R C Adkins (Cranfield Institute of Technology, Cranfield, Beds, England), D S Matharu, and J O Yost (Rolls-Royce, Ltd, Aero Div, Filton, Bristol, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-136* 11 p 5 refs Members, \$1 50, nonmembers, \$3 00 Research sponsored by the Cranfield Institute of Technology and Rolls-Royce, Ltd

A highly efficient but relatively short length diffuser is described It can produce high levels of pressure recovery, both with and without external suction being applied Emphasis is placed on pressure losses experienced by a bleed air and on a flow mechanism

V T

**A80-42250 # Boundary layer studies on highly loaded cascades using heated thin films and a traversing probe** M L G Oldfield (Oxford University, Oxford, England), R Kiock (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany), A T Holmes, and C G Graham (Rolls Royce, Ltd, Aero Div, Bristol, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-137* 13 p 18 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Ministry of Defence (Procurement Executive)

In the continuing quest for increased turbine efficiency, the part played by blade profile shape remains crucial Three turbine vanes with successively increased aerodynamic loading were tested in the High Speed Cascade Wind Tunnel at DF-VLR Braunschweig In addition to wake traverses, measurements of the boundary layer behavior were made These consisted of (1) use of a constant temperature anemometer to measure the fluctuating heat transfer rate on an array of thin film platinum thermometers deposited on the vanes and (2) a flattened, traversing pitot probe held against the vane surface Transition measured by these techniques is described

(Author)

**A80-42251 # The combined effect of axial velocity density ratio and aspect ratio on compressor cascade performance** U Stark (Braunschweig, Technische Universität, Braunschweig, West Germany) and H Hoheisel (Deutsche Forschungs und Versuchsanstalt für Luft- und Raumfahrt, Institut für Entwurfs-Aerodynamik, Braunschweig, West Germany) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-138* 13 p 21 refs Members, \$1 50, nonmembers, \$3 00 Research supported by the Deutsche Forschungsgemeinschaft

The paper describes theoretical and experimental investigations on the combined effect of axial velocity density ratio (AVDR) and aspect ratio (AR) on compressor cascade performance in incompressible and compressible flow The results presented demonstrate that it is the aspect ratio that defines the axial velocity distribution through the cascade at a given wall shape and contraction ratio It is further shown that it is, in turn, the axial velocity distribution that decisively determines the local values of pressure distributions as well as the

cascade overall parameters like turning angles and loss coefficients

(Author)

**A80-42252 # On the pressure losses due to the tip clearance of centrifugal blowers** M Ishida (Nagasaki University, Nagasaki, Japan) and Y Senoo (Kyushu University, Fukuoka, Japan) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-139* 9 p 10 refs Members, \$1 50, nonmembers, \$3 00

The pressure distribution along the shroud is measured for three types of centrifugal impeller at seven different values of tip clearance each The change of input power due to a change of tip clearance is related to the effective blockage at the impeller tip Since the change of input power is little for the test cases, the variation of local pressure gradient along the shroud is mostly attributed to the change of local pressure loss The local pressure loss is related to the local tip clearance ratio and to the local pressure gradient based on the deceleration of relative velocity in the impeller Since the local pressure gradient is largest near the throat of impeller is used as the representative value The tip clearance loss is related to the clearance ratio and the pressure rise based on the deceleration of relative velocity in the impeller A good correlation is observed in all cases at various flow rate

(Author)

**A80-42253 # Vorticity modelling of blade wakes behind isolated annular blade-rows - Induced disturbances in swirling flows** C S Tan (MIT, Cambridge, Mass) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10 13, 1980, Paper 80-GT 140* 15 p 26 refs Members, \$1 50, nonmembers, \$3 00 Contract No F49620-78-C-0084

A general analysis is proposed for studying the fluid mechanical behavior of blade wakes from an annular blade-row in highly swirling flow The coupling between the centrifugal force and the vorticity, which is inherent to highly swirling flows, can significantly modify the wake behavior from that in a two dimensional situation In steady flow, theoretical considerations show that a blade wake consists primarily of two distinct types of vorticity (1) trailing vorticity shed from the blade due to a spanwise variation in blade circulation, and (2) vorticity associated with defects in stagnation pressure (or rotary stagnation in relative coordinate system) Three types of disturbances can be identified in the resulting three-dimensional disturbance field (1) the exponentially decaying type (potential, irrotational), (2) the purely convected type (rotational), and (3) the non-convected type (both rotational and irrotational parts)

(Author)

**A80-42254 Design study for a fuel efficient turbofan engine** R C Kingcombe and S W Dunning (National Gas Turbine Establishment, Farnborough, Hants, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-141* 9 p 8 refs Members, \$1 50, nonmembers, \$3 00

An engine design study is presented in which the target is a 15 percent reduction in installed specific fuel consumption over the large engines currently in service while still meeting anticipated noise and emissions regulations The fuel saving is achieved with a low specific thrust (bypass ratio 10) and a high overall cycle pressure ratio (42 at cruise) A three-shaft design is proposed, employing highly loaded components in order to reduce the number of turbomachinery stages and hence keep down cost and weight It is argued that this approach is the one most compatible with projected technological advances The engine configuration is given and the key features explained, highlighting areas where further research would be of particular advantage Finally, the predicted engine performance is given, together with an estimate of the savings in direct operating cost

(Author)

**A80-42255 \* # The Energy Efficient Engine /E3/ - Advancing the state of the art** W B Gardner and D E Gray (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hart-

ford, Conn) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-142* 11 p 7 refs Members, \$1 50, nonmembers, \$3 00 NASA-sponsored research

The NASA-sponsored Energy Efficient Engine (E3) Program, intended to develop and demonstrate the technology for reducing fuel consumption in future environmentally acceptable turbofan engines, is presented The development of the flight propulsion system design is outlined and the resulting preliminary design is presented Component design and subcomponent supporting technology verification work in progress is discussed, with attention given to fabrication development, the transition duct, mixer design, the fan, the high-pressure compressor, the combustor, and the high-pressure turbine It is noted that the detailed design of the core components is essentially complete and fabrication of the hardware has begun, with the program on schedule toward testing in 1982 A L W

**A80-42258 \* #** Results from tests on a high work transonic turbine for an energy efficient engine D E Crow, H Welna, I D Singer (United Technologies Corp, Pratt and Whitney Aircraft Group, East Hartford, Conn), and M R Vanco (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-146* 9 p Members, \$1 50, nonmembers, \$3 00 Contract No NAS3 20646

The experimental results of the evaluation of two high work, transonic, single-stage turbines investigated under the Energy Efficient Engine (E3) Program are presented The objective of the E3 program is to provide an advanced technology base for a new generation of fuel conservative turbofan engines A single stage turbine required fewer cooled airfoils, a reduced number of leakage paths and no interstage seals These advanced energy efficient engines require high engine pressure ratios resulting in high expansion ratio, transonic, turbine designs which must have high aerodynamic efficiency The goal of the turbine program is to develop a high pressure turbine that is compatible with the overall engine design and has an uncooled efficiency of 90 8 percent (Author)

**A80-42259 #** The determination of deviation angles at exit from the nozzles of an inward flow radial turbine F Fairbanks (Hatfield Polytechnic, Hatfield, Herts, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-147* 7 p 9 refs Members, \$1 50, nonmembers, \$3 00

A method for predicting the deviation angle at exit from the nozzles of an inward flow radial turbine using a streamline curvature method is given Measurements of flow angles and stagnation and static pressures across the nozzle exit span of a small turbine have been made The accuracy of the analysis is shown by comparison with experimental results Finally, the developed theory has been used to show the possible effect on the deviation angle at exit from the nozzles of reducing the number of stator blades (Author)

**A80-42260 #** An investigation of vane-island diffusers at high swirl M A Rayan and T T Yang (Clemson University, Clemson, S C) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-148* 5 p 8 refs Members, \$1 50 nonmembers, \$3 00

The results of an experimental investigation of the performance of vane island diffusers at high swirl ( $\lambda = 10$ ) are presented in this paper Five different sets of vane-island designs and their corresponding performance are reported, and this study indicates that the performance of the vane-island diffuser depends to a significant degree on the mechanism of flow at the impeller exit The investigation also shows that the radial distance from the vane leading edge to the impeller exit is one important factor in diffuser effectiveness The lowest loss coefficient obtained was achieved when the vane-island leading edge was at a radius approximately equal to 1 2 times the diffuser inlet radius, and with the ratio of diffuser exit area to impeller exit area approximately equal to 1 (Author)

**A80-42264 #** Development and field experience of a new 29000 HP gas turbine J K Hubbard and C Austin (Dresser Industries, Inc, Olean, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-152* 8 p Members, \$1 50, nonmembers, \$3 00

**A80-42266 #** Blade tip and knife edge rub testing of FELTMETAL seals R P Tolokan, A R Erickson (Brunswick Corp, DeLand, Fla), and R T Frank (United States Crane, Certification Bureau, Orlando, Fla) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-154* 7 p Members, \$1 50, nonmembers, \$3 00

A rub test program was conducted using Brunswick's high speed rub rig to determine the independent effect of density and tensile strength on the abrasibility of FELTMETAL seal material and to determine the optimum parameters for specific seal products A series of 29 tests, 0 020 in deep (0 5 mm) 360-deg rubs, were conducted on the inner air seal (knife edge) configuration with Hastelloy X and Haynes 188 seal material Fifteen tests were conducted on the outer air seal (blade tip) configuration with seal materials of the same alloys The program demonstrated that ultimate tensile strength rather than density is the predominant factor in determining abrasibility for the fiber metal system Maximum tensile strengths were reduced and tighter density and tensile ranges were specified for four FELTMETAL seal products to provide acceptable abrasibility for 360 deg rubs while maintaining erosion resistance (Author)

**A80-42267 #** High-temperature, coal-fired combustor with ceramic heat exchangers for CCGT systems H W Carpenter, J Campbell, Jr, L H Russell, and D E Wright (Rockwell International Corp, Rocketdyne Div, Canoga Park, Calif) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-155* 6 p Members, \$1 50, nonmembers, \$3 00 Contract No EF 77-C-01-2612

High temperature, coal fired combustors with ceramic heat exchangers were designed for CCGT systems The objective in evaluating CCGT systems is to convert U S coal to electricity with higher efficiency Higher temperatures are required to accomplish this goal and ceramic heat exchanger surfaces allow the use of working fluid temperatures to 2500 F and higher The results of a comprehensive government study are described in which an atmospheric fluidized bed and cyclone fired combustor/heat exchanger were designed for operation at 1750 and 2250 F (Author)

**A80-42268 #** Cycle optimization for a 10,000 SHP high efficiency gas turbine system R Hendriks (Thomassen Holland, Netherlands) and P Levine (Fern Engineering Co, Bourne, Mass) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-157* 5 p 8 refs Members, \$1 50, nonmembers, \$3 00

A new gas turbine system is under development by Thomassen Holland b v and Fern Engineering The machine features a two-stage inter-cooled centrifugal compressor, a regenerator and an annular combustor Prototype units will be operating in 1982 Cycle optimization results are presented which lead to the selection of a rotor inlet temperature of 2042 F, an overall compression ratio of 9 5 and a thermal efficiency of 44 percent (Author)

**A80-42270 #** Preliminary evaluation of coal-fired fluid bed combustion-augmented compressed air energy storage power plants R D Lessard, A J Giramonti (United Technologies Research Center, East Hartford, Conn), and D Merrick (Coal Processing Consultants, Ltd, Harrow, Middx, England) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-160* 8 p 9 refs Members, \$1 50, nonmembers, \$3 00



This paper presents highlights of an ongoing study program to assess the technical and economic feasibility of advanced concepts for generating peak load electric power from a compressed air energy storage (CAES) power plant incorporating a coal-fired fluid bed combustor (FBC). It reviews the analyses performed to select an FBC/CAES power plant system configuration for the subsequent conceptual design phase of the study. Included in this review are the design and operating considerations involved with integrating either an atmospheric or a pressurized fluid bed combustor with a CAES system to yield practical system configurations, the integration of system configurations, the parametric performance of these system configurations, and the preliminary screening which considered performance, cost, and technical risk and led to the identification of an open-bed PFBC/CAES system as having the greatest near-term commercialization potential (Author)

**A80-42274 # Turbopropulsion combustion - Research needs** A M Mellor, P A Leonard (Purdue University, West Lafayette, Ind), and R E Henderson (USAF, Aero Propulsion Laboratory, Wright Patterson AFB, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-164* 6 p 11 refs Members, \$1 50, nonmembers, \$3 00 Contract No F33615 77-C-2069

A near term, applied research program in turbopropulsion combustion, sponsored primarily by the Air Force and the Naval Air Propulsion Center, is described in general terms with several areas of more fundamental supporting research also discussed. In the former, the approach is to develop more systematic design information which can be applied to both combustors and afterburners, and to involve computer models only in nonreacting flows at the present time. Strain and creep data, and a better fatigue model are required and advances in coating or bonding technology as well as in high temperature, oxidation resistant materials are needed. S D

**A80-42275 # The effect of aerodynamic phase lag on the twin vibration mode model of aeroengine fan flutter** R A J Ford (New South Wales, University, Kensington, Australia) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-166* 8 p 5 refs Members, \$1 50, nonmembers, \$3 00

An earlier paper analyzed aeroengine fan flutter in terms of twin orthogonal vibration modes in the fan. This paper extends the analysis by incorporating variable aerodynamic phase lags between a blade motion and the resulting aerodynamic forces. The extended analysis predicts two independent kinds of flutter. If the total damping within each mode is negative, each mode develops a self-sustaining vibration at its own natural frequency. This was not predicted by the earlier twin mode analysis. Even when the damping in each mode is positive an interaction between the modes can cause flutter under some conditions. This behavior is basically of the form described in the earlier paper, but there are significant detailed changes when variable aerodynamic phase lags are introduced (Author)

**A80-42276 # Redesign of structural vibration modes by finite-element inverse perturbation** K A Stetson and I R Harrison (United Technologies Research Center, East Hartford, Conn) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-167* 9 p Members, \$1 50, nonmembers, \$3 00

A previously developed technique for redesigning the vibrational properties of structures, by inverting the first-order perturbation analysis of the equations of motion, has been applied to a NASTRAN finite element analysis for plates and shells. The program finds the minimal changes to the thicknesses of the plate elements necessary to effect a given set of changes in the modal frequencies and shapes. Results have been obtained for a flat cantilever plate, a cantilever segment of a cylinder, and for a compressor blade for a jet engine (Author)

**A80-42277 # Blade excitation by elliptical whirling in viscous-damped jet engines** N Klompas (General Electric Co., Gas Turbine Div., Schenectady, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-168* 7 p 5 refs Members, \$1 50, nonmembers, \$3 00

An extension of the author's earlier method of analyzing multishaft jet engine dynamics accounting for flexibility of bladed disks is outlined to calculate the first whirl harmonic for given nonlinear characteristics of squeeze-film dampers. A second whirl harmonic, of which experimental verification is found in Campbell's paper of 1924, is shown induced by orbit ellipticity. The possibility that this harmonic, especially due to backward whirling, may be a source of blade excitation at higher frequencies than currently recognized from linear analysis is discussed by relating some engine experience (Author)

**A80-42279 # Thermodynamics of heavy fuels operation in gas turbine** R E Pavri and J M Hill (General Electric Co., Gas Turbine Div., Schenectady, N Y) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-171* 8 p Members, \$1 50, nonmembers, \$3 00

This paper discusses the effects of deposition on a gas turbine performance when operating on ash forming fuels. Parameters affected by ash deposits which cause turbine efficiency degradation are presented. Thermodynamic relationship between turbine nozzle flow area reduction, efficiency loss and firing temperature variation on two different methods of firing temperature control are derived (Author)

**A80-42280 # Heat transfer phenomena in gas turbines** J R Taylor (United Technologies Corp., Commercial Products Div., East Hartford, Conn) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-172* 12 p 73 refs Members, \$1 50, nonmembers, \$3 00

A discussion of the problems encountered in prediction of heat transfer in the turbine section of a gas turbine engine is presented. Areas of current concern to designers where knowledge is deficient or lacking are elucidated. Consideration is given to methods and problems associated with determination of heat transfer coefficients, external gas temperatures, and, where applicable, film cooling effectiveness. The paper is divided into parts dealing with turbine airfoil heat transfer, endwall heat transfer, and heat transfer in the internal cavities of cooled turbine blades. Recent literature dealing with these topics is listed (Author)

**A80-42283 # Future trends in subsonic transport energy efficient turbofan engines** R P Johnston and P Ortiz (General Electric Co., Cincinnati, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-177* 10 p 7 refs Members, \$1 50, nonmembers, \$3 00

Details of the NASA sponsored General Electric Energy Efficient Engine technology program are presented along with a description of the engine, cycle and aircraft system benefits. Opportunities for further performance improvement beyond this program are examined. Studies leading to the selection of the engine cycle and configuration are summarized. The advanced technology features, cycle and component performance levels are also presented. An evaluation of the benefits of the fully developed Flight Propulsion System (FPS) is made relative to the NASA program goals by comparing the FPS with the CF6-50C where both are installed in advanced subsonic transport aircraft. Results indicate that a mission fuel saving from 15 to 23 percent is possible depending on mission length (Author)

**A80-42284 \* #** CF6 fan performance improvement R F Patt (General Electric Co, Evandale, Ohio) and D C Reemsnyder (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-178* 11 p Members, \$1 50, nonmembers, \$3 00

A significant portion of the NASA-sponsored Performance Improvement Program for the CF6 engine was the development of an improved fan concept This involved aerodynamic redesign of the CF6 fan blade to increase fan efficiency while retaining the mechanical integrity, operability, and acoustic characteristics of the existing blade A further improvement in performance was obtained by adding a fan case stiffener ring to decouple blade case vibrational characteristics, permitting a significant reduction in running tip clearance Engine testing was performed to establish the performance, mechanical and acoustic properties of the new design relative to the current fan, and to establish power management characteristics for the CF6-50C2/E2 engine A significant improvement in cruise power SFC of 1 8 percent was demonstrated in Sea Level testing projected to altitude flight conditions (Author)

**A80-42285 #** Experience in extending the life of gas turbine blades J Liburdy and J O Stephens *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-181* 10 p Members, \$1 50, nonmembers, \$3 00

This paper presents the effects of deterioration of gas turbine blade life with prolonged service exposure This deterioration is primarily due to internal microstructural changes and the formation of creep voids or cavitation Methods of evaluating residual blade life or life trend curves are presented along with a documentation of the creep damage observed The extension of blade life by Hot isostatic pressing versus reheat treatment is discussed and data is presented to show that complete recovery of properties can be achieved even after the material has suffered extensive internal creep damage As a result, the time between overhauls for blades can be significantly extended, and the need for replacement blades can be minimized (Author)

**A80-42286 #** Analysis of rotating stall in vaneless diffusers of centrifugal compressors A N Abdelhamid (Carleton University, Ottawa, Canada) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 10-13, 1980, Paper 80-GT-184* 8 p 8 refs Members, \$1 50, nonmembers, \$3 00 National Research Council of Canada Grant No A-7429

Self-excited flow oscillations in radial vaneless diffusers of centrifugal compressors are investigated analytically using the linearized equations of motion for unsteady flows Solutions of the differential equations are made to satisfy boundary conditions at diffuser inlet and exit which in typical conversion systems represent the coupling between the diffuser and upstream and downstream components The results indicate that the rotational speed of the stall pattern is dependent on the diffuser radius ratio and the coupling conditions between the impeller and the diffuser It is shown that the dependence of the onset of the flow oscillations on the diffuser radius ratio is strong if the conditions at diffuser inlet are such that low speed rotating stall patterns are generated in the diffuser Onset of high speed rotating stall patterns is more affected by the coupling conditions between the impeller and the diffuser than by the diffuser radius ratio (Author)

**A80-42342 #** Synthesis of piloting properties of training simulators with allowance for the human factor (Sintez pilotazhnykh svoystv trenazherov s uchetom chelovecheskogo faktora) N A Kirsenko (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) *Kibernetika i Vychislitel'naya Tekhnika*, no 46, 1979, p 16-21 In Russian

A method for the structural synthesis of training simulators with an immobile cabin is presented, the synthesis is based on the condition of similarity of the piloting properties of the simulator to

the piloting properties of an aircraft in the absence of noninstrumental acceleration information A design example of the proposed method is presented, and its efficiency is evaluated B J

**A80-42348 #** Theoretical-experimental synthesis of a multicriterial ergatic control system (Teoretiko-eksperimental'nyi sintez mnogokriterial'noi ergaticheskoi sistemy upravleniia) A N Voronin, V V Pavlov, E I Pavliuk, V D Siabro, and V A Shmat (Akademiia Nauk Ukrainskoi SSR, Institut Kibernetiki, Kiev, Ukrainian SSR) *Kibernetika i Vychislitel'naya Tekhnika*, no 46, 1979, p 53-58 10 refs In Russian

A method has been developed for the synthesis of the performance criterion of an ergatic control system, its application to the parametric optimization of a man-machine control system is discussed The particular example of the synthesis of a system for the longitudinal-motion control of an aircraft during glide is discussed B J

**A80-42350 #** Some problems involving the assurance of the controllability of an aircraft in the control-wheel regime (Nekotorye zadachi bezopasnosti upravliaemosti vozdušnogo korablia v shturval'nom rezhime) L N Degtiarenko and V I Krivonozhkin (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) *Kibernetika i Vychislitel'naya Tekhnika*, no 46, 1979, p 82-84 In Russian

A learning theory approach is taken to the investigation of the limiting controllability of an aircraft in the control-wheel regime with emphasis on the role of the pilot Three problems of controllability are formulated with reference to the learning hypothesis B J

**A80-42353 #** New aircraft - Where are we heading in the 1980s and 1990s I S Macdonald (Air Canada, Montreal, Canada) *Aircraft Engineering*, vol 52, July 1980, p 13-17

Future improvements in aircraft and engine design with regard to fuel economy are surveyed Attention is given to high by-pass engines, supercritical airfoils, lightweight composites, and active controls which can provide an answer to span increases without the need for major wing redesign Digital electronic systems, colored CRTs and propulsion improvements are also discussed, and emphasis is placed on the costs and imminence of aircraft and equipment replacement J P B

**A80-42572** Automatic landing - Now a matter of course *Interavia*, vol 35, July 1980, p 583-586

The background of automatic landing is reviewed with emphasis on British Airways (particularly Trident aircraft) experience Consideration is given to the following issues related to the implementation of automatic landing systems fully integrated design, system integrity, ground operations, and the need for Category III B J

**A80-42573** MLS - User commitment is needed now M F Whitney *Interavia*, vol 35, July 1980, p 587-590

Consideration is given to the origin of MLS, ILS limitations, MLS benefits, and possible problems with the introduction of MLS It is argued that all segments of the aviation community must now join in a commitment to proceed with MLS with the full enterprise and determination which will be needed to overcome the inevitable problems during the initial period of operation, when the benefits will be necessarily restricted It is suggested that a forum of users and providers of landing guidance is essential to capitalize on the initiative which has been taken by ICAO and the investment which has been made B J

**A80-42574** Britain's new air traffic control radar network W C Stokhof and P Garside (Hollandse Signaalapparaten, Hengelo, Netherlands) *Interavia*, vol 35, July 1980, p 631-633

The system which recently won the UK CAA contract for a new long-range radar network is described The system consists of the

## A80-42575

AEG-Telefunken SRE-M5 antenna, and transmitter, receiver, and signal processing equipment from Hollandse Signalapparaten It should meet UK CAA requirements for a radar network that would operate from the 1980s to the year 2000 B J

**A80-42575** Sixteen years of Mach 3 flight B R Rich (Lockheed-California Co., Burbank, Calif.) *Interavia*, vol 35, July 1980, p 636, 637

Experience, dating back to the early 1960s, with the high-supersonic, high-altitude operations of the YF-12/SR-71 Blackbird aircraft is reviewed. Future prospects for the development of SST aircraft in the United States are also considered, problems of Mach 3 flight are discussed. B J

**A80-42576 #** Applied aerodynamics of helicopters (Prakticheskaia aerodinamika vertoletov) V F Romasevich and G A Samoïlov Moscow, Voenizdat, 1980 384 p 22 refs. In Russian

Some aspects of helicopter flight dynamics and aerodynamics are examined in the light of actual helicopter behavior under various normal and critical flight conditions. Characteristic pilot errors are discussed, and guidelines for helicopter pilots are given for a range of flight conditions. Particular attention is given to the basic characteristics of helicopter flight, some specific phenomena of flight dynamics and aerodynamics, and to the physical nature of helicopter flight limitations. V P

**A80-42659 \*** Meteorological and air pollution modeling for an urban airport P R Swan (NASA, Ames Research Center, Moffett Field, Calif.) and I Y Lee (San Jose State University, San Jose, Calif.) *Journal of Applied Meteorology*, vol 19, May 1980, p 534-544 7 refs

Results are presented of numerical experiments modeling meteorology, multiple pollutant sources, and nonlinear photochemical reactions for the case of an airport in a large urban area with complex terrain. A planetary boundary-layer model which predicts the mixing depth and generates wind, moisture, and temperature fields was used, it utilizes only surface and synoptic boundary conditions as input data. A version of the Hecht Seinfeld-Dodge chemical kinetics model is integrated with a new, rapid numerical technique, both the San Francisco Bay Area Air Quality Management District source inventory and the San Jose Airport aircraft inventory are utilized. The air quality model results are presented in contour plots, the combined results illustrate that the highly nonlinear interactions which are present require that the chemistry and meteorology be considered simultaneously to make a valid assessment of the effects of individual sources on regional air quality. A T

**A80-42798 #** The HUD optoelectronic projection indicator systems. I (Elektroniczno-optyczne systemy wskazania projekcyjnych HUD I) E Malinski (Instytut Lotnictwa, Warsaw, Poland) *Technika Lotnicza i Astronautyczna*, vol 35, June 1980, p 10-14 10 refs. In Polish

The paper deals with the design, development, and evolution of head-up displays for military aircraft. The advantages of HUD systems over conventional methods with respect to control of combat maneuvers, navigation, and flight control are noted. Design criteria and engineering solutions are reviewed. V P

**A80-42799 #** Analysis of the influence of the design parameters on the characteristics of an aircraft in spinning nose dive I (Analiza wpływu parametrów konstrukcyjnych na właściwości samolotu w korkociągu I) L Jarzebinski *Technika Lotnicza i Astronautyczna*, vol 35, June 1980, p 19-22. In Polish

**A80-42824** Back-door surveillant - Mark Three Nimrod heralds immense AEW boost *Air International*, vol 19, Aug 1980, p 59-63

The first of Nimrod AEW Mk 3s, designed as an efficient high-technology early warning system, is now commencing flight

tests to fulfill development work on performance and handling qualities, airframe systems operation, and testing of the high-capacity cooling system for the avionics. The Nimrod AEW Mk 3 airframe is a modification of that of Nimrod MR Mk 1, the Nimrod AEW Mk 3 retains the 12,160 lb Rolls Royce RB 168-20 Spey Mk 250 turbofans of the marine surveillance Nimrods and utilizes their fuel supply as a heat sink to cool the avionics systems. The AEW system is installed with the operators in the forward cabin, while the radar, IFF, and communications equipment are located towards the rear of the fuselage. The Nimrod AEW Mk 3 requires a tactical crew of six and a flight crew of four. Most of the early warning Nimrods will be committed to NATO as the UK's contribution to West European AEW coverage in lieu of its participation in the NATO E-3 Sentry program, and six Nimrod AEW Mk 3s will be able to cover the entire UK air defence region. V L

**A80-42825** Mikoyan Flogger *Air International*, vol 19, Aug 1980, p 70-75, 86, 87

A family of combat aircraft assigned the name of Flogger in the West now provides the backbone of Soviet TacAir and will fulfill the same role for all major WarPac air arms in the coming years. These aircraft featuring pilot-selected variable wing sweep with NASA-style outboard hinges have been conceived by the Mikoyan-Gurevich design bureau as a flexible combat aircraft combining increased warload and range performance with a field performance no more demanding than that of fighters of the preceding generation. Major design features and performance data are presented for MiG-23 MF Flogger-B optimized for air-air mission, MiG 27 Flogger-D, a dedicated ground-to-air aircraft, and other models of this family. V L

**A80-42831** Interferometer design and data handling in a high-vibration environment I - Interferometer design R P Walker and J D Rex (USAF, Geophysics Laboratory, Bedford, Mass.) In Multiplex and/or high-throughput spectroscopy, Proceedings of the Seminar, San Diego, Calif., August 27, 28, 1979. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p 88-91

An AFGL interferometer used in airborne work is described in terms of the mechanisms utilized to counteract the influences of the harsh aircraft cabin environment. The problems of vibration are dealt with by reliance upon a command voltage slaved balanced servo drive and Bendix Corp. Flexure Pivots for the moving mirror transport system. A piezoelectric crystal system maintains auto alignment of the stationary mirror thereby countering the warping effects that arise from aircraft cabin temperature fluctuations. The entire interferometer is further isolated from vibration by suspending it within an outer case on Aeroflex Corp. flexible cable mounts. The result is an instrument that delivers highly accurate and reliable data. (Author)

**A80-42832** Interferometer design and data handling in a high-vibration environment II - Data handling J H Schummers (USAF, Geophysics Laboratory, Bedford, Mass.) In Multiplex and/or high-throughput spectroscopy, Proceedings of the Seminar, San Diego, Calif., August 27, 28, 1979. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p 92-95. Research supported by the U S Defense Nuclear Agency and DARPA.

Procedures have been developed for data handling from interferometers used in the high vibration environment produced by an NKC-135 aircraft. These procedures will be described in this paper, covering the data recording, calibration, data processing, storage, and analysis procedures that have been developed and used at the Air Force Geophysics Laboratory. (Author)

**A80-42918 #** An experimental aircraft to test new technologies W Haberland *Dornier-Post* (English Edition), no 2, 1980, p 10-13

The Dornier TNT experimental aircraft designed for flight testing relevant key technologies for new General Aviation aircraft is described. Emphasis is placed on the design of a new-technology

wing (TNT) Following the presentation of the aircraft at the ILA'80, it was used for take-off and landing run measurements V T

**A80-42924 #** The status of theoretical methods for calculation of detached flows (Der Stand theoretischer Methoden zur Berechnung abgeloster Stromungen) P Sacher (Messerschmitt Bolkow Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft und Raumfahrt, Symposium, Munich, West Germany, Sept 19, 20, 1979, Paper 56* p 21 refs In German (MBB-FE122-S-PUB-12)

Current methods for calculating detached flows are surveyed. Models are presented which cover four areas: (1) potential theory, (2) boundary layer models, (3) empirical models and (4) Navier-Stokes solutions. It is shown that numerous methods have been developed that are applicable even under the stipulation that they are proven methods. Further, civil applications in the automotive field are also considered. Attention is given to industry methods for dealing with relevant problems in the areas of rockets, rotary wing aircraft and airplanes. Finally, a summary of especially important areas of further development is presented. M E P

**A80-42937 #** Experimental investigation of helicopter aerodynamics /2nd revised and enlarged edition/ (Eksperimental'nye issledovaniia po aerodinamike vertoleta /2nd revised and enlarged edition/) V F Antropov, G B Burakov, A S D'achenko, A K Martynov, P M Novoselov, A V Stepanov, and V R Lipatov. Moscow, Izdatel'stvo Mashinostroeniia, 1980. 240 p. In Russian.

The book deals with experimental methods and procedures for determining the aerodynamic characteristics of a helicopter and also of its rotor and other elements. Methods of determining the angular displacements of the rotor blade root and the elastic strains in blades by means of special sensors and strain gauges are examined, along with methods of measuring the aerodynamic loads on rotor blades and methods of determining the structure of flows about a helicopter model. V P

**A80-42964 #** Laminar boundary layer on swept wings of infinite span at an angle of attack (Laminarnyi pogranichnyi sloi na strelovidnykh kryl'akh beskonechnogo razmakha, obtekaemykh pod uglom ataki) I G Brykina, E A Gershbein, and S V Peigin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1980, p 27-39. 24 refs. In Russian.

In the present paper, the compressible boundary layer flow on swept wings of infinite span is studied for various angles of attack under the assumption of an impermeable or BLC wing surface. A first-approximation analytical solution is obtained (also for axisymmetric flow) by an integral method of successive approximations. Asymptotic solutions of the boundary layer equations are obtained for large values of the BLC parameter. V P

**A80-42965 #** Heat transfer at a breaking point of the leading edge of a plate in hypersonic flight (Teploobmen v okrestnosti tochki izloma perednei kromki plastiny pri giperzvukovom polete) G N Dudin and V Ia Neiland. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1980, p 40-45. 7 refs. In Russian.

The analysis deals with the three-dimensional viscous gas flow past a flat plate with salient point of the leading edge generatrix, in the presence of strong interaction between the boundary layer and the external hypersonic flow. A numerical solution of the problem is obtained. It is shown that intense self-induced secondary flows may arise at the salient point and that these induced flows may lead to local peaking of friction and heat fluxes. V P

**A80-42969 #** Investigation of flows in Laval nozzles at small Reynolds numbers (Issledovanie techenii v soplakh Lavalia pri nizkikh chislakh Reinal'dsa) V Ia Levin, V E Nigodiuk, U G Pirumov, O I Firsov, and S A Shustov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, May-June 1980, p 90-97. 11 refs. In Russian.

Rae's (1971) numerical method for calculating viscous low-density nozzle flows in the slender-channel approximation is applied to the numerical analysis of the local and integrated parameters of viscous gas flow in a Laval nozzle. The effectiveness of this approach is demonstrated by comparison with the experiment and calculations performed by other investigators. V P

**A80-43106 #** Automation of aircraft control under unsteady flight conditions (Avtomatizatsiia neustanovivshikhsia rezhimov poleta samoletov). E G Smenkovskii. Moscow, Izdatel'stvo Mashinostroeniia, 1980. 144 p. 21 refs. In Russian.

Some aspects of automating the control of a main liner in takeoff, landing, and aborted landing are examined. A method of 'refined linearization of nonlinearities' is proposed, using which a range of problems can be handled within the formalism of linear differential equations with constant coefficient, even in the case of heavy control loads. Attention is given to the characteristics of ground-based and onboard takeoff and landing aides and to decision making in landings under poor visibility conditions. V P

**A80-43107 #** Automation of air navigation and air traffic control (Avtomatizatsiia samoletovozhdeniia i upravleniia vozdukhnykh dvizheniem) P A Agadzhanov, V G Vorob'ev, A A Kuznetsov, and E D Markovich. Moscow, Izdatel'stvo Transport, 1980. 360 p. 38 refs. In Russian.

The book deals with the basic concepts of air navigation, theory of flight control, and principles of designing onboard piloting and navigation systems. Much attention is given to the organization, planning, and operation of air traffic control and to the automation of the acquisition, processing, and displaying of information on the air situation. Approaches to the automation of air traffic control, in particular at major airports, are examined. V P

**A80-43160** Development of corrosion-inhibited lubricants for gas turbine engines and helicopter transmissions. C Brown (U S Naval Material Command, David W Taylor Naval Ship Research and Development Center, Annapolis, Md) and F Feinberg (U S Naval Air Propulsion Test Center, Trenton, N J). *American Society of Lubrication Engineers, Annual Meeting, 35th, Anaheim, Calif, May 5-8, 1980, Preprint 80-AM 6C-3* 6 p.

In order to alleviate the problem of bearing corrosion in aircraft engines and gearboxes, a program to develop a corrosion-inhibited MIL-L-23699 lubricant was initiated. This program was designed to: (1) determine and evaluate the factors affecting corrosion inhibition of MIL-L-23699 lubricants, (2) determine the mechanism of this corrosion, (3) develop a laboratory test to simulate this corrosion, (4) conduct formulation studies and evaluations of potential corrosion inhibitors, (5) evaluate the roles of the chloride ion and oil decomposition products on corrosion and (6) complete the development of a corrosion-inhibited MIL-L-23699 lubricant. All program goals were achieved. Engine-performance verification of these lubricants is under way. (Author)

**A80-43166** Operation of an all-ceramic mainshaft roller bearing in a J-402 gas-turbine engine. G Hamburg (Teledyne CAE, Toledo, Ohio), P Cowley (Federal-Mogul Corp, Ann Arbor, Mich), and R Valori (U S Naval Air Propulsion Test Center, Trenton, N J). *American Society of Lubrication Engineers, Annual Meeting, 35th, Anaheim, Calif, May 5-8, 1980, Preprint 80-AM-3C-1* 7 p. 11 refs. Army-sponsored research, Contract No. N00140-76-C-1104.

The data presented in this paper are the result of the first installation and operation of a silicon nitride bearing in a mainshaft supporting position of a currently operational gas-turbine engine. The paper identifies some of the potential advantages of the use of ceramic bearings for certain gas-turbine applications, and also defines some of the limits, design constraints, and manufacturing criteria which must be considered in determining the effective use of this material for specific applications. (Author)

**A80-43178** Investigation of Air Force MIL-H-5606 hydraulic system malfunctions induced by chlorinated solvent contamination C E Snyder, Jr., G J Morris (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), L J Gschwender (Dayton, University, Dayton, Ohio), and W B Campbell (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *American Society of Lubrication Engineers, Annual Meeting, 35th, Anaheim, Calif., May 5-8, 1980, Preprint 80-AM-5C-2* 4 p

A field problem in the C-141 aircraft associated with hydraulic selector valve malfunctions in landing gear and door systems was attributed to corrosion of the valve spool and sleeve. This corrosion was caused by the presence of chlorine in the operational hydraulic fluid. The primary source of chlorine contamination was determined to be from residual chlorinated solvents used in maintenance procedures. This paper discusses (1) proof of chlorine involvement in the selector valve problem, (2) the prevalence of chlorinated solvent contamination in Air Force aircraft, and (3) steps taken to control chlorine in C-141 hydraulic systems (Author)

**A80-43181 #** Heat pipe avionic thermal control systems R S Cook and K H Token (McDonnell Aircraft Co., St. Louis, Mo.) *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-4* 7 p 6 refs Members, \$1 50, nonmembers, \$3 00

This paper describes improved thermal control system designs for both air cooled and liquid cooled avionics. The two systems use heat pipes to efficiently transfer heat from printed circuit boards to the avionic coolant. The resulting decrease in cooling requirements, relative to current air cooled designs, permits an increase in avionic reliability and a simultaneous reduction in cooling system penalties to the aircraft. An analytical evaluation of these heat pipe avionic thermal control systems was conducted for a subsonic V/STOL aircraft. Results presented include thermal control system weights, power and heat sink requirements, and aircraft takeoff gross weight penalties (Author)

**A80-43182 #** The cabin air conditioning and temperature control system for the Boeing 767 and 757 airplanes R E Crabtree, M P Saba, and J E Strang (AirResearch Manufacturing Company of California, Torrance, Calif.) *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-5* 5 p Members, \$1 50, nonmembers, \$3 00

The emphasis in the design of the 767 and 757 air conditioning systems has been to incorporate technological advances that will result in an energy efficient, maintainable system with 'widebody' comfort. A major factor has been to reduce bleed airflow use with an advanced system design that produces more cooling than a traditional system. Ram air reduction and improved maintenance features are also design goals that have been considered with the use of digital temperature controls and air bearings in the air cycle machine (Author)

**A80-43183 #** Optimizing the performance of the P-3C environmental control system P F Zalesak (US Naval Air Systems Command, Naval Air Test Center, Patuxent River, Md.) *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-6* 10 p 12 refs Members, \$1 50, nonmembers, \$3 00

The thermal environment of both flight crew and onboard electronics equipment is an important parameter affecting crew effectiveness and weapon system reliability. Although this parameter is receiving greater attention in the design of newer aircraft, it continues to be a problem in older aircraft where a complete redesign of the environmental control system (ECS) is not feasible. The problem arises when military aircraft in inventory receive updates (additions) to their weapon system avionics suites. The additional avionics impose a greater cooling load on the existing ECS and disturb whatever thermodynamic balance that may exist. Because of limited baseline data, engineers responsible for optimizing portions

of the ECS to accommodate a new avionics configuration are often forced to use their best 'engineering guess' or simplified ECS software models to determine the best redesign approach. This paper outlines a procedure for resolving this dilemma (Author)

**A80-43204 #** Noise suppressors for jet engine testing M Lepor (US Naval Oceans Systems Center, San Diego, Calif.) *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-28* 7 p 9 refs Members, \$1 50, nonmembers, \$3 00

Noise control is one of the factors associated with post-maintenance jet engine ground run-up operations. Abatement alternatives currently being considered include modification of existing water-cooled test cells, the introduction of air-cooled noise suppression systems, and technology advancements on cost-effective noise emission control techniques (Author)

**A80-43221 #** Environmental control system concept study for a Navy V/STOL aircraft W F Hilbert, A Bruno (Grumman Aerospace Corp., Bethpage, N Y.), and J E McNamara (US Naval Material Command, Naval Air Development Center, Warminster, Pa.) *American Society of Mechanical Engineers, Intersociety Environmental Systems Conference, San Diego, Calif., July 14-17, 1980, Paper 80-ENAs-47* 9 p Members, \$1 50 nonmembers, \$3 00

Energy efficient closed-loop air and vapor cycles, rotary-vaned positive-displacement air cycle machinery, partial closed-loop air cycles, and advanced centrifugal machinery with high speed electric motor drives show promise for advancing the state-of the art in ECS design. This paper presents study results to identify the benefits of this advanced ECS technology when applied to subsonic Navy V/STOL aircraft. Results show that the use of bleed air driven turbo-machines with partial recirculation of used cooling air back to the turbomachinery leads to the lowest overall system takeoff gross weight penalty to the aircraft and to the lowest life cycle costs. For this system, the total life cycle cost penalty decreased with decreasing avionic junction temperatures between 115 and 80 C, and then increased rapidly at junction temperatures lower than 80 C (Author)

**A80-43283 \* #** A theoretical and experimental investigation of propeller performance methodologies K D Korkan, G M Gregorek (Ohio State University, Columbus, Ohio), and D C Mikkelsen (NASA, Lewis Research Center, Subsonic Propulsion Section, Cleveland, Ohio) *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1240* 22 p 37 refs Grant No NSG-3247

This paper briefly covers aspects related to propeller performance by means of a review of propeller methodologies, presentation of wind tunnel propeller performance data taken in the NASA Lewis Research Center 10 x 10 wind tunnel, discussion of the predominant limitations of existing propeller performance methodologies, and a brief review of airfoil developments appropriate for propeller applications (Author)

**A80-43284 #** Wing-body pitch damping at arbitrary Mach number L E Ericsson (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1801* 9 p 21 refs Contracts No NG2269-73-C-0713, No NG0921 77-C-A294

Simple computational means are presented for prediction of wing body damping from incompressible to hypersonic velocities. The present paper extends previously developed analytic means for prediction of body-alone pitch damping to include the effect of tandem or cruciform lifting surfaces of low aspect ratio. At subsonic to low supersonic speeds a modification of an earlier developed wing-alone theory is used, and at hypersonic speeds the wing effect is obtained through simple strip theory. Comparison with experimental results shows that the accuracy of the developed theory is sufficient for preliminary design usage (Author)

**A80-43285 \* #** Performance improvement of delta wings at subsonic speeds due to vortex flaps J F Marchman, III, E B Plentovich, and D Manor (Virginia Polytechnic Institute and State University, Blacksburg, Va) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1802* 11 p 8 refs NASA-supported research

Subsonic wind tunnel tests were conducted to determine performance improvements possible from the use of leading edge vortex flaps (LEVF) on delta wings. Various flap sizes and deflection angles were examined and lift-to-drag ratio improvements of up to 40% were found at moderate angles of attack on 60 deg and 75 deg swept wings. The LEVF is concluded to be effective in moving the wing's leading edge vortex onto the flaps, tilting the vortex-induced force vector forward to produce a thrust or reduce the wing's drag while maintaining attached flow and lift on the wing's upper surface. (Author)

**A80-43286 \* #** A vortex-lattice method for the calculation of the nonsteady separated flow over delta wings D Levin and J Katz (NASA, Ames Research Center, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1803* 8 p 20 refs

An analysis is made of the wake structure and the forces on a delta wing as it undergoes nonsteady motion, wherein the flow separates at the leading edge. Comparisons of these predictions with existing experimental and theoretical data for the nonsteady linear and nonlinear motions indicate good agreement. It was found that the time-dependent, wake shedding numerical procedure applied here for the wake rollup and the lift force calculation resulted in considerable saving of computer time over methods using the iterative wake rollup procedure. Calculated results for various motions of the delta wing, including the plunging motion, are presented for both the separated and the attached flow cases. (Author)

**A80-43287 #** An experimental investigation of a wing with controlled mid-span flow separation V F Meznarsic and L W Gross (McDonnell Aircraft Co., St Louis, Mo) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1804* 10 p 10 refs

A wing with a bounded region of separated flow at high angles of attack was tested in the McDonnell Aircraft Company low speed wind tunnel. Extensive wing surface pressure data, the boundaries of the separated flow bubble above and aft of the wing, and flow visualization data were obtained. Flow field velocity measurements were integrated to determine the displacement thicknesses of the viscous flow, which were subsequently used to determine an equivalent inviscid shape. The equivalency was verified by comparing the calculated potential flow pressures of this shape with the measured pressures. The results of this test will be used in the development of an analytical method for the calculation of the flow about stalled wings. (Author)

**A80-43289 #** CTOL/VSTOL comparison - A view from the deck N Vignevic and W Riviere (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1812* 11 p Navy-supported research

This paper compares aircraft carrier capability with advanced notional CTOL aircraft - conventional takeoff and landing (catapult and arresting gear dependent) - and with notional VSTOL aircraft - capable of takeoff and landing in the vertical mode with increased mission payload and performance when operated in a STO (short takeoff) overload condition for the year 2000. Investigations were conducted on how generic aircraft were affected by the ship environment and how aircraft operations could be optimized. Starting with the CTOL aircraft, investigations were performed to determine the limiting operational factors and constraints. This established baseline parameters for the operational sensitivity studies. Sensitivity studies were then made comparing equal size, equal cost, and equal performance airwings. Results of these studies parametr-

cally show the impact on sorties over all mission ranges out to 700 nautical miles at various cost levels. (Author)

**A80-43290 #** Consistent takeoff and landing criteria for Naval aircraft of various basing concepts L A Trobaugh and F J O'Brimski (U.S. Navy, Naval Air Systems Command, Washington, D.C.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1813* 8 p

This paper reviews in detail the rationale behind the development of the takeoff and landing guidelines used for the Sea Based Air Master Study. It shows how these criteria are driven by the operating concepts, engagement scenarios and ship configurations and how changes or relaxation of certain guidelines affect the size of selected configurations. It also points out changes made in the guidelines during the course of the study and examines changes which might be made now that most of the work on the notional designs is complete. Additional operational considerations are discussed to show the need for continued studies and simulator work. (Author)

**A80-43292 #** Advanced circulation control wing system for Navy STOL aircraft J H Nichols, Jr and R J Englar (U.S. Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1825* 12 p 14 refs

An advanced high lift system is being developed which combines a Circulation Control Wing (CCW) with Upper Surface Blowing (USB) to produce significant lift for STOL operations by Navy aircraft. The concept uses Circulation Control to pneumatically deflect USB engine thrust and thus augment aerodynamic wing lift produced by the outboard CCW. Wind tunnel investigations have confirmed significant thrust turning to angles near 165 deg, providing a simple, highly effective STOL and thrust reverser system. A no-moving parts VTOL system obtained by deflecting thrust to angles around 90 deg is also suggested. The paper presents experimental results, a conceptual design for a proposed CCW + CC/USB STOL aircraft, and predicted STOL characteristics for that aircraft. Payoff in aircraft mechanical simplicity is also discussed. (Author)

**A80-43293 #** Impact of aircraft vs logistics characteristics on operational readiness. I C Stiles (Grumman Aerospace Corp., Bethpage, N.Y.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1830* 10 p

The paper considers the relationship between the aircraft design characteristics, operational parameters, and the existing naval logistic system. It was shown that (1) it is feasible to predict readiness figures of merit based on the aircraft design characteristics by using the Designed-Full Systems Capability Figures-Of-Merit (FOM) status of an aircraft weapons system, (2) that mission requirements dictate the need for a large, complex aircraft, or a small, simple aircraft which in turn drives the resulting Figures-Of-Merit in an inverse manner, (3) the reliability of the total aircraft level in excess of 15 of Mean Flight Hours Between Failure produces small increases in overall readiness FOM, (4) the overall logistic support contribution to readiness can be monitored and evaluated on the aircraft level using the existing Maintenance Material Management data and the Logistic Support System Capability FOM, and (5) visibility should be expanded to track the realtime contribution of all Weapon Replaceable Assemblies. A T

**A80-43295 #** Stability and control taught by design of tail surfaces R L Swann (Oklahoma State University, Stillwater, Okla.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1835* 5 p

As part of a senior aerospace engineering course on conventional airplane stability and control, the students are asked to complete a design project which requires the application of the analytical concepts learned in the course. The project used the past two years is

the design of the horizontal and vertical tails for a light, single-engine, general aviation airplane. Design specifications to be met are given, as well as pertinent wing and fuselage aerodynamic data. Progress is evaluated by requiring several milestone reports during the course. A final written report documents the total project and compliance with the specifications. (Author)

**A80-43297 # Evaluation and selection of new aircraft for the eighties** R E Gordon (American Airlines, Inc., Tulsa, Okla.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1838* 6 p

This paper examines the approach currently used by one airline to evaluate, compare and select new aircraft and engine types. The need for new aircraft and engine types is reviewed in terms of mission requirements (capacity and range), fleet age, noise rule, and the critical importance of fuel efficiency for the 1980s. Discussion of the significant direct operating cost elements such as crew, fuel, maintenance, and depreciation are addressed along with other aircraft cost elements that are becoming more important in these evaluation efforts. Emphasis is placed on the increasingly important role of the engine and rapidly increasing fuel prices. In the 1980s, other considerations outside of the classic direct operating cost analysis which will be major aircraft selection factors include operational improvements on existing fleets, deregulation impacts, and financial capability. (Author)

**A80-43298 # The economics of commonality - A Boeing product strategy view** M A Cronie and P R Thompson (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1839* 9 p

Rapidly escalating fuel and other costs mandate maximizing efficiency in the design, production, and operation of commercial jet transports. This paper addresses the commonality aspect of aircraft design as one means to improve economic performance of both the manufacturer and the user. The paper illustrates that the economic benefits of design commonality must be judged against other benefits arising from technical innovation. The challenges presented in quantifying the impact of commonality on a diverse customer population are explored. Examples are given of commonality and noncommonality between models of the Boeing Commercial Jet Family. The effect of today's business environment on the manufacturer's viewpoint and actions is also illustrated. (Author)

**A80-43299 # Airline economic benefit through engine development** D F Stark and M T Loferski (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1841* 8 p

Aircraft gas turbine engines have continued their remarkable advancement from their commercial introduction nearly a quarter of a century ago. Fuel efficiency and engine durability have improved dramatically even though thrust has grown nearly fivefold. New requirements for noise and emission reduction have been met. The efforts to improve manufacturing capability, reduce engine cost, and reduce engine weight have seen the payoff of technology improvements in reducing the costs of ownership. The development of new families of engines as well as the initiation of new engine technologies are demonstrating our emphasis on providing engines to improve airline operating profits. (Author)

**A80-43300 # The economic impact of materials technology on supersonic transport selection** D L Horning, R H Johnston, and J V Werner (Lockheed-California Co., Burbank, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1842* 9 p

A series of studies on Advanced Supersonic Transports (AST) have been performed to determine the relative airline profitability of various speed regimes and structural configurations in order to narrow the spectrum for future analysis. Of the many possible

configurations, seven candidates were selected to cover the speed, material and manufacturing process spectrum: five Mach 2.0 and two Mach 2.55 configurations. Included are conventional aluminum and titanium design with conventional manufacturing processes, and various mixes of advanced aluminum, titanium and composite structural designs with advanced manufacturing processes. The study indicates: (1) lower speed aircraft are more cost effective than the higher speed aircraft, (2) composite aircraft with their significantly lower weight provide the highest return on investment (ROI) and lowest fare. (Author)

**A80-43301 \* # Effects of discontinuous drooped wing leading-edge modifications on the spinning characteristics of a low-wing general aviation airplane** D J DiCarlo, H P Stough, III, and J M Patton, Jr (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1843* 12 p 9 refs

Wind tunnel and flight tests were conducted to determine the effects of several discontinuous drooped wing leading-edge configurations on the spinning characteristics of a light, single engine, low wing research airplane. Particular emphasis was placed on the identification of modifications which would improve the spinning characteristics. The spanwise length of a discontinuous outboard droop was varied and several additional inboard segments were added to determine the influence of such leading-edge configurations on the spin behavior. Results of the study indicated that the use of only the discontinuous outboard droop, over a specific spanwise area, was most effective towards improving spin and spin recovery characteristics, whereas the segmented configurations having both inboard and outboard droop exhibited a tendency to enter a flat spin. (Author)

**A80-43302 \* # Full-scale wind-tunnel investigation of the effects of wing leading-edge modifications on the high angle-of-attack aerodynamic characteristics of a low-wing general aviation airplane** J L Johnson, Jr., W A Newsom, and D R Satran (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1844* 17 p 16 refs

The paper presents the results of a recent investigation to determine the effects of wing leading edge modifications on the high angle-of-attack aerodynamic characteristics of a low wing general aviation airplane in the Langley Full-Scale Wind Tunnel. The investigation was conducted to provide aerodynamic information for correlation and analysis of flight-test results obtained for the configuration. The wind-tunnel investigation consisted of force and moment measurements, wing pressure measurements, flow surveys, and flow visualization studies utilizing a tuft grid, smoke and nonintrusive mini-tufts which were illuminated by ultra violet light. In addition to the tunnel scale system which measured overall forces and moments, the model was equipped with an auxiliary strain gage balance within the left wing panel to measure lift and drag forces on the outer wing panel independent of the tunnel scale system. The leading edge modifications studied included partial- and full span leading edge droop arrangements as well as leading edge slats. (Author)

**A80-43303 \* # Determination of an angle of attack sensor correction for a general aviation airplane at large angles of attack as determined from wind tunnel and flight tests** T M Moul and L W Taylor, Jr (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1845* 9 p 13 refs

A comprehensive investigation into the flow correction for an angle of attack sensor mounted ahead of the wing tip of a general aviation research airplane has been conducted at the Langley Research Center. This correction has been determined in wind tunnels using a full-scale model up to angles of attack of 45 deg and a 1/5-scale model up to 80 deg angle of attack. The flow correction has

also been obtained in flight by using a standard technique at low angles of attack and in spinning flight at larger angles of attack, by using both a simple approximate technique and a parameter estimation technique. The results show the correction is significant, reaching 10 deg at a measured angle of attack of about 90 deg. The flow correction was sensitive to the angle of sideslip at measured angles of attack greater than 60 deg and was not influenced by wing leading-edge modifications or aileron deflections (Author)

**A80-43304 \* #** Aerodynamic design optimization of a fuel efficient high-performance, single-engine, business airplane B J Holmes (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80 1846* 13 p

A design study has been conducted to optimize a single engine airplane for a high performance cruise mission. The mission analyzed included a cruise speed of about 300 knots, a cruise range of about 1300 nautical miles, and a six passenger payload (5340 N (1200 lb)). The purpose of the study is to investigate the combinations of wing design, engine, and operating altitude required for the mission. The results show that these mission performance characteristics can be achieved with fuel efficiencies competitive with present day high-performance, single- and twin-engine, business airplanes. It is noted that relaxation of the present Federal Aviation Regulation, Part 23, stall speed requirement for single engine airplanes facilitates the optimization of the airplane for fuel efficiency (Author)

**A80-43305 #** Fuel efficiency of small aircraft B H Carson (U.S. Naval Academy, Annapolis, Md) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1847* 9 p 10 refs

There is a basic mismatch between the amount of power installed in small propeller driven aircraft and that required for efficient cruising, which results from climb performance requirements. It is shown in this paper that there is a way of using excess power for most efficient cruise, the resulting airspeed coming closest to the Gabrielli von Karman limit line of vehicular performance. A survey of 111 light aircraft was conducted, and it is found that many are operated at this optimum, while many more are not. A figure of merit is developed that measures cruise performance. Rationale is presented that is directly applicable to design for cruise efficiency (Author)

**A80-43306 #** Educational aspects of multi-microprocessor design used in flight simulation applications F E Huguenin (Zurich, Eidgenossische Technische Hochschule, Zurich, Switzerland) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1852* 8 p

The paper presents the results of the design of a tightly coupled computer system for the real-time simulation of the lift and drag coefficients of a transport aircraft. Attention is given to the educational aspects of the design process of the system and to the chosen computer configuration. A software design problem is also outlined V T

**A80-43307 #** Use of contingency ratings on a subsonic V/STOL propulsion system V L Reed (General Electric Co, Aircraft Engine Group, Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1855* 5 p

This paper describes a study conducted on a typical advanced subsonic turbofan engine to evaluate the applicability and results of contingency ratings. Types of ratings considered were an emergency rating for use one time-only, followed by immediate engine overhaul and a very short-duration rating that depends upon thermal lag to prevent damage to the engine hot section. The applicability of such contingency ratings depends upon the exact manner in which the engine components are matched and operated. Special ratings may be used in some cases to relieve specific core engine sizing constraints, permitting an improved cycle optimization. However, in cases where

the fan is sized to operate at its maximum flow capacity, additional core energy cannot increase the energy of the low pressure system, and little additional thrust results (Author)

**A80-43308 #** Development of the 'D' vented thrust deflecting nozzle E W Rosenberg and D W Esker (McDonnell Aircraft Co, St Louis, Mo) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1856* 9 p 6 refs

The 'D' vented nozzle has been developed to provide efficient thrust vectoring for advanced subsonic V/STOL aircraft. The development of the nozzle, aerodynamic performance, and current future testing are described. The performance of the 'D' nozzle has been established through a number of small scale model tests at McDonnell Aircraft Company (MCAIR) and a large scale, tip turbine fan test at NASA Ames. Vectoring performance obtained during the most recent tests is presented for variations of nozzle pressure ratio, nozzle exit area, and thrust vector angle for both uniform and nonuniform entrance flow. Evaluation of vectoring performance for the case of core engine failure is also discussed (Author)

**A80-43309 #** Preliminary design of a very advanced technology light twin for the mid-80's J Roskam, F Grosveld, B van Keppel, J Eijsink, and A v d Hoeven (Kansas, University, Lawrence, Kan) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80 1862* 11 p 14 refs

A preliminary design analysis was performed on a specification that called for a twin engine business aircraft with performance nearing that of a jet airplane, coupled with the fuel efficiency of a turboprop. Use was made of advanced technologies in the areas of aerodynamics, propulsion, construction and stability and control. Results are presented which indicate a significant improvement in performance compared to turboprop airplanes currently in use (Author)

**A80-43310 #** Economics - The performance parameter for large airplanes G L Huggins (Cessna Aircraft Co, Wichita, Kan) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80 1863* 11 p

An analytical study was undertaken to identify those design characteristics which would optimize the earning potential of a new airplane. Designs considered were (1) a re-engined Ag Husky (and derivatives thereof), and (2) completely new configurations (biplane, monoplane, and spanloader concepts were investigated). Variations in hopper capacity, weight, wing area, and engine size were investigated. The economic potential of each configuration investigated was analyzed by flying it (via computer simulation) through a matrix of 18 spray missions. The optimum design characteristics were determined by comparing their effects on the results of the simulations (Author)

**A80-43311 #** Advanced technology impact on future Navy aircraft R K Lobb (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1865* 17 p 12 refs

A review and evaluation of current and near future technology as applicable to Navy aircraft for the remainder of the century is presented. Attention is given to the design problems which result from the unique requirements of the Navy. Emphasis is given to an evaluation of pacing technologies which promise payoffs in increased performance and reduced life cycle costs. Finally, management and funding trends are considered M E P

**A80-43312 #** Performance advances in fighter aircraft Measuring and predicting progress W L Stanley (Rand Corp, Santa Monica, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif, Aug 4-6, 1980, Paper 80-1867* 7 p



A new approach has been developed for measuring advances in jet fighter air vehicle performance. The approach recognizes the multiparameter trade offs imposed by the development process by simultaneously considering trends in a number of performance areas, rather than treating each area separately. Relationships are established between the time of appearance of an aircraft design and such parameters as specific power, sustained load factor, Breguet range, and payload fraction. Using the approach to project where the current acquisition environment is leading us with respect to fighter performance suggests that (1) U.S. fighter air vehicle performance is presently advancing at a diminishing rate, (2) increasing the rate of advance may be costly, and (3) performance growth opportunities offered by derivative aircraft seem limited. The results raise some questions about the most desirable mix of investment in air vehicle, avionics, and armament technology. (Author)

**A80-43313 #** **Advanced structures - Meeting the challenge of low-cost future aircraft systems** L. Ascani, B. Burroughs, L. Lackman, and W. O'Brien (Rockwell International Corp., North American Aircraft Div., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1868* 11 p

Aircraft technology is continually being challenged to develop new and innovative aircraft concepts with higher performance and lower cost. In the structures area, several new advances are meeting this challenge. Large and complex primary structure components designed for integral composite fabrication methods show significant improvement over conventional composite techniques. Superplastic-formed and diffusion bonded (SPF/DB) titanium offers low-cost methods of fabricating efficient aircraft hardware. Fiber reinforced advance titanium (FRAT) promises to effectively combine the high strength/stiffness and tailorability of filamentary composites with the low-cost fabrication methods of SPF/DB. These and other new and advanced technologies are presented showing their impact on the aircraft of the future. (Author)

**A80-43314 \* #** **Effect of winglets on performance and handling qualities of general aviation aircraft** C. P. van Dam (Kansas University, Lawrence, Kan.), B. J. Holmes (NASA, Langley Research Center, Hampton, Va.), and C. Pitts (Oklahoma State University, Stillwater, Okla.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1870* 8 p 22 refs

Recent flight and wind tunnel evaluations of winglets mounted on general aviation airplanes have shown improvements in cruise fuel efficiency, and climbing and turning performance. Some of these analyses have also uncovered various effects of winglets on airplane handling qualities. Retrofitting an airplane with winglets can result in reduced cross wind take-off and landing capabilities. Also, winglets can have a detrimental effect on the lateral directional response characteristics of aircraft which have a moderate to high level of adverse yaw due to aileron. 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 these flying quality problems. (Author)

**A80-43315 \* #** **Effect of propeller slipstream on the drag and performance of the engine cooling system for a general aviation twin-engine aircraft** J. Katz, V. R. Corsiglia, and P. R. Barlow (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1872* 8 p 7 refs

The pressure recovery of incoming cooling air and the drag associated with engine cooling of a typical general aviation twin-engine aircraft was investigated experimentally. The semispan model was mounted vertically in the 40- by 80-Foot Wind Tunnel at Ames Research Center. The propeller was driven by an electric motor to provide thrust with low vibration levels for the cold-flow configuration. It was found that the propeller slipstream reduces the frontal air spillage around the blunt nacelle shape. Consequently, this slipstream effect promotes flow reattachment at the rear section of

the engine nacelle and improves inlet pressure recovery. These effects are most pronounced at high angles of attack, that is, climb condition. For the cruise condition those improvements were more moderate. (Author)

**A80-43316 \* #** **Scaling wake-particle interactions for aerial applications research** A. I. Ormsbee, M. B. Bragg, and M. D. Maughmer (Illinois University, Urbana, Ill.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1873* 7 p 9 refs Grant No. NsG 1434

The differential equation for the trajectory of a spherical particle injected into an aircraft wake was developed and the proper scaling relations extracted. After some simplification a convenient set of similarity parameters was established. Using these similarity parameters a scale model test program was designed and performed in the NASA Langley vortex research facility. The results of the tests demonstrated the validity of the similarity parameters in conducting scale model testing for aerial application research. (Author)

**A80-43317 \* #** **Noise reduction characteristics of general aviation type dual-pane windows** F. Grosveld, R. Navaneethan, and J. Roskam (Kansas University, Lawrence, Kan.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1874* 8 p 8 refs NASA-supported research

The noise reduction characteristics of general-aviation-type, dual-pane windows in various configurations have been experimentally investigated. The effects of inner and outer pane thickness, spacing between the panes, edge conditions, inclination of the inner pane and depressurization of the air in between the panes are presented. The space in between the two window panes is sealed airtight in all cases. Results show that increasing the mass of a 'floating' window pane does not increase the noise reduction below the fundamental resonance frequency. It is concluded that the concept of depressurization of the air between thin (1/8 in.) Plexiglas panes and application of multiple-free edge conditions for the inner pane are promising to reduce noise levels in general aviation airplanes. (Author)

**A80-43318 #** **The impact of propulsion performance parameters on V/STOL design and sizing** J. D. Louthan (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1875* 7 p

Vought, in cooperation with NASA's Lewis Research Center, conducted several series of tests on inlets and nozzle systems for a tandem lift/cruise fan propulsion system concept developed by Vought for subsonic and supersonic V/STOL applications. This paper examines the impact of these emerging test results on the size and performance capabilities of a subsonic V/STOL aircraft which uses tandem fan propulsion. The design impacts are defined in terms of (a) adjustments in size/weight with mission and performance held constant and (b) effects on mission and performance capabilities for a fixed vehicle size and configuration. (Author)

**A80-43319 #** **Impact of ramp launch technology on a Navy support aircraft** C. R. Engleby, Sr (Lockheed-California Co., Burbank, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1878* 7 p Contract No. N00019-79 G-0050

Light aircraft carrier designs are being considered in order to increase the number of air capable ships and disperse air power more widely at sea. The deletion of catapult launch devices is a major contributor to reducing the weight, complexity and cost of these ships, but this requires aircraft with short takeoff run capability. The ramp launch techniques developed by the British and used by the Sea Harrier, which is a very high thrust-to-weight ratio design, is shown to be applicable to reducing the deck run of conventional Navy aircraft. A short takeoff using a free deck run and a ramp is achieved

by lifting off at a speed less than stall speed and accelerating to a 1g flight speed during a ramp-induced semi-ballistic flight trajectory. This paper shows the impact of the ramp launch technique on low thrust-to-weight ratio aircraft and describes a design study to modify the Navy S-3A ASW aircraft to operate from a light aircraft carrier with an 800-foot deck run and a 4-degree circular arc launch ramp (Author)

**A80-43320 \* #** An analysis of thrust-induced effects on the longitudinal aerodynamics of STOL fighter configurations. J W Paulson, Jr (NASA, Langley Research Center, Low-Speed Aerodynamics Branch, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1879* 7 p 7 refs

An analysis of the thrust-induced longitudinal aerodynamic characteristics of three fighter type configurations is presented. A brief discussion of the take-off and landing requirements for the next generation fighter aircraft leads to the conclusion that advances in lift coefficient and thrust reversing will be required to allow short-field operation. Typical power-on longitudinal aerodynamic data for the three fighter configurations, indicating different approaches to meeting the high-lift coefficient requirement, are discussed. Thrust reversing is not addressed in this paper. The power-on data are analyzed to determine what power effects are present, that is, direct thrust, boundary-layer control, vortex flows, or supercirculation. The results of the analysis indicate, for the configurations studied, that induced effects are small compared to direct thrust and that boundary-layer control, rather than leading-edge vortex flows or supercirculation, is the only significant thrust-induced effect (Author)

**A80-43321 #** Development of a mission adaptive wing system for a tactical aircraft. W W Gilbert (General Dynamics Corp., Fort Worth Div., Fort Worth, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1886* 10 p

The cruise efficiency of the supercritical airfoil in the transonic range is well known. Adaptation of this technology to a multi role tactical aircraft system requiring Mach 2+ maximum speed and 7g maneuver is enhanced by airfoil modification capabilities. This paper describes the hardware design and development of a Mission Adaptive Wing System utilizing variable camber leading and trailing edge mechanisms to optimize wing airfoil for all flight conditions. Development included design and manufacture of a full scale wing test component to demonstrate system capability and reliability (Author)

**A80-43322 #** Design for quick reaction aircraft modification. R A Morrison (Lockheed California Co., Burbank, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1887* 8 p

The paper describes the techniques and shortcuts used to reduce engineering time for the preparation of aircraft prototype or modification drawings. The techniques include Computer Graphics Augmented Design and Manufacturing (Cadam), nondimensional EMD drawings, line following routers, computer assisted loft plots, and the tailoring of existing designs to a modified design. The combining of these methods results in one-of-a-kind assemblies rapidly produced with a significant reduction in the number of drawings without sacrificing quality. Examples of recent programs for an experimental L-1011 aircraft tail assembly and for test installations for P-3 ASW aircraft were given. A T

**A80-43323 #** Design engineering. I J Kubasak (Lockheed-California Co., Burbank, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1888* 15 p 9 refs

The subject of design engineering and the role of the design engineer as practiced in the aircraft industry is addressed. Attention is given to the applied technology and methodology in order to illustrate how the design engineer functions in the main stream of the

engineering effort. It is shown that this effort begins early in the life cycle of the aircraft, by helping marketing to sell. The effort is then followed by the preliminary design phase, and continues through the project design phase. It is continued further by helping to test and to build, and finally, by helping to maintain the aircraft in service. The role of the design engineer as a composite of many designers in the project design activity who must put together the science and the aircraft structure and technology is discussed. M E P

**A80-43327 #** Systems redesign for compatibility with C-141 fuselage stretch. B A Peaster (Lockheed-Georgia Co., Marietta, Ga.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1892* 8 p

The fuselage of the C-141 aircraft was to be stretched by inclusion of a 160 inch long plug forward of the wing and 120 inch long plug aft of the wing. The Hydraulic, Oxygen and Control Systems would be affected by this structural change and some redesign would be necessary. The technical approach to these problems is discussed, and the method used to investigate the problem, and the final solutions are shown (Author)

**A80-43328 \* #** Sensitivity of the optimal preliminary design of a transport to operational constraints and performance index. S M Shiva (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1895* 14 p 14 refs

Constrained parameter optimization was used to perform the optimal preliminary design of a medium range transport configuration. The impact of choosing a performance index was studied and the required fare for a 15 percent return-on investment was proposed as a figure-of-merit. A number of design constants and constraint functions were systematically varied to document the sensitivities of the optimal design to a variety of economic and technological assumptions. Additionally, a comparison is made for each of the parameter variations between the baseline configuration and the optimally redesigned configuration (Author)

**A80-43329 #** A new test arena for aircraft research and development. J P McHenry and R L York (SRI International, Systems Development Dept., Menlo Park, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1898* 9 p

The paper describes the Tactical Air Crew Combat Training System (TACTS)/Air Combat Instrumentation (ACMI) developed to improve fighter pilot performance. The system also proved capable of providing inexpensive and timely aircraft performance data for many applications in addition to training. The system produces aircraft weapons and tracking data, including three axis load factors, velocities, attitude rates, and angles of attack/sideslip, in addition to offering a real time operation. The system is expected to be used in future development of new aircraft and weapons. A T

**A80-43330 #** Full scale test of a stall proof device. H L Chevalier and M L Faulkner (Texas A & M University, College Station, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug 4-6, 1980, Paper 80-1899* 9 p

An airplane stall proofing system utilizing a spoiler as a second pitch control system has been tested on a full sized model representative of a low wing general aviation aircraft. The tests were conducted in the NASA Langley 30 x 60 foot full scale wind tunnel. A test velocity of 86 feet per second, corresponding to a Reynolds number of  $2.20 \times 10^6$  to the 6th, was used. Using the test results, this report shows the stall proofing capability of the spoiler and verifies a previous theoretical approach to analyzing the spoiler's contribution to airplane static longitudinal stability. Controlled spoiler deployment in a narrow angle of attack range immediately preceding stall produced a reduction in pitching moment coefficient and an increase in longitudinal static stability. The data also illustrate some Reynolds

number limitations of small scale model testing in the development of the spoiler system (Author)

**A80-43333 #** Three dimensional supersonic flow through a cascade of twisted flat plates C F Grainger *American Society of Mechanical Engineers, Fluids Engineering Conference, New Orleans, La, Mar 10-13, 1980, Paper 80-FE-3* 7 p 5 refs Members, \$1 50, nonmembers, \$3 00

The three dimensional flow through a cascade of twisted flat plate blades is calculated using a computer program based on a finite-difference approximation to the method of characteristics The relative flow is supersonic but the axial flow is subsonic For two-dimensional flow under similar conditions, the inlet flow field is one of 'unique-incidence', the effect discussed by Starke (1975) and others In the present work the understanding of this effect is extended to three-dimensional flow Important differences between the two and three-dimensional flow fields are explained in terms of the interaction between neighboring sections of the flow (Author)

**A80-43379** Lift improvement of an aerofoil by periodic deformations R Laporte (Montpellier II, Universite, Montpellier, France) *International Journal of Engineering Science*, vol 18, no 7, 1980, p 957-970 16 refs

The irrotational 2-dimensional motion of an incompressible inviscid fluid at rest at infinity, effected by the displacement and the deformation of an aerofoil, is investigated Complex potential, lift force and pitching moment acting on the aerofoil are determined, after introducing a Joukowski condition at the cusp of the profile Then periodic deformations of an aerofoil are constructed giving an improvement of the lift force (Author)

**A80-43399** Convective-film cooling of nozzle-type turbine blades V V Zikeev (*Teplofizika Vysokikh Temperatur*, vol 17, Nov-Dec 1979, p 1319-1327) *High Temperature*, vol 17, no 6, May 1980, p 1095-1103 22 refs Translation

The article gives the results of a theoretical and experimental investigation of the convective-film cooling of nozzle-type blades of gas turbines On the basis of a model of a heat sink with the use of a power law of the change in the velocity in the boundary layer, dependences were obtained for calculation of the efficiency of film-type cooling, in good agreement with the results of experiments, carried out under actual conditions (Author)

**A80-43599 \* #** Location and propagation of shock associated noise from supersonic jets T D Norum and J M Seiner (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 6th, Hartford, Conn, June 4-6, 1980, Paper 80-0983* 8 p 9 refs

Shock associated noise from unheated supersonic jets is investigated through acoustic measurements in both the near and far fields The peak Helmholtz number of broadband shock noise is found to be independent of nozzle pressure ratio when based on the length of the shock cells and the ambient speed of sound This indicates that the acoustic wavelengths generated in the shock noise process are limited in size by the shock cell spacing Excellent agreement between power spectral densities measured at various far-field angles is obtained at and above the peak shock noise frequency when source convection effects are included Results show a directivity of broadband shock noise pointed in the upstream direction, with omnidirectionality being approached only at high pressure ratios The relative importance of shock noise with respect to jet mixing noise is found to be maximum near the pressure ratio at which a Mach disc begins to form in the jet Near field measurements point to the downstream shock cells as the region where the dominant shock noise emanates from the jet (Author)

**A80-43683 #** Certification of avionics systems on the commercial airplanes of the 1980's J R Combley (Boeing Commercial

Airplane Co., Seattle, Wash) (*Canadian Aeronautics and Space Institute, Flight Test Symposium, Ottawa, Canada, Mar 25, 26, 1980*) *Canadian Aeronautics and Space Journal*, vol 26, 2nd Quarter, 1980, p 83-91

The purpose of this paper is to discuss the certification of avionics systems on the next generation of commercial airplanes, with particular emphasis on the flight testing requirements In order to do this it is necessary to outline the development of new avionics systems, particularly digital computers and cathode ray tube (CRT) displays, over the last decade, showing how these developments have led to the systems which will be certified on the new airplanes This discussion will also describe the integration of what used to be separate functional systems into a single flight management system as well as the elimination of some traditional systems The new Aeronautical Radio and Instrument Corporation (ARINC) specifications for digital avionics systems and for a standard data transmission format between systems are described The proposed avionics systems for a new commercial transport airplane, the Boeing 767, will be briefly described in terms of system function Flight test experience during development and certification of new systems, particularly digital systems, will be related to the expected certification testing on the new airplanes This certification testing will include bench tests and use of simulators in addition to flight testing (Author)

**A80-43686 #** A technique for simulating the motion and ground effect of aircraft wake vortices R H Wickens (National Aeronautical Establishment, Ottawa, Canada) *Canadian Aeronautics and Space Journal*, vol 26, 2nd Quarter, 1980, p 129-133 5 refs

An experimental technique is described which is intended to simulate the motion and induced flows of a vortex pair in ground effect without the use of a wind tunnel or lifting surface The basic principle of the simulation is that the trailing vortex flows which occur in planes downwind of the aircraft, relative to an observer fixed on the ground, are similar in most respects to the vortex pair in two-dimensional flows The production of lift and the shedding of trailing vortices result from a large number of short impulsive flows which disturb the ambient fluid and merge into a continuous streamwise effect The sudden appearance of the vortices and their subsequent downward motion is meant to represent the passage of an aircraft above an observer on the ground B J

**A80-43687 #** A streamtube concept for lift - With reference to the maximum size and configuration of aerial spray emissions R H Wickens (National Aeronautical Establishment, Ottawa, Canada) *Canadian Aeronautics and Space Journal*, vol 26, 2nd Quarter, 1980, p 134-143 9 refs

The momentum streamtube theory of airplane performance is a simple means of relating downwash to lift, and has been used to evaluate different classes of aircraft in which the distributive effects of engine power may be important In this note, the concept is extended to include the effects of ground interaction, and is also examined as a means of estimating the maximum initial size of airborne aircraft generated spray emissions (Author)

**A80-43739** Mach 2.2 F-16 development under way E J Bulban *Aviation Week and Space Technology*, vol 113, July 21, 1980, p 20-22

The paper describes the development of a Mach 2.2 supersonic cruise version of the F 16 aircraft featuring an advanced-technology wing The improvements include a 125% increase in the air-to-air combat mission radius and doubling of the supersonic cruise radius of action, a 120% increase in air-to-ground mission radius and doubling of payload, a decrease of 33% in takeoff and landing distances, and maneuverability improvement providing tripling of gun-firing opportunities during air-combat The bolt-on wing concept will allow 93% of the fuselage airframe components and 91% of the avionics subsystems to be utilized Because of the 1351 lb increase in wing structural weight due to its greater area and thickness, the upper and lower skins will be fabricated from graphite epoxy

composites, this will save 574 lb of weight compared to the use of aluminum, and will ease the fabrication of complex contours A T

**A80-43784 #** Investigation of the thermal state of longitudinally cooled rotor blades (Issledovanie teplovogo sostoiانيا rabochikh lopatok pri prodol'nom techenii okhladitelia) L V Arsen'ev, I B Mitriaev, V G Polishchuk, and N P Sokolov (Leningradskii Politekhnikeskii Institut, Leningrad, USSR) *Energetika*, vol 23, May 1980, p 43-49 In Russian

In the experiments described, a turbine stage and eight combustion chambers (providing an operational temperature of 1100 C) were used to study the temperature fields of rotor blades cooled longitudinally with air and water vapor The cooling effectiveness was found to be satisfactory In the case of air, the gas temperature in front of the blade may reach 1000 to 1150 C In the case of water vapor, the cooling effectiveness was appreciably higher, permitting a raise in gas temperature to 1250 C V P

**A80-43787 #** Perturbing influence of the probe on the characteristics of a subsonic wake behind a two-dimensional model (Vozmushchayushchee vlianie zonda na kharakteristiki dozvukovogo sleda za ploskoi model'iu) L A Ignat'evskaya and V A Savost'ianov (Moskovskii Energeticheskii Institut, Moscow, USSR) *Energetika*, vol 23, May 1980, p 116-119 7 refs In Russian

The paper deals with a vapor tunnel study of the influence of the probe configuration and flow conditions on the base pressure and vortex streets of a plane model The parameters of the turbulent wake were investigated For a probe located in the symmetry plane of the near wake, two sources of pressure pulsations were observed, one, at the tail section of the model in the region of vortex street formation, and the other at the forward stagnation point The pressure pulsations were accompanied by density waves propagating in the flow V P

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requirements can be met though marginally. The maximum lift requirement at  $M = 0.5$  and most of the profile drag objectives cannot be met without some compromise of at least one of the higher order priorities. Author

## STAR ENTRIES

**N80-26264\***# National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**LOW-SPEED AIRSPEED CALIBRATION DATA FOR A SINGLE-ENGINE RESEARCH-SUPPORT AIRCRAFT**  
 Bruce J Holmes Jun 1980 22 p refs  
 (NASA-TM-81832) Avail NTIS HC A02/MF A01 CSCL 01D

A standard service airspeed system on a single engine research support airplane was calibrated by the trailing anemometer method. The effects of flaps, power, sideslip, and lag were evaluated. The factory supplied airspeed calibrations were not sufficiently accurate for high accuracy flight research applications. The trailing anemometer airspeed calibration was conducted to provide the capability to use the research support airplane to perform pace aircraft airspeed calibrations. Author

**N80-26265#** Transportation Research Board Washington D C  
**AVIATION FORECASTING, PLANNING, AND OPERATIONS**

David E Raphael, Adib Kanafani, Redha Behbehani, Huey-Shin Yuan, and Sergio Zuniga 1979 86 p refs  
 (PB80-154354 TRB/TRR-732 LC-80-11905  
 ISBN-0-039-02987-2 ISSN-0361-1981) Avail NTIS  
 HC A05/MF A01 HC also available from Transportation Research Board 2101 Constitution Ave NW Washington D C 20418 CSCL 05C

The overall business environment in aviation markets and prices, completion and regulation and operations and technology are addressed. Major emphasis is placed on the following: aviation forecast assumptions and discontinuities, forecasting airport traffic and airport planning. GRA

**N80-26266\***# National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif

**A COMPUTER PROGRAM TO GENERATE TWO-DIMENSIONAL GRIDS ABOUT AIRFOILS AND OTHER SHAPES BY THE USE OF POISSON'S EQUATION**

Reese L Sorenson May 1980 62 p refs  
 (NASA-TM-81198 A-8178) Avail NTIS HC A04/MF A01 CSCL 01A

A method for generating two dimensional finite difference grids about airfoils and other shapes by the use of the Poisson differential equation is developed. The inhomogeneous terms are automatically chosen such that two important effects are imposed on the grid at both the inner and outer boundaries. The first effect is control of the spacing between mesh points along mesh lines intersecting the boundaries. The second effect is control of the angles with which mesh lines intersect the boundaries. A FORTRAN computer program has been written to use this method. A description of the program, a discussion of the control parameters and a set of sample cases are included. EDK

**N80-26267\***# Boeing Vertol Co Philadelphia Pa  
**DESIGN AND ANALYTICAL STUDY OF A ROTOR AIRFOIL**  
 Final Report

L U Dadone May 1978 93 p refs  
 (Contract NAS1-14659)  
 (NASA-CR-2988 D210-11239-1) Avail NTIS  
 HC A05/MF A01 CSCL 01A

An airfoil section for use on helicopter rotor blades was defined and analyzed by means of potential flow/boundary layer interaction and viscous transonic flow methods to meet as closely as possible a set of advanced airfoil design objectives. The design efforts showed that the first priority objectives including selected low speed pitching moment, maximum lift and drag divergence

**N80-26268\***# Kansas Univ Center for Research Inc Lawrence Flight Research Lab  
**A COMPUTER PROGRAM FOR CALCULATING AERODYNAMIC CHARACTERISTICS OF LOW ASPECT-RATIO WINGS WITH PARTIAL LEADING-EDGE SEPARATION**  
 Sudhir C Mehrotra and C Edward Lan May 1978 132 p  
 (Grant NsG-1046)  
 (NASA-CR-145362 CRINC-FRL-266-2) Avail NTIS  
 HC A07/MF A01 CSCL 01A

The necessary information for using a computer program to predict distributed and total aerodynamic characteristics for low aspect ratio wings with partial leading-edge separation is presented. The flow is assumed to be steady and inviscid. The wing boundary condition is formulated by the Quasi-Vortex-Lattice method. The leading edge separated vortices are represented by discrete free vortex elements which are aligned with the local velocity vector at midpoints to satisfy the force free condition. The wake behind the trailing edge is also force free. The flow tangency boundary condition is satisfied on the wing including the leading and trailing edges. The program is restricted to delta wings with zero thickness and no camber. It is written in FORTRAN language and runs on CDC 6600 computer. J M S

**N80-26269\***# Aerospace Systems Inc, Burlington, Mass  
**STEADY, OSCILLATORY, AND UNSTEADY SUBSONIC AND SUPERSONIC AERODYNAMICS, PRODUCTION VERSION (SOUSSA-P 11) VOLUME 1 THEORETICAL MANUAL**  
 Final Report

Luigi Morino Jan 1980 134 p  
 (Contract NAS1-14977)  
 (NASA-CR-159130 ASI-TR-78-45-Vol-1) Avail NTIS  
 HC A07/MF A01 CSCL 01A

Recent developments of the Green's function method and the computer program SOUSSA (Steady Oscillatory, and Unsteady Subsonic and Supersonic Aerodynamics) are reviewed and summarized. Applying the Green's function method to the fully unsteady (transient) potential equation yields an integro-differential-delay equation. With spatial discretization by the finite-element method, this equation is approximated by a set of differential-delay equations in time. Time solution by Laplace transform yields a matrix relating the velocity potential to the normal wash. Premultiplying and postmultiplying by the matrices relating generalized forces to the potential and the normal wash to the generalized coordinates, one obtains the matrix of the generalized aerodynamic forces. The frequency and mode-shape dependence of this matrix makes the program SOUSSA useful for multiple frequency and repeated mode-shape evaluations. ARH

**N80-26271#** Naval Ship Research and Development Center Annapolis Md

**NUMERICAL OPTIMIZATION OF CIRCULATION CONTROL AIRFOILS** Interim Report, Sep 1978 - Dec 1979

Tsze Tai, C George H Kidwell Jr, and Garret N Vanderplaats  
 Apr 1980 48 p refs  
 (DTNSRDC-80/060 Aero-1265) Avail NTIS  
 HC A03/MF A01

A numerical procedure developed for optimizing the circulation control airfoils is presented. The procedure finds the optimum basic airfoil shapes subjected to specified flow conditions and geometric constraints. It consists of a numerical optimization code for linear constrained problems coupled with a viscous potential flow interaction analysis for necessary viscous inviscid flow field calculations. The desired airfoil shape is defined by a combination of baseline shapes representative of airfoils suitable for circulation control purpose. The coefficients of these basis vectors are then used as the design variables in the optimization process. Three baseline shapes (a cambered ellipse, a cambered ellipse with a drooped trailing edge, and cambered ellipse with a logarithmically spiralled trailing edge) are employed for special contouring of the trailing edge geometry. With some minor

modification of the analysis method the combined program allows optimization for maximum lift without substantial difficulty but for minimizing the drag further improvement of the analysis method is required Author

**N80-26275\*#** National Aeronautics and Space Administration, Washington D C

**WORKS ON THEORY OF FLAPPING WING**

V V Golubev Jun 1980 140 p refs Transl into ENGLISH from the book Trudy po Teorii Mashushchego Kryla Moscow, State Publishing House of Tech-Theoret Lit, 1957 p 399-569 Transl by Kanner (Leo) Associates, Redwood City Calif (Contract NASw-3199) (NASA-TM-75750) Avail NTIS HC A07/MF A01 CSCL 01B

It is shown mathematically that taking account of the boundary layer is the only way to develop a theory of flapping wings without violating the basic observations and mathematics of hydromechanics A theory of thrust generation by flapping wings can be developed if the conventional downstream velocity discontinuity surface is replaced with the observed Karman type vortex streets behind a flapping wing Experiments show that the direction of such vortices is the reverse of that of conventional Karman streets The streets form by breakdown of the boundary layer Detailed analysis of the movements of certain birds and insects during flight in place is fully consistent with this theory of the lift thrust and drag of flapping wings Further directions for research into flight with flapping wings are indicated Author

**N80-26277#** Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio Analysis and Optimization Branch

**UNSTEADY PRESSURE MEASUREMENTS ON OSCILLATING MODELS IN EUROPEAN WIND TUNNELS**

James J Olsen Mar 1980 83 p refs (AF Proj 2307) (AD-A083248 AFWAL-TM-80-1-FIBR) Avail NTIS HC A05/MF A01 CSCL 20/4 -

The purpose of this report is to summarize the broad aspects of the aerodynamic tests that have been performed over the last twenty years on oscillating bodies and wings in European wind tunnels While an extensive list of references is available in the open literature, there does not seem to be a general awareness in the United States government or aerospace industry of the intensity and diversity of European efforts This report gives the background of the development of the major European testing facilities and illustrates the payoffs that have been accrued in the Netherlands Germany France and England GRA

**N80-26284\*#** Jet Propulsion Lab California Inst of Tech Pasadena

**FUSELAGE VENTILATION DUE TO WIND FLOW ABOUT A POSTCRASH AIRCRAFT**

Jay W Stuart 15 Jun 1980 26 p refs (Contract NAS7-100) (NASA-CR-163273 JPL-Pub-80-36) Avail NTIS HC A03/MF A01 CSCL 01C

Postcrash aircraft fuselage fire development dependent on the internal and external fluid dynamics is discussed The natural ventilation rate a major factor in the internal flow patterns and fire development is reviewed The flow about the fuselage as affected by the wind and external fire is studied An analysis was performed which estimated the rates of ventilation produced by the wind for a limited idealized environmental configuration The simulation utilizes the empirical pressure coefficient distribution of an infinite circular cylinder near a wall with its boundary later flow to represent the atmospheric boundary layer The resulting maximum ventilation rate for two door size openings with varying circumferential location in a common 10 mph wind was an order of magnitude greater than the forced ventilation specified in full scale fire testing The parameter discussed are (1) fuselage size and shape (2) fuselage orientation and proximity to the ground, (3) fuselage-openings size and location (4) wind speed and direction and (5) induced flow of the external fire plume is recommended The fire testing should be conducted to a maximum ventilation rate at least an order of magnitude greater than the inflight air conditioning rates B D

**N80-26285\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**PRELIMINARY RESULTS OF SIMULATED VORTEX ENCOUNTERS BY A TWIN-ENGINE, COMMERCIAL AIRCRAFT DURING FINAL LANDING APPROACH**

Earl C Hastings Jr G Thomas Holbrook and Gerald L Keyser Jr May 1980 56 p refs (NASA-TM-81782) Avail NTIS HC A04/MF A01 CSCL 01C

Piloted simulations of encounters with vortices of various ages and degrees of attenuation were performed with the Visual Motion Simulator In the simulations a twin engine commercial transport on final approach, encountered the modeled vortices of a four engine, wide body commercial transport The data show the effect of vortex age and attenuation on the severity of the initial upset as well as the effect of the vortex encounters on the landing capability Author

**N80-26286#** National Transportation Safety Board Washington, D C

**AIRCRAFT ACCIDENT REPORTS BRIEF FORMAT, US CIVIL AVIATION ISSUE NUMBER 8, 1979 ACCIDENTS**

25 Jun 1980 170 p (NTSB-BA-80-5) Avail NTIS HC A08/MF A01

Three hundred general aviation aircraft accident reports occurring in the US civil aviation operations during calendar year 1979 are discussed The facts conditions, circumstances and probable cause (s) for each accident are studied Additional statistical information is tabulated by injury index injuries and causal factors B D

**N80-26287#** National Transportation Safety Board, Washington D C

**AIRCRAFT ACCIDENT REPORT COMAIR, INC, PIPER PA-31-310, NAVAJO, N6842L, GREATER CINCINNATI AIRPORT, COVINGTON, KENTUCKY, 8 OCTOBER 1979**

28 May 1980 36 p (NTSB-AAR-80-8) Avail NTIS HC A03/MF A01

On October 8 1979 at 1008 26 COMAIR, Inc Flight 444 a Piper PA31-310 with a pilot and seven passengers on board crashed on takeoff from runway 18 at the Greater Cincinnati Airport Covington Kentucky The pilot and the seven passengers on board were killed and the aircraft was destroyed After 1500 to 2000 ft of takeoff roll the aircraft lifted off abruptly and climbed slowly to about 150 ft above the runway Following liftoff the pilot reported a loss of power from an engine and the tower controller cleared the pilot to return and land Seconds later the aircraft rolled to the right to an inverted position and dove nose first to the ground The National Transportation Safety Board determines that the probable cause of the accident was the loss of control following a partial loss of power immediately after liftoff The accident could have been avoided if either the pilot had rejected the takeoff or had raised the landing gear and flaps His failure to take decisive action may have been due to preoccupation with correcting the malfunction and a lack of familiarity with the aircraft and with its emergency procedures Contributing to the accident was the pilot's inexperience in multiengine aircraft a hurried departure inadequate training inexperienced company management and ineffective FAA certification and surveillance of the operator Author

**N80-26288#** Aeronautical Systems Div, Wright-Patterson AFB Ohio Technical and Resources Management Div

**AERONAUTICAL SYSTEMS TECHNOLOGY NEEDS ESCAPE, RESCUE AND SURVIVAL Annual Report**

D C Kittinger Feb 1980 34 p Supersedes ASD-TR-79-5038 (AD-A083552 ASD-TR-80-5010 ASD-TR-79-5038) Avail NTIS HC A03/MF A01 CSCL 06/7

This report is a part of a compilation of formalized Technology Needs (TN) covering Equipment Subsystems as identified in the Aeronautical Systems Division They are based on development/operational experience systems studies and new concepts - all related to future system applications Their presentation is to serve a threefold purpose i.e (1) guidance for technology program (2) proven developmental potential and (3) engineer-

ing data/requirements essential for technology use in systems  
The identified needs delineate progress desired in performance  
control design flexibility safety and cost GRA

**N80-26291#** Advisory Group for Aerospace Research and Development Neuilly-Sur-Seine (France)

**TECHNICAL EVALUATION REPORT ON THE 29TH GUIDANCE AND CONTROL PANEL SYMPOSIUM ON AIR TRAFFIC MANAGEMENT CIVIL/MILITARY SYSTEMS AND TECHNOLOGIES**

C deBruyn (Liege Univ Belgium) Mar 1980 20 p Symp held at Copenhagen 9-12 Oct 1979 (AGARD AR-149 ISBN-92-835-1356-8) Avail NTIS HC A02/MF A01

Air traffic control is considered as a joint civil/military system with emphasis on the caom compatibility the coordination and the complementary aspects of the civil and military components The adequacy of those ATC concepts in current use is discussed and recent advances in technology are reviewed J M S

**N80-26292#** National Inst for Aeronautics and Systems Technology Pretoria (South Africa)

**THE ANALYTICAL PREDICTION OF THE SEPARATION BEHAVIOUR OF EXTERNAL STORES AFTER RELEASE FROM THE CARRIER AIRCRAFT PART 2 APPLICATIONS**

G J vandenBroek Aug 1979 225 p refs (CSIR-NAIST-79/103-Pt-2 ISBN-0-7988-1650-3) Avail NTIS HC A10/MF A01

An analytical store separation prediction method was developed The method is based on inviscid linear potential theory for subsonic and supersonic flow The aircraft and external store are divided into a large number of panels each of which contains an aerodynamic singularity distribution Source and vortex distributions are used The strengths of the singularities are determined and the store loads obtained The store loads are combined with the six-degree-of-freedom equations of motion to provide the separation characteristics of the store Various aspects of the computational method are investigated in considerable detail Approximative schemes are studied to speed up the calculations, resulting in an economical separation prediction method Extensive comparisons with experimental data regarding the various aspects of the computational method are included In general satisfactory agreement is observed Areas for improvement are defined F O S

**N80-26293#** Rockwell International Corp Los Angeles Calif Aircraft Div

**DESIGN STUDIES OF LAMINAR FLOW CONTROL (LFC) WING CONCEPTS USING SUPERPLASTICS FORMING AND DIFFUSION BONDING (SPF/DB) Final Report, Aug 1978 - Sep 1979**

Vernon E Wilson May 1980 114 p refs (Contract NAS1-15488) (NASA-CR-159220) Avail NTIS HC A06/MF A01 CSCL 01C

Alternate concepts and design approaches were developed for suction panels and techniques were defined for integrating these panel designs into a complete LFC 200R wing The design concepts and approaches were analyzed to assure that they would meet the strength stability and internal volume requirements Cost and weight comparisons of the concepts were also made Problems of integrating the concepts into a complete aircraft system were addressed Methods for making splices both chordwise and spanwise fuel light joints and internal duct installations were developed Manufacturing problems such as slot alignment tapered slot spacing, production methods and repair techniques were addressed An assessment of the program was used to developed recommendations for additional research in the development of SPF/DB for LFC structure E D K

**N80-26294#** Societe Nationale Industrielle Aerospatiale Paris (France) Lab Centrale

**EVOLUTION OF MATERIALS AND ASSOCIATED TECHNOLOGIES IN AEROSPACE MATERIAL STRUCTURES [EVOLUTION DES MATERIAUX ET DES TECHNOLOGIES ASSOCIEES DANS LES STRUCTURES DE MATERIAUX AEROSPATIAUX]**

G Sertour and G Hilaire 30 May 1979 57 p In FRENCH Presented at 14th Congr Intern Aeron Paris 6-8 Jun 1979 (SNIAS-792-551-106) Avail NTIS HC A04/MF A01

A brief history of developments is given Specific topics examined include propagation of fatigue cracks stress corrosion aluminum alloy forming processes and composite materials Selected applications are illustrated tanks for the 1st stage of Ariane structures of the Mirage 2000 Concorde and Airbus a 300B aircraft and Intelsat 5 Marecs antenna a rigid solar generator Ariane's double launching system composite carbon-carbon materials with multidirectional armatures and a Kevlar coil for a propulsion device Author (ESA)

**N80-26296\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif

**HEAD-UP DISPLAY IN THE NON-PRECISION APPROACH**

J M Naish May 1980 20 p refs (NASA-TM-81167 A-8061) Avail NTIS HC A02/MF A01 CSCL 01D

The problem of head-up guidance for an aircraft making an instrument approach without glide slope information is discussed Requirements for path control are considered for each section of the approach profile and a head-up display is developed to meet these needs The display is an unreferenced flight director which is modified by adding a ground referenced symbol as an alternative guidance component The director is used for holding altitude in the first segment and for descent at a controlled rate in the second segment It is used in the third segment to maintain the minimum decision altitude while assessing the approach situation This is done by means of occasional brief changes to the referenced symbol In the final segment a visual approach is made with the referenced symbol used continuously for path control The display is investigated experimentally in simulated approaches made by three pilots The results show a fair agreement between objective and subjective estimates of the quality of landing decisions E D K

**N80-26297\*#** Old Dominion Univ Research Foundation Norfolk Va

**EXPERIMENTAL AND ANALYTICAL STUDIES OF A TRUE AIRSPEED SENSOR Final Report, period ending 29 Feb 1980**

G L Goglia and J Y Shen Jun 1980 173 p refs (Grant NsG-1177) (NASA-CR-163261) Avail NTIS HC A08/MF A01 CSCL 10D

A true airspeed sensor having a flow phenomenon which is the vortex precession or the vortex whistle no moving parts and is independent of temperature density altitude or humidity changes is proposed The designed sensor consists basically of a vortex tube, a swirler, and a pickup system When air passes through the swirler a precessional flow is generated at the region before and after the sudden enlargement area An audible vortex whistle is generated the signal picked up by the microphone and the frequency response shown in a frequency counter Measurements for both the closed conduit test and wind tunnel test are recorded A computer is used to obtain the numerical solution For a specific flow rate or airspeed the larger the exit swirler angle the greater the frequency response For a smaller cross sectional area at a precessional flow region the frequency response is higher As the airspeed is increased the Strouhal number dependent only on the exit angle of the swirler remains constant E D K

**N80-26298\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif

**REDUCTION OF NITRIC OXIDE EMISSIONS FROM A COMBUSTOR Patent**

Roger A Craig and Huw O Pritchard, inventors (to NASA) Issued 27 May 1980 6 p Filed 8 Sep 1977 Supersedes N77-31260



## N80-26300

(15 - 22, p 2912) Continuation of abandoned US Patent Appl SN-684045, filed 7 May 1976  
(NASA-Case-ARC-10814-2 US-Patent-4,204 402  
US-Patent-Appl-SN-831632 US-Patent-Class-60-39 06  
US-Patent-Class-60-733 US-Patent-Class-60-746  
US-Patent-Appl-SN-684045) Avail US Patent and Trademark Office CSCL 21E

A turbojet combustor and method for controlling nitric oxide emissions by employing successive combustion zones is described. After combustion of an initial portion of the fuel in a primary combustion zone, the combustion products of the primary zone are combined with the remaining portion of fuel and additional plenum air and burned in a secondary combustion zone under conditions that result in low nitric oxide emissions. Low nitric oxide emissions are achieved by a novel turbojet combustor arrangement which provides flame stability by allowing stable combustion to be accompanied by low nitric oxide emissions resulting from controlled fuel-lean combustion (ignited by the emission products from the primary zone) in a secondary combustion zone at a lower combustion temperature resulting in low emission of nitric oxide.

Official Gazette of the U S Patent and Trademark Office

**N80-26300\*#** Pratt and Whitney Aircraft Group East Hartford Conn Commercial Products Div  
**EXPERIMENTAL AERODYNAMIC AND ACOUSTIC MODEL TESTING OF THE VARIABLE CYCLE ENGINE (VCE) TESTBED COANNULAR EXHAUST NOZZLE SYSTEM**  
D P Nelson and P M Morris 15 Jun 1980 83 p  
(Contract NAS3-20061)  
(NASA-CR-159710 PWA-5550-31) Avail NTIS  
HC A05/MF A01 CSCL 21E

Aerodynamic performance and jet noise characteristics of a one sixth scale model of the variable cycle engine testbed exhaust system were obtained in a series of static tests over a range of simulated engine operating conditions. Model acoustic data were acquired. Data were compared to predictions of coannular model nozzle performance. The model tested with and without a hardwall ejector had a total flow area equivalent to a 0.127 meter (5 inch) diameter conical nozzle with a 0.65 fan to primary nozzle area ratio and a 0.82 fan nozzle radius ratio. Fan stream temperatures and velocities were varied from 422 K to 1089 K (760 R to 1960 R) and 434 to 755 meters per second (1423 to 2477 feet per second). Primary stream properties were varied from 589 to 1089 K (1060 R to 1960 R) and 353 to 600 meters per second (1158 to 1968 feet per second). Exhaust plume velocity surveys were conducted at one operating condition with and without the ejector installed. Thirty aerodynamic performance data points were obtained with an unheated air supply. Fan nozzle pressure ratio was varied from 1.8 to 3.2 at a constant primary pressure ratio of 1.6. Primary pressure ratio was varied from 1.4 to 2.4 while holding fan pressure ratio constant at 2.4. Operation with the ejector increased nozzle thrust coefficient 0.2 to 0.4 percent. B D

**N80-26301\*#** Pratt and Whitney Aircraft Group East Hartford Conn Commercial Products Div  
**EXPERIMENTAL AERODYNAMIC AND ACOUSTIC MODEL TESTING OF THE VARIABLE CYCLE ENGINE (VCE) TESTBED COANNULAR EXHAUST NOZZLE SYSTEM COMPREHENSIVE DATA REPORT**  
D P Nelson and P M Morris Jun 1980 225 p  
(Contract NAS3-20061)  
(NASA-CR-159711 PWA-5550-40) Avail NTIS  
HC A10/MF A01 CSCL 21E

The component detail design drawings of the one sixth scale model of the variable cycle engine testbed demonstrator exhaust system tested are presented. Also provided are the basic acoustic and aerodynamic data acquired during the experimental model tests. The model drawings an index to the acoustic data an index to the aerodynamic data tabulated and graphical acoustic data and the tabulated aerodynamic data and graphs are discussed. B D

**N80-26302\*#** General Electric Co Cincinnati Ohio Aircraft Engine Group

## CF6 JET ENGINE PERFORMANCE IMPROVEMENT PROGRAM HIGH PRESSURE TURBINE AERODYNAMIC PERFORMANCE IMPROVEMENT

W A Fasching Jul 1980 156 p refs  
(Contract NAS3-20629)  
(NASA-CR-159832) Avail NTIS HC A08/MF A01 CSCL 21E

The improved single shank high pressure turbine design was evaluated in component tests consisting of performance heat transfer and mechanical tests and in core engine tests. The instrumented core engine test verified the thermal mechanical and aeromechanical characteristics of the improved turbine design. An endurance test subjected the improved single shank turbine to 1000 simulated flight cycles the equivalent of approximately 3000 hours of typical airline service. Initial back-to-back engine tests demonstrated an improvement in cruise sfc of 1.3% and a reduction in exhaust gas temperature of 10 C. An additional improvement of 0.3% in cruise sfc and 6 C in EGT is projected for long service engines. Author

**N80-26303#** Air Force Aero Propulsion Lab Wright-Patterson AFB, Ohio  
**THEORETICAL PERFORMANCE FOR NON-STATIC EJECTOR THRUST AUGMENTORS Final Report, Feb - Sep 1979**

James S Petty Jan 1980 54 p  
(AF Proj 3066)  
(AD-A083246 AFAPL-TR-79-2120) Avail NTIS  
HC A04/MF A01 CSCL 21/5

An analytical study was performed to determine the theoretical limits on the performance of nonstatic ejector thrust augmentors. Idealizing assumptions were made, such as inviscid compressible working fluids, isentropic flows in inlets, diffusers, nozzles, and ducts, constant pressure mixing, and thermally and calorically perfect fluids. By ignoring details of the primary flow pump, the performance of ejector augmentors was found in terms of three parameters (the secondary/primary mass flow ratio, a pressure parameter, and a temperature parameter) in a form which was not an explicit function of the flight Mach number. It was also shown that multi-stage ejectors offered no performance improvement over ideal single-stage ejectors. Two primary pump devices, a turbine engine gas generator and an isentropic compressor, were considered. With them, the Mach number dependent behavior of ideal ejectors was determined. As a result of this study, the following conclusions were drawn: (1) the performance of ideal ejector is severely degraded by increasing the primary fluid temperature; (2) the performance of ideal ejectors is degraded faster than that of ideal turbofans as the flight Mach number is increased; (3) neither the turbine engine nor the isentropic compressor is a suitable pump for ideal ejectors, except at very low Mach numbers; and (4) ejector augmentors should be most useful for low flight speed applications, e.g. V/STOL. GRA

**N80-26304#** Boeing Aerospace Co Seattle Wash Boeing Military Airplane Development  
**PIPSI/NAVY RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS FOR THE NAVY GAS TURBINE ENGINE CODE NEPCOMP Final Report, 28 Jun - 11 Oct 1979**  
W H Ball 11 Oct 1979 58 p refs  
(Contract N62269-79-C-0278)  
(AD-A083172 NADC-TM-79081-60) Avail NTIS  
HC A04/MF A01 CSCL 21/5

This report describes the work accomplished during a fourteen-week contract to modify two existing interactive computer programs for calculating installed engine performance, including inlet and nozzle corrections, and to demonstrate their use for the NADC. GRA

**N80-26305#** Naval Air Test Center Patuxent River Md Strike Aircraft Test Directorate  
**A COMPREHENSIVE APPROACH IN-FLIGHT THRUST DETERMINATION**  
Paul W Chapin 15 Feb 1980 22 p  
(AD-A081511 NATC-TM-3-SA) Avail NTIS  
HC A02/MF A01 CSCL 21/5

A systematic comprehensive approach was used recently to develop an in-flight thrust computational routine for a mixed-flow dual spool, augmented turbofan engine with a variable area convergent-divergent exhaust nozzle. To provide an insight for the necessity of this approach, a brief historical background of in-flight thrust measurement is presented and classical nozzle theory is discussed briefly. The development of the computational routine is discussed and some general test planning guidelines are presented. GRA

**N80-26308#** Rolls-Royce Ltd, Bristol (England)  
**EXPERIMENTAL FULL-AUTHORITY DIGITAL ENGINE CONTROL ON CONCORDE**

J McNamara, C G Legge and E Roberts (Sperry Gyroscope Co Great Neck, NY) *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 17 p

Avail NTIS HC A11/MF A01

The first ever flight standard full-authority digital engine controller is described. As well as the existing dry engine control and monitoring functions, the controller incorporated reheat control, fault recording and ground-check and fitted into the same volume as the existing analogue dry engine controller. Particular emphasis is given to computer monitoring techniques and the production of high-integrity software. RCT

**N80-26309#** VDO-Luftfahrtgeraete Werk Adolf Schindling G m b H Frankfurt (West Germany)

**THE SECONDARY POWER SYSTEM CONTROL UNIT, AND ELECTRONIC SUBSYSTEM IN THE PANAIA TORNADO**  
W Bender *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 8 p

Avail NTIS HC A11/MF A01

The Secondary Power System Control Unit is discussed with emphasis on system configuration. The automatic starting cycle of the APU operation of the accessory drive gearboxes under well defined speed and acceleration conditions as well as the starting phase of the aircraft engines are described. RCT

**N80-26311#** Societe Microturbo, Toulouse (France)  
**A NEW FUEL SUPPLY CONTROL SYSTEM FOR SMALL TURBOMACHINES [NOUVEAU SYSTEME DE COMMANDE DE DEBIT DE CARBURANT POUR PETITES TURBOMACHINES]**

F Arnaud, J Gonzales, and B Secher *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 13 p *In* FRENCH

Avail NTIS HC A11/MF A01

Small turbomachines used as starting systems or as autonomous power groups require specific devices for controlling fuel flow. The constraints proper to these turbomachines and the different solutions possible are reviewed. The underlying principle and operations are described for an original system which is composed of an electropump whose speed can be varied by an electronic device and a simplified pressure differential regulator. The main problems encountered in two particular applications are discussed. Transl by A R H

**N80-26312#** Plessey Aerospace Ltd Titchfield (England)  
**TRANSDUCERS FOR ENGINE CONTROL SYSTEMS**

G E Davies *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 12 p

Avail NTIS HC A11/MF A01

Some active fluidic transducers which measure the fundamental nondimensional quantities required for engine control systems are described. The use of these transducers offers a true nondimensional measurement of engine performance and allows the system designer a freer choice of control parameters. RCT

**N80-26313#** Pierburg Luftfahrtgeraete Union G m b H Neuss (West Germany)

**A COMBINED PARALLEL-DIGITAL AND PULSE-DURATION MODULATED FUEL METERING SYSTEM**

H Holzem *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 6 p refs

Avail NTIS HC A11/MF A01

A fuel metering system is presented which is controlled parallel-digitally by a computer. This system is preferably suited for small and medium size engines. High accuracy requirements coupled with both robust and simple construction are met. The design and functional description is supplemented by the laboratory test results so far achieved. RCT

**N80-26314#** Societe Nationale d Etude et de Construction de Moteurs d Aviation Suresnes (France)

**THE APPLICATION OF MICROPROCESSORS TO THE REGULATION OF MILITARY AIRCRAFT ENGINES THE DESIGN OF ELECTRONIC REGULATORS [APPLICATION DES MICROPROCESSEURS A LA REGULATION DES MOTEURS D'AVIONS MILITAIRES CONCEPTION DES REGULATEURS ELECTRONIQUES]**

J M Collin and B Gaj *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 16 p refs *In* FRENCH

Avail NTIS HC A11/MF A01

The availability of highly integrated circuits offers the designer new possibilities for rationally defining automata numerically integrated in the engine regulating system. The architecture of these automata is defined by simultaneously taking into consideration functional specifications, operational specifications which have an important bearing on the reliability and security of missions and the technological constraints imposed by an aggressive environment. The possibilities offered by microprocessors are illustrated with a summary description of three types: a microcomputer type regulator, a multimicroprocessor system and a regulator with a data processor. Transl by A R H

**N80-26315#** Hawker Siddeley Dynamics Ltd Hatfield (England)  
**THE DESIGN CONCEPT AND EXPERIMENTAL RESULTS USING THE INTEL 8080/8085 MICROPROCESSOR**

Nicholas A Justice *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 9 p

Avail NTIS HC A11/MF A01

Prototype flight equipment was built using the 8080A and is flying with full authority in a twin engine helicopter. Isochronous load sharing on torque with simultaneous data logging output of transducer inputs and control functions was provided for monitoring purposes. This detailed background provided valuable insight to the true flexibility of a microprocessor controller and also illustrated any shortcomings that the later generation devices will need to overcome. RCT

**N80-26316\*#** Air Force Aero Propulsion Lab Wright-Patterson AFB, Ohio

**DESIGN, EVALUATION AND TEST OF AN ELECTRONIC, MULTIVARIABLE CONTROL FOR THE F100 TURBOFAN ENGINE**

Charles A Skira (Systems Control, Inc Palo Alto Calif), Ronald L DeHoff, and W Earl Hall Jr (Systems Control Inc Palo Alto Calif) *In* AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 21 p refs. Sponsored in part by NASA

Avail NTIS HC A11/MF A01 CSCL 21E

A digital multivariable control design procedure for the F100 turbofan engine is described. The controller is based on locally linear synthesis techniques using linear quadratic regulator design methods. The control structure uses an explicit model reference form with proportional and integral feedback near a nominal trajectory. Modeling issues, design procedures for the control law and the estimation of poorly measured variables are presented. RCT

**N80-26317#** Pisa Univ (Italy)  
**ENGINE INTAKE CONTROL DESIGN FOR ADVANCED FIGHTER AIRCRAFT**

Dino Dini and R Lazeretti /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 11 p refs (For primary document see N80-26306 17-07)  
 Avail NTIS HC A11/MF A01

The factors influencing variable geometry intake design for fighter aircraft over their flight velocity profile are reviewed. Separate operating performance ranges depending on the positions of the changeover valves ramps and doors are analyzed for an acceptable design compromise. A criterion for prediction of airframe integration effects on inlet stability with application to advanced fighter aircraft is presented and discussed. To accommodate desired flow changes through the engine as flight speed altitude and climatic conditions change the control of intake is studied and designed taking into account mutual interferences between propulsion units and controlled elements. Airframe/propulsion integration in fighter aircraft is considered in the design of intake control. MG

**N80-26318#** Centre d'Etudes et de Recherches Toulouse (France) Dept d'Automatique

**DETERMINING THE OPTIMAL CONTROL LAWS FOR SETTING THE RPM'S OF A TURBOJET ENGINE [DETERMINATION DE LOIS OPTIMALES DE MONTEE EN REGIME D'UN TURBOREACTEUR]**

C Barrouil /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 4 p refs In FRENCH

Avail NTIS HC A11/MF A01

Two operational modes can be distinguished for a simple body turbojet engine without afterburning: changing the limits and regulating the limits. A rapid change of limits is desirable but a suitable margin of safety must be assured during the transition and the engine must be left in a practically stabilized state after the transition. The engine controls are the fuel flow and the tail pipe section. They are released by actuators which are themselves controlled by a digital or analog computer or electromechanically. The control laws are not sought for the actuators directly but for the fuel flow and the optimal tail pipe section. The laws determined are those displayed on the actuators. Transl by A R H

**N80-26319#** Motoren- und Turbinen-Union Muenchen G m b H (West Germany)

**MODE CONTROL A FLEXIBLE CONTROL CONCEPT FOR MILITARY AIRCRAFT ENGINES**

Klaus Bauerfeind /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 9 p

Avail NTIS HC A11/MF A01

An engine control concept (mode control) which will minimize the aircraft performance penalties due to normal engine matching to severe handling requirements is described. In mode control these penalties are reduced by matching the engine closer to the optimum steady state performance of the aircraft. Extreme flight conditions are registered and signalled to an electronic control system. This control system then trims and overrides the normal control laws in order to provide the necessary margins required for safe operation so long as the extreme condition prevails. In order to implement mode control successfully the response rates of the engine variables or trims must be compatible with the requirements, i.e., the respective rates at which a certain problem can develop. Because of the type of computing required a digital control system is more suitable for this task than an analogue one. The example of a military three spool by-pass engine equipped with an afterburner is presented. MG

**N80-26320#** Smiths Industries Ltd Basingstoke (England) Aviation Div

**REDUNDANCY CONCEPTS IN FULL AUTHORITY ELECTRONIC ENGINE CONTROL, PARTICULARLY DUAL REDUNDANCY**

E S Eccles E D Simons (Dowty and Systems Cheltenham, England) and J F O Evans /n AGARD Advan Control Systems

for Aircraft Powerplants Feb 1980 14 p

Avail NTIS HC A11/MF A01

The available methods of redundancy in full authority electronic engine controls and the reasons for their selection in particular applications are surveyed with particular reference to the effects of the electro-hydraulic interface. Various dual redundant arrangements, Adour and Pegasus engine controls and helicopter controls are specifically addressed. System safety and the variety of failure survival strategies which can be employed are considered. In general ease of analysis is accompanied by simple failure survival strategies. More complex strategies may result in higher system availabilities and there is therefore a trade-off to conduct between non-recurring design cost and system availability in service. The impact of more flexible system architectures due to microprocessors and military requirements are discussed and the direction of future development is indicated. MG

**N80-26321#** Societe Nationale Industrielle Aerospatiale Toulouse (France) Bureau d'Etudes Installation Motrice

**CONTROL OF THE ENGINES FOR THE NEW AIRBUS FAMILY [CONDUITE DES MOTEURS DE LA NOUVELLE FAMILLE AIRBUS]**

Jean-Claude Tchavdarov /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 14 p refs

Avail NTIS HC A11/MF A01

The general problem of engine performance is considered including the objectives to be satisfied and the basic principles to be retained. The operation of the A-300 aircraft is described with emphasis on gas control, hydromechanical regulation, principal instrumentation, motors, the theory and choice of performance parameters, associated automatic systems, and operational procedures. Solutions currently envisioned for future AIRBUS A-310 are presented particularly the introduction of partially electronic regulation. Transl by A R H

**N80-26323#** Lucas Aerospace Ltd Birmingham (England) A UNIFIED DIGITAL APPROACH TO THE CONTROL OF A DIVERSE RANGE OF ENGINES

M J Joby and R D Powell /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 12 p refs

Avail NTIS HC A11/MF A01

Digital control systems for gas turbine engines are examined in the light of the commonality of hardware and software requirements between diverse applications. Alternative control configurations for a main gas turbine engine are examined including (1) a full hydromechanical (2) hydromechanical with a supervisory electronic trim (3) a full electronic with a hydromechanical backup and (4) a full electronic with a further electronic backup. Through a consideration of the digital control unit structure for the different configurations the commonality in hardware requirements is demonstrated. In addition, by having modules for each input and output a standard pack of cards can be created from which a selection can be made for any application. Self monitoring and testing capabilities in digital systems are examined and examples from different applications are discussed, including helicopters, civil transport engines, industrial gas turbines, and military power plants. MG

**N80-26324#** Bodenseewerk Geratetechnik G m b H Ueberlingen (West Germany)

**ADVANTAGES OF THE DIGITAL TECHNOLOGY FOR THE REALIZATION OF ENGINE CONTROL SYSTEMS**

G Dahl and H Drtel /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 8 p

Avail NTIS HC A11/MF A01

Requirements to be met by the digital control units and the advantages resulting therefrom are discussed. It is shown that with respect to their capacity future digital engine control units have essential advantages (integrated engine-flight control functions, reliability, adjustments) compared to hydromechanical and analog electronic systems. Digital control units have a

higher efficiency but will probably be of the same volume than actual control units. A considerable reduction of the interface and its volume will only be possible if the environment of the digital computer is digitalized as well that means if sensors are provided with a digital pick-up and if a direct digital control of the actuators and the displays is available M G

**N80-26325#** Rolls-Royce Ltd Leavesden (England) Aero Div  
**THE DIGITAL CONTROL SYSTEM AS PART OF AN INTEGRATED ACCESSORY FIT FOR FUTURE ENGINES**  
 M P Perks and T G Morton /n AGARD Advan Control Systems for Aircraft Powerplants Feb 1980 11 p ref

Avail NTIS HC A11/MF A01

The development of digital control systems for gas turbine engines is discussed. It is suggested that the traditional approach of designing the control system in isolation from the other accessories on a gas turbine engine may not provide the most cost effective total solution for an engine having a digital control system. It is considered that the integrity of the digital control can be maintained while providing additional functions not associated with its prime control task. This could allow the development of advanced monitoring systems to minimize life cycle costs and achieve maximum aircraft utilization. The application of these principles to helicopter engines is discussed and an arrangement proposed which could provide substantial benefits both to the helicopter pilot and to the ground crew. Pilot work-load would be substantially reduced by advising him of engine or aircraft management factors on a need to know basis. Operators would benefit from regular information on the operational status of the engines. M G

**N80-26327\*#** Optimization Software Inc Los Angeles Calif  
**OPTIMIZATION AND SIMULATION OF FLIGHT CONTROL LAWS UNDER PARAMETER UNCERTAINTY AND EXTERNAL DISTURBANCES Final Report**  
 1 Dec 1979 136 p refs  
 (Contract NASw-3158)  
 (NASA-CR-163292) Avail NTIS HC A07/MF A01 CSCL 01C

Several tasks pertinent to flight control in parameter uncertainty and wind-gust loading were successfully completed. Identification algorithms for extracting stability and control derivatives from flight data taking gust loading into account were developed. They were verified by simulation and evaluated thoroughly on actual flight data taken on a Lockheed Jet Star flying in turbulence. In particular the need for automatically generated dither-like inputs was studied. Criteria for performance evaluation using stochastic models were developed for gust alleviation as well as handling quantities. Algorithms for assessing degradation in performance due to parameter uncertainty were developed and evaluated using flight test data. Author

**N80-26328\*#** National Aeronautics and Space Administration  
 Hugh L Dryden Flight Research Center, Edwards Calif  
**DEVELOPMENT AND FLIGHT TEST RESULTS OF AN AUTOHOTTLE CONTROL SYSTEM AT MACH 3 CRUISE**  
 Glenn B Gilyard and John J Burken Jul 1980 40 p refs  
 (NASA-TP-1621, H-1090) Avail NTIS HC A03/MF A01 CSCL 01C

Flight test results obtained with the original Mach hold autopilot designed the YF-12C airplane which uses elevator control and a newly developed Mach hold system having an autothrottle integrated with an altitude hold autopilot system are presented. The autothrottle tests demonstrate good speed control at high Mach numbers and high altitudes while simultaneously maintaining control over altitude and good ride qualities. The autothrottle system was designed to control either Mach number or knots equivalent airspeed (KEAS). Excellent control of Mach number or KEAS was obtained with the autothrottle system when combined with altitude hold. Ride qualities were significantly better than with the conventional Mach hold system. E D K

**N80-26329#** Messerschmitt-Boelkow-Blohm G m b H Otto-brunn (West Germany) Unternehmensbereich Flugzeuge  
**INTERACTIVE DESIGN SYSTEM FOR AIRCRAFT DYNAMIC CONTROL PROBLEMS**  
 Wolfgang J Kubbat, G Oesterheld and U Korte 6 Sep 1979  
 19 p Presented at SMP of AGARD Meeting, Neubiberg West Germany 3-6 Sep 1979  
 (MBB-FE-324/S/Pub/11) Copyright Avail NTIS  
 HC A02/MF A01

An interactive system for control law design and synthesis is described. Available methods (continuous discrete, time domain-frequency domain) are reviewed and the system is illustrated. Selection of method (ie discrete vs continuous complete vs incomplete state feedback optimal control vs pole-placement etc) is followed by a dialog designer-computer with immediate results presented in numerical and graphical form (plots, print-outs). Each result is stored and can be compared with any other via dual plots. The system also allows the input of disturbance like white or colored noise ramps steps sine and cosine combinations. There is no practical restriction on the number of state variables. A helicopter control problem is used to demonstrate use of the system. Author (ESA)

**N80-26330#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France)  
**TECHNICAL EVALUATION REPORT ON THE FLUID DYNAMICS PANEL SYMPOSIUM ON AERODYNAMIC CHARACTERISTICS OF CONTROLS**  
 H H B M Thomas Mar 1980 18 p refs  
 (AGARD-AR-157 ISBN-92-835-1351-7) Avail NTIS  
 HC A02/MF A01

The different ways in which active control technology can impact aircraft design and tasks facing the aerodynamist are reviewed, including the effect of aircraft configuration on relaxed stability and the effect of control integration on aerodynamics. The correlation of flight and wind tunnel control effectiveness measurements is considered as well as difficulties in predicting transonic flow and attached flow. A R H

**N80-26331#** Yang (Nai C) and Associates New York, NY  
**NONDESTRUCTIVE EVALUATION OF AIRPORT PAVEMENTS VOLUME 3. OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC**  
 David Yang Sep 1979 47 p  
 (Contract DOT-FA77WA-3964)  
 (AD-A079591 FAA-RD-78-154-Vol-3) Avail NTIS  
 HC A03/MF A01 CSCL 01/5

Sensitivity analysis of aircraft parameters on functional pavement design is discussed. The MLGPAV program is an integrated system which is data independent based on defined mathematical models and operational logic. The input data is divided into job and universal default inputs. The job inputs consists of only the aircraft data such as (1) forecast of aircraft movements (2) maximum takeoff weight (3) natural frequency of aircraft at tire pavement interface (4) tire pressure of main landing gear wheel (5) wheel configuration of main landing gear and (6) gear spacing. The default system contains all of the data independent of the aircraft such as (1) regional cost values (2) types of facility runway taxiway apron (3) navigation system (4) operation speed (5) roughness and maintenance standards (6) subgrade conditions and (7) airport traffic distribution. A unified mechanistic method is used to design five types of functional pavements for identical service requirements on riding quality and maintenance needs. They are (1) asphalt pavements in southern or northern region (2) concrete pavements on stabilized or aggregate base and (3) full depth stabilized base pavement. J M S

**N80-26332#** Oregon Univ Eugene Dept of Psychology  
**LOW COST SIMULATION OF PILOTING TASKS**  
 Gerald M Reicher Brian J Davidson Harold L Hawkins and Gilbert Osgood 21 Jan 1980 29 p refs

N80-26334

(Contract N00014-77-C-0643)  
(AD-A080856 TR-4) Avail NTIS HC A03/MF A01 CSCL  
05/9

An attempt was made to validate a low cost, low fidelity computer driven flight simulator. The validation is required so that the simulator can be used as a criterion task to see whether we can predict flight performance on the basis of performance on other tests of individual cognitive ability like attentional flexibility, visual representational skill, priority setting and planning. The simulator was based on instrument flying rather than visual contact flying and incorporated secondary tasks to further tax the pilots capacity. Simulator performance is correlated with hours of flight training, the best correlations coming from conditions which impose additional task demands. GRA

**N80-26334#** Johns-Manville Sales Corp Denver Colo  
Research and Development Center  
**HEAT RECLAMATION FROM FLIGHT SIMULATORS Final  
Report, 1 Sep 1978 - Mar 1980**  
P B Shepherd Mar 1980 7 p  
(Contract DAAK70-78-D-0002)  
(AD-A081754) Avail NTIS HC A02/MF A01 CSCL 05/9

The objective of Task Order no 9 was to conduct a market and literature survey to determine the current state-of-the-art on heat reclamation devices for air conditioners used with flight simulators. Applicability of such devices to each flight simulator facility will be evaluated and will include energy savings cost effectiveness, operation maintenance, safety code compliance and product warranty limitation considerations. GRA

**N80-26335#** Air Force Human Resources Lab, Williams AFB  
Anz Flying Training Div  
**APPLICATION OF FLIGHT SIMULATOR RECORD/  
PLAYBACK FEATURE Interim Report, Jan - May 1979**  
Ronald G Hughes Samuel T Hannan and William E Jones  
Dec 1979 16 p refs  
(AF Proj 1123)  
(AD-A081752 AFHRL-TR-79-52) Avail NTIS  
HC A02/MF A01 CSCL 05/9

Undergraduate Pilot Training (UPT) students acquired a complex visual task in ASPT under one of three instructional conditions which differed in their use of an automated record/playback feature. The study evaluated differences in performance resulting from (1) periodic, repeated use of a recorded, instructor-presented demonstration, (2) periodic use of replay of student performance and (3) use of equivalent training time for additional practice. The data indicated little or no instructional value associated with repeated exposures to the original demonstration of the task to be learned. While the (replay) condition produced terminal performances with fewer errors on the average than the (demo) condition, differences between (practice) and (replay) groups were not statistically significant. The surprising finding of the study was the effectiveness of simple practice relative to that of the two, so-called (instructional) conditions. These data would suggest that, at least in some instances, a training approach that provided only for basic performance feedback e.g. a (score) might be equally as effective as one with provision for presenting repeated access to recorded demonstrations and/or replays of previous performance. GRA

**N80-26336#** Aeronautical Systems Div Wright-Patterson AFB,  
Ohio Technical and Resources Management Div  
**AERONAUTICAL SYSTEMS TECHNOLOGY NEEDS-TEST  
FACILITIES AND TEST EQUIPMENT Annual Report**  
Donald C Kittinger Feb 1980 56 p refs Supersedes  
ASD-TR-79-5039  
(AD-A083553 ASD-TR-80-5011 ASD-TR-79-5039) Avail  
NTIS HC A04/MF A01 CSCL 14/2

This report is part of a compilation of formalized Technology Needs (TN) covering Equipment Subsystems as identified by the Aeronautical Systems Division. They are based on development/operational experience, system studies and new concepts - all related to future system applications. Their presentation is to serve a threefold purpose: i.e. guidance for technology program proven development potential and engineering data/requirements essential for technology use in systems. The identified needs

delineate progress desired in performance control design flexibility safety and cost. GRA

**N80-26391\*#** Little (Arthur D) Inc Cambridge Mass  
**AN ASSESSMENT OF THE RISK ARISING FROM ELECTRICAL EFFECTS ASSOCIATED WITH THE RELEASE OF CARBON FIBERS FROM GENERAL AVIATION AIRCRAFT FIRES**  
Donald Rosenfield and Joseph Fiksel Feb 1980 104 p  
(Contract NAS1-15380)  
(NASA-CR-159206) Avail NTIS HC A06/MF A01 CSCL  
11D

A Poisson type model was developed and exercised to estimate the risk of economic losses through 1993 due to potential electric effects of carbon fibers released from United States general aviation aircraft in the aftermath of a fire. Of the expected 354 annual general aviation aircraft accidents with fire projected for 1993, approximately 88 could involve carbon fibers. The average annual loss was estimated to be about \$250 (1977 dollars) and the likelihood of exceeding \$107 000 (1977 dollars) in annual loss in any one year was estimated to be at most one in ten thousand. Author

**N80-26392\*#** Little (Arthur D) Inc Cambridge Mass  
**AN ASSESSMENT OF THE RISK ARISING FROM ELECTRICAL EFFECTS ASSOCIATED WITH CARBON FIBERS RELEASED FROM COMMERCIAL AIRCRAFT FIRES**  
Ashok S Kalelkar Joseph Fiksel Donald Rosenfield David L Richardson and John Hagopian Feb 1980 144 p  
(Contract NAS1-15380)  
(NASA-CR-159205 C-81857) Avail NTIS HC A07/MF A01  
CSCL 11D

The risks associated with electrical effects arising from carbon fibers released from commercial aviation aircraft fires were estimated for 1993. The expected annual losses were estimated to be about \$470 (1977 dollars) in 1993. The chances of total losses from electrical effects exceeding \$100 000 (1977 dollars) in 1993 were established to be about one in ten thousand. Author

**N80-26393\*#** Operations Research Inc Silver Spring Md  
**ADVANCED RISK ASSESSMENT OF THE EFFECTS OF GRAPHITE FIBERS ON ELECTRONIC AND ELECTRIC EQUIPMENT**  
L Poczinki Merrill Cornell and Lawrence Kaplan May 1980  
167 p refs  
(Contract NAS1-15379)  
(NASA-CR-159210) Avail NTIS HC A08/MF A01 CSCL  
11D

An assessment of the risk associated with accidents involving aircraft with carbon fiber composite structural components is examined. The individual fiber segments cause electrical and electronic equipment to fail under certain operating conditions. A Monte Carlo simulation model was used to computer the risk. Aircraft accidents with fire release of carbon fiber material entrainment of carbon fibers in a smoke plume transport of fibers downwind transfer of some fibers into the interior of buildings failures of electrical and electronic equipment and economic impact of failures are discussed. Risk profiles were prepared for individual airports and the Nation. The vulnerability of electrical transmission equipment to carbon fiber incursion and aircraft accident total costs is investigated. B D

**N80-26394\*#** Little (Arthur D) Inc Cambridge Mass  
**AS ASSESSMENT OF POWER SYSTEM VULNERABILITY TO RELEASE OF CARBON FIBERS DURING COMMERCIAL AVIATION ACCIDENTS**  
Gerald R Larocque Jan 1980 41 p refs  
(Contract NAS1-15380)  
(NASA-CR-159208) Avail NTIS HC A03/MF A01 CSCL  
11D

The vulnerability of a power distribution system in Bedford and Lexington Massachusetts to power outages as a result of exposure to carbon fibers released in a commercial aviation accident in 1993 was examined. Possible crash scenarios at Logan Airport based on current operational data and estimated

carbon fiber usage levels were used to predict exposure levels and occurrence probabilities. The analysis predicts a mean time between carbon fiber induced power outages of 2300 years with an expected annual consequence of 0.7 persons losing power. In comparison to historical outage data for the system, this represents a 0.007% increase in outage rate and 0.07% increase in consequence. Author

**N80-26431#** Pratt and Whitney Aircraft Group West Palm Beach Fla

**APPLICATION OF RAPIDLY SOLIDIFIED ALLOYS**

C M Adam R G Bourdeau, J W Broch and A R Cox Jun 1979 25 p

(Contract F33615-76-C-5136)

(AD-A083496 PWA-FR-12127) Avail NTIS HC A02/MF A01 CSCL 11/6

This program is being conducted for the purpose of applying the principle of rapid solidification to aluminum and iron alloy powder and subsequent development of stronger alloy compositions for fan blade application (Al alloys) and higher speed bearing materials (Fe alloys). Centrifugal atomization and forced convective cooling are being used to produce the fast cooled powder. During this report period adaptation of the RSR process to aluminum and iron systems was continued. The evaluation of the first aluminum alloy matrix was partially completed and a second matrix was selected. Hardness testing and microstructural evaluation of Fe alloys was performed. GRA

**N80-26585#** Ohio State Univ., Columbus Electroscience Lab

**A CAVITY-TYPE BROADBAND ANTENNA WITH A STEERABLE CARDIOID PATTERN Final Report**

B A Munk and C J Larson Dec 1979 92 p refs

(Contract N00014-78-C-0855)

(AD-A083226 ESL-711559-2) Avail NTIS HC A05/MF A01 CSCL 09/5

This report describes a new vertically polarized cavity-type antenna with a cardioid pattern steerable in the horizontal plane. The front-to-back ratio is better than 15 dB over a 25% bandwidth and better than 20 dB within half that total bandwidth. The average gain is approximately 2 dB above a monopole and the VSWR-2 except at the very end of the band. The beamwidth in the front as well as the nullwidth in the back is so wide that the beam is directed only in the four cardinal directions in the horizontal plane. A working model will be delivered to NRL as part of the contract. GRA

**N80-26599#** National Aeronautics and Space Administration Hugh L Dryden Flight Research Center, Edwards Calif

**PORTABLE DEVICE FOR USE IN STARTING AIR-START UNITS FOR AIRCRAFT AND HAVING CABLE LEAD TESTING CAPABILITY Patent**

William R Rosier (Serv-Air Inc Edwards Calif) and George G Volk inventors (to NASA) (Serv-Air Inc Edwards Calif) Issued 20 May 1980 7 p Filed 9 Mar 1978 Supersedes N78-19166

(16 - 10 p 1263) Sponsored by NASA

(NASA-Case-FRC-10113-1 US-Patent-4,204 154

US-Patent-Appl-SN-885066 US-Patent-Class-324-51) Avail

US Patent and Trademark Office CSCL 09C

A portable device for starting aircraft engines and the like is disclosed. The device includes a lead testing and motor starting circuit characterized by (1) a direct current voltage source, (2) a pair of terminal plugs connected with the circuit (each being characterized by a first second and third terminal) (3) a pair of manually operable switches for connecting the first terminal of each plug of the pair to the positive side of the voltage source (4) a circuit lead connecting to the second terminal of each plug the negative side of said source (5) a pair of electrical cables adapted to connect said first and second terminals of each plug to an air-start unit and means for connecting each cable of the pair of cables between the first terminal of one plug and the third terminal of the other plug of the pair and (6) a second pair of manually operable switches for selectivity connecting the third terminal of each plug of the pair to the negative side of the voltage source.

Official Gazette of the U S Patent and Trademark Office

**N80-26638\*#** Georgia Inst of Tech Atlanta Engineering Experiment Station

**A 94/183 GHz AIRCRAFT RADIOMETER SYSTEM FOR PROJECT STORM FURY Final Technical Report, 20 Sep 1976 - 30 Apr 1980**

J A Gagliano J A Stratigos R E Forsythe J M Schuchardt

J M Welch and D O Gallentine Apr 1980 96 p

(Contract NAS5-23710)

(NASA-CR-160000) Avail NTIS HC A05/MF A01 CSCL 14B

A radiometer design suitable for use in NASA's WB-57F aircraft to collect data from severe storm regions was developed. The design recommended was a 94/183 GHz scanning radiometer with 3 IF channels on either side of the 183.3 GHz water vapor line and a single IF channel for a low loss atmospheric window channel at 94 GHz. The development and construction of the 94/183 GHz scanning radiometer known as the Advanced Microwave Moisture Sounder (AMMS) is presented. The radiometer scans the scene below the aircraft over an angle of  $\pm$  or - 45 degrees with the beamwidth of the scene viewed of approximately 2 degrees at 94 GHz and 1 degree at 183 GHz. The AMMS data collection system consists of a microcomputer used to store the radiometer data on the flight cartridge recorder, operate the stepper motor driven scanner, and collect housekeeping data such as thermistor temperature readings and aircraft time code. B D

**N80-26658\*** National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio

**COMPOSITE SEAL FOR TURBOMACHINERY Patent**

Robert C Bill and Lawrence P Ludwig inventors (to NASA)

Issued 10 Jun 1980 4 p Filed 4 Aug 1978 Supersedes

N78-31103 (16 - 22, p 2897) Division of US Patent Appl

SN-801290 filed 27 May 1977 US Patent-4 135 851

(NASA-CASE-LEW-12131-2, US-Patent-4 207 024

US-Patent-Appl-SN-931090 US-Patent-Class-415-174

US-Patent-Class-415-196 US-Patent-Appl-SN-801290

US-Patent-4 135 851) Avail US Patent and Trademark Office

CSCL 11A

A gas path seal suitable for use with a turbine engine or compressor is provided. A shroud wearable or abradable by the abrasion of the rotor blades of the turbine or compressor shrouds the rotor blades. A compliant backing surrounds the shroud. The backing is a compliant material covered with a thin ductile layer. A mounting fixture surrounds the backing.

Official Gazette of the U S Patent and Trademark Office

**N80-26680#** Lockheed-California Co Burbank

**SUMMARY OF 1979 INDEPENDENT RESEARCH ON RISK ANALYSIS METHODS**

L Bakow and J C Ekvall 22 Dec 1977 43 p refs

(LR-28390) Avail NTIS HC A03/MF A01

A statistical analysis was conducted on aluminum superconducting-nonconducting (S-N) fatigue test data. The scatter (log normal standard deviation) for S-N data is comparable to the scatter for spectrum fatigue test data. However, the log normal standard deviation of the S-N data was larger than spectrum fatigue data for higher levels of confidence. Scatter factors to be applied to fatigue test results were worked out for various levels of probability and confidence. The scatter characteristics of the K sub Ic aluminum fracture toughness data was also evaluated. A statistical procedure was developed to determine A-basis and B-basis fracture toughness values. B D

**N80-26687** City Univ., London (England) Dept of Mechanical Engineering

**RECENT ADVANCES IN HELICOPTER VIBRATION CONTROL**

G T S Done In Shock and Vibration Inform Center The

Shock and Vibration Dig V 12 No 1 Jan 1980 p 21-25

refs (For primary document see N80-26685 17-39)

Avail SVIC Code 5804, Naval Research Lab Washington

D C 20375 \$15 00/set, annual rate \$100 00

The control of forced vibration excitation and response of helicopter airframes is addressed. Methods and hardware for

vibration control including isolators absorbers, direct rotor control and structural modification are considered J M S

**N80-26697\*#** Virginia Polytechnic Inst and State Univ Blacksburg  
**NONLINEAR TRANSIENT ANALYSIS BY ENERGY MINIMIZATION A THEORETICAL BASIS FOR THE ACTION COMPUTER CODE**

Manohar P Kamat Jul 1980 109 p refs  
 (Contract NAS1-15080 Grants NGR-47-004-14 NSG-1546)  
 (NASA-CR-3287) Avail NTIS HC A06/MF A01 CSCL 20L

The formulation basis for establishing the static or dynamic equilibrium configurations of finite element models of structures which may behave in the nonlinear range are provided With both geometric and time independent material nonlinearities included the development is restricted to simple one and two dimensional finite elements which are regarded as being the basic elements for modeling full aircraft-like structures under crash conditions Representations of a rigid link and an impenetrable contact plane are added to the deformation model so that any number of nodes of the finite element model may be connected by a rigid link or may contact the plane Equilibrium configurations are derived as the stationary conditions of a potential function of the generalized nodal variables of the model Minimization of the nonlinear potential function is achieved by using the best current variable metric update formula for use in unconstrained minimization Powell's conjugate gradient algorithm, which offers very low storage requirements at some slight increase in the total number of calculations, is the other alternative algorithm to be used for extremely large scale problems A R H

**N80-26885\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**SUPPORTING STATEMENT FOR COMMUNITY STUDY OF HUMAN RESPONSE TO AIRCRAFT NOISE**

Thomas K Dempsey Richard DeLoach and David G Stephens Mar 1980 30 p  
 (NASA-TM-81803) Avail NTIS HC A03/MF A01 CSCL 13B

A study plan for quantifying the relationship between human annoyance and the noise level of individual aircraft events is studied The validity of various noise descriptors or noise metrics for quantifying aircraft noise levels are assessed E D K

**N80-26971#** Environmental Protection Agency Ann Arbor Mich Standards Development and Support Branch  
**EVALUATION OF HC (HYDROCARBON) CONTROL STRATEGIES FOR GENERAL AVIATION PISTON ENGINES**

Richard S Wilcox Jul 1979 19 p refs  
 (PB80-155393 EPA-AA-SDSB-79-17) Avail NTIS HC A02/MF A01 CSCL 01C

The cost effectiveness of controlling hydrocarbon (HC) exhaust emissions from general aviation piston powered aircraft is evaluated Recent analyses have indicated that these aircraft are not major contributors to violations of the National Ambient Air Quality Standard for CO which adversely affect the public health and welfare Although HC emissions from general aviation are also small when compared to many other sources the oxidant problem is so widespread that all reasonable controls should be implemented GRA

**N80-27212** Societe Nationale Industrielle Aerospatiale Paris (France) Direction Centrale Industrielle  
**VALUE ANALYSIS FOR THE AIRCRAFT AIRBUS [L'ANALYSE DE LA VALEUR DANS UN PROGRAMME INTERNATIONAL]**

Robert Tassinari 1979 34 p In FRENCH Presented at Soc of Am Value Eng Intern Conf on Save Proc Vol 19 1979 (SNIAS-792-501-105) Avail NTIS HC A03

The implementation of an agreement among Germany England France Netherlands and more recently Spain, to develop a transport aircraft is discussed with emphasis on the economic and technical aspects involved The method in which the various tasks were assigned and performed is described Project and

value engineering considerations are reviewed as well as the factors determining the choice of materials and the methods for optimizing the system The management of modification procedures is described and some value analysis examples are included A R H

**N80-27274#** Battelle Columbus Labs Ohio  
**THE GENERAL AVIATION DYNAMIC MODEL VOLUME 2 TECHNICAL REPORT Final Report, 2 Sep 1977 - 30 May 1979**

Michael A Duffy and Jane H McCreery 30 May 1979 169 p refs  
 (Contract DOT-FA77WA-4043)  
 (AD-A073544 FAA-AVP-79-8-Vol-2) Avail NTIS HC A08/MF A01 CSCL 01/2

A detailed description of the General Aviation Dynamics (GAD) model is given It contains a complete set of statistics including actual data for the estimated causal relationships within each sector of the model Also illustrated is how the GAD model can be used to evaluate alternative policy actions The model is a dynamic simulation interactive computer model built upon the cause-effect interactions displayed between various sectors of the general aviation system GRA

**N80-27277** Pennsylvania State Univ University Park  
**A NUMERICAL AND EXPERIMENTAL STUDY OF THE TURBULENT WAKES OF TURBOMACHINERY ROTOR BLADES, ISOLATED AIRFOILS, AND A CASCADE OF AIRFOILS Ph D Thesis**

Chunill Mah 1980 341 p  
 Avail Univ Microfilms Order No 8015798

Three turbulence models were employed to obtain closure of the governing equations The first model was comprised of transport equations for the turbulent kinetic energy and the rate of energy dissipation and the second and third models were comprised of equations for the rate of turbulent kinetic energy dissipation and Reynolds stresses respectively The second model handles the convection and diffusion terms in the Reynolds stress transport equation collectively while the third model handles them individually All three models were modified for the effect of streamline curvature The rotation originated redistribution terms were added in the transport equation of Reynolds stresses of the second and third models The turbulent wakes of an isolated airfoil and a cascade of airfoils are handled as simpler cases of the general rotating three dimensional wake The numerical results demonstrate that the second and third models provide accurate predictions but the computer time and memory storage can be considerably saved with the second model Dissert Abstr

**N80-27278** California Univ Los Angeles  
**AIRFOILS AT SONIC VELOCITY Ph D Thesis**

Egbert Sau-Nam Tse 1980 103 p  
 Avail Univ Microfilms Order No 8016054

A method for calculating flows and corresponding airfoil shapes where the free-stream Mach number is unity is described The calculation is done in two parts both are on hodograph planes The basic equation is the Tricomi equation and is solved numerically In one part which corresponds to the front section of the airfoil the equation is solved in a region where it changes type The algorithm developed is thus type dependent The implicit difference scheme formulates uses a rectangular grid in the elliptic region and a characteristic grid in the hyperbolic region In the other part which corresponds to the rear part of the airfoil a method of characteristics is used The boundary curve is prescribed in the hodograph and the shape of the airfoil is determined afterwards This is useful in airfoil design The computed result for a thin wedge is in good agreement with analytic results obtained by others Airfoil with convex surfaces and parabolic noses are generated Their center of pressure distribution lift coefficient drag coefficient and moment coefficient are also obtained Dissert Abstr

**N80-27280\*#** Boeing Aerospace Co Seattle Wash  
**AN IMPROVED PANEL METHOD FOR THE SOLUTION OF THREE-DIMENSIONAL LEADING EDGE VORTEX FLOWS**

**VOLUME 2 USER'S GUIDE AND PROGRAMMER'S DOCUMENT Report, Dec 1977 - May 1979**

E N Tinoco P Lu and F T Johnson Washington NASA  
Jul 1980 176 p refs  
(Contracts NAS1-15169 NAS1-15275)  
(NASA-CR-3279) Avail NTIS HC A09/MF A01 CSCL 01A

A computer program developed for solving the subsonic three dimensional flow over wing-body configurations with leading edge vortex separation is presented. Instructions are given for the proper set up and input of a problem into the computer code. Program input formats and output are described as well as the overlay structure of the program. The program is written in FORTRAN. A R H

**N80-27281\*# Lockheed-Georgia Co., Marietta  
EXPLORATORY STUDIES OF THE CRUISE PERFORMANCE  
OF UPPER SURFACE BLOWN CONFIGURATIONS Final  
Summary Report**

J A Braden J P Hancock J E Hackett K P Burdges and  
V Lyman Washington NASA Jul 1980 191 p refs  
(Contract NAS1-13871)  
(NASA-CR-3193 LG77ER0028) Avail NTIS  
HC A09/MF A01 CSCL 01A

The data and major conclusions obtained from an experimental/analytical study of upper-surface blown (USB) configurations at cruise are summarized. The high-speed (subsonic) experimental work studying the aerodynamic effects of wing-nacelle geometric variations, was conducted around semi-span model configurations composed of diversified interchangeable components. Power simulation was provided by high pressure air ducted through closed forebody nacelles. Nozzle geometry was varied across size exit aspect ratio exit position and boattail angle. Both 3-D force and 2-D pressure measurements were obtained at cruise Mach numbers from 0.5 to 0.8 and at nozzle pressure ratios up to about 3.0. The experimental investigation was supported by an analytical synthesis of the system using a vortex lattice representation with first-order power effects. Results are also presented from a compatibility study in which a short-haul transport is designed on the basis of the aerodynamic findings in the experimental study as well as acoustical data obtained in a concurrent program. High-lift test data are used to substantiate the projected performance of the selected transport design. A R H

**N80-27282\*# Boeing Aerospace Co Seattle Wash  
AN IMPROVED PANEL METHOD FOR THE SOLUTION OF  
THREE-DIMENSIONAL LEADING-EDGE VORTEX FLOWS  
VOLUME 1 THEORY DOCUMENT Topical Report, Dec -  
May 1977**

F T Johnson P Lu, and E N Tinoco Washington NASA  
Jul 1980 123 p refs  
(Contract NAS1-15169 NAS1-15275)  
(NASA-CR-3278) Avail NTIS HC A06/MF A01 CSCL 01A

An improved panel method for the solution of three dimensional flow and wing and wing-body combinations with leading edge vortex separation is presented. The method employs a three dimensional inviscid flow model in which the configuration the rolled-up vortex sheets and the wake are represented by quadratic doublet distributions. The strength of the singularity distribution as well as shape and position of the vortex spirals are computed in an iterative fashion starting with an assumed initial sheet geometry. The method calculates forces and moments as well as detail surface pressure distributions. Improvements include the implementation of improved panel numerics for the purpose of elimination the highly nonlinear effects of ring vortices around double panel edges, and the development of a least squares procedure for damping vortex sheet geometry update instabilities. A complete description of the method is included. A variety of cases generated by the computer program implementing the method are presented which verify the mathematical assumptions of the method and which compare computed results with experimental data to verify the underlying physical assumptions made by the method. F O S

**N80-27283\*# National Aeronautics and Space Administration  
Langley Research Center Langley Station Va****EFFECT OF REYNOLDS NUMBER ON STABILITY CHARACTERISTICS OF A CRUCIFORM WING-BODY**

Robert L Stallings Jr Milton Lamb and Carolyn B Watson  
Jul 1980 111 p refs  
(NASA-TP-1683 L-13530) Avail NTIS HC A06/MF A01  
CSCL 01A

An experimental investigation was conducted to determine the effect of Reynolds number on the stability characteristics of a body with cruciform wings at large angles of attack. Pressure distributions and force and moment data (axial force not measured) are presented for Mach 1.60 and 2.70. Reynolds numbers based on body diameter from approximately 130,000 to 2,800,000 and angles of attack from 0 deg to 50 deg. In general the data show only small effects of Reynolds number throughout the range of test condition. Also discussed are force balance and pressure data that suggest a direct relationship between wind choking and the onset of a nonlinear stability variation with angle of attack. Author

**N80-27287\*# National Aeronautics and Space Administration  
Ames Research Center Moffett Field Calif  
EXPERIMENTAL STUDIES OF SCALE EFFECTS ON  
OSCILLATING AIRFOILS AT TRANSONIC SPEEDS**

Sanford S Davis Jul 1980 16 p refs  
(NASA-TM-81216 A-8259) Avail NTIS HC A02/MF A01  
CSCL 01A

Experimental data are presented on the effect of Reynolds number on unsteady pressures induced by the pitching motion of an oscillating airfoil. Scale effects are discussed with reference to a conventional airfoil (NACA 64A010) and a supercritical airfoil (NLR 7301) at mean-flow conditions that support both weak and strong shock waves. During the experiment the Reynolds number was varied from 3,000,000 to 12,000,000 at a Mach number and incidence necessary to induce the required flow. Both fundamental frequency and complete time history data are presented over the range of reduced frequencies that is important in aeroelastic applications. The experimental data show that viscous effects are important in the case of the supercritical airfoil at all flow conditions and in the case of the conventional airfoil under strong shock-wave conditions. Some frequency-dependent viscous effects were also observed. Author

**N80-27289# Detroit Diesel Allison Indianapolis Ind  
TIME-VARIANT AERODYNAMICS FOR TORSIONAL  
MOTION OF LARGE-TURNING AIRFOILS Final Report**

R L Jay M D Rothrock, R E Riffel and G T Sinnet Jan  
1980 109 p refs  
(Contract N00019-79-C-0087)  
(AD-A083766 DDA-EDR-10192) Avail NTIS  
HC A06/MF A01 CSCL 20/4

A cascade of five airfoil sections modelling the hub section of an advanced design turbine featuring a high inlet Mach number and 112 degrees of turning was evaluated at 4 steady-state conditions of varying exit Mach number and expansion ratio. The resulting steady-state airfoil surface pressures were compared to a state-of-the-art analytical prediction. A time-variant investigation was conducted at the 4 operating conditions of the steady-state experiment. Time-variant pressure signals were obtained from a Kulite-instrumented airfoil as the cascade was torsionally oscillated at four values of interblade phase angle per expansion ratio by computer-controlled electromagnetic drive systems. The dynamic pressure signals were evaluated in amplitude and phase lag (referenced to blade motion) and correlated with a state-of-the-art analytical prediction based on a flat-plate cascade. A quasi-static experiment was performed to relate the dynamic surface pressure amplitudes to those obtained by resetting the cascade to various temporal positions in the torsional cycle of oscillation. GRA

**N80-27290# Nielsen Engineering and Research Inc Mountain  
View Calif**

**DATA REPORT FOR AN EXTENSIVE STORE SEPARATION  
TEST PROGRAM CONDUCTED AT SUPERSONIC SPEEDS  
Final Report, Jun 1975 - Aug 1979**



Frederick K Goodwin and Calvin L Dyer (AFFDL) Wright-Patterson AFB Ohio AFFDL Dec 1979 292 p refs (Contract F33615-76-C-3077 AF Proj 2403) (AD-A083848 NEAR-TR-205 AFFDL-TR-79-3130) Avail NTIS HC A13/MF A01 CSCL 20/4

This report describes an extensive store separation test program conducted at Mach number range covering 1.5 to 2.5. The purpose of the program was to provide a systematic set of data which could be used to evaluate and improve analytical techniques for predicting supersonic store separation trajectories. Parent aircraft configurations tested ranged from a simple circular body mid-wing configuration without pylons and racks to a noncircular fuselage with wing flow through engine inlets and pylons and racks. The parent configuration was built up component by component so model component effects could be isolated. Flow-field survey store pressure-distribution, store force-and-moment and store trajectory data were obtained. The store tested were circular and elliptical in cross section with various fin arrangements. The data obtained during five wind-tunnel entries are summarized in this report. The data have been collected on magnetic tapes and FORTRAN computer programs have been written which retrieve the data from the tapes. This report also describes the use of these programs and tapes and describes the tabulated output from the programs. GRA

**N80-27293#** Naval Ship Research and Development Center Bethesda Md Aviation and Surface Effects Dept  
**NUMERICAL OPTIMIZATION OF CIRCULATION CONTROL AIRFOILS** Interim Report, Sep 1978 - Dec 1979  
Tsze C Tai George H Kidwell Jr and Garret N Vanderplaats Apr 1980 51 p refs (ZRO230201)

(AD-A084129 DTNSRDC/AERO-1265 DTNSRDC-80/060) Avail NTIS HC A04/MF A01 CSCL 20/4

A numerical procedure developed for optimizing the circulation control airfoils is presented. The procedure finds the optimum basis airfoil shapes subjected to specified flow conditions and geometric constraints. It consists of a numerical optimization code for linear constrained problems coupled with a viscous-potential flow interaction analysis for necessary viscous-inviscid flow field calculations. The desired airfoil shape is defined by a combination of baseline shapes representative of airfoils suitable for circulation control purposes. The coefficients of these basis vectors are then used as the design variables in the optimization process. Three baseline shapes (a cambered ellipse a cambered ellipse with a drooped trailing edge and a cambered ellipse with a logarithmically spiralled trailing edge) are employed for special contouring of the trailing edge geometry. With some minor modification of the analysis method the combined program allows optimization for maximum lift without substantial difficulty but for minimizing the drag further improvement of the analysis method is required. GRA

**N80-27296#** ARO Inc Arnold Air Force Station Tenn  
**MUTUAL INTERFERENCE OF MULTIPLE BODIES IN THE FLOW FIELD OF THE F-4C AIRCRAFT IN THE TRANSONIC SPEED RANGE** Final Report, 12 - 21 Nov 1979

A A Hesketh AEDC Dec 1979 90 p refs (AD-A084704 AEDC-TR-79-P79) Avail NTIS HC A05/MF A01 CSCL 20/4

A wind tunnel field was conducted to study the mutual interference of multiple bodies in the flow field of the F-4C aircraft. The test utilized 1/20 scale models of the F-4C aircraft the MK-83 bomb (with and without fins) and the triple ejector rack (TER) to obtain aerodynamic loads on the MK-83 at and near the carriage position on the wing inboard pylon. Flow field data in the vicinity of the TER were also obtained. Test variables included aircraft angle of attack from -3 to 17 deg freestream Mach number from 0.60 to 0.95 and aircraft configuration. Freestream aerodynamic loads data were also obtained on the MK-83 bomb model. GRA

**N80-27300** Ohio State Univ Columbus  
**GENERAL AVIATION DYNAMICS THE IMPACT OF COST RECOVERY** Ph D Thesis

Michael Alan Duff 1980 231 p  
Avail Univ Microfilms Order No 8015869

The regulation of air commerce to promote its development and safety as well as the operation of the air traffic control system are discussed. A complete application of the policy approach to the problem of general aviation cost recovery is described. Some additional quantitative insight into understanding the general aviation system and its probable response to increased user charges are provided. Dissert Abstr

**N80-27301** California Univ Los Angeles  
**A DYNAMIC MODEL OF THE AIR TRANSPORT INDUSTRY** Ph D Thesis

Mohammad Bagher Ayati 1980 298 p  
Avail Univ Microfilms Order No 8015950

A modeling process to stimulate the dynamic process of economics of the Air Transportation industry is presented. The model process consists of development of a conceptual model to relate aircraft technology aviation fuels airline operation and economics of air transportation. A methodology based on digraph theory is suggested to facilitate a straightforward technique for presentation and simulation of a class of socio-economic systems. The methodology has been successfully applied to simulate a dynamic model of air transportation economics. Results of the model validation shows negligible difference between actual and projected values. Dissert Abstr

**N80-27303\*#** National Aeronautics and Space Administration Washington D C

**THE DEVELOPMENT OF THE ZEPPLIN DIRIGIBLE FOR LONG DISTANCE TRANSPORTATION**

Albert Ehrle Apr 1980 18 p Transl into ENGLISH of Gedenken an die Hundertste Wiederkehr des Geburtstages des Grafen Zeppelin Deutschen Akademie der Luftfahrtforschung West Germany 17 Jun 1938 p 33-47 Transl by Kanner (Leo) Associates Redwood City Calif (Contract NASw-3199)

(NASA-TM-76143) Avail NTIS HC A02/MF A01 CSCL 01C

Changes in the design and construction of German airships for regular transoceanic passenger transportation during the 1916 to 1938 period are described. Technical problems related to structural weight fuel reduction and passenger comfort are considered. A R H

**N80-27306#** Transportation Systems Center Cambridge Mass  
**CHICAGO MONOSTATIC ACOUSTIC VORTEX SENSING SYSTEM VOLUME 1 DATA COLLECTION AND REDUCTION** Final Report, Jan 1976 - Sep 1977

D C Burnham Oct 1979 34 p refs (AD-A076929 TSC-FAA-79-18-1-Vol-1 FAA-RD-79-103-1) Avail NTIS HC A03/MF A01 CSCL 20/4

A Monostatic Acoustic Vortex Sensing System MAVSS was installed at Chicago's O'Hare International Airport to measure the strength and decay of aircraft wake vortices from landing aircraft. The MAVSS consists of an array of acoustic antennas which measure the vertical profile up to 60 m altitude of the vertical component of the wind. The decay in wake vortex strength is measured as the vortex passes over successive antennas in the array. Volume I describes the MAVSS principles of operation the hardware developed and data reduction methods employed. GRA

**N80-27307#** Systems Control Inc Palo Alto Calif  
**WEST COAST LORAN-C FLIGHT TEST** Final Report

Thomas E Scalise Erich Bolz and Edwin D McConkey Mar 1980 209 p refs (Contract DOT-FA75WA-3662) (AD-A084039 FAA-RD-80-28) Avail NTIS HC A10/MF A01 CSCL 17/7

A flight test program was flown within the coverage area of the West Coast Loran-C chain during June and July 1979. The purpose of the test was to add to the growing statistical data base that will be used to assess Loran-C as a supplement to or replacement for the present VOR/DME navigation system. The test objectives were to (1) Evaluate the West Coast

Loran-C chain by quantifying navigation and position errors within its coverage area (2) Test Loran-C as a non-precision approach aid in mountainous conditions using a commercially available Loran-C receiver/navigator in this case a Teledyne TDL-711 (3) Record the effects of bias shifts and station outages on overall accuracy and approach procedures especially near a baseline extension (4) Calculate the absolute flight technical error (FTE) during Loran-C approaches using a typical general aviation aircraft The main conclusions of the test were The West Coast Loran-C chain appears stable and dependable Time difference errors were consistent and related to signal propagation differences over land and over water TDL-711 was found to be easy to operate giving stable and repeatable course guidance although susceptible to random loss of track a problem which may be software related The system did not accurately calculate cross track deviation and distance to waypoint Without needed hardware software and/or procedural changes Loran-C may not meet the RNAV non-precision approach requirements of AC 90-45A GRA

**N80-27308#** National Aviation Facilities Experimental Center Atlantic City N J  
**ATARS/ATC SIMULATION TESTS WITH SITE ADAPTATION LOGIC IN THE PHILADELPHIA TERMINAL AREA Final Report, May - Oct 1978**

Gary W Morfitt Sidney B Rossiter James R Windle Arthur W Fillius and Thomas A Choyce Mar 1980 56 p refs (FAA Proj 034-242-340) (AD-A083718 FAA-NA-79-23 FAA-RD-79-116) Avail NTIS HC A04/MF A01 CSCL 17/7

The purpose of this project was to provide further evaluation and refinement of the Automatic Traffic Advisory and Resolution Service (ATARS) concept The tests were conducted at the National Aviation Facilities Experimental Center (NAFEC) at Atlantic City New Jersey using the Air Traffic Control Simulation Facility (ATCSF) Test results indicated that ATARS had no significant impact on the controllers or control procedures in a Philadelphia Terminal Control Area (TCA) environment Outside the immediate TCA where the majority of encounters occurred the factors contributing to the generation of alarms were in general satellite operations and the use of Visual Flight Rules (VFR) separation criteria The incidence of positive resolution advisories was low averaging only 0.5 encounters per hour Recommendations are to reduce the size of the ATARS desensitization zone at the Philadelphia main airport to approximately 2.0 nautical miles (nmi) from runway thresholds to incorporate a convergence/divergence detection filter into the ATARS algorithm and to investigate the possibility of reducing tracker lag by improving turn and level off detection GRA

**N80-27309#** AMAF Industries Columbia Md  
**FEASIBILITY OF OFFSET CARRIER SYSTEMS FOR AIR TRAFFIC CONTROL Interim Report**

J David Claiborne Oct 1979 17 p refs (Contract DOT-FA78WAI-830) (AD-A084044 FAA-RD-79-106 IR-2) Avail NTIS HC A02/MF A01 CSCL 17/7

A brief description of FAA trials of offset carrier systems and multiple outlet systems is given Short descriptions are also given of existing offset carrier systems in Great Britain and the ARINC system in the United States The communication deficiencies that could be remedied by an offset carrier system are listed A short discussion is given concerning the system design deficiencies inherent with an offset carrier system No conclusions are made concerning the usefulness or practicality of an offset carrier system GRA

**N80-27310#** Arinc Research Corp Annapolis Md  
**AN EVALUATION OF AIRCRAFT SEPARATION ASSURANCE CONCEPTS USING AIRLINE FLIGHT SIMULATORS VOLUME 1 STUDY REPORT Final Report**

Bruce Morgenstern and Thomas P Berry Nov 1979 108 p (Contract DOT-FA78WA-4091) (AD-A083986 Rept-1343-01-3-2058-Vol-1) FAA-RD-79-124-1) Avail NTIS HC A06/MF A01 CSCL 01/2

This report documents an evaluation of Aircraft Separation Assurance (ASA) concepts using an airline flight simulator The primary objective of the experiment was to determine the cockpit information requirements for an aircraft collision avoidance system Qualified pilots from commercial aviation and industry flew typical operational scenarios in the simulated Los Angeles area During the flight conflict situations with other aircraft developed and pilots were asked to respond to these situations on the basis of information presented to them by one of three experimental collision avoidance displays Computer-collected data on pilot response to collision avoidance commands and resultant miss distances were correlated with data from questionnaires filled out by participating pilots to determine the cockpit information requirements The subjective comments addressed the areas of required display information items use of color audible alert symbols workload pilot confidence in the system and pilot display preference Altitude range relative bearing and other aircraft heading have been identified as the most important and most essential information elements in the resolution of potential conflicts The report provides a statistical analysis of the accumulated data and includes recommendations for the development and operational implementation of the ASA program GRA

**N80-27311#** Arinc Research Corp Annapolis Md  
**AN EVALUATION OF AIRCRAFT SEPARATION ASSURANCE CONCEPTS USING AIRLINE FLIGHT SIMULATORS VOLUME 2 APPENDICES Final Report**

Bruce Morgenstern and Thomas P Berry Nov 1979 170 p refs (Contract DOT-FA78WA-4091) (AD-A083897 Rept-1343-01-3-2058-Vol-2) FAA-RD-79-124-2) Avail NTIS HC A08/MF A01 CSCL 01/2

This report supplements the main study report of a cockpit evaluation of ASA concepts It contains a description of the flight scenarios used a copy of the pilot advance briefing and pre-briefing copies of the flight crew questionnaire and supplemental questionnaire with all comments data analysis formulas and test bed description details GRA

**N80-27312#** Ohio Univ Athens Avionics Engineering Center

**IN-SERVICE IMPROVEMENTS TO RELIABILITY AND MAINTAINABILITY OF THE INSTRUMENT LANDING SYSTEM Final Report, Oct 1977 - May 1979**

May 1979 487 p refs (Contract DOT-FA78WA-4062) (AD-A075556 EER-40-1 FAA-R-6750-2 FAA-AAF-420) Avail NTIS HC A21/MF A01 CSCL 17/7

This report documents results of task efforts undertaken by Ohio University between October 1977 and May 1979 Engineering data resulting from a study of the sideband reference glide-slope system baseline operating parameters and the effects of specific faults are presented A series of perturbational studies conducted at commissioned sideband reference facilities and numerous field experiments at Ohio University's Tamiami Florida site facility are described Suggested technical improvements and text changes for existing technical manuals have also resulted The effects of a wide range of terrain profiles on the performance of sideband reference null reference and capture effect systems are compiled in album form Sideband reference system setup procedures are reviewed the electrical and physical requirements for the counterpoise are explored and an introductory look at threshold-plane DDM profiles is presented ILS anomaly investigations have resulted in the design testing and implementation of a modification to the Type FA-5723 clearance transmitter Also predictions of complete glide-slope performance for a proposed site on Runway 22L at Boston Logan are presented The maximum allowable VSWR for the 15-element V-Ring and the O-Ring localizers are investigated based on theoretical and experimental work The findings are that the maximum VSWR is not that of a simple specification but rather that of values that are within the bounds of worst and best-case conditions depending on the value of the complex reflection coefficient GRA

**N80-27313#** National Telecommunication Information Administration Boulder Colo Inst for Telecommunication Sciences  
**POTENTIAL USE OF HIGH FREQUENCY DATA TRANSMISSION FOR OCEANIC AIR TRAFFIC CONTROL IMPROVEMENT Final Report, Aug 1978 - Jul 1979**

Martin Nesenbergs Sep 1979 48 p refs  
 (Contract DOT-FA-RA-78-15)  
 (AD-A075810 FAA-AM-TSC-79-9) Avail NTIS  
 HC A03/MF A01 CSCL 17/2

This report is concerned with the transatlantic Air Traffic Control (ATC) data links in the high frequency (HF) band. The report tries to broaden the appropriate communication system concepts by fortifying them with general parametric objectives. While such a broad approach cannot escape practical constraints and reductions especially in eventual design and implementation stages it is nevertheless a useful tool here. It leads one to characterize the HF propagation medium more fully. This in turn enables one to conceive data communications outlines with more advanced structures and with emphasis on exploiting the latest technology both hardware and software. A full study should be beyond this initial effort and incorporate several system alternatives plus their tradeoffs in terms of objective gains versus system costs. This brief report concludes with a parametric summary of ATC HF channel issues, operational factors and the importance of performance specification. Pertinent unresolved issues are also listed at the end. GRA

**N80-27314#** Transportation Systems Center Cambridge Mass  
**ANALYSIS OF EXPANDABILITY AND MODIFIABILITY OF COMPUTER CONFIGURATION CONCEPTS FOR ATC VOLUME 1 DISTRIBUTED CONCEPT Final Report**

David F Clapp Joseph B Hagopian and Ronald M Rutledge  
 Nov 1979 195 p refs  
 (AD-A084045 TSC-FAA-79-31 FAA-EM-79-22-Vol-1) Avail  
 NTIS HC A09/MF A01 CSCL 17/7

The questions of expandability and modifiability of a 1990-era Air Traffic Control (ATC) system are addressed. Two strawman systems are described at the functional level: a Baseline System which represents the ATC system as it might be just after the replacement of the current National Airspace System (NAS) en route computers and a Future System which represents what might be derived ten years later under an appropriate scenario for ATC development. A distributed processing computer configuration is postulated for the Baseline System and processing and communications loads are calculated on the basis of traffic and parameter estimates for 1985. Expansion and modification of the Baseline System to produce the Future System designed to meet estimated 1995 loads under the supplied scenario are examined. The distributed processing concept as considered here was deemed generally suitable for use in the ATC system of the future. GRA

**N80-27315#** Transportation Systems Center Cambridge Mass  
**AN INVESTIGATION OF LASER LIGHTING SYSTEMS TO ASSIST AIRCRAFT LANDING Final Report, Oct 1978 - Sep 1978**

D C Burnham and J F Fantasia Oct 1979 64 p refs  
 (AD-A077722 TSC-FAA-79-22 FAA-RD-79-97) Avail NTIS  
 HC A04/MF A01 CSCL 17/7

A model for the visual detectability of narrow light beams was developed and used to evaluate the system performance of two laser lighting system configurations: (1) a laser VASI and (2) a crossed beam glide path indicator. Laboratory experiments confirmed the validity of the model. Using a criterion taken from the Federal Standard for laser safety, the potential hazards of each of the system concepts were evaluated. The following results were obtained for readily available laser power levels: neither system will work during bright daylight; the laser VASI can be seen at night at the middle marker for visual ranges greater than 5000 ft; the crossed beam system can be seen at night at the middle marker for visual ranges greater than 700 ft. GRA

**N80-27317#** Royal Signals and Radar Establishment, Malvern (England)

**PRECISION NAVIGATION FOR AIR TRAFFIC MANAGEMENT**

S Radcliffe Oct 1979 9 p refs Presented at the AGARD GOP Symp Copenhagen 29 Oct 1979  
 (AD-A083947 RSRE-Memo-3220 DRIC-BR72506) Avail  
 NTIS HC A02/MF A01 CSCL 17/7

This report discusses the problems that would arise if airspace users had the use of NAVSTAR or some other much better position fixing aid than at present and the uses that ATC could or could not make of this capability. There would be formidable transitional problems in the vertical plane because NAVSTAR measures height from the Earth's center whereas current altimeters measure atmosphere pressure. In either vertical or horizontal planes much work will be necessary to prove that the separation standards can be reduced at all. The paper discusses changes that might be possible in the ATC system should appreciable reductions in separation standards prove possible. NAVSTAR might form the basis of a collision avoidance system based on either the broadcast coordinates of each aircraft or on a time-frequency basis using NAVSTAR as the time reference. The latter scheme would offer protection of a fully equipped aircraft against a threat that could not afford the expense of a NAVSTAR fit. This paper is a contribution to the 29th AGARD GCP Symposium, Copenhagen Oct 1979. It is issued as a memo to make it available earlier and in an unclassified document. GRA

**N80-27319#** Transportation Systems Center Cambridge Mass  
**ENHANCED TERMINAL INFORMATION SERVICES (ETIS) UTILIZING THE DISCRETE ADDRESS BEACON SYSTEM (DABS) DATA LINK-CONCEPT DESCRIPTION Final Report, Sep 1978 - Apr 1979**

Robert W Wisleder Jul 1979 90 p refs  
 (AD-A073205 TSC-FAA-79-11 FAA-RD-79-73) Avail NTIS  
 HC A05/MF A01 CSCL 17/7

This report describes a concept for providing enhanced terminal information services (ETIS) to aircraft utilizing the ground-air-ground data link capability of the Discrete Address Beacon System (DABS). ETIS is envisioned as an eventual replacement for and significant improvement to the Automated Terminal Information Services (ATIS) in use today. The initial step in developing the concept is the establishment of requirements for an ETIS system. This is followed by a determination of the information and data to be provided to the aircraft over the data link and the probable sources of that data. An assumption is made that the availability of automated weather sensor systems of some form will coincide with implementation of ETIS. A detailed functional description of the system is then given, including system configuration, interfaces with other ATC automation systems and hardware and software both at the airport and at the controlling ATC facility. Also discussed are message content and formats, controller and pilot display design considerations, criteria for dispatch of ETIS messages and a number of operational considerations. The report concludes with several typical flight scenarios representative of different levels of aircraft avionics and pilot capabilities in an air traffic control environment where ETIS is implemented. GRA

**N80-27320#** Facility Checking Squadron (1866th) (AFCS) Scott AFB Ill

**SSILS INITIAL EVALUATION REPORT DAVIS-MONTHAN AFB, ARIZONA, 16-20 NOVEMBER 1979 Final Report**

Joseph P Coyle 11 Apr 1980 109 p  
 (AD-A084635 Rept-79/66N-195) Avail NTIS  
 HC A06/MF A01 CSCL 01/4

This report presents the results of the 16 - 20 November 1979 TRACALS Evaluation of the Davis-Monthan AFB AN/GRN-29(V) SSILS and associated power systems. The evaluation was conducted in conjunction with the system commissioning to determine the capabilities and limitations of the system in its installed environment. Results presented in this report can be used as a guide to anticipated performance until there is a significant change in ground equipment, siting, environment, screening or operational use. GRA

**N80-27323#** National Bureau of Standards Washington D C  
Center for Applied Mathematics

**PROBABILITIES OF VERTICAL OVERLAP A SENSITIVITY ANALYSIS**

Howard K Hung Judith F Gilsinn and Karla F Hoffman Mar  
1980 72 p refs Sponsored in part by FAA Washington DC  
(PB80-161151 NBSIR-80-1990) Avail NTIS  
HC A04/MF A01 CSCL 01C

Because of the potential increase in traffic at FL 290 and above both current and alternative vertical separation standards are being reviewed A sensitivity analysis carried out to assess how different assumptions about the probability distribution of total vertical error affect the probability of vertical overlap is documented The four factors affecting the probability of vertical overlap which are examined are the functional form of the vertical-error distribution function the standard deviation of this probability distribution the vertical dimensions of the aircraft and the vertical separation standard Probabilities of vertical overlap were computed over a range of possibilities for each of these four factors in order to discern the effect of each factor

GRA

**N80-27324#** Advisory Group for Aerospace Research and Development Neuilly-Sur-Seine (France)

**AIR TRAFFIC MANAGEMENT CIVIL/MILITARY SYSTEM AND TECHNOLOGIES**

Feb 1980 300 p refs Presented at the Guidance and Control Panel Symp Copenhagen 9-12 Oct 1979  
(AGARD-CP-273 ISBN-92-835-1347-9) Avail NTIS  
HC A13/MF A01

Various aspects of air traffic on control in civil and military systems and technologies are presented The specific areas discussed are (1) operational scene and requirements (2) civil/military cooperation (3) aspects of air traffic management philosophy (criteria and human factors communications and separation) (4) air traffic management in hostile environment (5) flight management in terminal area (6) subsystem technology and (7) advanced systems

**N80-27325#** Board of Trade London (England)

**AIR TRAFFIC IN NATO EUROPE ITS CHARACTERISTICS AND ITS NEEDS**

I M Pedder *In* AGARD Air Traffic Management Civil/Mil  
Systems and Technol Feb 1980 3 p

Avail NTIS HC A13/MF A01

The needs and characteristics of air traffic in NATO Europe are reviewed The divergent requirements and particular problems of airspace users are described and it is concluded that efficient use of the airspace can only be achieved through cooperation between the civil and military authorities Areas where research and development would be fruitful are listed Author

**N80-27326#** Army Avionics Research and Development Activity Fort Monmouth N J Air Traffic Management Systems Div  
**HELICOPTER AIR TRAFFIC MANAGEMENT SYSTEMS WITH CIVIL/MILITARY INTEROPERABILITY**

Joseph T Saganowich *In* AGARD Air Traffic Management  
Civil/Mil Systems and Technol Feb 1980 16 p refs

Avail NTIS HC A13/MF A01

In order to achieve significant near-term improvement in the Army's air traffic management capability several configurations of very lightweight air traffic management equipment (VLATME) were developed Based upon totally compatible use of today's common civil/military system ATCRBS (air traffic control radar beacon system) Concurrently with the VLATME development helicopter instrument landing technology work over the past few years has revealed that the key to solving this problem lies in the ability to perform deceleration of the aircraft on instruments along the approach path so as to bring the aircraft to a hover a few feet above the intended landing point The decelerated instrument approach means that helicopter spacings will have to be much smaller than those encountered in fixed wing practice

if reasonable flow rates are to be realized Because of the potential garbling problem in conventional ATCRBS with closely spaced aircraft a system which integrates the ground and airborne equipments of a scanning beam microwave landing system with the airborne transponder while preserving interoperability was also developed and successfully tested RES

**N80-27327#** Selenia Sp A Rome (Italy)

**A STUDY FOR DEVELOPMENT OF METHODS FOR AIR TRAFFIC MANAGEMENT**

R Petrioli S Pardini G Bertoni (Bologna Univ) and C Bonivento (Bologna Univ) *In* AGARD Air Traffic Management Civil/Mil  
Systems and Technol Feb 1980 14 p refs

Avail NTIS HC A13/MF A01

Models and methods for optimal air traffic management were studied as part of the multi-year project Navigation aids and air traffic control funded by the Italian National Research Council (CNR) The scope of the study on the context of CNR project is reviewed The software structure its main characteristics and possible utilizations in the planning and management of air traffic system is discussed Finally a description is given of more relevant used models and algorithms RES

**N80-27328#** Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany) Human Engineering Dept

**SYSTEM, AIRSPACE, AND CAPACITY REQUIREMENTS FOR FUTURE ATC-SYSTEMS**

Ruediger Seifert and Guenther Och *In* AGARD Air Traffic  
Management Civil/Mil Systems and Technol Feb 1980  
15 p refs

Avail NTIS HC A13/MF A01

Based on control capacity measurements of various air traffic control (ATC) systems a theory of control capacity was developed The theory of control capacity allows comprehensive knowledge to be gained concerning the relationship and interdependence of the following (1) The airspace configuration (including the present separation requirements) the traffic structure and the resulting conflict probability (2) The airspace capacity the control capacity of the ATC control positions (functional units) and their dependence on air traffic structure and the technical ATC system features and capabilities Using the theory of control capacity systems of different technical structure were then assessed Outdated present days and future ATC systems are compared showing the effect certain technical components and/or system functions have on system capacity RES

**N80-27329#** Civil Aeromedical Inst Oklahoma City Okla  
Aviation Psychology Lab

**AIR TRAFFIC CONTROL AUTOMATION ITS IMPACT AND USE IN THE SELECTION AND SCREENING OF AIR TRAFFIC CONTROLLERS**

James O Boone *In* AGARD Air Traffic Management Civil/Mil  
Systems and Technol Feb 1980 7 p refs  
see N80-27324 18-04)

Avail NTIS HC A13/MF A01

The impact of automation in air traffic control on personnel screening is discussed The mathematical and technical aspects as they are currently being developed are focused upon RES

**N80-27330#** Eurocontrol Agency Brussels (Belgium)

**DATA LINK THE KEY TO IMPROVEMENTS IN CIVIL/MILITARY AIR TRAFFIC MANAGEMENT?**

M E Cox *In* AGARD Air Traffic Management Civil/Mil  
Systems and Technol Feb 1980 20 p refs

Avail NTIS HC A13/MF A01

Experimental work which is being undertaken both to explore how an air/ground data link might be exploited for future air traffic control purposes and to determine its possible capacity requirements is described Details of the form and functions of experimental equipment built to investigate what is believed to be the major problem area influencing communications improvements the pilot/link interface are given Details are also given of studies investigating the possible use of the link in transferring aircraft derived data both to yield improvements in the precision

N80-27331

of meteorological forecast data and to enhance the performance of radar-based tracking and conflict-alerting systems Capacity requirements and the feasibility of realizing a link for these purposes within the next two decades are discussed R E S

**N80-27331#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany)

**MIDAIR CONFLICTS AND THEIR POTENTIAL AVOIDANCE BY PROGRESSIVE IMPLEMENTATION OF AUTOMATION**

O Weber /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 16 p refs

Avail NTIS HC A13/MF A01

Actual midair conflicts between civil and military aircraft in German airspace where at least one of the airplanes involved was flying under visual flight rules were analyzed Operational environmental and human factors which contributed to the accidents and the limits of the see and avoid concept for collision avoidance are discussed Some shortcomings of the present air traffic control system are mentioned Taking the actual midair conflicts and some simulated three dimensional flights as examples the improvement of collision avoidance by progressive implementation of advanced techniques is discussed The lead time to the potential conflict or to a circular zone of protection the distance at the closest approach and some other thresholds estimated by means of a ground-based radar system or an airborne electronic collision avoidance system are used as main criteria for an automatic conflict alert Potential advantages of a data link to detect sudden manoeuvres in time are mentioned R E S

**N80-27332#** National Aerospace Lab Amsterdam (Netherlands)  
**DETERMINATION OF THE SAFETY IN A NORTH ATLANTIC ORGANIZED TRACK SYSTEM WITH REDUCED LATERAL SEPARATION**

G Moek and C R Traas /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 7 p refs

Avail NTIS HC A13/MF A01

Collision risk modelling as related to the reduction of lateral separation from 120 NM to 60 NM at any fixed level in the North Atlantic Organized Track System is considered Requirements on the navigation performance are described which aircraft must be able to meet if this reduction would be implemented Two statistical tests are derived which can be applied to the measured number of navigation errors to determine whether the actual navigation performance is such that the system with 60 NM lateral separation meets a target level of safety The first test which belongs to the standard equipment of the NAT/SPG for judging the safety of the track system is based on one random model for all navigation errors The second test is applicable for the case different types of navigation errors can be distinguished and modelled separately The different contribution of each type of error to the total risk is taken into account by the use of weighting factors This test however is still in discussion in the North Atlantic Systems Planning Group A R H

**N80-27333#** Army Air Traffic Control Office APO New York NY 09056

**US ARMY USERS OUTLOOK ON AIR TRAFFIC MANAGEMENT**

William H Maloney and Larry P Kreps /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 5 p

Avail NTIS HC A13/MF A01

The need for air traffic control not only in support of its fixed base peace-time mission but also its tactical mission is recognized by the U S Army Air traffic management as it existed during the Vietnam era of the 1960s and as it evolved during the 1970s is described The European scenario literally dictates doctrine for hostile operations in a mid-intensity environment What is happening and planned from an ATC viewpoint in support of U S Army/Europe (USAREUR) is discussed including the future potential of a global positioning system A R H

**N80-27334#** Army Avionics Research and Development Activity Fort Monmouth N J Advanced Avionics Systems Div

**THE DEVELOPMENT AND TEST OF A TACTICAL SELF-CONTAINED LANDING SYSTEM**

Norman K Shupe /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 25 p refs

Avail NTIS HC A13/MF A01

The existence of a digital symbol generator (DSG) whose basic function is to compute and display the augmenting symbolic data necessary to operate a helicopter in the NOE environment via a FLIR presentation of the contact world and a digitally-generated topographic map display (DMG) is sufficient justification to consider adaptation of the DSG and DMG equipments to the reversionary function of providing IMC terrain-following and tactical landing capabilities The control/display architecture necessary to use a radar altimeter to control the elevation flight path of the aircraft and a Doppler radar to control the deceleration of the aircraft is presented The assumed precision navigation system provides the Northing/Easting aircraft position (1) to permit the aircraft to be steered along the prescribed ground track to the landing zone (2) to provide a starting point for interrogation of the DMG terrain elevation data for purposes of generating anticipation for the TF system and (3) to act in concert with the velocity output of the Doppler radar for purposes of following a preprogrammed deceleration profile to the landing zone A multi-phase simulation and flight-test program to assess the performance of the complete system in the NOE environment are described A R H

**N80-27335#** Bendix Corp Detroit Mich Communications Div

**VERY LIGHTWEIGHT AIR TRAFFIC MANAGEMENT SYSTEM USING AN ELECTRONIC SCAN ANTENNA**

P J Woodall and J L Shagena Jr /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 12 p

Avail NTIS HC A13/MF A01

An electronically scanned antenna with all solid-state interrogator complemented by a multi-microprocessor driver tactical interactive display provides a full alphanumeric PPI air traffic management system This system utilizes the standard Mark X/XII ACTRBS/IFF airborne transponder to provide position information on all targets (up to 100) and tracked range azimuth and altitude (via mode C) on up to 13 targets The two key features of this system are the electronically steered matrix-fed cylindrical array and the microprocessor based intelligent controller The controller performs search and active track minimizing interrogator PRF (64-198.5/Sec) and electromagnetic interference The antenna and R/T are physically integrated into a single assembly to minimize set-up time and maximize reliability A R H

**N80-27336#** Elektronik-System G m b H Munich (West Germany)

**TECHNICAL AND OPERATIONAL FACTORS CONCERNING THE LICENSING AND INTRODUCTION OF A NEW MICROWAVE LANDING SYSTEM FOR CATEGORY 2**

K G Brammer and K D Kricke /In AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 12 p refs

Avail NTIS HC A13/MF A01

For the new aircraft Tornado and Alpha-Jet the landing system SETAC is now being prepared for category 2 service at the assigned air bases in Germany As soon as this system's technical capabilities are to be exploited to the full extent for operational use all relevant rules and regulations applicable for ILS category 2 operations must be exhaustively expanded and supplemented This concerns concepts for infrastructural measures such as extension of obstacle clearance limits to the whole area of coverage calibration and testing of the total radio field modifications of the approach light pattern additional training and licensing of ATC staff and pilots etc In order to reduce this extensive task to a short-term solution a stagewise procedure of system introduction is outlined The concept is to utilize SETAC equipment with all the corresponding advantages regarding installation but to retain in the first stage as closely as possible all regulations flight procedures and instrumentation pertaining to ILS approach and landing A R H

**N80-27337#** Systems Control Inc West Palm Beach Fla  
**THE INTEGRATION OF AREA NAVIGATION AND THE  
 MICROWAVE LANDING SYSTEM**

Donald W Richardson and Paula M Rich (FAA Washington D C) *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 17 p Sponsored by FAA

Avail NTIS HC A13/MF A01

The RNAV and MILS are non-competitive complementary navigation/landing systems that working together can markedly enhance the safety and efficiency of terminal area operation while at the same time impacting the overall concept of terminal airspace management. Primarily these systems afford the opportunity which has been debated so vigorously for many years of converting to a distributed management philosophy of ATC system design and operation in which much of the navigation function is transferred from the radar vectors issued by the ground controller to the flight crew aided by increasingly available low cost multifunction avionics systems. Some activities on the part of the United States Federal Aviation Administration to develop and integrate these complementary capabilities into the terminal area airspace system are examined. A R H

**N80-27338#** Thomson-CSF Arcueil (France)  
**SINTAC-C TMA APPLICATION OF SINTAC-C IN THE  
 TERMINAL AREA, DURING LANDING AND GROUND  
 TAXIING**

Lj Milosevic and J Hetyei *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 20 p

Avail NTIS HC A13/MF A01

An integrated navigation traffic control collision avoidance and communication system is described which can control between 200 and 1000 aircraft according to the number of runways (or airports) included in terminal area. During final approach and landing the system controls 16 aircraft the maximum which can be considered in the MLS beam with a 30 second landing rate. According to the required control capacity the system uses one two or three time-shared nets for all the functions and for all the in flight and ground phases. The navigation transmission rates are very high (32-16 Hz) thus ensuring a practically continuous navigation function. The surveillance and synchronization frequency depend on the area a maximum of 4 seconds in the terminal area and a 1 second maximum at landing time. Three types of SINTAC ground stations are considered (1) SINTAC-TMA 100-150 km range covering the TMA area with three or four stations (2) SINTAC-landing located at the far-end of the runway (precision DME) range and antenna beam aperture same as MLS and (3) SINTAC-ground taxiing airport area coverage by three stations station range 5 to 10 km. A R H

**N80-27339#** Singer-Kearfott Wayne N J  
**EVOLUTION AND TRANSITION OF TODAY'S MILITARY  
 LANDING SYSTEM TO COMPATIBILITY WITH PRESENT  
 AND FUTURE CIVIL MILITARY SYSTEMS**

Albert J Shapiro *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 13 p

Avail NTIS HC A13/MF A01

The operational need for a single avionics system to operate with the present instrument landing system the future ICAO approved microwave landing system and the Marine remote area approach landing system (MRAALS) is discussed. The operational solution developed in response to a U S Navy/Marine requirement is a multimode receiver that is capable of operating with any of the systems mentioned above. The evolutionary process involved in progressing from a single to a multiple mode system capability is reviewed with emphasis on the technological advances leading to a most cost and volume effective solution. Author

**N80-27340#** Hollandse Signaalapparaten N V Hengelo  
 (Netherlands)  
**INTRODUCTION ON LORADS AND ASDE**

Erik Chr Priebee *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 18 p

Avail NTIS HC A13/MF A01

A long range radar and display system (LORADS) and airport surface detection equipment (ASDE) are described. A panoramic view of both systems its functional and operational requirements and the system architecture of both the hardware and software are given. M G

**N80-27341#** Ferranti Ltd Bracknell (England) Computer Systems

**APPLICATIONS OF MICROPROCESSORS IN AIR TRAFFIC**

David L Stoddart *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 10 p refs

Avail NTIS HC A13/MF A01

The use of microprocessors in air traffic control (ATC) systems is examined. The characteristics of microprocessors are compared with those of mini and main frame computers to identify the most suitable role of the microprocessor in ATC Systems. The application of microprocessors for system functions such as Data Link Management Display Console Management and Format Converters is discussed. To emphasize the impact of microprocessors on system design a conventional display system is compared with one using microprocessors where this device is built into the overall design of the display system with consequent saving in display generation hardware. The design is extended so that the display microprocessor becomes the central element in display console management. The F100L microprocessor is described in some detail and used as model to define the capability of a microprocessor. M G

**N80-27342#** Royal Signals and Radar Establishment Malvern (England) Ground Radar and ATC Dept

**PRECISION NAVIGATION FOR AIR TRAFFIC MANAGEMENT**

S Ratcliffe *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 5 p refs

Avail NTIS HC A13/MF A01

The problems that would arise if airspace users had the use of NAVSTAR or some other much better position-fixing aid than at present and the uses that air traffic control (ATC) could or could not make of this capability are examined. There would be formidable transitional problems in the vertical plane because NAVSTAR measures height from the Earth's center whereas current altimeters measure atmosphere pressure. In either vertical or horizontal planes much work would be necessary to prove that the separation standards can be reduced at all. The changes that might be possible in the ATC system should appreciable reductions in separation standards prove possible are discussed. NAVSTAR might form the basis of a collision avoidance system based on either the broadcast coordinates of each aircraft or on a time frequency basis using NAVSTAR as the time reference. The latter scheme would offer protection of a fully equipped aircraft against threat that could not afford the expense of a NAVSTAR fit. M G

**N80-27343#** Mitre Corp Bedford Mass  
**JTIDS AN INTEGRATED COMMUNICATIONS NAVIGATION  
 AND IDENTIFICATION SYSTEM, AND ITS POTENTIAL  
 FOR AIR TRAFFIC MANAGEMENT**

Donald D Neuman *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 13 p refs

Avail NTIS HC A13/MF A01

The integrated data communications, voice communications navigation and identification features of the Joint Tactical Information Distribution System (JTIDS) are described with emphasis on those features applicable to air traffic management. The JTIDS system architecture simultaneously provides data at the ground centers and in the cockpit. Airspace control and advisory data are made available to all aircraft to permit subscribers

to be aware of and comment upon directions provided to others Network control techniques are discussed which support civil air traffic management applications These techniques provide for the apportionment of capacity among subscribers in such a manner as to allow all subscribers access to all data in their area of interest without real time network management The potential exists for a substantial reduction in the avionics boxes aboard aircraft A JTIDS like system can simultaneously provide the data for airspace management and control collision avoidance area navigation air-to-air coordination cooperative surveillance cockpit situation display airport surface traffic control and possibly instrument landing The transition from the existing air traffic management system to a JTIDS like system is also addressed Austere terminal designs appear to be possible at a cost that is affordable for general aviation M G

**N80-27344#** Federal Aviation Administration Washington, D C Systems Research and Development Service  
**DISCRETE ADDRESS BEACON SYSTEM**  
 P D Hogkins *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 10 p refs

Avail NTIS HC A13/MF A01

A discrete address beacon system (DABS) to provide upgraded air traffic control radar beacon system (ATCRBS) surveillance is discussed The DABS concept provide improved air traffic control automation service and ground based automatic traffic advisory and resolution service through its integral high capacity digital air ground data link The compatibility of DABS with ATCRBS interrogation concepts and the computer processing subsystem are specifically discussed and current testing and evaluations of the system are reviewed M G

**N80-27345#** Royal Signals and Radar Establishment, Malvern (England)  
**ADSEL SELECTIVE ADDRESS SSR. PERFORMANCE OF THE EVALUATION STATION**  
 R C Bowes T B Nichols and J M Bonny *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 8 p refs

Avail NTIS HC A13/MF A01

A selectively addressed radar system (ADSEL) designed to overcome the garble problem of the current secondary surveillance radar (SSR) system and provide a data link facility is discussed The system requires aircraft to carry a transponder which includes the selective address mode of operation and a ground station with monopulse direction finding system plus data processing facilities In particular the evaluation trials that have been carried out are reviewed and the results of a large number of aircraft flights are given The main aim of the trials is to assess the accuracy with which the position of an aircraft can be measured the performance of the communication links and to optimise the operating rules A detailed analysis is given of the performance of the SSR and ADSEL system when monitoring two aircraft flying close together such that their transponder replies were garbling M G

**N80-27346#** Lincoln Lab Mass Inst of Tech Lexington  
**SURVEILLANCE PERFORMANCE MEASUREMENTS OF THE SSR MODE OF THE DISCRETE ADDRESS BEACON SYSTEM**

Vincent A Orlando and Paul R Drouilhet *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 11 p refs Sponsored by FAA

Avail NTIS HC A13/MF A01

The field measurements taken to evaluate the surveillance performance of the Discrete Address Beacon System (DABS) are described Simultaneous measurements made by transportable measurements facilities and the existing ground stations provided the opportunity for a side-by-side comparison of DABS off-boresite monopulse and conventional surveillance measurement performance The results indicate that both range and azimuth accuracies of the DABS design are four times better than those provided by current terminal secondary surveillance

radar (SSR) equipment Blip/scan ratio for monopulse SSR is 98% or better and remains high in crossing track situations where the performance of existing equipment is observed to degrade Significantly this improvement in SSR performance was accomplished with 1/4 the pulse repetition frequency of the present equipments M G

**N80-27347\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif  
**EFFECTIVENESS OF ADVANCED FUEL-CONSERVATIVE PROCEDURES IN THE TRANSITIONAL ATC ENVIRONMENT**

L Tobias and Paul J Obrien (National Aviation Facilities Experimental Center Atlantic City NJ) *In* AGARD Air Traffic Management Civil/Mil Systems and Technol Feb 1980 14 p refs  
 Avail NTIS HC A13/MF A01 CSCL 17G

The real time simulation (involving both the pilot and the air traffic controller) of fuel conservative approaches profile descents and four dimensional area navigation to assess the effectiveness of the procedures is discussed Generally results indicate some difficulties with the procedures tested in a mixed traffic environment and point to the need for computer assistance for effective implementation of candidate procedures M G

**N80-27348** Washington Univ Seattle  
**EFFECT OF SOME STRUCTURAL PARAMETERS ON ELASTIC ROTOR LOADS BY AN ITERATIVE HARMONIC BALANCE Ph D Thesis**

Abraham Eipe 1979 122 p  
 Avail Univ Microfilms Order No 8012195

The coupled flap-lag equations of motion for an elastic helicopter blade in forward flight are derived including several structural coupling parameters These nonlinear equations of motion are solved by an iterative harmonic balance method Depending on the nature of the rotor load trim the equations for the steady thrust and roll and pitch moments are also solved simultaneously with the flap equation of motion to obtain the unknown control settings Once the generalized coordinates and the control settings are known the rotor load harmonics are computed by Fourier analysis Effects of various structural coupling parameters on rotor loads are studied for three typical rotors a stiff in-plane hingeless tail rotor a soft in-plane hingeless main rotor and an articulated main rotor The results show excellent convergence of the iterative solution scheme Dissert Abstr

**N80-27349** California Univ Los Angeles  
**MULTILEVEL OPTIMUM DESIGN OF WING BOX STRUCTURES WITH FIBER COMPOSITE PANEL COMPONENTS Ph D Thesis**

Massood Mehrinfar 1980 180 p  
 Avail Univ Microfilms Order No 8016018

A multilevel approach is used which considers the overall sizing of the structure using equivalent thickness type design variables as a system level task while detailed design is carried out at the component level for each individual panel The total structural weight is taken as the system level objective function while the change in equivalent system stiffness is taken to be the objective function for each of the uncoupled component level problems The key idea is to select the component level objective function so as to minimize change in component loads due to subsequent force redistribution accomplished by taking the change in stiffness as the component level objective function to be minimized Finite element analysis is used at the system level to compute the internal forces Each fiber composite panel is modelled by stacking layers of orthotropic assumed stress rectangular elements representing equivalent thicknesses Approximation concepts such as linking constraint deletion and explicit approximations of retained constraints are employed A quadratic extended interior penalty function formulation is used as the optimization tool at both the system and component design modification levels Dissert Abstr

**N80-27350\*#** Hydraulic Research Textron Valencia Calif  
**FLIGHTWORTHY ACTIVE CONTROL LANDING GEAR FOR A SUPERSONIC AIRCRAFT Final Report**

Irving Ross Washington NASA Jun 1980 141 p ref  
(Contract NAS1-15455)  
(NASA-CR-3298) Avail NTIS HC A07/MF A01 CSCL 01C

A flightworthy active control landing gear system for a supersonic aircraft was designed to minimize aircraft loads during takeoff impact rollout and taxi. The design consists of hydromechanical modifications to the existing gear and the development of a fail-safe electronic controller. Analytical results indicate that for an aircraft sink rate of 0.914 m/sec (3 ft/sec) the system achieves a peak load reduction of 36% during landing impact. LFM

**N80-27351\***# National Aeronautics and Space Administration Washington D C

**MEASURES FOR IMPROVING THE ZEPPELIN AIRSHIPS FOR LONG DISTANCE TRANSPORTATION**

Ludwig Ferdinand Duerr Apr 1980 19 p Transl into ENGLISH of Gedenken an die Hundertste Wiederkehr des Geburtstages des Grafen Zeppelin Deutschen Akademie der Luftfahrtforschung West Germany 17 Jun 1938 p 15-30 Transl by Kanner (Leo) Associates Redwood City Calif  
(Contract NASw-3199)  
(NASA-TM-76142) Avail NTIS HC A02/MF A01 CSCL 01C

Factors to be considered in the construction of dirigibles include the design and weight of support structures static and aerodynamic loads on the main ring the annealing of support materials and the dynamic gas pressure. Adaptations made for using helium as the lifting gas and a method for extracting ballast are described. ARH

**N80-27352**# Ballistic Research Labs, Aberdeen Proving Ground Md

**MUZZLE BLAST OVERPRESSURE LEVELS ON THE AH-1S HELICOPTER TOW SIGHT UNIT Final Report**

Edward M Schmidt and Edmund J Gion Mar 1980 32 p  
Supersedes ARBRL-IMR-620  
(DA Proj 1L1-61102-AH-43)  
(AD-A084027 AD-E430410 ARBRL-MR-02997 ARBRL-IMR-620) Avail NTIS HC A03/MF A01 CSCL 19/1

An experimental program was conducted to measure the muzzle blast overpressures upon a simulated AH-1S Helicopter Tow Sight Unit (TSU). Different weapon configurations were fired to examine the effect of gun caliber and the presence of muzzle devices. Surface pressure distributions were measured along the line of symmetry of the TSU and were supplemented by spark shadowgraphs of the blast wave propagation. Limited data was acquired in the BRL Aerodynamics Range to measure the trajectory perturbation association with the internal gas dynamics of the muzzle devices. GRA

**N80-27353**# McDonnell Aircraft Co St Louis Mo  
**THE F-4 SERVICE LIFE TRACKING PROGRAM CRACK GROWTH GAGES Final Report, Feb 1978 - Sep 1979**

C R Saff Wright-Patterson AFB Ohio AFFDL Dec 1979 138 p refs  
(Contract F42600-78-D-0014 AF Proj 2401)  
(AD-A083978 AFFDL-TR-79-3148) Avail NTIS HC A07/MF A01 CSCL 01/3

The objective of this program was to evaluate the ability of a crack growth gage to monitor potential crack growth damage in fatigue critical locations of F-4C/D aircraft structure. Crack growth gages were designed for use on the lower wing skin of F-4 aircraft. An element test program was performed to verify gage design and provide data for predicting gage behavior when attached to the fatigue test article. Results of those tests prompted performance of a supplemental test program to investigate effects of sheet thickness on crack growth retardation. Results from both of these test programs were used to develop procedures to predict crack growth in gages attached to the fatigue test article. Eight gages were bonded to the test article using room temperature cure adhesive after an elevated cure temperature adhesive failed. Results show gage crack growth is predictable. Analysis results demonstrate the monitoring potential of the gage. GRA

**N80-27354**# Boeing Vertol Co Philadelphia, Pa  
**STUDY OF COST/BENEFIT TRADEOFFS AVAILABLE IN HELICOPTER NOISE TECHNOLOGY APPLICATIONS Final Report**

R H Spencer and H Sternfeld Jr Jan 1980 34 p refs  
(Contract DOT-FA78WA-4161)  
(AD-A083955 FAA/EE-80-5) Avail NTIS HC A03/MF A01 CSCL 01/3

This study investigated cost/benefit tradeoffs using the case histories of four helicopters for which design and development were complete and in three cases have undergone substantial flight testing. The approach to quieting each helicopter was an incremental reduction of each source as required to obtain reductions in flyover noise with modifications to other secondary systems only as necessary. The methodology used to predict the effects of the design modifications on acquisition, maintenance and operating costs were typical of those employed by rotorcraft manufacturers. The reduction of helicopter flyover noise generally was achieved through reductions in rotor tip speed. Performance characteristics were maintained to specified minimums for each aircraft in the study. GRA

**N80-27355**# Federal Aviation Administration Washington D C Office of Environment and Energy

**ENERGY CONSERVATION POTENTIAL OF GENERAL AVIATION ACTIVITY**

Sep 1979 52 p refs  
(AD-A081182 FAA/EE-79-20) Avail NTIS HC A04/MF A01 CSCL 01/2

Three approaches for reducing energy consumption were investigated: hardware modification, pilot education and air traffic control. It is recommended that research into new aircraft engine designs, automatic mixture controls, conventional engine fuel saving improvements, composite materials development and aerodynamic drag reduction continue and that this hardware be introduced into the fleet when cost, reliability and safety considerations allow. It is further recommended that the pilot awareness and education programs listed above be implemented by the FAA and the general aviation industry and finally that the ATC actions listed should be further evaluated to determine whether the anticipated fuel savings justify their implementation. GRA

**N80-27356**# Noah (J Watson) Associates Inc Falls Church Va

**COSTS AND BENEFITS OF REQUIRING NEW PRODUCTION OF OLDER AIRCRAFT TYPES TO MEET AMENDED NOISE STANDARDS Final Report**

C F Day and E D Studholme Sep 1979 76 p refs  
(Contract DOT-FA78WA-4192)  
(AD-A080130 FAA/EE-79-22) Avail NTIS HC A05/MF A01 CSCL 01/3

This report examines costs and benefits associated with requiring new production of older aircraft models to meet amended noise standards. Two cases are examined: (1) all aircraft produced after 1983 must meet a noise emission standard halfway between Stage 2 and Stage 3 limits and (2) all aircraft produced after 1985 must meet Stage 3 noise standards. The cost elements are combined and expressed as a change in direct operating costs in either cost-per-passenger mile or cost-per-aircraft mile as appropriate. Noise benefits are estimated in terms of the change in area under a 100 EPNL contour resulting from the amended standards. GRA

**N80-27357**# Bolt Beranek and Newman Inc Canoga Park Calif

**COST/BENEFIT TRADEOFFS AVAILABLE IN AIRCRAFT NOISE TECHNOLOGY APPLICATIONS IN THE 1980'S Final Report**

John F Wilby and William J Galloway Dec 1979 175 p refs  
(Contract DOT-FA77WA-4037)  
(AD-A082028 BBN-3856 FAA/EE-80-2) Avail NTIS HC A08/MF A01 CSCL 01/3

The current status of aircraft noise control technology is reviewed to identify those measures that have a reasonable



potential for application to aircraft coming into service in the 1980s Noise reduction achievable when these noise control measures are applied to two transport category airplanes a business jet and a small propeller-driven twin is determined Costs and performance penalties are determined for each noise control option Benefits are measured by reductions in FAR 36 certification noise levels and in reductions in EPNL contour areas The study shows that current late 1970s noise control practices permit transport category airplanes to meet the FAR 36 Stage 3 noise limits yet application of additional noise control measures is not likely to provide additional reduction of the noise levels for these aircraft by more than 3 decibels New business jet noise levels will be as much as 10 decibels lower than Stage 3 limits for takeoff and as much as 5 decibels lower on approach with additional reductions of more than 3 decibels unlikely Introduction of newly designed geared reciprocating engines would provide reductions of 10 or more decibels for high performance single and twin-engined propeller-driven small airplanes relative to existing practice GRA

**N80-27359#** General Electric Co Burlington Vt Armament Systems Dept

**AIR TO AIR HELICOPTER FIRE CONTROL EQUATIONS AND SOFTWARE GENERATION Final Report, 20 Dec 1978 - 31 Aug 1979**

John W Carlson, David B Ellis Theresa Parisi and Abbas A Rizvi Nov 1979 111 p  
(Contract DAAK10-79-C-0028)  
(AD-A084115 Doc-80APB509) Avail NTIS  
HC A06/MF A01 CSCL 19/5

Fire control equations suitable for use in a helicopter air-to-air gunnery engagement are developed Maximum use is made of existing software from the Closed Loop Fire Control System (CLFCS) New target state estimator ballistics and gun order modules are developed to account for target motion effects The resulting software was coded and run in the CLFCS fire control computer and made to interface with a modified Multiweapon Fire Control System GRA

**N80-27360\*#** National Aeronautics and Space Administration Langley Research Center Langley Station, Va

**FLIGHT INVESTIGATION OF COCKPIT-DISPLAYED TRAFFIC INFORMATION UTILIZING CODED SYMBOLOLOGY IN AN ADVANCED OPERATIONAL ENVIRONMENT**

Terence S Abbott Gene C Moen Lee H Person Jr Gerald L Keyser Jr Kenneth R Yenni and John F Garren Jr Jul 1980 31 p refs  
(DA Proj 1L2-62209-AH-76)  
(NASA-TP-1684 AVRADCOM-TR-80-B-4 L-13584) Avail  
NTIS HC A03/MF A01 CSCL 01D

Traffic symbology was encoded to provide additional information concerning the traffic which was displayed on the pilot's electronic horizontal situation indicators (EHSI) A research airplane representing an advanced operational environment was used to assess the benefit of coded traffic symbology in a realistic work-load environment Traffic scenarios involving both conflict-free and conflict situations, were employed Subjective pilot commentary was obtained through the use of a questionnaire and extensive pilot debriefings These results grouped conveniently under two categories display factors and task performance A major item under the display factor category was the problem of display clutter The primary contributors to clutter were the use of large map-scale factors the use of traffic data blocks and the presentation of more than a few airplanes In terms of task performance the cockpit-displayed traffic information was found to provide excellent overall situation awareness Additionally mile separation prescribed during these tests LFM

**N80-27361\*#** Curtiss-Wright Corp Wood-Ridge NJ  
**PERFORMANCE, EMISSIONS, AND PHYSICAL CHARACTERISTICS OF A ROTATING COMBUSTION AIRCRAFT ENGINE, SUPPLEMENT A**

R K Lamping I Manning, D Myers and B Tjoa May 1980 74 p

(Contract NAS3-20808)  
(NASA-CR-135119 CW-WR-76-028 3) Avail NTIS  
HC A04/MF A01 CSCL 21E

Testing was conducted using the basic RC2-75 engine to which several modifications were incorporated which were designed to reduce the hydrocarbon emissions and reduce the specific fuel consumption The modifications included close-in surface gap spark plugs increased compression ratio rotors and provisions for utilizing either side or peripheral intake ports or a combination of the two if required The proposed EPA emissions requirements were met using the normal peripheral porting The specific fuel economy demonstrated for the modified RC2-75 was 283 g/kW-hr at 75% power and 101 brake mean effective pressure (BMEP) and 272.5 g/kW-hr at 75% power and 111 BMEP The latter would result from rating the engine for takeoff at 285 hp and 5500 rpm instead of 6000 rpm EDK

**N80-27363\*#** National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

**NUMERICAL CALCULATION OF TRANSONIC AXIAL TURBOMACHINERY FLOWS**

Djordje S Dulikravich 1980 10 p refs Presented at 7th Intern Conf on Numerical Methods in Fluid Dyn, Stanford Calif, 23-27 Jun 1980 sponsored by NASA AFOSR NSF and ONR (NASA-TM-81544 E-500) Avail NTIS HC A02/MF A01 CSCL 21E

A numerical method and the results of a computer program are presented for solving an exact three dimensional full potential equation that models rotating and nonrotating inviscid absolutely irrotational homentropic flows Besides calculating the flows through an arbitrarily shaped rotor or stator blade row mounted on an axisymmetric hub and confined in an axisymmetric duct the computer program is also capable of analyzing flow fields about arbitrarily shaped wing body combinations propellers helicopter rotors in hover and wind turbine rotors The governing equation is solved numerically in a fully conservative form by using an artificial time concept a finite volume technique rotated type dependent differencing successive line overrelaxation and sequential boundary conforming grid refinement An artificial viscosity is added in fully conservative form and an initial guess for the potential field is applied as determined by a two dimensional cascade analysis Author

**N80-27364\*#** General Electric Co Cincinnati Ohio Aircraft Engine Group

**CF6-6D ENGINE PERFORMANCE DETERIORATION**

Ray H Wulf W H Kramer J E Pass and J J Smith Jan 1980 286 p refs  
(Contract NAS3-20631)  
(NASA-CR-159786 R80AEG218) Avail NTIS  
HC A13/MF A01 CSCL 21E

Cruise cockpit recordings and test cell performance data in conjunction with hardware inspection data from airline overhaul shops were analyzed to define the extent and magnitude of performance deterioration of the General Electric CF6-6D model engine These studies successfully isolated short-term deterioration from the longer term and defined areas where a significant reduction in aircraft energy requirements for the 1980s can be realized Unrestored losses which remain after engine refurbishment represent over 70% of the loss at engine shop visit Sixty-three percent of the unrestored losses are cost-effective to restore which could reduce fuel consumed by CF6-6D engines in 1980 by 10.9 million gallons Author

**N80-27365\*#** National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

**LOSS MODEL FOR OFF-DESIGN PERFORMANCE ANALYSIS OF RADIAL TURBINES WITH PIVOTING-VANE, VARIABLE-AREA STATORS**

Peter L Meitner and Arthur J Glassman 1980 22 p refs Proposed for presentation at the Aerospace Congr Los Angeles 13-16 Oct 1970 sponsored by the Society of Automotive Engineers Prepared in cooperation with Army Aviation Research and Development Command Cleveland (NASA-TM-81532 AVRADCOM-TR-80-C-15 E-455) Avail NTIS HC A02/MF A01 CSCL 21E

An off-design performance loss model is developed for variable-area (pivoted vane) radial turbines. The variation in stator loss with stator area is determined by a viscous loss model while the variation in rotor loss due to stator area variation (for no stator end-clearance gap) is determined through analytical matching of experimental data. An incidence loss model is also based on matching of the experimental data. A stator vane end-clearance leakage model is developed and sample calculations are made to show the predicted effects of stator vane end-clearance leakage on performance. Author

**N80-27366#** United Technologies Corp Windsor Locks Conn  
**INFLUENCE OF NOISE REDUCTION ON WEIGHT AND COST OF GENERAL AVIATION PROPELLERS Final Report**  
Robert J Klatte and Frederick B Metzger Jun 1979 111 p refs

(Contract DOT-FA78WA-4111)  
(AD-A082120 FAA-AEE-79-18) Avail NTIS  
HC A06/MF A01 CSCL 01/3

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 or cost penalty. Greater reductions in noise resulted in increased 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. GRA

**N80-27367#** Science Applications Inc Canoga Park Calif  
**AFOSR CONTRACTORS MEETING ON AIR-BREATHING COMBUSTION DYNAMICS AND KINETICS, 1979 ABSTRACTS**

R B Edelman 1 Feb 1980 159 p refs Conf held in Alexandria Va 28 Jan - 1 Feb 1980  
(Contract F49620-77-C-0044 AF Proj 2308)  
(AD-A083651 AFOSR-79-1173TR) Avail NTIS  
HC A08/MF A01 CSCL 21/5

The report consists of a collection of abstracts of the numerous research progress reports given by AFOSR contractors and of invited papers from other governmental agencies and contractors. These papers presented over a five day period composed the 1979 annual contractors meeting on Air-Breathing Combustion Dynamics and Kinetics. The principal investigators and their organizational association are also identified. GRA

**N80-27368#** Pennsylvania State Univ University Park Applied Research Lab

**DOCUMENTATION OF CASCADE UNSTEADY PRESSURE DIFFERENCE PROGRAM**

I-C Shen 5 Jan 1980 46 p refs  
(Contract N00024-79-C-6043)  
(AD-A083987 ARL/PSU-TM-80-10) Avail NTIS  
HC A03/MF A01 CSCL 21/5

The response of an axial flow turbomachine to spatial velocity variations can be determined by the unsteady pressure distribution function which has been developed and represents an extension of an earlier analysis of the unsteady lift. A computer program has been written to formulate the unsteady pressure difference as a function of design parameters. This program is versatile in that it includes the effects of the cascade geometrical parameters and disturbance flow characteristics such as the blade camber, angle of incidence nonconvected disturbance, and it also gives the unsteady lift and moment. The documentation and the use of this program are presented herein. GRA

**N80-27369#** Pennsylvania State Univ University Park Applied Research Lab

**NATURE OF INLET TURBULENCE AND STRUT FLOW DISTURBANCES AND THEIR EFFECT ON TURBOMACHINERY NOISE**

R Trunzo B Lakshminarayana and D E Thompson 25 Feb 1980 64 p refs

(Contract N00024-79-C-6043)  
(AD-A084355 ARL/PSU-TM-80-20) Avail NTIS  
HC A04/MF A01 CSCL 21/5

Results of an investigation in which turbomachinery rotor sound spectra were correlated with aerodynamic measurements of the inlet turbulence strut wake and vortex flow strengths are reported. Aerodynamic measurements included mean velocity profiles turbulence intensity and axial length scales. Inlet turbulence data indicate that the major effect of flow contraction appears to be the elongation of turbulent eddies from 20 cm to 200 cm. Eddies of this size dominate the blade passing frequency (BPF) tones. Decreasing eddy size by use of a grid revealed vortex flow strength to be the second major sound source. A doubling of vortex flow strength produced a 6 dB increase in the SPL of the first BPF. The sound pressure level showed less than a 2 dB change with doubling of wake turbulence intensity or velocity defect. A discussion of the relative importance of various sources of noise due to flow distribution at the inlet is given. This report will be submitted to the Journal of Sound and Vibration for publication. GRA

**N80-27370#** Detroit Diesel Allison Indianapolis Ind  
**HIGH-TEMPERATURE RADIAL TURBINE DEMONSTRATION Final Report, 15 Jun 1977 - 15 Nov 1979**

B A Ewing and Donald S Monson Apr 1980 204 p refs  
(Contract DAAJ02-77-C-0031 DA Proj 1L2-62209-AH-76)  
(AD-A084120 DDA-EDR-9990 USAAVRADCOM-TR-80-D-6)  
Avail NTIS HC A10/MF A01 CSCL 21/5

The objective of this program was to provide and demonstrate the technology required to economically manufacture a cooled high temperature radial turbine with sufficient integrity and aerodynamic performance to meet future Army requirements for a reliable low-cost high performance small gas turbine engine. The work to accomplish this objective was subdivided into three phases. GRA

**N80-27371#** Advisory Group for Aerospace Research and Development Neuilly-Sur-Seine (France)

**COMBUSTOR MODELLING**

Feb 1980 377 p refs In ENGLISH and FRENCH Meeting held in Cologne 3-5 Oct 1979  
(AGARD-CP-275 ISBN-92-835-0260-4) Avail NTIS  
HC A17/MF A01

Twenty-four papers addressing the different models and methods used in turbine engine research are presented. Four general areas are discussed: basic phenomena, transient phenomena and instabilities, furnaces and boilers, and gas turbine combustors and R/H systems.

**N80-27373#** Sheffield Univ (England) Dept of Chemical Engineering and Fuel Technology

**FUNDAMENTAL MODELLING OF MIXING, EVAPORATION AND KINETICS IN GAS TURBINE COMBUSTORS**

J Swithenbank A Turan (Science Applications Inc Woodland Hills Calif) P G Felton and D B Spalding (Imperial Coll of Science and Technology) In AGARD Combustor Modelling Feb 1980 21 p refs

Avail NTIS HC A17/MF A01

Past achievements, current status and future prospects of combustor modeling are discussed. The past achievements largely consist of detailed studies of idealized flames which have given an understanding of the relevant fundamental processes. However, gas turbine combustor computations must include the simultaneous interacting processes of three dimensional two-phase turbulent flow, evaporating droplets, mixing, radiation and chemical kinetics. At the present time, numerical prediction algorithms are becoming available which can model all these processes to

compute the hydrodynamic, thermodynamic and chemical quantities throughout a three dimensional field Complementary stirred reactor network algorithms permit the prediction of minor constituents (pollutants) again including such effects as droplet evaporation and unmixedness Experimental verification of these various predictions reveals remarkably good agreement between measured and predicted values of all parameters in spite of the physical and mathematical assumptions currently used Future problems include more accurate modeling of turbulence/kinetic interactions, numerical procedure optimization and detailed measurements of residence time distribution and two-phase parameters in real hot combustors RES

**N80-27374#** Imperial Coll of Science and Technology London (England) Dept of Chemical Engineering and Chemical Technology

**MATHEMATICAL MODELLING OF GAS-TURBINE COMBUSTION CHAMBERS**

W P Jones and J J McQuirk *In* AGARD Combustor Modelling Feb 1980 11 p refs Sponsored by Rolls-Royce Ltd

Avail NTIS HC A17/MF A01

A mathematical model for predicting the performance of gas turbine combustion chambers is described The model is based on the finite difference solution of the averaged forms of the governing partial differential conservation equations and turbulent transport is approximated via a variable density form of the k-epsilon turbulence model The reactions associated with heat release are assumed sufficiently fast for chemical equilibrium to prevail on an instantaneous basis and the influence of local turbulent fluctuations in mixture strength accounted for by a beta-probability density function Liquid fuel sprays are represented by a transport equation for the probability density function describing the variation of droplet mass fraction with droplet radius Computations of 2-d axisymmetric and 3-d flows are compared with experimental results and an assessment made of the adequacy of the various submodels embodied in the prediction procedure Author

**N80-27382#** Science Applications Inc, Woodland Hills, Calif Combustion Dynamics and Propulsion Technology Div

**FUNDAMENTAL CHARACTERIZATION OF ALTERNATIVE FUEL EFFECTS IN CONTINUOUS COMBUSTION SYSTEMS**

R B Edelman A Turan P T Harsha E Wong and N S Blazowski (Exxon Research and Engineering Co Linden W J) *In* AGARD Combustor Modelling Feb 1980 14 p refs

Avail NTIS HC A17/MF A01

The problem of net soot generation which is aggravated by the reduced hydrogen content characteristic of syncrudes that have been identified as probable alternate fuel sources for use in gas turbines is addressed The kinetics of the process are modeled using the quasi-global concept while experimental data are developed primarily from a laboratory jet stirred combustor Results are presented showing that soot emissions can be characterized in terms of major species and that soot oxidation must be included in the prediction of net soot generation In addition the techniques being employed for coupling the chemical and aerodynamic processes are outlined E D K

**N80-27393#** Purdue Univ Lafayette Ind School of Mechanical Engineering

**SEMI-EMPIRICAL CORRELATIONS FOR GAS TURBINE EMISSIONS, IGNITION, AND FLAME STABILIZATION**

A M Mellor *In* AGARD Combustor Modelling Feb 1980 13 p refs

(Contract F33615-77-C-2069)

Avail NTIS HC A17/MF A01

For operating conditions where the fuel evaporation rate is fast compared to the fuel vapor/air mixing rate a characteristic time model has been formulated to predict gaseous emissions and efficiency in terms of combustor inlet conditions and geometry The model which involves kinetic and fluid mechanic times has been used to design low metric oxide burners and study of several different conventional engine combustors suggests that

the correlation may be universal A related model which includes a fuel droplet evaporation time is being validated with data from laboratory combustors for spark ignition and lean flame stabilization The preliminary application of this latter model to engine situations is described Author

**N80-27394#** Universite Laval (Quebec)

**COMBUSTION MODELLING WITHIN GAS TURBINE ENGINES, SOME APPLICATIONS AND LIMITATIONS**

J Odgers *In* AGARD Combustor Modelling Feb 1980 14 p refs

Avail NTIS HC A17/MF A01

Some of the more pertinent models postulated to describe the performance of gas turbine combustors are reviewed Six different design/development stages are considered (1) the initial sizing of a combustor (2) the initial development testing (3) primary zone modelling (4) secondary zone modelling (5) dilution zone modelling and (6) changes due to the alteration of ambient conditions The models are assessed in scope 1 plausibility experimentally, and in terms of time and economic justification For (1) it is suggested that a zero-dimensional model suffice as also for (2) Item (3) will probably require a three dimensional model (4) and (5) with probably suffice with A zone or two dimensional model For item (6) a zero-order model might well be satisfactory If it can be produced with sufficient accuracy a single complex (probably three dimensional) model could adequately describe all items (1) to (6) The need of future data the type of models which may be used currently and those which are likely to be used in the future are discussed ARH

**N80-27395#** Office National d Etudes et de Recherches Aeronautiques Paris (France)

**AERODYNAMIC STUDY OF A COMBUSTION CHAMBER WITH A VIEW TO ITS SEMI-EMPIRICAL MODELLING**

Patrick Hebrard and Philippe Magre *In* AGARD Combustor Modelling Feb 1980 18 p refs *In* FRENCH ENGLISH summary

Avail NTIS HC A17/MF A01

The prediction of combustion performance and of polluting species formation in turbomachine combustors requires a calculation method that takes into account all phenomena taking place in various parts of the combustion chamber Among these aerodynamic effects often very poorly known must be introduced to justify modelling methods based on a combination of elementary combustors these methods rest on a correct description of their features and their relationships location nature volume flowrate and distribution connexions To this end experiments were carried out on a combustor model both without and with combustion with a view to (1) characterize the combustor aerodynamics by visualizations in the water tunnel and velocity measurements on an aerodynamic model (2) measure residence times in a flame tube by thermomodulation (aerodynamics) and particle dynamics (water tunnel) and (3) determine the combustion efficiency and the polluting species production for each regime Using these results for the development of a one dimensional model of elementary combustors makes it possible to calculate the distribution function of residence time in all elementary reactors especially in the primary zone The overall performance of the combustor can also be predicted The agreement between calculated and experimental results is satisfactory if the simplicity of the assumptions on which the model is based is considered ARH

**N80-27396** California Univ Berkeley  
**COUPLED BENDING-TORSION FLUTTER IN CASCADES WITH APPLICATIONS TO FAN AND COMPRESSOR BLADES** Ph D Thesis

Oddvar Olav Bendiksen 1980 270 p

Avail Univ Microfilms Order No 8015952

A method is presented for determining the aeroelastic stability boundaries of a cascade with aerodynamic, inertial and structural coupling between the bending and torsional degrees of freedom The real rotor is modeled as an infinite two dimensional cascade of identical harmonic motion with an arbitrary but constant interblade phase angle Lane's assumption about the possible

flutter mode shapes is assumed to hold. Two different unsteady aerodynamic theories are incorporated into the flutter analysis. The first is Whitehead's solution for the unsteady incompressible flow through an oscillating cascade. The second is a solution for the unsteady supersonic flow through a cascade with a subsonic leading edge locus. The aeroelastic stability boundary of the cascade is obtained by solving a complex eigenvalue problem analogous to the isolated wing case. The eigenvalue problem is solved directly and the critical interblade phase angle is determined by minimizing the flutter speed with respect to this phase angle while maintaining the restrictions imposed by Lane's assumption. Boundaries are presented for both the incompressible and the supersonic case for several cascade configurations, locations of elastic axis, coupling strength, and structural damping. Dissert Abstr

**N80-27397\***# Northrop Corp Hawthorne Calif Aerosciences Lab

**SYSTEM DESCRIPTION AND ANALYSIS PART 1 FEASIBILITY STUDY FOR HELICOPTER/VTOL WIDE-ANGLE SIMULATION IMAGE GENERATION DISPLAY SYSTEM Final Report**

Oct 1977 198 p Sponsored in part by Army Air Mobility and Research and Development Lab and Ames Research Center Mountain View Calif (Contract NAS2-9351) (NASA-CR-152376 NOR-77-102-Pt-1) Avail NTIS HC A09/MF A01 CSCL 14B

A preliminary design for a helicopter/VSTOL wide angle simulator image generation display system is studied. The visual system is to become part of a simulator capability to support Army aviation systems research and development within the near term. As required for the Army to simulate a wide range of aircraft characteristics, versatility and ease of changing cockpit configurations were primary considerations of the study. Due to the Army's interest in low altitude flight and descents into and landing in constrained areas, particular emphasis is given to wide field of view, resolution, brightness, contrast, and color. The visual display study includes a preliminary design, demonstrated feasibility of advanced concepts, and a plan for subsequent detail design and development. Analysis and tradeoff considerations for various visual system elements are outlined and discussed.

E D K

**N80-27398# Operations Research, Inc Silver Spring Md STUDY OF OPTICAL TECHNIQUES FOR INDIRECT GENERATION OF RUNWAY APPROACH LIGHTS Final Report, Sep 1978 - Sep 1979**

James C Bremer, L James Happel and Ronald A Parise Sep 1979 55 p refs (AD-A080434 ORI-TR-1557) Avail NTIS HC A04/MF A01 CSCL 01/5

The steel towers which are currently used to support runway approach lights present a significant collision hazard to landing aircraft and are being replaced by frangible towers which reduce but do not eliminate this hazard. This study analyzes optical concepts for indirect generation of runway approach lights which would reduce the tower height or the mass of elevated components. Three concepts are investigated: projection of images with mirrors, use of a ground based lamp in conjunction with a diverging mirror in the light plane, and use of a fiber optic light pipe. The projection of images can achieve a height reduction of several feet but would require the construction and maintenance of large mirrors. The other two techniques could eliminate wiring from elevated structures but would require more complex optics and higher levels of power consumption. None of these techniques appears to be practical when the marginal benefits are weighted against their complexity and cost. GRA

**N80-27430# Vought Corp Dallas Tex INVESTIGATION OF APPLICATION PARAMETERS AND TESTING OF RAIN EROSION COATINGS Final Technical Report**

G W Kelly 13 Mar 1980 93 p refs (Contract N00019-78-C-0125) (AD-A083578 Rept-2-30400/OR-52380) Avail NTIS HC A05/MF A01 CSCL 11/4

This program was sponsored in order that the performance of selected rain erosion coatings might be evaluated and that those parameters affecting the performance of these materials might be studied with the goal in mind to upgrade rain erosion coatings for use on high performance aircraft. In order to realize this goal, the following characteristics of two select polyurethane materials were evaluated: coating adhesion to the reinforced composite substrates, solvent evaporation rates or solvent release from each select rain erosion coating material for the purpose of reducing coating porosity of the cured material, a polymerization study related to the chemical reactivity of these moisture reactive materials after exposure to known quantities of free water, a coating familiarization study for each of the rain erosion coating materials, radar signal attenuation studies to determine signal losses through the rain erosion coating, and high-speed erosion tests for selected coating materials and primer combinations. GRA

GRA

**N80-27456# Ohio State Univ Research Foundation Columbus Dept of Aeronautical and Astronautical Engineering IGNITION, COMBUSTION, DETONATION, AND QUENCHING OF REACTIVE MIXTURES Interim Report, 1 Apr 1978 - 31 Mar 1979**

Rudolph Edse Nov 1979 51 p refs (Grant AF-AFOSR-3604-78 AF Proj 2308) (AD-A083737 AFOSR-80-0302TR) Avail NTIS HC A04/MF A01 CSCL 21/2

The effects of initial gas temperature, pressure, density, and energy transfer to the gas in the detonation wave have been studied to develop an equation which can be used to predict the length of transition from deflagration to detonation (induction distance) in confined and unconfined combustible gas mixtures. Flame speeds of various hydrogen-oxygen-inert gas mixtures have been measured to determine the relationship between flame speed (deflagration) and induction distance. A nozzle burner having a sine curve contour was used for these experiments to obtain well-defined laminar flame cones permitting reliable and reproducible evaluations. The quenching distances of methane-air, methane-oxygen, acetylene-air, and hydrogen-air flames were not affected by potassium chloride, sodium bicarbonate, or potassium phosphate coatings on the quenching surfaces. It was also found that the quenching distances of these flames are independent of the linear speed of the unburned gas as long as the flows are laminar. Variations of the burner width also did not affect the quenching distances. However, rather significant increases of the quenching distances were observed when the narrow sides between the quenching distances were observed when the narrow sides between the quenching surfaces were closed. New iteration formulas have been developed to simplify and reduce the computational work for calculating detonation parameters and the performance of thermal engines (ramjet, rocket gas turbine, and internal combustion engine). GRA

GRA

**N80-27486# Douglas Aircraft Co Inc Long Beach Calif PRIMARY ADHESIVE BONDED STRUCTURE TECHNOLOGY (PABST) PHASE 3 TOOLING, FABRICATION AND QUALITY ASSURANCE Final Report, Feb 1975 - Jun 1979**

K L Land and F B Lennert 15 Oct 1979 107 p refs (Contract F33615-75-C-3016 AF Proj 486U) (AD-A083228 MDC/MR/DR-983 AFFDL-TR-79-3154) Avail NTIS HC A06/MF A01 CSCL 11/2

The Primary Adhesively Bonded Structure Technology (PABST) program's overall objective was to demonstrate significant improvements in cost, integrity, and durability of primary fuselage structures using latest adhesive bonding techniques, materials, and processes. Accordingly, this document summarizes the findings during Phase 3, Fabrication and Details, highlights of the Manufacturing and Quality Assurance effort in the areas of Tooling and Fabrication. Construction of the Full Scale Demonstration Component (FSDC) provides important performance comparisons of various bond tools, surface preparation techniques, adhesives, primers, bagging approaches, and inspection methods. The fabrication of large constant and non-constant section bonded panels for the FSDC also provided invaluable

N80-27510

manufacturing experience established a natural testbed for validation of Phase 2 Detail Design and yielded excellent feedback for advancement of the PABST technology in Engineering Materials and Process and Quality Assurance GRA

**N80-27510\*#** National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio  
**ADVANCED FUEL SYSTEM TECHNOLOGY FOR UTILIZING BROADENED PROPERTY AIRCRAFT FUELS**

G M Reck Jun 1980 23 p refs Proposed for presentation at 12th Congr of the Intern Council of the Aeron Sci, Munich 13-17 Oct 1980  
(NASA-TM-81538 E-492) Avail NTIS HC A02/MF A01 CSCL 21D

Possible changes in fuel properties are identified based on current trends and projections The effect of those changes with respect to the aircraft fuel system are examined and some technological approaches to utilizing those fuels are described RCT

**N80-27512#** Exxon Research and Engineering Co Linden NJ  
**CARBON SLURRY FUELS FOR VOLUME LIMITED MISSILES Annual Report, Sep 1978 - Oct 1979**

R H Salvesen D C Rigano W S Blazowski and W F Taylor Nov 1979 219 p refs  
(Contract F33615-78-C-2025 AF Proj 3048)  
(AD-A084710 EXXON/PLUS 1KW79 AR-1  
AFAPL-TR-79-2122) Avail NTIS HC A10/MF A01 CSCL 21/4

The Air Force has contracted with ER E to develop a carbon slurry fuel with a minimum of 180 000 BTU/gal This report provides results of the first year's effort of this twenty-seven month program Initial results indicate that a dispersion of carbon black in JP-10 with select dispersing agents can be made that meets the BTU requirements Preliminary results look promising Combustion tests using a specially developed Liquid Fuel Jet Stirred Combustor (LFJSC) have demonstrated that carbon burnout efficiencies greater than 90% are achievable with 300 nm particles in residence times down to 4 ms Homogeneous iron lead manganese and zirconium catalysts at concentrations up to 1000 ppm proved ineffective as accelerators of carbon burnout Further tests are in progress to optimize the composition of the most promising formulations and to test these materials under more vigorous conditions in order to determine their suitability for missile applications GRA

**N80-27513#** Virginia Polytechnic Inst and State Univ Blacksburg  
**THE 1H AND 13C FOURIER TRANSFORM NMR CHARACTERIZATION OF JET FUELS DERIVED FROM ALTERNATED ENERGY SOURCES Final Progress Report, 23 Mar 1978 - 30 Aug 1979**

H C Dorn 30 Aug 1979 80 p refs  
(Contract N00173-78-C-0424)  
(AD-A084169) Avail NTIS HC A05/MF A01 CSCL 07/4

Initially four jet samples were examined in this phase of the study using gel permeation liquid chromatography We have previously discussed these results in the six month Progress Report Although the gel permeation approach has the advantage of nearly quantitative recovery from the chromatography column (typically greater than 95%) and high preparative loading it suffers from two drawbacks in studies of the present jet fuels In general the molecular weight and/or size of the compounds present in typical jet fuels do not cover a broad range This is an obvious result of the relatively narrow distillation range(s) used to generate the jet fuels That is the gel permeation approach is more ideally suited in separations involving mixtures with a broad range in size and/or molecular weight (e g 100-1000 MW), whereas the jet fuels have a more narrow range (e g 100-250MW) GRA

**N80-27562#** Magnavox-General Atronics Philadelphia Pa  
**HIGH POWER HF AND NOISE CANCELLATION SYSTEM Final Technical Report, Oct 1978 - Jan 1980**

Samuel J Harris and Stephen J Rosasco Griffiss AFB NY RADC Mar 1980 48 p refs

(Contract F30602-78-C-0338 AF Proj 2338)  
(AD-A084016 GAC-3392-3403-13 RADC-TR-80-56) Avail NTIS HC A03/MF A01 CSCL 20/14

The objectives of this effort were achieved and should permit high power HF (2-30 MHz) transmitters and conventional HF receivers to be collocated on an aircraft and operated simultaneously (full duplex) with appreciably less than 10% frequency separation between the transmit and receive channels The option of frequency assignment between the Maximum Usable Frequency (MUF) and the Lowest Usable Frequency (LUF) for the transmit and receive frequencies can result in a 40 dB improvement in a duplex circuit or stated another way it may be the only way to establish a circuit between two points One or more full duplex HF circuits can be operated simultaneously on an aircraft The technique employed is a high power HF Interference Cancellation System which is adaptive and completely automatic The significance of this effort is that it has direct application to C3 aircraft and collocated ground HF sites including those sites with transmitters of ultra high power output (1 kW) In addition the ultra linear high power weight/controller technology employing goniometers can be applied in any frequency range from VLF to UHF GRA

**N80-27568#** Transportation Systems Center Cambridge Mass  
**THEORETICAL FEASIBILITY OF DIGITAL COMMUNICATION OVER OCEAN AREAS BY HIGH FREQUENCY RADIO Final Report, Aug 1978 - Jul 1979**

George W Haydon Charles M Rush and Larry R Teters Nov 1979 89 p refs Prepared in cooperation with the National Telecommunication Information Admin Boulder Colo  
(AD-A079424 TSC-FAA-79-26 FAA-EM-78-20) Avail NTIS HC A05/MF A01 CSCL 17/2

The theoretical reliability of digital data transmission via high-frequency radio is examined for typical air traffic routes in the Atlantic and Pacific areas to assist the U S Department of Transportation in the evaluation of a system for improving air traffic control over ocean areas The expected performance of a reference high-frequency data transmission system of 1200 bits per second with a permissible error rate of one in a thousand binary error is expressed as a percentage of time that a given theoretical reliability will be equaled or exceeded The expected performance of air-to-air HF systems is also considered and it is concluded that these systems should work for the reference communication system out to the line-of-sight range of about 800 km for high-flying aircraft GRA

**N80-27573#** Ohio State Univ Columbus  
**RADIATION BY SOURCES ON PERFECTLY CONDUCTING CONVEX CYLINDERS WITH AN IMPEDANCE SURFACE PATCH**

L Ersoy and P H Pathak Griffiss AFB NY RADC Jan 1980 129 p refs  
(Contract F19628-77-C-0107 AF Proj 2305)  
(AD-A084345 ESL-784641-2) Avail NTIS HC A07/MF A01 CSCL 20/14

This report deals with an asymptotic high frequency analysis of the radiation patterns of a magnetic line source or a magnetic line dipole located on a uniform impedance surface patch which partly covers an electrically large perfectly conducting convex cylinder This work is relevant for example to the analysis of fuselage mounted airborne antennas for satellite communication purposes In the latter application impedance surface patches may be employed to increase the radiation intensity near the horizon over that which would ordinarily exist in the absence of any such impedance loading In the present analysis the impedance surface patch is represented as an equivalent aperture in the rest of the perfectly conducting convex cylinder Approximate asymptotic expressions for the (equivalent aperture distribution) i e for the (currents on the impedance surface patch) are developed in this work for the two source types these expressions for the currents are valid in the neighborhood of the source The radiation pattern of this configuration is then found in a straightforward manner by numerically integrating this current distribution in conjunction with a simple and accurate asymptotic high frequency form of the perfectly conducting convex cylinder Green's function Radiation pattern calculations based on this

analysis are found to compare quite well with a numerical moment method type solution a previous GTD solution for those impedances which support an Elliot mode and also with some presently available experimental results GRA

**N80-27663#** Douglas Aircraft Co Inc Long Beach Calif  
**MODELLING REQUIREMENTS FOR THE CALCULATION OF THE TURBULENT FLOW AROUND AIRFOILS, WINGS AND BODIES OF REVOLUTION**

Turner Cebeci and H U Meir (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen West Germany) *In* AGARD Turbulent Boundary Layers Jan 1980 12 p refs

(Contract N00019-78-M-0466)

Avail NTIS HC A17/MF A01

The merits of turbulence models were considered for the calculation of the flow around geometric configurations of relevance to airplane and missile design. Calculated results obtained with three turbulence models were compared to each other and to the boundary layer measurements. Significant results are reported. RCT

**N80-27665#** National Aerospace Lab Amsterdam (Netherlands)  
**BOUNDARY LAYER MEASUREMENTS ON A TWO-DIMENSIONAL WING WITH FLAP AND A COMPARISON WITH CALCULATIONS**

B vandenBerg and B Oskam *In* AGARD Turbulent Boundary Layers Jan 1980 14 p refs

Avail NTIS HC A17/MF A01

Measurements performed on a wing flap configuration which was so designed that flow separations occur nowhere apart from a small laminar separation bubble on the wing nose are presented and discussed. The measurements comprise surface pressure measurements, boundary layer and wake traverses at 16 stations and flow visualization tests to establish the presence of separation bubbles and boundary layer transition regions. The data resolve the various flow phenomena sufficiently well to provide a significant test case for calculation methods for the flow around multielement airfoils. Comparison with such a calculation method showed satisfactory agreement in many respects. A need for improved modelling was found to exist in some regions, particularly for the wing wake above the flap. MG

**N80-27680#** Naval Air Propulsion Test Center Trenton NJ  
Measurement and Information Systems Dept  
**TURBINE FLOWMETERS AND THEIR APPLICATIONS AT THE NAVAL AIR PROPULSION CENTER Final Report**

R E Oberndorfer Apr 1980 31 p refs

(W05980000)

(AD-A084181 NAPC-MS-34) Avail NTIS HC A03/MF A01 CSCL 14/2

At the Naval Air Propulsion Center it has a specific requirement to make accurate mass flow measurements on the fuel flow of a gas turbine engine to determine the performance characteristics. The problem of acquiring mass flow from the inherent volumetric flow data of a turbine flowmeter is discussed. The development of a universal curve from calibration data is discussed. The unique curve fits for flowmeter viscosity and specific gravity and their use during on-line data acquisition is described. The accuracy of the final mass flow data and its dependence on the errors associated with viscosity, specific gravity, temperature and frequency measurement is discussed. Some techniques used at NAPC to reduce these errors are described. GRA

**N80-27681#** National Technical Information Service Springfield Va

**HOLOGRAPHIC FLOW VISUALIZATION CITATIONS FROM THE NTIS DATA BASE Progress Report, 1968 - Mar 1980**

Brian Carrigan Apr 1980 84 p Supersedes NTIS/PS-79/0453 NTIS/PS-78/0351

(PB80-808199 NTIS/PS-79/0453 NTIS/PS-78/0351) Avail NTIS HC \$30 00/MF \$30 00 CSCL 20D

A bibliography containing 77 abstracts concerning the use of holographic methods in flow visualization is presented. Research covering flow in wind tunnels, gas lasers, aircraft wakes, aircraft engines, supersonic flow and shock waves is cited. Most of the techniques involve interferometric holography. GRA

**N80-27682#** National Technical Information Service Springfield Va

**HOLOGRAPHIC FLOW VISUALIZATION CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Mar 1980**

Brian Carrigan Apr 1980 128 p Supersedes NTIS/PS-78/0352

(PB80-808207 NTIS/PS-79/0454 NTIS/PS-78/0352) Avail NTIS HC \$30 00/MF \$30 00 CSCL 20D

Worldwide research on holographic flow visualization is cited. The studies cover techniques, theory, equipment and various applications to measure flow in lasers, shock tubes, wind tunnels and over aerodynamic surfaces. This updated bibliography contains 122 abstracts, 19 of which are new entries to the previous edition. DOE

**N80-27696\*#** National Aeronautics and Space Administration  
Lewis Research Center Cleveland, Ohio

**THE RESPONSE OF TURBINE ENGINE ROTORS TO INTERFERENCE RUBS**

Albert F Kascak 1980 18 p refs Presented at Army Sci Conf West Point N Y 17-19 Jun 1980. Film Supplement number C-294 to this report is available on request from Chief Management Services Division (5-5) National Aeronautics and Space Administration Lewis Research Center 21000 Brookpark Road Cleveland Ohio 44135

(NASA-TM-81518 AVRADCOM-TR-80-C-14 E-462) Avail NTIS HC A02/MF A01 CSCL 21D

A method was developed for the direct integration of a rotor dynamics system experiencing a blade loss induced rotor rub. Both blade loss and rotor rub were simulated on a rotor typical of a small gas turbine. A small change in the coefficient of friction (from 0.1 to 0.2) caused the rotor to change from forward to backward whirl and to theoretically destroy itself in a few rotations. This method provides an analytical capability to study the susceptibility of rotors to rub induced backward whirl problems. LFM

**N80-27719\*#** National Aeronautics and Space Administration  
Lewis Research Center Cleveland Ohio

**COMPARISON OF ELASTIC AND ELASTIC-PLASTIC STRUCTURAL ANALYSES FOR COOLED TURBINE BLADE AIRFOILS**

Albert Kaufman Jul 1980 15 p refs

(NASA-TP-1679 E-241) Avail NTIS HC A02/MF A01 CSCL 20K

Elastic plastic stress strain states in cooled turbine blade airfoils were calculated by three methods for the initial takeoff transient of an advanced technology aircraft engine. The three analytical methods compared were a three dimensional elastic plastic finite element analysis, a three dimensional elastic finite element analysis and a one dimensional elastic plastic beam theory analysis. Structural analyses were performed for eight cases involving different combinations of mechanical and thermal loading on impingement cooled airfoils with and without leading edge film cooling holes. The von Mises effective total strains at maximum takeoff computed from the elastic and elastic plastic finite element analyses agreed with 9 percent for rotating airfoils and 28 percent for stationary airfoils with the elastic results on the conservative side. Author

**N80-27816#** Defense Intelligence Agency Washington, D C  
**HYDROGEN TECHNOLOGY FOREIGN CHANGE 1 Report for period ending Feb 1980**

James D Busi and Phillip Greenbaum 14 Apr 1980 66 p (AD-A083665 DIA-DST-1860S-522-78-CHG-1) Avail NTIS HC A04/MF A01 CSCL 10/2

Hydrogen is both a promising medium for the efficient storage and transmission of energy and a potential alternate fuel. Hydrogen is not a primary energy source however since its production is dependent upon other energy sources (thermal, electrical and radiant). To be practicable as a fuel hydrogen must be produced in bulk quantities with a standardized purity that will satisfy consumer specifications. In addition improved distribution systems must make hydrogen widely available to military industrial and domestic consumers if the successful evolution of a hydrogen economy is to occur. The greatest potential military impact of hydrogen lies in its use as an aviation fuel. Because of its high specific energy (124 kJ/kg--2.7 times greater than conventional aviation fuels) hydrogen has potential use as a fuel for subsonic transports, supersonic aircraft and helicopters however safety measures, logistics and storage and handling systems must be developed and standardized before this capability can be achieved. Initial experimental use of hydrogen in military aircraft may occur in the 1980s. A followup conversion and modification of aircraft and airports to hydrogen will require an additional 10 to 15 years. Secondary military interests include the use of hydrogen fuel cells for portable and transportable power generation, and its use as a propellant in aerospace applications. GRA

**N80-27837#** Aerospace Medical Research Labs Wright-Patterson AFB Ohio  
**COMMUNITY NOISE EXPOSURE RESULTING FROM AIRCRAFT OPERATIONS VOLUME 7 ACOUSTIC DATA ON AIRCRAFT GROUND RUNUP NOISE SUPPRESSORS**  
 Robert A Lee Dec 1979 282 p  
 (AF Proj 7231)  
 (AD-A083701 AMRL-TR-73-110-Vol-7) Avail NTIS  
 HC A13/MF A01 CSCL 01/2

This report presents the results of field measurements of the far-field noise produced on the ground by military aircraft operating inside Grade-2 demountable suppressors during ground runup operations. For these ground runups data are presented as a function of angle and distance to the aircraft. All of the data are normalized to standard acoustic reference conditions of 59 F temperature and 70% relative humidity. Volume 1 discusses the scope, limitations and definitions needed to understand and use the volumes containing the noise data. Noise data are presented in this Volume 7 for the following aircraft suppressor systems: A-7 in the AF32A-19 and AF-32A-24 noise suppressors; KC-135A in the modified AF32A-52 noise suppressor; F-4 in the AF32A-14 noise suppressor; F-5 in the AF32A-18 noise suppressor; F-15 in the AF32A-23 noise suppressor; F-16 in the AF32A noise suppressor; F-100 in the AF32A-16 noise suppressor; F-106 in the AF32A-17 noise suppressor; F-111 in the AF32A-13 noise suppressor and T-38 in the AF32A-18 noise suppressor. GRA

**N80-27838#** Computer Sciences Corp Arlington Va  
**NOISE ABATEMENT ECONOMIC POLICY ANALYSIS MODEL NAEPAM VOLUME 2 USER'S GUIDE Final Report, Sep 1978 - Jul 1979**  
 Andras Spiegel and Roger A Shepherd Jul 1979 162 p  
 2 Vol  
 (Contract DOT-FA78WA-4163)

(AD-A081159 FAA-AEE-79-8-2) Avail NTIS  
 HC A08/MF A01 CSCL 01/2

The development and evaluation of noise emission charge systems for inducing aircraft noise abatement modifications is described in Noise Abatement Economic Policy Analysis Model -- /NAEPAM. The objective of this User's Guide is to describe the model implementation and to provide the necessary information to analysts who wish to execute the model. GRA

**N80-27839#** Computer Sciences Corp Arlington Va  
**NOISE ABATEMENT ECONOMIC POLICY ANALYSIS MODEL NAEPAM, VOLUME 1 Final Report, Sep 1978 - Jul 1979**  
 Andras Spiegel and Roger A Shepherd Jul 1979 73 p refs  
 2 Vol

(Contract DOT-FA79WA-4163)  
 (AD-A081190 FAA-AEE-79-8-1) Avail NTIS  
 HC A04/MF A01 CSCL 01/2

This report examines the role of economic disincentive as an inducement to noise abatement. The particular disincentive analyzed is a system of noise emission charges (NEC) which is imposed at airports on commercial aircraft operations which are above maximum noise emission allowances. The methodology developed is in the form of a mathematical programming (MP) model which seeks to minimize the total cost of a disincentive-based policy. Preliminary analyses conducted with the model indicate (qualitatively) that the method of noise emission charges administered at the airport level on operations exceeding the current noise emission standards is an economically feasible method for inducing noise abatement. The single most critical assumption underlying this conclusion is that if the NEC administration is voluntary then a sufficient number of airports must impose the charges. The modeling concept presented is suitable for the analysis of a broad spectrum of aviation economic policy related issues. GRA

**N80-27840#** Federal Aviation Administration Washington D C  
 Office of Environment and Energy  
**INTEGRATED NOISE MODEL (INM) VERSION 2 USER'S GUIDE**

Thomas Connor and Robert Hinckley Sep 1979 405 p  
 Supersedes FAA-EQ-78-01  
 (AD-A079493 FAA-AEE-79-09 FAA-EQ-78-01) Avail NTIS  
 HC A18/MF A01 CSCL 01/2

This document contains the instructions to execute the Integrated Noise Model (INM) Version 2. The INM is a collection of computer programs which can calculate the aircraft noise environment in the vicinity of an airport given certain information on airport location, layout and the type and movement of its air traffic. GRA

**N80-27842#** Mitre Corp McLean, Va Metrek Div  
**FAA INTEGRATED NOISE MODEL VALIDATION PHASE 1 ANALYSIS OF INTEGRATED NOISE MODEL CALCULATIONS FOR AIR CARRIER FLYOVERS**  
 R G Gados and J M Aldred Dec 1979 103 p refs  
 (Contract DOT-FA80WA-4370)  
 (AD-A081426 MTR-79W FAA/EE-80-04) Avail NTIS  
 HC A06/MF A01 CSCL 01/3

The Federal Aviation Administration's Integrated Noise Model is a set of computer programs which is used to predict the noise impact of aircraft in the vicinity of an airport. Through use of extensive statistical analyses, this study investigates the accuracy and suitability of the noise model in calculating aircraft noise exposure by examining the agreement between the noise model in calculating single noise events and the actual measurement of those events, assessing the sensitivity and controllability of the noise model to aircraft thrust assumptions, and investigating noise curves used in calculating noise exposure by testing variables for significance in estimating noise and by comparing the shape of empirical noise curves with those already in the noise model. Data for the analysis were obtained from field observations of noise from air carrier flight operations over various noise monitoring sites near Washington National and Dulles International Airports. GRA

**N80-28091#** Adaptronics Inc McLean Va  
**INVESTIGATION INTO ADAPTIVE CONTROL OF A SLIP-CAST, REACTION-BONDED SILICON-NITRIDE PROCESS VIA ADAPTIVE LEARNING NETWORK MODELING Final Technical Report, 31 Jan - 30 Sep 1979**  
 Dixon Cleveland, Peter M Garafola, Basil A Decina and Anthony N Muccardi 30 Nov 1979 97 p refs  
 (Contract MDA903-79-C-0186 DARPA Order 3799)  
 (AD-A083730 ADI-REF-542) Avail NTIS HC A05/MF A01  
 CSCL 07/1

A program was conducted to model the modulus of rupture (MOR) strength using Adaptive Learning Networks (ALNs) for aircraft engine components produced by a slip-cast reaction-bonded silicon-nitride production process. The primary objectives of the work were to identify key process variables and to predict

optimum values for those variables as a guide for further experimentation. Nonlinear models have been synthesized that predict MOR with an average error of about 4 ksi over a range from 18.6 to 47.8. The manufacturing and analysis work done to date has demonstrated the feasibility of modeling the slip-cast RBSN process with the Adaptive Learning Network methodology and is viewed as the first iteration in the optimization procedure which is ultimately aimed at finding those manufacturing conditions which will produce the strongest, most consistent material strengths. GRA

**N80-28153#** Watkins and Associates Lexington Ky  
**ASSESSMENT OF THE ENVIRONMENTAL COMPATIBILITY OF DIFFERING HELICOPTER NOISE CERTIFICATION STANDARDS** Final Report

Richard G Edwards, Alvin B Broderson Roger W Barbour Donald F McCoy and Charles W Johnson Jun 1979 67 p refs Prepared in cooperation with Kentucky Univ Lexington (Contract DOT-FA78WA-4194) (AD-A080525 FAA-AEE-79-13) Avail NTIS HC A04/MF A01 CSCL 01/2

Areas having the heaviest helicopter activity in the US were visited and environmental noise measurement made in order to evaluate the impact of possible relaxed noise emission standards for helicopters restricted to remote regions. Measurement results showed that an average of 10 flyovers per hour produced a one hour energy-averaged sound level (Leq) of 54.5 dBA a level 2.5 dBA above ambient. An average of 34 events per hour adjacent to heliports produced a one-hour Leq of 63.1 dBA which was 13.3 dBA above ambient. If emission levels were increased by 10 dBA projected Leq values of 57.0 and 71.2 dBA resulted for the flyover and heliport conditions respectively. Sixty-four percent of those responding to a questionnaire stated that they had not experienced a problem from helicopter noise. The degree to which the remaining respondents were bothered ranged from (slightly) to (very annoyed) with no significant preference for either category. GRA

**N80-28157#** Wyle Labs Inc El Segundo Calif  
**CORRECTION PROCEDURES FOR AIRCRAFT NOISE DATA VOLUME 1 PSEUDOTONES** Final Report

R Rackl Dec 1979 210 p refs (Contract DOT-FA78WA-4143) (AD-A081962 WR-79-9-Vol-1 FAA/EE-80-1-Vol-1) Avail NTIS HC A10/MF A01 CSCL 20/1

Pseudotones are spectral irregularities due to ground reflections which can cause tone corrections in the calculation of Effective Perceived Noise Level which are not generated by the aircraft itself. Several analytical (reflection theory lower cutoff frequency for tone corrections) and instrumentation (ground and pole microphones) methods were investigated which remove the pseudotones. In support of this study a substantial number of aircraft noise measurements were obtained and analyzed in detail. These data are also summarized in the report. GRA

**N80-28158#** Wyle Labs Inc El Segundo Calif  
**CORRECTION PROCEDURES FOR AIRCRAFT NOISE DATA VOLUME 2 BACKGROUND NOISE CONSIDERATIONS** Final Report

L Sutherland J Parkinson and D Hoy Dec 1979 115 p (Contract DOT-FA78WA-4143) (AD-A082011 WR-79-9-Vol-2 FAA-EE-80-1-Vol-2) Avail NTIS HC A06/MF A01 CSCL 20/1

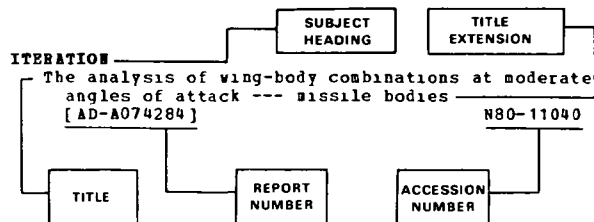
The impact of background noise on the value of PNL, PNL<sub>T</sub> and the resulting EPNL noise metric in aircraft certification to FAR Part 36 is examined in this report, the second in a series of reports on aircraft noise measurement correction procedures. Procedures to remove background noise effects from data measured in the form of one-third octave band sound pressure levels for jet and large propeller aircraft, or data in the form of A-weighted noise levels for light propeller driven aircraft, are defined. After evaluating various techniques for different ratios of signal-to-background noise, one simple correction method for turbojet/turbofan aircraft noise is proposed. The recommended method consists of applying an energy correction up to a

maximum of -10 dB for that portion of the background noise spectra dominated by energy-adding or predetection background noise. For the remaining portion of the background noise spectra, the non-additive postdetection background noise floor tends to mask out bands very close to or below this noise floor. A simple spectrum extrapolation procedure is recommended in this case. Another background noise correction method for light propeller aircraft noise is also proposed. This procedure simply involves application of an energy correction to the as-measured A-weighted aircraft signal using the A-weighted background noise level. Procedures are also suggested for measuring the background noise level in order to account for the randomness of the fluctuating background noise level. GRA



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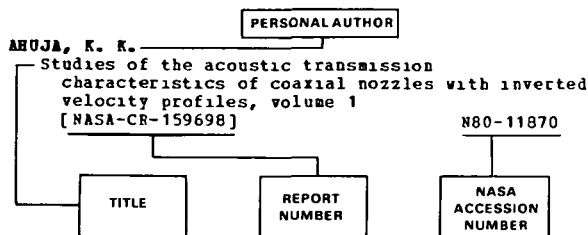
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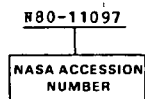
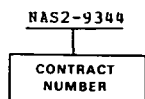
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