NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(210)
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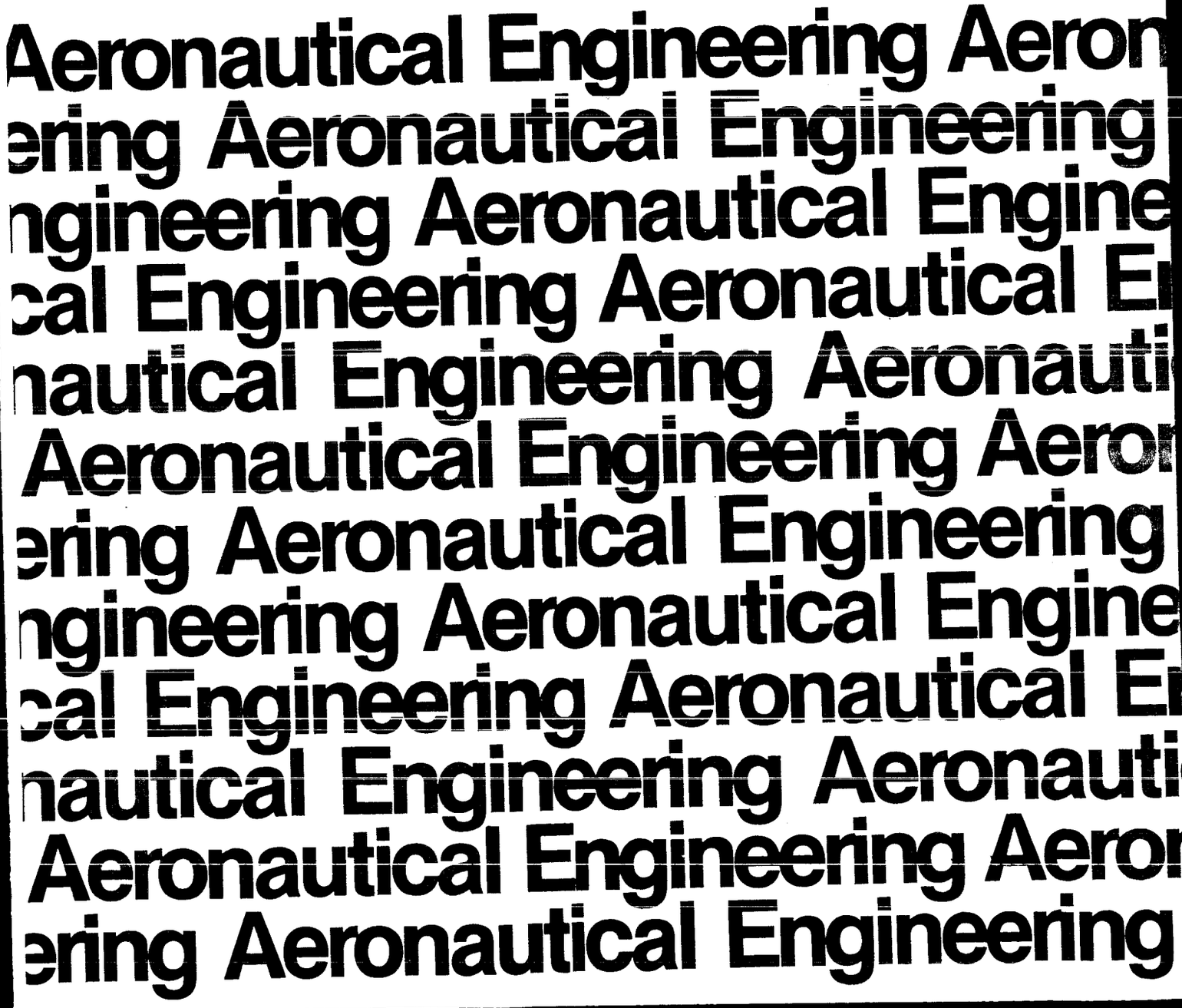
National Aeronautics and Space Administration



ACCESSION NUMBER RANGES

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NASA SP-7037(210)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 210)

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 January 1987 in

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

NASA Scientific and Technical Information Branch 1987
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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 409 reports, journal articles and other documents originally announced in January 1987 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 by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cummulative index will be published.

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Category 10	**Astronautics** Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.	38
Category 11	**Chemistry and Materials** Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.	38

Category 12 Engineering 44
Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

Category 13 Geosciences 54
Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

Category 14 Life Sciences N.A.
Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

Category 15 Mathematical and Computer Sciences 56
Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

Category 16 Physics 57
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

Category 17 Social Sciences 61
Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

Category 18 Space Sciences 62
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

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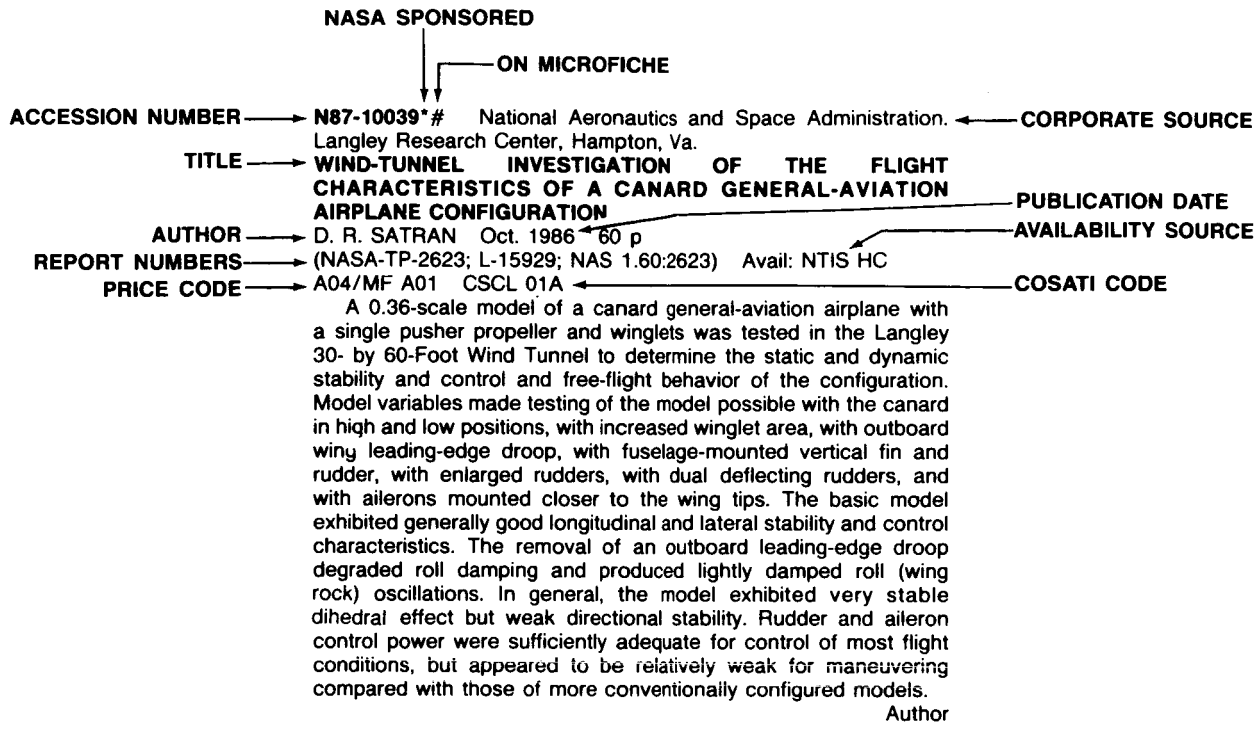
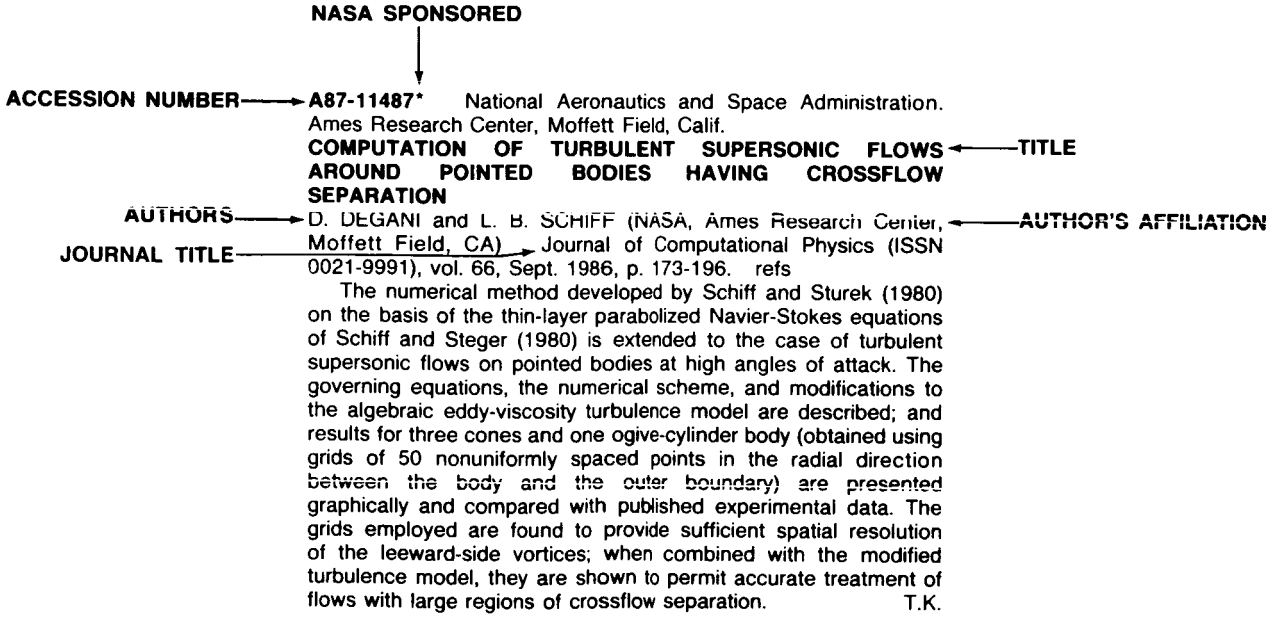
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 210)

FEBRUARY 1987

01

AERONAUTICS (GENERAL)

A87-11801
RADIO TECHNICAL COMMISSION FOR AERONAUTICS, ANNUAL ASSEMBLY MEETING AND TECHNICAL SYMPOSIUM, WASHINGTON, DC, NOVEMBER 19-21, 1985, PROCEEDINGS
J. C. ALCORN, ED. (Radio Technical Commission for Aeronautics, Washington, DC) Washington, DC, Radio Technical Commission for Aeronautics, 1985, 163 p. For individual items see A87-11802 to A87-11807.

Progress in the realization of the U.S. National Airspace System (NAS) Plan, the organizations established to accomplish the Plan goals, and the prospects for upgrading internationally standard aviation communications, navigation and surveillance systems are described. Details of the management structure devised to coordinate, monitor and support the joint government-industry partnership which is implementing the NAS Plan are provided. Government and industry points of view are presented, noting benefits of the various program structures and cost and technical tracking mechanisms which have been emplaced to ensure that the Plan goals are met. Finally, the results of studies by the ICAO Future Air Navigation Systems Committee to identify communications, navigation and surveillance technologies and systems which might meet the requirements for becoming international standards are discussed. M.S.K.

A87-11802#
THE NEED TO EXECUTE THE NATIONAL AIRSPACE SYSTEM PROGRAM AND FOR R&D BEYOND
D. D. ENGEN (FAA, Washington, DC) IN: Radio Technical Commission for Aeronautics, Annual Assembly Meeting and Technical Symposium, Washington, DC, November 19-21, 1985, Proceedings . Washington, DC, Radio Technical Commission for Aeronautics, 1985, p. 21-26.

The goals and progress in implementation of the National Airspace System (NAS) Plan are summarized in a speech by the FAA Administrator. Most of the contracts that will be issued for the 90-program Plan have been signed, including the host computer, the ASR-p radar, an advanced automation system development, a flight service automation system, the MLS, Mode S, etc. Current Federal budget difficulties have not yet seriously hampered the progress of the Plan. The system is expected to double ATC productivity while reducing System operations and maintenance personnel and costs by 1/3 by the year 2000. Finally, a short history of FAA participation in experimental aerospace technology and communications programs over the past decade is provided. M.S.K.

A87-13001
JOINT NATIONAL SYMPOSIUM ON THE INFLUENCE OF AVIATION ON ENGINEERING AND THE FUTURE OF AERONAUTICS IN AUSTRALIA, MELBOURNE, AUSTRALIA, AUGUST 8, 9, 1985, PREPRINTS AND SUPPLEMENTARY PAPERS
Symposium organized and sponsored by the Institution of Engineers, Australia and Royal Aeronautical Society. Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co. (National Conference Publication 85/9), 1985. Preprints, 106 p.; Supplementary Papers, 62 p. For individual items see A87-13002 to A87-13017.

The present conference considers computer-integrated manufacturing, the manufacture of bonded composite assemblies for aircraft, advancements in the condition monitoring of gears and rolling element bearings, condition monitoring of large commercial turbofan engines, novel gas turbine materials, and advanced fiber-reinforced composites for airframe applications. Also discussed are the future of air power in the defense of Australia, future procurement and operations of rotary wing aircraft in the Royal Australia Navy, the future balance between Australian aerospace-related education, research and industry, and the educational requirements for the Royal Melbourne Institute of Technology aeronautical engineering degree. O.C.

A87-13002#
THE INFLUENCE OF AEROSPACE DEVELOPMENTS UPON DEVELOPMENTS IN MANUFACTURING
R. S. DAVIE, L. M. GILLIN, and J. K. RUSSELL (Swinburne Institute of Technology, Hawthorn, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 1-4.

An interpretive development history is presented for the ways in which growing demands for higher precision and extreme fabrication process condition resistances in the processes and materials of the aerospace industry have served as drivers in manufacturing engineering generally. Aerospace design complexity has notably led to the intensive development of computer aided design and manufacturing technologies that have subsequently undergone very general application in other industries. O.C.

A87-13005#
MANUFACTURE OF BONDED COMPOSITE ASSEMBLIES FOR AIRCRAFT
I. M. CUCKSON (Government Aircraft Factories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 19-22.

The F/A-18 Trailing Edge Flap, which is currently being manufactured in Australia as part of that country's participation in the F/A-18 program, exemplifies the critical structural components that can be manufactured by bonding carbon fiber-reinforced composite materials. Attention is presently given to the flap's subelement manufacture in the form of laminates, and their bonding to a honeycomb, as well as to the nondestructive testing to which the finished assembly is subjected. O.C.

A87-13012#
THE FUTURE OPERATIONS AND PROCUREMENT OF ROTARY WING AIRCRAFT IN THE ROYAL AUSTRALIAN NAVY
N. RALPH (Royal Australian Navy, Canberra, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 53-58.

A87-13013#
FUTURE DEVELOPMENTS AND MANUFACTURING AT GAF
W. M. KIDD (Government Aircraft Factories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 59-65.

An evaluation is made of ongoing R&D work at Australia's Government Aircraft Factories (GAF), whose integrated development and manufacturing capability extends from the ability to conduct feasibility design studies to in-service support of manufactured products. In addition to aircraft system and component design, GAF has accumulated expertise in the design of control systems, the application of composite and superplastic metallic materials, the use of CAD, flight testing, environmental testing, chemical milling, and the structural bonding of advanced composites. O.C.

A87-13014#
FUTURE DEVELOPMENTS AND MANUFACTURING AT C.A.C
J. A. C. KENTWELL (Commonwealth Aircraft Corp., Ltd., Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 66-71.

An evaluation is made of recent advancements in the aircraft development and manufacturing technology available to an Australian proprietary firm concerned with airframes, engines, and defense-related equipment. The company is currently involved in Australian coproduction of the F/A-18 aircraft and of its F404 engine's components. A strong trend toward manufacturing facilities' automation is being supported. O.C.

A87-13016#
THE FUTURE OF INTERNATIONAL AIR TRANSPORT
R. J. YATES (Qantas Airways, Ltd., Sydney, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Supplementary Papers . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 14-52.

Modern aircraft are discussed with respect to the commercial and regulatory environment and technological advances, and with emphasis on their impact on Australia's economy and commercial airlines. Towards the goals of reducing aircraft weight and cost while increasing range capability, projected 747 changes include application of more powerful fuel efficient engines such as the Rolls Royce RB211 524D4, a fly-by-wire flight control system and advanced avionics to reduce the number of flight crew from three to two, and new lightweight materials to enhance payload range capability. Increased bypass ratios in advanced turbofans, ultrabypass ratio contra fans, and propfans are considered, in addition to aluminum-lithium alloys, carbon fiber reinforced plastics, and thermoplastic composites. Other avionics and aerodynamics issues are examined. R.R.

A87-13017#
DEVELOPMENTS AT ARL TO MEET FUTURE AUSTRALIAN NEEDS IN AERONAUTICS
G. L. BROWN (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Supplementary Papers . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 59-62.

Current Australian Aeronautical Research Laboratory (ARL) programs are discussed, illustrating a trend away from civil work and towards military aviation, and emphasizing the impact of computing, material sciences, and microelectronics on aeronautics development. Military aviation programs include the development of combat models to evaluate missile performance and other defense issues, airframe life assessment and extension, and assessment of aircraft performance and fatigue life. Future directions of expansion such as avionic systems, integrated control, systems analysis, and helicopter activities are envisioned at ARL. R.R.

N87-10002# Federal Aviation Administration, Atlantic City, N.J. Technical Center.
HELICOPTER MLS FLIGHT INSPECTION PROJECT Final Report
S. B. SHOLLENBERGER and B. R. BILLMANN Apr. 1986 251 p
(DOT/FAA/CT-86/14) Avail: NTIS HC A12/MF A01

The results of tests designed to formalize microwave landing system (MLS) heliport flight inspection procedures are described. The tests, conducted in November 1985, demonstrated the feasibility of using a helicopter to perform some portion of the flight inspection of the MLS at heliports. Significant findings included the fact that radio theodolite techniques could be used for tracking a helicopter not equipped with stability augmentation equipment. Constituent parts of a portable flight inspection package were also identified and tested. Author

N87-10003*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
DEVELOPMENT OF A TURBOMACHINERY DESIGN OPTIMIZATION PROCEDURE USING A MULTIPLE-PARAMETER NONLINEAR PERTURBATION METHOD Final Report
S. S. STAHARA Sep. 1984 260 p
(Contract NAS3-20836)
(NASA-CR-3831; NAS 1.26:3831; NEAR-TR-295) Avail: NTIS HC A12/MF A01 CSCL 01B

An investigation was carried out to complete the preliminary development of a combined perturbation/optimization procedure and associated computational code for designing optimized blade-to-blade profiles of turbomachinery blades. The overall purpose of the procedures developed is to provide demonstration of a rapid nonlinear perturbation method for minimizing the computational requirements associated with parametric design studies of turbomachinery flows. The method combines the multiple parameter nonlinear perturbation method, successfully developed in previous phases of this study, with the NASA TSONIC blade-to-blade turbomachinery flow solver, and the COPES-CONMIN optimization procedure into a user's code for designing optimized blade-to-blade surface profiles of turbomachinery blades. Results of several design applications and a documented version of the code together with a user's manual are provided. Author

N87-10004# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)
H. ZHANG, S. CHEN, X. CHEN, H. YAN, and X. HUO 9 May 1986 94 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 6, no. 4, 1985 p 301-312; 321-334; 362-370; 379-384; 393-404
(AD-A167918; FTD-ID(RS)T-0109-86) Avail: NTIS HC A05/MF A01 CSCL 20D

The following articles are from Acta Aeronautica et Astronautica Sinica, vol.6, no. 4, 1985: Advances in the Study of Separated Flows; Longitudinal Stability Analysis of Elastic Vehicles; Numerical Computation of Two Phase Turbulent Combustion Processes; Gust Alleviation Using Combined Control Laws; Calculation of Supersonic Flows around a Three-dimensional Wing and a Waisted Body with Characteristic Method in Stream Surface Coordinates; and Thermodynamic Analysis of Turbofan Engines. GRA

N87-10828*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
GRADUATE ENGINEERING RESEARCH PARTICIPATION IN AERONAUTICS Final Report, period ending 31 Aug. 1986
A. S. ROBERTS, JR. Aug. 1986 80 p
(Contract NGR-47-003-052)
(NASA-CR-179798; NAS 1.26:179798) Avail: NTIS HC A05/MF A01 CSCL 01B

The Aeronautics Graduate Research Program commenced in 1971, with the primary goal of engaging students who qualified for regular admission to the Graduate School of Engineering at Old Dominion University in a graduate engineering research and study program in collaboration with NASA Langley Research Center, Hampton, Virginia. The format and purposes of this program are discussed. Student selection and program statistics are summarized. Abstracts are presented in the folowing areas: aircraft design, aerodynamics, lift/drag characteristics; avionics; fluid mechanics; solid mechanics; instrumentation and measurement techniques; thermophysical properties experiments; large space structures; earth orbital dynamics; and environmental engineering. B.G.

N87-10829*# Kentron International, Inc., Hampton, Va.
NUMERICAL METHODS AND A COMPUTER PROGRAM FOR SUBSONIC AND SUPERSONIC AERODYNAMIC DESIGN AND ANALYSIS OF WINGS WITH ATTAINABLE THRUST CONSIDERATIONS
H. W. CARLSON and K. B. WALKLEY Washington NASA Aug. 1984 78 p
(Contract NAS1-16000)
(NASA-CR-3808; NAS 1.26:3808) Avail: NTIS HC A05/MF A01 CSCL 01B

This paper describes methodology and an associated computer program for the design of wing lifting surfaces with attainable thrust taken into consideration. The approach is based on the determination of an optimum combination of a series of candidate surfaces rather than the more commonly used candidate loadings. Special leading-edge surfaces are selected to provide distributed leading-edge thrust forces which compensate for any failure to achieve the full theoretical leading-edge thrust, and a second series of general candidate surfaces is selected to minimize drag subject to constraints on the lift coefficient and, if desired, on the pitching moment coefficient. A primary purpose of the design approach is the introduction of attainable leading-edge thrust considerations so that relatively mild camber surfaces may be employed in the achievement of aerodynamic efficiencies comparable to those attainable if full theoretical leading-edge thrust could be achieved. The program provides an analysis as well as a design capability and is applicable to both subsonic and supersonic flow. Author

N87-10830# Air Force Test Pilot School, Edwards AFB, Calif.
PERFORMANCE AND QUALITY FLIGHT TEST TEXTBOOK. VOLUME 2: FLYING QUALITIES
Apr. 1986 1640 p
(AD-A168124) Avail: NTIS HC A99/MF A06 CSCL 01B

Flying qualities is that discipline in the aeronautical sciences that is concerned with basic aircraft stability and pilot-in-the-loop controllability. With the advent of sophisticated flight control systems, vectored thrust, forward-swept wings, and negative static margins, the concept of flying qualities takes on added dimensions. In aeronautical literature there are three terms bandied about which are generally considered synonymous. These terms are flying qualities, stability and control, and handling qualities. Among others, the textbook contains the following articles: Introduction to Flying Qualities; Vectors and Matrices; Differential Equations; Equations of Motion; Longitudinal Static Stability; Maneuvering Flight; Lateral-Directional Static Stability; Dynamic Stability; Roll Coupling; High Angle of Attack; Engine-Out Theory and Flight Testing; Aeroelasticity; Feedback Control Theory, and Flight Control Systems. GRA

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A87-10409
A NUMERICAL ANALYSIS OF SUPERSONIC BOTTOM FLOW WITH THERMAL MODIFICATION OF THE WAKE [CHISLENNYI ANALIZ SVERKHZVUKOVOGO DONNOGO TECHENIIA V USLOVIIAKH TEPLOVOGO VOZDEISTVIIA NA SLED]
V. I. GOLOVICHEV Fizika Goreniia i Vzryva (ISSN 0430-6228), vol. 22, May-June 1986, p. 78-84. In Russian. refs

Numerical solutions to full nonstationary Navier-Stokes equations are used to analyze the structure of an axisymmetric wake flow behind a body in the case of supersonic homogeneous flow past the body. In particular, the effect of fuel injection in the bottom region or into an inviscid supersonic flow is investigated in order to evaluate the efficiency of various methods of increasing bottom pressure through heat transfer to the near wake. It is shown that a combined method of thermal modification of bottom flow provides an efficient way to reduce the drag of bodies moving at supersonic velocities. V.L.

A87-10517#
UNSTEADY AERODYNAMIC MODELING OF A FIGHTER WING IN TRANSONIC FLOW
J. B. MALONE (Lockheed-Georgia Co., Advanced Flight Sciences Dept., Marietta), L. N. SANKAR (Georgia Institute of Technology, Atlanta), and W. A. SOTOMAYER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 611-620. Previously cited in issue 17, p. 2425, Accession no. A84-37975. refs
(Contract F33615-83-C-3215)

A87-10520#
VORTEX-STRETCHED FLOW AROUND A CRANKED DELTA WING
A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) and C. J. PURCELL (ETA Systems, Inc., Saint Paul, MN) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 636-640. Previously cited in issue 01, p. 5, Accession no. A86-11043. refs

A87-10521#
AERODYNAMIC ANOMALIES - CAN CFD PREVENT OR CORRECT THEM?
R. S. SHEVELL (Stanford University, CA) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 641-649. Previously cited in issue 01, p. 4, Accession no. A86-11033. refs

A87-10522*# North Carolina State Univ., Raleigh.
EULER EQUATIONS ANALYSIS OF THE INITIAL ROLL-UP OF AIRCRAFT WAKES
R. A. MITCHELTREE, H. A. HASSAN (North Carolina State University, Raleigh), and R. J. MARGASON (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 650-655. Previously cited in issue 07, p. 829, Accession no. A86-19675. refs
(Contract NCC1-84)

A87-10523#
FURTHER DEVELOPMENT OF THE INFLUENCE FUNCTION METHOD FOR STORE AERODYNAMIC ANALYSIS
A. CENKO (Hofstra University, Hempstead, NY), R. MEYER, and F. TESSITORE (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 656-661. Previously cited in issue 05, p. 584, Accession no. A83-16622. refs
(Contract F33615-82-C-3007)

A87-10524*# Informatics General Corp., Palo Alto, Calif.
UNSTEADY TRANSONICS OF A WING WITH TIP STORE
G. P. GURUSWAMY (Informatics General Corp., Palo Alto, CA), P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA), and E. L. TU Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 662-668. USAF-supported research. Previously cited in issue 07, p. 828, Accession no. A86-19633. refs

A87-10525#
BODY OF REVOLUTION COMPARISONS FOR AXIAL- AND SURFACE-SINGULARITY DISTRIBUTIONS
J. M. DSA and C. DALTON (Houston, University, TX) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 669-672. refs

A comparison is made between the surface velocities generated by two different singularity methods of representing an axisymmetric body in an incompressible uniform flow, i.e., the method of axial singularities and the method of surface-distributed singularities. In particular, the two methods are compared by performing calculations for an ellipsoid of revolution (finess ratio 7) and for an afterbody. The surface-singularity method is found to be the better of the two approaches. Although this method needs a relatively larger number of points to represent adequately the geometry of a body and requires more computing time, its ability to represent even complex body shapes makes it the superior method. V.L.

A87-10603
DENSITY FIELD OF A VISCOUS GAS JET ISSUING FROM A CONICAL NOZZLE INTO VACUUM [POLE PLOTNOSTI STRUI VIAZKOGO GAZA, ISTEKAIUSHCHEGO IZ KONICHESKOGO SOPLA V VAKUUM]
E. N. BONDAREV, M. P. BURGASOV, I. A. VASILEV, and A. S. KOKOREV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 25-30. In Russian. refs

An approximation dependence for calculating the density field in a viscous gas jet issuing from a conical nozzle into vacuum is derived on the basis of experimental data and the numerical solution of the full system of Navier-Stokes equations. The dependence of jet parameters on Reynolds number is given for the Re number range of 500-5000. The results are found to agree well with findings for supersonic ideal-gas jets. B.J.

A87-10609
METHOD OF MERIDIONAL SECTIONS IN PROBLEMS INVOLVING A THREE-DIMENSIONAL BOUNDARY LAYER [METOD MERIDIONAL'NYKH SECHENII V ZADACHAKH PROSTRANSTVENNOGO POGRANICHNOGO SLOIA]
V. V. LUNEV and E. A. SENKEVICH Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 67-73. In Russian. refs

It is shown that the problem of calculating the heat-transfer distribution on the surface of a body in three-dimensional flow can be simplified substantially when the effect of three-dimensionality is small. The three-dimensional problem is reduced to a set of two-dimensional problems along the lines of meridional sections of the body. The exact boundary layer equations can be solved independently along each meridional plane. B.J.

A87-10610
EXCITATION OF THE NATURAL OSCILLATIONS OF A BOUNDARY LAYER BY AN EXTERNAL ACOUSTIC FIELD [VOZBUZHDENIE SOBSTVENNYKH KOLEBANII POGRANICHNOGO SLOIA VNESHNIM AKUSTICHESKIM POLEM]
A. A. MASLOV and N. V. SEMENOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 74-78. In Russian. refs

An electric-discharge apparatus was used to study the excitation of natural oscillations in a laminar boundary layer by an external acoustic field. Experiments were carried out in a supersonic wind tunnel at a Mach number of 2.0. Three regions were found where the external acoustic perturbations are most effectively converted to the natural oscillations of a supersonic boundary layer on a flat plate: the leading edge of the plate, the acoustic branch of the neutral curve, and the lower branch of the neutral stability curve. B.J.

A87-10614
NUMERICAL INVESTIGATION OF SUPERSONIC FLOW PAST SPIKE-TIPPED BLUNT BODIES [CHISLENNOE ISSLEDOVANIE SVERKHZVUKOVOGO OBTEKANIIA ZATUPLENNYKH TEL S VYDVINUTOI VPERED IGLOI]
V. N. KARLOVSKII and V. I. SAKHAROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 119-127. In Russian. refs

A method is developed for calculating the supersonic flow of an ideal gas near axisymmetric spike-tipped blunt bodies. An analysis is made of the flow past a truncated cone with a spherically blunted cylindrical spike as a function of the ratio (K) of the spike length to the diameter of the end part of the body, and as a function of the Mach number. Several steady flow regimes were observed, including a regime involving the formation of circulation zones and internal shock waves in the shock layer. It is shown that the mounting of the spike on the truncated cone can reduce the cone drag by 40-50 percent. The drag coefficient is studied as a function of K at M = 3. B.J.

A87-10615
CONICAL WING OF MAXIMUM LIFT-TO-DRAG RATIO IN A SUPERSONIC GAS FLOW [KONICHESKOE KRYLO MAKSIMAL'NOGO AERODINAMICHESKOGO KACHESTVA V SVERKHZVUKOVOM POTOKE GAZA]
V. I. LAPYGIN and P. V. TRETIAKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 128-133. In Russian. refs

A theoretical analysis of conical wings at Mach numbers greater than 2 shows that maximum lift-to-drag ratio is possessed by wings with a flat lower surface. Simple analytical relationships are obtained determining the wing aerodynamic characteristics at angles of attack up to the separation of the bow shock from the leading edges. B.J.

A87-10618
CALCULATION OF UNSTEADY SUPERSONIC FLOW PAST A PLANE BLADE ROW UNDER THE EFFECT OF VORTEX INHOMOGENEITIES IN THE ONCOMING FLOW [RASCHET NESTATSIONARNOGO SVERKHZVUKOVOGO OBTEKANIIA PLOSKOI RESHETKI PLASTIN PRI VOZDEISTVII NA NEE VIKHREVYKH NEODNORODNOSTEI NABEGAIUSHCHEGO POTOKA]
K. K. BUTENKO and A. A. OSIPOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 152-160. In Russian. refs

Ni's (1979) approach is used to calculate the unsteady flow past a plane blade row under the effect of vortex inhomogeneities in the supersonic oncoming flow. Formulas are obtained for the intensity of unsteady pressure shocks and vortex wakes shedding from the blade trailing edges. Calculation examples are presented which illustrate the accuracy of the method and its capabilities. B.J.

A87-10619
MATHEMATICAL MODELING OF SEPARATED FLOW PAST A WING PROFILE AND AERODYNAMIC HYSTERESIS [MATEMATICHESKOE MODELIROVANIE OTRYVNOGO OBTEKANIIA KRYLOVOGO PROFILIA I AERODINAMICHESKOGO GISTEREZISA]
S. M. BELOTSERKOVSKII, V. N. KOTOVSKII, M. I. NISHT, and R. M. FEDOROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 161-169. In Russian. refs

The unsteady-flow approaches of Kotovskii et al. (1982, 1983, 1984), based on ideal-fluid and boundary-layer models, are extended. This makes it possible to describe the separated flow past a wing profile in a wide range of angles of attack with allowance for separation on the surface as well as the hysteresis phenomenon. The proposed model allows a detailed investigation of unsteady processes in the boundary layer on the profile surface and in the near aerodynamic wake. B.J.

A87-10620
OPTIMAL CONTROL OF VISCOUS FLOW AT HIGH REYNOLDS NUMBERS [OPTIMAL'NOE UPRAVLENIE VIAZKIM POTOKOM PRI BOL'SHIKH CHISLAKH REINOL'DSA]
M. A. BRUTIAN, P. L. KRAPIVSKII, and V. V. SYCHEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), May-June 1986, p. 174-176. In Russian.

An effort is made to determine the theoretical minimum of drag on a body that can be achieved through boundary layer control via suction or blowing. This problem is investigated for the laminar flow of a viscous incompressible fluid past a body at high Reynolds numbers. Drag minimization is considered for a sphere and for planar bodies. B.J.

A87-10675
MOTION OF A GAS IN A DUCT BEHIND A MOVING BODY [DVIZHENIE GAZA V KANALE ZA PODVIZHNYM TELOM]
V. F. MAKSIMOV and IU. G. FILIPPOV Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), May-June 1986, p. 111-113. In Russian.

The nonstationary two-dimensional problem of gas flow behind an elongated body accelerating to supersonic velocities is solved numerically, and a computer simulation is carried out using a program written in FORTRAN. A pattern of reverse flow in the bottom region developing with increasing body velocity is obtained. A comparison is made with the one-dimensional case. V.L.

A87-11117#
VORTEX SIMULATION OF PROPAGATING STALL IN A LINEAR CASCADE OF AIRFOILS
C. G. SPEZIALE (Georgia Institute of Technology, Atlanta), F. SISTO, and S. JONNAVITHULA (Stevens Institute of Technology, Hoboken, NJ) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 108, Sept. 1986, p. 304-312. refs
(Contract N00014-84-K-0741)

A vortex method developed by Spalart (1984) is used in the numerical simulation of propagating stall in a linear cascade of airfoils at high Reynolds numbers. Calculations are presented for a variety of flow geometries and several different flow regimes are obtained for a given cascade of airfoils, disturbance wavelength, and stagger angle. These include attached flow for lower angles of attack and a chaotic deep stall configuration at larger angles of attack; there is a narrow intermediate range of such angles where propagating stall takes place. The physical traits of this propagating stall are parameterized and a quantative study of the effects of camber and imposed wavelength is performed. K.K.

A87-11411* University Coll. of Swansea (Wales).
RECENT DEVELOPMENTS IN FEM-CFD
R. LOEHNER, K. MORGAN, J. PERAIRE, and O. C. ZIENKIEWICZ (Swansea, University College, Wales) IN: The Free-Lagrange method; Proceedings of the First International Conference, Hilton Head Island, SC, March 4-6, 1985 . Berlin and New York, Springer-Verlag, 1985, p. 236-254. Research supported by the Ministerio de Educacion y Ciencia of Spain. refs
(Contract NAGW-478)

The current status of CFD with regard to unstructured grids employing finite element methods and Eulerian frames is reviewed. Algorithms suitable for the computation of large three-dimensional problems involving flow past arbitrary geometries are developed. Adaptive mesh refinement strategy is reviewed, and domain splitting or local time-stepping are briefly addressed. The development of search algorithms of optimal order, variable time-stepping Jacobi smoothers for elliptic problems, and transport concepts for hyperbolics to help achieve good performance for unstructured multigrid processes is discussed. As examples, transient supersonic flow in a channel, regular shock reflection of a wall, viscous flow past a protruberance, potential flow past a cylinder, and Burgers equation are considered. C.D.

A87-11487* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPUTATION OF TURBULENT SUPERSONIC FLOWS AROUND POINTED BODIES HAVING CROSSFLOW SEPARATION
D. DEGANI and L. B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) Journal of Computational Physics (ISSN 0021-9991), vol. 66, Sept. 1986, p. 173-196. refs

The numerical method developed by Schiff and Sturek (1980) on the basis of the thin-layer parabolized Navier-Stokes equations of Schiff and Steger (1980) is extended to the case of turbulent supersonic flows on pointed bodies at high angles of attack. The governing equations, the numerical scheme, and modifications to the algebraic eddy-viscosity turbulence model are described; and results for three cones and one ogive-cylinder body (obtained using grids of 50 nonuniformly spaced points in the radial direction between the body and the outer boundary) are presented graphically and compared with published experimental data. The grids employed are found to provide sufficient spatial resolution of the leeward-side vortices; when combined with the modified turbulence model, they are shown to permit accurate treatment of flows with large regions of crossflow separation. T.K.

A87-11495#
CALCULATION OF BOUNDARY LAYER OF A THREE DIMENSIONAL S-SHAPED INLET
Z. XING and S. ZEN Northwestern Polytechnical University, Journal, vol. 4, July 1986, p. 361-370. In Chinese, with abstract in English. refs

A simplified, fast-computation time method is presented for modeling the three-dimensional boundary layer in an S-shaped jet engine intake design. A streamline coordinate system is implemented over the S-shaped geometry in order to reduce the problem to that of an axisymmetric flow. A perturbation method is embedded in the flow calculations to accelerate identification of the streamline flow axes and the location of the edge of the boundary layer. Sample calculations are provided for S-shaped inlets with free stream Mach numbers ranging from 0.5-0.9 and varying mass ratios. The model outputs, which can be obtained with a personal computer, show reasonable agreement with experimental data on the variation of the boundary layer parameters. M.S.K.

A87-11509* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NUMERICAL SIMULATION OF VISCOUS SUPERSONIC FLOW OVER A GENERIC FIGHTER CONFIGURATION
D. S. CHAUSSEE (NASA, Ames Research Center, Moffett Field, CA), G. BLOM (Boeing Co., Seattle, WA), and J. WAI IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 63-69. Previously announced in STAR as N86-15627. refs

A87-11510
A PRE-PROCESSED IMPLICIT ALGORITHM FOR 3D VISCOUS COMPRESSIBLE FLOW
W. N. DAWES (Central Electricity Generating Board, Whittle Laboratory, Cambridge, England) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 70-77. refs

The efficient numerical simulation by time marching methods of high Reynolds number compressible flow in turbomachine geometries is considered. An algorithm is developed with guaranteed diagonal dominance and low operation count by preprocessing the basic Beam-Warning implicit algorithm with a suitable matrix operator. Results for the flow in a linear cascade of turbine blades demonstrate the development of the passage vortex and associated strong three-dimensional effects. R.R.

A87-11512
EULER SOLUTIONS ON O-O GRIDS AROUND WINGS USING LOCAL REFINEMENT
L.-E. ERIKSSON (Flygtekniska Forsoksanstalten, Bromma, Sweden) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 86-96. refs

Local grid refinement as a means to improve the accuracy of finite-difference solutions to the Euler equations is here investigated in both two and three space dimensions. Two alternative conservative interface conditions for the centered finite-volume scheme with explicit multistage time-stepping are described and applied to the computation of steady Euler solutions on locally refined O-type grids around wings. In 2D a comparison between the two interface conditions shows that they perform equally well and are stable even when shocks intersect the interface. One of the interface conditions is also investigated in 3D and several computed examples show that it performs equally well in this case also. Stability is achieved even when shocks or vortices intersect the interface. Author

A87-11516
APPLICATION OF A 2D TIME-MARCHING EULER CODE TO TRANSONIC TURBOMACHINERY FLOW
H.-W. HAPPEL (MTU, Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 129-136. Research supported by the Bundesministerium der Verteidingung. refs

This paper describes a time-marching finite area method to obtain the steady 2D blade-to-blade solution along an axisymmetric stream surface with changing radius and stream tube thickness. The conservation laws are solved in a rotating frame. The numerical scheme is explicit and first order accurate in time and space. To achieve stability, explicit numerical viscosity is added. In order to increase the convergence speed, a sequential grid-refining procedure and a multiple-grid algorithmus are used in the code. The accuracy and computational efficiency of the computer code are demonstrated for realistic blade geometries. The comparison with airfoil measurements shows good agreement for turbine and compressor cascades. Author

A87-11526
NUMERICAL EXPERIMENTS WITH A TOTAL VARIATION DIMINISHING (TVD) MACCORMACK SCHEME
C. M. KWONG (Salford, University, England) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 217-224. Research supported by the Ministry of Defence of England. refs

The application of a TVD MacCormack scheme is outlined and assessed. The scheme is seen to be robust, to resolve discontinuities well, to be free from oscillations typical of second or higher order accurate schemes and to have no problem-dependent parameters to be adjusted. Following the numerical procedure outlined in this paper, many existing MacCormack algorithms can be modified to good effect. The TVD property of the scheme is demonstrated by the numerical computations relating to the 1-D linear wave equation and the nonlinear inviscid Burger's equation. The scheme is further used to solve the inviscid Euler equations in one- and two-dimensions relating to practical transonic and supersonic flow problems. Comparisons between three schemes - MacCormack, Operator-Switching MacCormack-Upwind, and TVD MacCormack schemes are also shown. Author

A87-11528
EFFICIENT NUMERICAL METHOD FOR TRANSONIC FLOW SIMULATIONS
E. VON LAVANTE (Old Dominion University, Norfolk, VA) and D. CLAES (Bochum, Ruhr-Universitaet, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 233-240. refs

A numerical method for solving the two-dimensional steady Euler equations using flux vector splitting is developed. The equations are expressed in curvilinear coordinates and the finite volume approach is used. The energy equation is omitted since only steady state solutions are required. Depending on the Mach number levels in the flow two different implicit operators are employed to enhance the stability properties of the present method. Present numerical results for several two-dimensional internal flow configurations are compared with predictions obtained by other authors. Author

A87-11533
IMPLICIT FINITE-DIFFERENCE SIMULATION OF SEPARATED HYPERSONIC FLOW OVER AN INDENTED NOSETIP
B. MUELLER and D. RUES (DFVLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 271-278. DFG-supported research. refs

Laminar hypersonic flow over a severely indented blunt nosetip at zero angle of attack is simulated by solving the axisymmetric Navier-Stokes equations using an implicit finite-difference method. New forms of convergence acceleration to the steady state are presented. The validity of the thin-layer approximation is confirmed for flow with a large separation region at high Reynolds numbers. Author

A87-11536* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SIMULATION OF ROTOR-STATOR INTERACTION USING THE EULER EQUATIONS AND PATCHED GRIDS
M. M. RAI (NASA, Ames Research Center, Moffett Field, CA) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 295-301. Previously announced in STAR as N86-17014. refs

A87-11537
NUMERICAL EXPERIMENT WITH INVISCID VORTEX-STRETCHED FLOW AROUND A CRANKED DELTA WING, SUPERSONIC SPEED
A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) and C. J. PURCELL (ETA Systems, Inc., Saint Paul, MN) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 310-318.

A numerical method that solves the Euler equations for compressible flow is used to study vortex stretching. The particular case simulated is supersonic flow of freestream Mach number 1.2 and alpha of 10 deg around the twisted and cambered cranked-and-cropped TKF delta wing of MBB. This geometry induces multiple leading-edge vortices in a straining velocity field that brings about flow instabilities, but the result is a state of statistical equilibrium. The discretization contains over 600,000 cells and offers sufficient degrees of freedom in the solution to resolve the small-scale unstable modes that lead to disordered vortex flow. Author

A87-11538
NUMERICAL SOLUTION OF THE EULER EQUATIONS USING RATIONAL RUNGE-KUTTA METHOD
N. SATOFUKA, K. MORINISHI, and H. TOKUNAGA (Kyoto Institute of Technology, Japan) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 319-326. refs

A simple and efficient numerical method for solving the Euler equations is proposed which consists of a combination of the central finite difference approximation to the space variables with the rational Runge-Kutta time integration scheme. Residual averaging and multigriding are included into the basic scheme to improve the rate of convergence to the steady state solution. The performance of the algorithm is demonstrated for two dimensional transonic flow past NACA0012 and RAE2822 airfoils, and good agreement is found between pressure distributions obtained with the present method and those derived from the Beam-Warming scheme. Though three times as many steps are required with the present method, only one-fourth of the CPU time/time step is needed in comparison with the Beam-Warming method. The present method is easily vectorizable without additional requirements such as extra memory, and extension to three-dimensional problems is straightforward. R.R.

A87-11540
CALCULATION OF STRONG VISCOUS/INVISCID INTERACTIONS ON AIRFOILS BY ZONAL SOLUTIONS OF THE NAVIER-STOKES EQUATIONS
M. A. SCHMATZ (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 335-342. DFG-supported research. refs

A method is presented to predict viscous/inviscid interacting flows by coupling iteratively zonal solutions of different fluid dynamic equations. Subdomains of weak interaction, where the Euler and the boundary layer equations together yield the equivalent inviscid flow, are coupled with domains of strong interactions. There the Navier-Stokes equations are solved. Characteristic boundary conditions are used at artificial boundaries of the overlapping computational grids due to the mathematical character of the equations. The two-dimensional calculations performed for subsonic and transonic flow problems indicate that the method should be an efficient aerodynamic tool in three-dimensional problems, too. Author

A87-11542* Old Dominion Univ., Norfolk, Va.
FINITE ELEMENT COMPUTATIONS FOR HIGH SPEED 3D INVISCID FLOWS
E. A. THORNTON and R. RAMAKRISHNAN (Old Dominion University, Norfolk, VA) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 359-366. NASA-supported research.

Recent progress in the development of finite element methodology for the prediction of aerothermal loads is described. Three dimensional, inviscid computations are presented, but emphasis is placed on development of an approach extendable to three dimensional viscous flows. Progress in key research areas is described. Initial 30 results from the computational procedure are described. Author

A87-11544
A SPLIT-MATRIX METHOD FOR THE INTEGRATION OF THE QUASI-CONSERVATIVE EULER-EQUATIONS
C. WEILAND (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 383-390. refs

A finite difference method based on the theory of characteristics is presented for the integration of the quasi-conservative Euler-equations. The eigenvalues and the sets of left and right eigenvectors which diagonalize the coefficient matrices are obtained from the nonconservative Euler-equations, and the coefficient matrices and the left and right eigenvectors for the conservative variables are derived from a simple similarity transformation. Special attention is paid to the boundary conditions at impermeable boundaries, and an algorithm utilizing the compatibility equations at a distance of a half cell width from the boundary where the sign of the eigenvalue is unique is introduced to overcome the failure, produced by the set of characteristic compatibility equations which transmit the information from the field to the boundary, in the conservation of the total enthalpy. Results are presented for supersonic blunt-body flow, transonic flow past airfoils, and transonic and supersonic flow past engine inlets. R.R.

A87-11782* Douglas Aircraft Co., Inc., Long Beach, Calif.
NUMERICAL AND PHYSICAL ASPECTS OF AERODYNAMIC FLOWS III; PROCEEDINGS OF THE THIRD SYMPOSIUM, CALIFORNIA STATE UNIVERSITY, LONG BEACH, CA, JANUARY 21-24, 1985
T. CEBECI, ED. (Douglas Aircraft Co.; California State University, Long Beach) Symposium supported by NASA, U.S. Army, NSF, and U.S. Navy. New York, Springer-Verlag, 1986, 493 p. For individual items see A87-11783 to A87-11786.

The present symposium considers hydrodynamic stability and turbulent transition, transition calculations in three-dimensional flows, a quasi-simultaneous finite difference approach for strongly interacting flows, the significance of the thin layer Navier-Stokes approximation, unsteady airfoil boundary layers, predictions and experiments on airfoils at low Reynolds numbers, and a comparison of interactive boundary layer and thin layer Navier-Stokes procedures. Also discussed are a viscous-inviscid interaction method for computing unsteady transonic separation, massive separation and dynamic stall on a cusped trailing edge airfoil, the computation of turbulent separated flows over wings, an iterative scheme for three-dimensional transonic flows, and the computation of three-dimensional flows with shock wave/boundary layer interaction. Many of the papers in this symposium were abstracted previously (cf., A85-42951). O.C.

A87-11783
CALCULATION METHODS FOR AERODYNAMIC FLOWS - A REVIEW
T. CEBECI (California State University, Long Beach) and J. H. WHITELAW (Imperial College of Science and Technology, London, England) IN: Numerical and physical aspects of aerodynamic flows III; Proceedings of the Third Symposium, Long Beach, CA, January 21-24, 1985 . New York, Springer-Verlag, 1986, p. 1-19. (Contract NSF MEA-80-18565)

The solution of inviscid flow equations for the design of three-dimensional bodies is well established, and provides useful information on lift at lower angles-of-attack. As this angle increases, so does the need to consider the influence of the viscous layer; interactive methods developed for airfoil flows can be extended to the cases of three-dimensional flow. At high angles of attack, separation can occur, and the relative merits of interactive inviscid-viscous procedures and the time-averaged Navier-Stokes equations become less certain. Unsteady two-dimensional flows also become increasingly difficult to deal with as the angle-of-attack increases, so that they are influenced by the frequency of the unsteadiness. O.C.

A87-11785* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPARISON OF INTERACTIVE BOUNDARY-LAYER AND THIN-LAYER NAVIER-STOKES PROCEDURES
U. MEHTA (NASA, Ames Research Center, Moffett Field, CA), K. C. CHANG, and T. CEBECI (Douglas Aircraft Co., Long Beach, CA) IN: Numerical and physical aspects of aerodynamic flows III; Proceedings of the Third Symposium, Long Beach, CA, January 21-24, 1985 . New York, Springer-Verlag, 1986, p. 198-215. Previously announced in STAR as N86-15244.

Numerical procedures for solving the thin-shear-layer Navier-Stokes equations and for the interaction of solutions to inviscid and boundary-layer equations are described and evaluated. To allow appraisal of the numerical and fluid dynamic abilities of the two schemes, they have been applied to one airfoil as a function of angle of attack at two slightly different Reynolds numbers. The NACA 0012 airfoil has been chosen because it allows comparison with measured lift, drag, and moment and with surface-pressure distributions. Calculations have been performed with algebraic eddy-viscosity formulations, and they include consideration of transition. The results are presented in a form that allows easy appraisal of the accuracy of both procedures and of the relative costs. The interactive procedure is computationally efficient but restrictive relative to the thin-layer Navier-Stokes procedure. The latter procedure does a better job of predicting drag than does the former. In both procedures, the location of transition is crucial for accurate or detailed computations, particularly at high angles of attack. When the upstream influence of pressure field through the shear layer is important, the thin-layer Navier-Stokes procedure has an edge over the interactive procedure. Author

A87-11786
COMPUTATIONS OF SEPARATED SUBSONIC AND TRANSONIC FLOW ABOUT AIRFOILS IN UNSTEADY MOTION
R. HOUWINK (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Numerical and physical aspects of aerodynamic flows III; Proceedings of the Third Symposium, Long Beach, CA, January 21-24, 1985 . New York, Springer-Verlag, 1986, p. 272-285. Research supported by the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart.

An investigation is made of the applicability of the NASA-Ames code LTRAN2 for the unsteady aerodynamic and aeroelastic characteristics of airfoils, and an assessment is made of its limitations through correlation of recent theoretical results with experimental data. For a supercritical airfoil oscillating in pitch with shock-induced separation, computed results are compared with experimental data showing the effect of Mach number and reduced frequency. Results are presented for the RA.16.SC1 and NACA 0012 airfoils. The aerodynamic resonance phenomena measured at higher frequency is not predicted; at low reduced frequency, however, the effect of Mach number on unsteady airloads on an oscillating airfoil is attached and separated transonic flow is well predicted. O.C.

A87-11890* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DRAG REDUCING OUTER-LAYER DEVICES IN ROUGH WALL TURBULENT BOUNDARY LAYERS
P. R. BANDYOPADHYAY (NASA, Langley Research Center, Hampton, VA) Experiments in Fluids (ISSN 0723-4864), vol. 4, no. 5, 1986, p. 247-256. refs
(Contract NAS1-17296)

The ability of outer-layer devices to reduce wall shear stress over a substantial streamwise distance in rough-wall turbulent boundary layers has been studied experimentally. The devices examined are a pair of thin flat ribbons placed in tandem as well as those having symmetric airfoil sections. The wall conditions examined are smooth, d- and k-type transverse-groove and sandgrain roughnesses. The wall drag is found to be reduced from the respective normal levels in all rough walls. All k-type rough walls exhibit a similar level of relative wall drag reduction which is also smaller than that in a smooth-wall. The d-type rough walls exhibit a transitional behaviour - the relative wall drag reduction drops from the smooth wall level to that of the k-type roughness with increasing roughness Reynolds number. However, the absolute reductions in the local wall shear stress are similar in both the rough and smooth walls. On the other hand, the relative reductions are lower in the rough walls because of a higher reference drag which is caused by the unique presence of a pressure component on which the devices are not as effective. Author

A87-12052
ON THE LARGE-SCALE STRUCTURES IN TWO-DIMENSIONAL, SMALL-DEFICIT, TURBULENT WAKES
I. WYGNANSKI, F. CHAMPAGNE, and B. MARASLI (Arizona, University, Tucson) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 168, July 1986, p. 31-71. refs
(Contract F49620-79-C-0224)

Two-dimensional turbulent small-deficit wakes are studied using the University of Arizona wind tunnel facility in order to determine the structure of the waves and the universality of their self-preserving states. Theoretical considerations are discussed and the experimental results are presented on a variety of wake generators, including circular cylinders, a symmetrical airfoil, a flat plate, and an assortment of screens of varying solidity, for a wide range of downstream distances. The results indicate that the normalized characteristic velocity and length scales depend on

the initial conditions, while the shape of the normalized mean velocity profile is independent of these conditions or the nature of the generator. On the other hand, the normalized distributions of the longitudinal turbulence intensity are dependent on the initial conditions. I.S.

A87-12145
EXPERIMENTAL INVESTIGATIONS OF THREE-DIMENSIONAL LAMINAR BOUNDARY LAYERS ON A SLENDER DELTA WING [EXPERIMENTELLE UNTERSUCHUNG DREIDIMENSIONALER LAMINARER GRENZSCHICHTEN AN EINEM SCHLANKEN DELTAFLUEGEL]
D. HUMMEL (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 10, May-June 1986, p. 133-145. In German. refs

The three-dimensional laminar boundary layers on the upper and the lower surface of a lambda = 1.0 delta wing at an angle of attack of alpha = 20.5 deg and a Reynolds number Re = 900,000 have been investigated by means of pressure distribution and boundary layer measurements and by surface oil flow patterns. The pressure distribution, the slope of the wall streamlines, the local flow direction at the wall and at the edge of the boundary layer, the boundary layer thickness and some characteristic velocity profiles are presented for both boundary layers. An accelerated external flow acts on the pressure side of the wing whereas, on the suction side downstream of the minimum pressure, a steep pressure rise is present and this leads to flow separation at 68 percent of the local half span. Considerably skewed velocity profiles were found in both boundary layers. A comparison with theoretical results for the suction side by Cooke (1967) shows good agreement between a quasi-conical finite difference boundary layer calculation and the experimental data. Author

A87-12146
A LAMINAR BOUNDARY LAYER METHOD FOR FLOWS IN PLANES OF SYMMETRY AND APPLICATION TO INCLINED ELLIPSOIDS OF REVOLUTION [LAMINARES GRENZSCHICHTVERFAHREN FUER STROEMUNGEN IN SYMMETRIEEBENEN UND ANWENDUNG AUF ANGESTELLTE ROTATIONSELLIPSOIDE]
H. W. STOCK (Dornier GmbH, Friedrichshafen, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 10, May-June 1986, p. 146-157. In German. refs

An integral method for computing laminar, compressible boundary layer flow in planes of symmetry is presented. It is based on a method for three-dimensional boundary layers. The flow on the windward- and leeward side of inclined ellipsoids of revolution is investigated. The analytical expression of the potential flow theory is used to describe the inviscid outer flow. The results are compared with measurements, in regions of weak viscous interactions, and with computations using finite difference methods. Special attention is paid to the leeside motion of the separation point, as influenced by changing the angle of attack and the axis ratio of the ellipsoid. It is shown that the separation point on the leeside suddenly jumps from the rear part of the body to the nose region when the angle of attack is increased. The influence of the axis ratio on this critical angle of attack is described, and the axis ratio for which the jump no longer occurs is determined. Author

A87-12148
THEORETICAL TREATMENT OF GUST SIMULATION IN THE WIND TUNNEL [THEORETISCHE BEHANDLUNG DER BOEENSIMULATION IM WINDKANAL]
B. LASCHKA and W. WEGNER (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 10, May-June 1986, p. 168-173. In German. refs

During the past years, gust generators consisting of a system of oscillating lifting surfaces have been or are being prepared for use in wind tunnels. The corresponding gust field can be assessed by applying unsteady wing theories. In the present report, the basic relationships for the calculation of the flow parameters of coupled lifting surfaces in incompressible flow are presented. Results for both aerodynamic forces and the flow field are given. Author

A87-12205
EXPERIMENTAL INVESTIGATION ON THE PERFORMANCES OF A TRANSONIC TURBINE BLADE CASCADE FOR VARYING INCIDENCE ANGLES
G. BENVENUTO and F. PITTALUGA (Genova, Universita, Genoa, Italy) IN: Measurement techniques in heat and mass transfer . Washington, DC, Hemisphere Publishing Corp., 1985, p. 179-191. refs

The paper presents and discusses the experimental results obtained in a transonic wind tunnel concerning a low-deflection turbine-blade cascade tested in correspondence with different outlet Mach numbers and incidence angles. The flow-visualization apparatus is described, indicating the peculiarities of the different techniques adopted (shadow, black and white or color schlieren). Flow-visualization pictures are presented and correlated to the aerodynamic analysis. Author

A87-12266
THE PREDICTION OF THE DRAG OF AEROFOILS AND WINGS AT HIGH SUBSONIC SPEEDS
R. C. LOCK (Royal Aircraft Establishment, Farnborough, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, June-July 1986, p. 207-226. refs

After a brief discussion of alternative ways in which the drag of an aircraft wing can be derived theoretically, attention is focused on a technique whereby the separate 'far-field' components of drag - viscous, trailing-vortex (induced) and wave - are calculated separately. In particular, a new approximate method is described for estimating the wave drag. Based on an exact two-dimensional analysis involving the flow conditions just upstream of the shock wave, a simple formula is derived which, to first order, involves only a knowledge of the Mach number distribution on the surface of the aerofoil ahead of the shock and of the surface geometry at its foot. The accuracy of this formula is assessed for aerofoils by comparison with more exact theoretical results and with experiment. A 'strip theory' extension to swept wings is proposed and illustrated by applying it to a particular transport-type wing body combination. Using experimental pressure measurements as input, all three components of drag are estimated theoretically, and by adding their sum to separate balance measurements of the body drag comparisons between 'theory' and experiment for the overall drag can be made. These show a satisfactory standard of accuracy, the error varying between -5 pct and -1 pct of the total drag over a wide range of Mach number and lift coefficient. Author

A87-12267
AN EXACT INTEGRAL (FIELD PANEL) METHOD FOR THE CALCULATION OF TWO-DIMENSIONAL TRANSONIC POTENTIAL FLOW AROUND COMPLEX CONFIGURATIONS
P. M. SINCLAIR (British Aerospace, PLC, Military Aircraft Div., Brough, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, June-July 1986, p. 227-236. refs

An integral formulation for the two-dimensional full potential equation is discussed. The basic principles of the standard panel and field methods are reviewed. The discretization of the equations and the iterative scheme for solving singularities, surface, and field of the field panel method are described. The scheme is modified in order to be applied to the study of transonic flows. The field panel method is applied to two single airfoils at subcritical and supercritical Mach numbers and to three multielement airfoils. The results are compared to data obtained with the standard panel method based on the linear Prandtl-Glauert equation and the Garabedian-Korn (1972) method; good correlation of the data is detected. The application of the field panel method to transonic flow about complex three-dimensional geometries is proposed. I.F.

A87-12586
ON THE OCCURRENCE OF REGULAR REFLECTION OF SHOCKS IN CONCAVE CORNER FLOWS
R. NIEHUIS, H. SCHOELER, and H. HORNUNG (DFVLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, West Germany) IN: Shock waves and shock tubes; Proceedings of the Fifteenth International Symposium, Berkeley, CA, July 28-August 2, 1985 . Stanford, CA, Stanford University Press, 1986, p. 155-161. refs

Results are reported from a theoretical and experimental study of regular reflection (RR) of shock waves from impingement of a three-dimensional supersonic flow on an internal corner. Geometrical considerations which permitted modeling the problem in terms of plane flow are described. Consideration was restricted to corner flows with cross-flow Mach numbers larger than 2.4 and the transition from RR to Mach reflection in this condition was numerically described. The analysis indicated that RR could occur in the corner flow. Two partially-glass plates were joined mechanically to control the corner angle and angle of attack when evaluating the theoretical predictions experimentally by means of interferometry and Schlieren photography. The experiments were run over 30 different angles of the wedge relative to the free stream. Fitting the wedge with a slit in the corner was found to permit RR to occur. M.S.K.

A87-12616
QUANTITATIVE STUDY OF SHOCK-GENERATED COMPRESSIBLE VORTEX FLOWS
M. MANDELLA, Y. J. MOON, and D. BERSHADER (Stanford University, CA) IN: Shock waves and shock tubes; Proceedings of the Fifteenth International Symposium, Berkeley, CA, July 28-August 2, 1985 . Stanford, CA, Stanford University Press, 1986, p. 471-477. refs
(Contract DAAG29-83-K-0146)

The method of pulsed holographic interferometry has been applied to the study of the formation, transport and interaction with a test surface of single two-dimensional shock-generated vortices. Radial density distributions have been determined, and preliminary calculations of pressure and velocity distributions have been obtained from the measured densities. Strong density and pressure drops are found to occur at the vortex center, verifying the serious transient pressure loading which occurs when a vortex interacts with an airfoil. There is also some indication that these vortices have supersonic cores. Finite-difference calculation of the density distribution shows a good agreement with experiment. Preliminary studies of interaction of vortices 'hurled' at the leading edge of a thin wedge show strong effects, featured by the rapid growth of secondary vortices. Author

A87-12617
UNSTEADY DRAG OVER CYLINDERS AND AEROFOILS IN TRANSONIC SHOCK TUBE FLOWS
K. TAKAYAMA (Tohoku University, Sendai, Japan) and K. ITOH IN: Shock waves and shock tubes; Proceedings of the Fifteenth International Symposium, Berkeley, CA, July 28-August 2, 1985 . Stanford, CA, Stanford University Press, 1986, p. 479-485. refs

The effectiveness of a transonic wind tunnel equipped with a holographic interferometer for collecting isopycnic data for deriving quantitative flow characteristics is described. Sample results are provided in the form of interferometric fringes for transonic flows past a cylinder and a NACA 0012 airfoil. Numerical techniques are defined for using the isopycnic data to obtain the density distribution with the known stagnation condition, the pressure distribution, the drag coefficient and the time variation of the drag coefficient. Good agreement is found with PLM simulation data for the same flowfields. M.S.K.

A87-12805
INDUCED DRAG OF A CURVED WING [INDUKTIVNOE SOPROTIVLENIE IZOGNUTOGO KRYLA]
G. I. MAIKAPAR PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), May-June 1986, p. 38-40. In Russian.

An equation is presented which provides a way to determine, from the wing shape, the cross-sectional shape of a free vortex sheet at infinity behind the system wing-fuselage (in the Trefftz plane). The effect of the wing curvature on the minimal induced drag is then estimated for the case where the cross-sectional shape of the free vortex sheet is close to that of a circular arc. It is shown that the induced drag of the curved wing is less than that of a straight wing and that the wing dihedral angle and the angles of the wing rotation axes should be selected with allowance for both the span and the curvature of the wing. V.L.

A87-12843
SIMILARITY LAW FOR THE SUPERSONIC FLOW PAST FLAT SURFACES WITH INTENSE DISTRIBUTED INJECTION [ZAKON PODOBIIA PRI SVERKHZVUKOVOM OBTEKANII PLOSKIKH POVERKHNOSTEI S SIL'NYM RASPREDELENNYM VDUVOM]
I. I. VIGDOROVICH, IU. A. VINOGRADOV, V. A. LEVIN, and V. I. ROZHDESTVENSKII (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 289, no. 3, 1986, p. 564-567. In Russian. refs

The similarity law for the pressure distribution on a porous plate in supersonic flow (freestream Mach = 2 and 3) with intense distributed injection is formulated and experimentally confirmed. The experimental results are found to be described well by the law and to agree well with the theoretical calculation of Vigdorovich and Levin (1983) based on a thin-layer model where the mixing layer is replaced by a contact-discontinuity surface. The best agreement is achieved when the lower bound of the j value for air is less than 1 percent and the upper bound (corresponding to k = 0.25) depends on the freestream Mach number. B.J.

A87-12956#
TRANSONIC CASCADE FLOW SOLVED BY SHOCK-CAPTURE COMPUTATION FOLLOWED BY SEPARATE-REGION COMPUTATION WITH SHOCK FITTING
C.-H. WU, Y. HUA, B. WANG, Z. WANG, J. ZHANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) et al. Journal of Engineering Thermophysics, vol. 7, May 1986, p. 112-119. In Chinese, with abstract in English. refs

A new method is presented to solve the transonic flow past a compressor cascade, considering the effect of inlet bow wave and passage shock, the flow downstream of which can be either subsonic or transonic. The computation consists of two steps. In the first step, a shock capturing solution is obtained by the use of a potential equation or stream function. In the second step, separate algorithms are used, respectively, for the supersonic flow upstream of and the subsonic or transonic flow downstream of the passage shock. Calculations are made for a typical double-circular-arc cascade at inlet Mach number varying from 1.03 to 1.34. The effects of axial-velocity density ratio and entropy increase downstream of the passage shock are clearly shown. The pressure distribution around the blade profile calculated with proper values of the axial-velocity density ratio and entropy increase compares favorably with experimental data. Author

A87-12957#
AN EXPERIMENTAL STUDY ON LARGE NEGATIVE INCIDENCE SEPARATED FLOW IN TWO-DIMENSIONAL TURBINE CASCADES
W. LIU and D. YE (Qinghua University, Beijing, People's Republic of China) Journal of Engineering Thermophysics, vol. 7, May 1986, p. 120-123. In Chinese, with abstract in English. refs

In order to investigate the characteristics of large negative incidence separated flow in turbine cascades, the separated region and its nature have been determined, and a separated flow model has been proposed by means of flow visualization and aerodynamic

measurements. Comparing the calculated values with experimental results, the feasibility of the separated flow proposed by the authors can be demonstrated. Author

A87-12958#
A QUASI-THREE-DIMENSIONAL METHOD FOR DIAGONAL FLOW FANS
K. WU, Z. CAI, and Y. OU (Huazhong University of Science and Technology, People's Republic of China) Journal of Engineering Thermophysics, vol. 7, May 1986, p. 124-126. In Chinese, with abstract in English. refs

A quasi-three-dimensional design method for diagonal flow impellers is introduced. A diagonal flow fan with downstream guide vanes has been designed and manufactured. A greatly inclined stream surface and axial velocity variation are this fan's feature. The performance testing and applications of the fan show the reliability of the design method. Author

N87-10005 Georgia Inst. of Tech., Atlanta.
NUMERICAL SOLUTION OF THE 3-DIMENSIONAL BOUNDARY LAYER EQUATIONS IN THE INVERSE MODE USING FINITE DIFFERENCES Ph.D. Thesis
S. F. RADWAN 1985 248 p
Avail: Univ. Microfilms Order No. DA8604015

A numerical formulation that uses a finite-difference method has been developed to solve the full three-dimensional boundary layer equations in inverse and direct modes. It is a implicit scheme and uses central differences in the direction normal to the wall, and weighted upwinding with three points in the plane parallel to the wall. The developed method has the following new features: (1) the formulation is done for non-orthogonal curvilinear coordinates; and (2) the developed scheme uses variable grid step size along all coordinates, and it preserves second-order accuracy if needed. The accuracy in the marching direction parallel to the wall can be of any order between first and second through input control. This makes the scheme stable and robust in the reversed flow regions. These features make the present numerical method more general and flexible than any of previous methods. The capability of the method in the inverse mode to march into the flow regions inaccessible to the direct mode calculations has been demonstrated for the following cases; (1) separated two-dimensional turbulent flow; (2) separated turbulent flow over an infinite swept wing and (3) laminar and turbulent flows over a prolate spheroid at low incidence. The principal achievement is the demonstration of the validity of the developed numerical inverse mode method to march into the regions of reversed flow which are inaccessible to the direct mode procedures. Dissert. Abstr.

N87-10006 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ANALYSIS OF THE VORTICAL FLOW AROUND A 60 DEG DELTA WING WITH VORTEX FLAP Ph.D. Thesis
B. SUNG 1985 260 p
Avail: Univ. Microfilms Order No. DA8605468

Subsonic wind tunnel investigations were conducted on a 60 deg. swept, flat plate, delta wing with a leading edge vortex flap. The pressure distributions were measured over a range of angles of attack starting from zero to 40 deg. to 5 deg. interval and flap deflection angles from zero to 45 deg. with 5 deg. increments at a Reynolds number of about 2.14 x 1 million based on the root chord. The flow visualization experiments were performed from zero degree to the stall angle, with ten different flap defection angles at the same Reynolds number. The mean flow field was measured at angles of attack 10 deg. and 15 deg. with the flap deflection angles of 10 deg. and 30 deg. at a Reynolds number of about 1.50 x 1 million. The experimental results show that the leading edge vortex flap is an effective means to control the vortex flow over a delta wing. The optimimum flap deflection angles were found where the primary vortex was confined to the leading edge vortex flap, thus producing a thrust on the flap. It was found that flap deflection could be used to restore a vortex flow from burst vortex condition. A non-linear vortex lattice code with a new velocity jump formula was developed to predict the aerodynamic characteristics of plain and vortex flapped delta wings including the pressure distributions. Dissert. Abstr.

N87-10007 Virginia Polytechnic Inst. and State Univ., Blacksburg.
THE EFFECT OF FREE STREAM DISTURBANCES AND CONTROL SURFACE DEFLECTIONS ON THE PERFORMANCE OF THE WORTMANN AIRFOIL AT LOW REYNOLDS NUMBERS Ph.D. Thesis
V. SUMANTRAN 1985 249 p
Avail: Univ. Microfilms Order No. DA8605467

A wing with a Wortmann FX-63-137-ESM airfoil section has been used to study some unique problems encountered in wing aerodynamics in the range of Reynolds numbers between 50,000 and 500,000. The wind-tunnel testing conducted in the 6' x 6' Stability tunnel included strain-gauge data, pressure data and flow-visualization studies. The laminar separation bubble which frequently occurs on the upper surface of the wing is found to dominate its performance and gives rise to a hysteresis loop for lift and drag. Changes in airfoil performance due to positive flap or control surface deflections resemble changes witnessed at higher Reynolds numbers. Negative deflections are seen to considerably change the stall behavior and the flow over the airfoil. This is due to the considerably greater effect on the separation bubble for negative flap deflections. The structure and mechanism of the laminar separation bubble can also be altered by the introduction of selected acoustic disturbances and increased free-stream turbulence. The wind-tunnel test-section environment is, therefore, capable of considerably altering wing performance in this regime. Dissert. Abstr.

N87-10009 Tennessee Univ., Knoxville.
A STUDY OF THE FLOW FIELD ABOUT AN UPPER SURFACE BLOWN WING AND ITS EFFECTS ON LONGITUDINAL STATIC STABILITY OF A SMALL JET AIRPLANE Ph.D. Thesis
U. P. SOLIES 1985 149 p
Avail: Univ. Microfilms Order No. DA8608294

The effects of powered lift technology on the longitudinal stability characteristics of an upper surface blown (USB) jet-flapped aircraft have been studied. Both theoretical and experimental methods were employed to investigate the flow field in the vicinity of the lifting wing and its influence on pitching moments of the aircraft in motion. A nonlinear vortex-lattice theory was used to model the lift induced airflow in the near flow field about the wing. Comparison with literature data showed excellent agreement, giving confidence in the method used. Flight tests were conducted with the Ball-Bartoe Jetwing technology demonstration aircraft to visualize flow angles on the fuselage surface and at selected points in the flow field near the horizontal tail. To save cost, simple data acquiring techniques were used. Also, the theoretical flow computations were restricted to a simplified Jetwing model with a relatively small number of panels. Still, there was fair agreement between theoretically and experimentally determined flow angles at the tail of the Jetwing aircraft. The vortex-lattice routine was then used for a parametrical study of flow angles and longitudinal stability parameters. The results show that the powered lift strongly affects the flow field about the wing.

N87-10014# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).
A DESCRIPTION OF A TURBULENT FLOW PAST A CIRCULAR CYLINDER BY A DISCRETE VORTEX METHOD
H. NAKAJIMA and Y. YOSHIZAWA (Tsukuba Univ. (Japan).) *In* Tokyo Univ. Proceedings of the Symposium on Mechanics for Space Flight, 1985 10 p 1985
Avail: NTIS HC A12/MF A01

Discrete vortex methods were often used to describe unsteady incompressible flows at high Reynolds numbers. Most studies already existing are concerned with large scale structures of the interested flows and integrated properties, that is, lift and drag coefficients of bodies. In order to examine potential abilities of the vortex methods in describing more detailed information, a correlation function in a wake of a circular cylinder is measured by a discrete vortex method and also an experiment of an actual

flow. Comparisons between them show that turbulent structures also could be well described by the discrete vortex method.
Author

N87-10030# Academy of Sciences (USSR), Moscow. Computing Center.
COMPUTATIONAL AERODYNAMICS OF SUPERSONIC LIFTING VEHICLES
P. I. CHUSHKIN and G. P. VOSKRESENSKY *In* Tokyo Univ. Proceedings of the Symposium on Mechanics for Space Flight, 1985 13 p 1985
Avail: NTIS HC A12/MF A01

A review of investigations on numerical modelling of supersonic three dimensional steady flows about lifting vehicles and their elements carried out in the Soviet Union during the last five years is given. An inviscid gas, both perfect and high-temperature, is considered. A number of characteristic examples are presented.
Author

N87-10033# Academy of Sciences (USSR), Moscow. Inst. of Applied Mathematics.
SUPERSONIC FLOW AROUND TIP SIDES OF WINGS
G. P. VOSKRESENSKY *In* Tokyo Univ. Proceedings of the Symposium on Mechanics for Space Flight, 1985 7 p 1985
Avail: NTIS HC A12/MF A01

The problem of supersonic flow around the tip sides of wings with swept or unswept leading edges and an attached shock wave is presented. The solution of the problem is based on the assumption that the surface of a rounded tip side of a wing is conical and the flow around it is self-similar. This fact makes it possible to use the self-similar stationing principle for the solution of the problem. The realization of this principle is carried out with the help of the finite-difference second-order algorithm. Author

N87-10039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
WIND-TUNNEL INVESTIGATION OF THE FLIGHT CHARACTERISTICS OF A CANARD GENERAL-AVIATION AIRPLANE CONFIGURATION
D. R. SATRAN Oct. 1986 60 p
(NASA-TP-2623; L-15929; NAS 1.60:2623) Avail: NTIS HC A04/MF A01 CSCL 01A

A 0.36-scale model of a canard general-aviation airplane with a single pusher propeller and winglets was tested in the Langley 30- by 60-Foot Wind Tunnel to determine the static and dynamic stability and control and free-flight behavior of the configuration. Model variables made testing of the model possible with the canard in high and low positions, with increased winglet area, with outboard wing leading-edge droop, with fuselage-mounted vertical fin and rudder, with enlarged rudders, with dual deflecting rudders, and with ailerons mounted closer to the wing tips. The basic model exhibited generally good longitudinal and lateral stability and control characteristics. The removal of an outboard leading-edge droop degraded roll damping and produced lightly damped roll (wing rock) oscillations. In general, the model exhibited very stable dihedral effect but weak directional stability. Rudder and aileron control power were sufficiently adequate for control of most flight conditions, but appeared to be relatively weak for maneuvering compared with those of more conventionally configured models.
Author

N87-10040*# Cincinnati Univ., Ohio. Dept. of Aerospace Engineering and Engineering Mec
ANALYSIS OF TWO-DIMENSIONAL INCOMPRESSIBLE FLOW PAST AIRFOILS USING UNSTEADY NAVIER-STOKES EQUATIONS
K. N. GHIA, G. A. OSSWALD, and U. GHIA 1986 15 p Previously announced in IAA as A85-42975
(Contract NAG1-465; AF-AFOSR-0160-80)
(NASA-CR-179823; NAS 1.26:179823) Avail: NTIS HC A02/MF A01 CSCL 01A

The conservative form of the unsteady Navier-Stokes equations in terms of vorticity and stream function in generalized curvilinear coordinates are used to analyze the flow structure of steady separation and unsteady flow with massive separation. The numerical method solves the discretized equations using an ADI-BGE method. The method is applied to a symmetric 12 percent thick Joukowski airfoil. A conformal clustered grid is generated; several 1-D stretching transformations are used to obtain a grid that attempts to resolve many of the multiple scales of the unsteady flow with massive separation, while maintaining the transformation metrics to be smooth and continuous in the entire flow field. Detailed numerical results are obtained for three flow configurations (1) Re = 1000, alpha = 5 deg., (2) Re =1000, alpha = 15 deg., (3) Re = 10,000, alpha = 5 deg. No artificial dissipation was added; however, lack of a fine grid in the normal direction has presently led to results which are considered qualitative, especially for case (3). Author

N87-10041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPIN-TUNNEL INVESTIGATION OF A 1/25-SCALE MODEL OF THE GENERAL DYNAMICS F-16XL AIRPLANE
R. D. WHIPPLE and W. L. WHITE Oct. 1984 51 p
(NASA-TM-85660; L-15616; NAS 1.15:85660) Avail: NTIS HC A04/MF A01 CSCL 01A

A spin-tunnel investigation of the spin and recovery characteristics of a 1/25-scale model to the General Dynamics F-16XL aircraft was conducted in the Langley Spin Tunnel. Tests included erect and inverted spins at various symmetric and asymmetric loading conditions. The required size of an emergency spin-recovery parachute was determined. Author

N87-10042*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUPERSONIC, NONLINEAR, ATTACHED-FLOW WING DESIGN FOR HIGH LIFT WITH EXPERIMENTAL VALIDATION
J. L. PITTMAN, D. S. MILLER, and W. H. MASON (Grumman Aerospace Corp., Bethpage, N.Y.) Aug. 1984 221 p
(NASA-TP-2336; L-15787; NAS 1.60:2336) Avail: NTIS HC A10/MF A01 CSCL 01A

Results of the experimental validation are presented for the three dimensional cambered wing which was designed to achieve attached supercritical cross flow for lifting conditions typical of supersonic maneuver. The design point was a lift coefficient of 0.4 at Mach 1.62 and 12 deg angle of attack. Results from the nonlinear full potential method are presented to show the validity of the design process along with results from linear theory codes. Longitudinal force and moment data and static pressure data were obtained in the Langley Unitary Plan Wind Tunnel at Mach numbers of 1.58, 1.62, 1.66, 1.70, and 2.00 over an angle of attack range of 0 to 14 deg at a Reynolds number of 2.0 x 10 to the 6th power per foot. Oil flow photographs of the upper surface were obtained at M = 1.62 for alpha approx. = 8, 10, 12, and 14 deg.
E.R.

N87-10043*# Grumman Aerospace Corp., Bethpage, N.Y.
VISCOUS WING THEORY DEVELOPMENT. VOLUME 1: ANALYSIS, METHOD AND RESULTS Final Report
R. R. CHOW, R. E. MELNIK, F. MARCONI, and J. STEINHOFF Oct. 1986 127 p
(Contract NAS1-16858)
(NASA-CR-178156; NAS 1.26:178156; RE-725-VOL-1) Avail: NTIS HC A07/MF A01 CSCL 01A

Viscous transonic flows at large Reynolds numbers over 3-D wings were analyzed using a zonal viscid-inviscid interaction approach. A new numerical AFZ scheme was developed in conjunction with the finite volume formulation for the solution of the inviscid full-potential equation. A special far-field asymptotic boundary condition was developed and a second-order artificial viscosity included for an improved inviscid solution methodology. The integral method was used for the laminar/turbulent boundary layer and 3-D viscous wake calculation. The interaction calculation included the coupling conditions of the source flux due to the wing surface boundary layer, the flux jump due to the viscous wake, and the wake curvature effect. A method was also devised

incorporating the 2-D trailing edge strong interaction solution for the normal pressure correction near the trailing edge region. A fully automated computer program was developed to perform the proposed method with one scalar version to be used on an IBM-3081 and two vectorized versions on Cray-1 and Cyber-205 computers.

N87-10044*# Grumman Aerospace Corp., Bethpage, N.Y.
VISCOUS WING THEORY DEVELOPMENT. VOLUME 2: GRUMWING COMPUTER PROGRAM USER'S MANUAL Final Report
R. R. CHOW and P. L. OGILVIE Oct. 1986 117 p
(Contract NAS1-16858)
(NASA-CR-178157; NAS 1.26:178157; RE-726-VOL-2) Avail: NTIS HC A06/MF A01 CSCL 01A

This report is a user's manual which describes the operation of the computer program, GRUMWING. The program computes the viscous transonic flow over three-dimensional wings using a boundary layer type viscid-inviscid interaction approach. The inviscid solution is obtained by an approximate factorization (AFZ)method for the full potential equation. The boundary layer solution is based on integral entrainment methods. Author

N87-10045# Goldschmied (Fabio R.), Monroeville, Pa.
WIND TUNNEL TEST OF THE MODIFIED GOLDSCHMIED MODEL WITH PROPULSION AND EMPENNAGE: ANALYSIS OF TEST RESULTS Final Report, 3 Mar. 1981 - 30 Nov. 1982
F. R. GOLDSCHMIED 1 Feb. 1986 115 p
(Contract N00167-81-C-0075)
(AD-A167360; FRG-82-1; DTNSRDC/ASED-CR-02-86) Avail: NTIS HC A06/MF A01 CSCL 20D

An extensive test program was carried out in DTNSRDC's 8x10 low-speed wind-tunnel for experimental verification of the integrated hull boundary-layer control/propulsion lighter-than-air design. The 1957 Goldschmied wind-tunnel model was overhauled with a new suction-slot inlet configuration, a suction/propulsion fan, a new aftbody and a tailboom/empennage assembly. The fan air power coefficient of the operational model with empennage ranged in steady flight from 0.0130 (free transition) to 0.0155 (transition tripped at 10% length) at the volume Reynolds number of two millions. Considerable excess thrust could be generated with an average incremental propulsive efficiency of 72%. As compared to wind-tunnel tests of conventional streamlined bodies with empennage at exactly the same volume Reynolds number, the integrated design offers 50% less equivalent drag for both free and tripped transitions. The empennage provided neutral static stability over the complete test range of 8 degrees; the ratio of total fin planform over volume equivalent was 0.404. It was found that efficient and stable BLC could be achieved only by the combination of Ringloeb cusp at the slot's leading-edge with suction flow and with the presence of the tailboom. The fan (or pump) design is an essential part of the system design: a procedure was developed for determining the optimum fan design parameters from the vehicle's wind-tunnel test data. GRA

N87-10046# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
APPLICATION OF BIFURCATION AND CATASTROPHE THEORIES TO NEAR STALL FLIGHT MECHANICS M.S. Thesis
C. A. HAWKINS 1985 247 p
(AD-A167697; AFIT/CI/NR-86-54T) Avail: NTIS HC A11/MF A01 CSCL 01A

This thesis sought to develop nonlinear systems analysis techniques capable of analyzing and predicting the complex behavior found in high-angle-of-attack flight. The primary research method involved calculation of equilibrium surfaces where the time rate of change of each of the state variables is set to zero in the aircraft equations of motion, and the states that will satisfy that condition are found for various control deflections. The equilibrium surfaces were calculated numerically through use of continuation methods. An equilibrium trajectory analysis of a fifth order model of the aircraft showed significant adverse yaw problems at high AOA as well as the presence of roll coupling. Bifurcational behavior was found in the same fifth order model and verified by previous research. A mechanism for transfer of kinetic energy during the catastrophic behavior shown is hypothesized. A spin equilibrium surface for the aircraft was determined from an eighth order model and, from that surface, possible control deflections for recovery from the spin were obtained. GRA

N87-10047# Nielsen Engineering and Research, Inc., Mountain View, Calif.
PREDICTION OF GUST LOADINGS AND ALLEVIATION AT TRANSONIC SPEEDS Final Report, 20 Sep. 1983 - 20 Jul. 1985
D. NIXON and K. L. TZUOO Mar. 1986 43 p
(Contract N00167-83-C-0114)
(AD-A167748; NEAR-TR-352; DTNSRDC/ASED-CR-01-86)
Avail: NTIS HC A03/MF A01 CSCL 20D

The transonic indicial theory is used to predict the effect of a gust on an airfoil at transonic speeds. The effect of operating two control surfaces is also modeled by the indicial method. The transonic indicial method is linear in a strained coordinate system and superposition can be used. This allows the effects of an arbitrary gust and control surface deflection to be modeled simply if the indicial responses for the gust and each control surface are known. The computation time is small and, therefore, an optimization technique can be used to determine the best control surface deflections to alleviate the gust loading. GRA

N87-10048# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
VORTEX SHEDDING OF A SQUARE CYLINDER IN FRONT OF A SLENDER AIRFOIL AT HIGH REYNOLDS NUMBERS. PART 1: SPACING EFFECT
T. NAKAGAWA, G. E. A. MEIER, R. TIMM, and H. M. LENT Oct. 1985 34 p Sponsored by Minna-James-Heinemann Foundation, Hannover, West Germany
(MPIS-23/1985; ISSN-0436-1199; ETN-86-98221) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22

The spacing effect on vortex shedding of a square cylinder in front of a NACA 0018 airfoil at high Reynolds numbers was visualized in wind tunnel tests. When the free stream velocity is constant, the amplitude of the pressure fluctuations at a point in the test section is of comparable order irrespective of the spacing between a square cylinder and an airfoil. When the separating shear layers from the upstream square cylinder reattach to the downstream airfoil, the pressure signal is most regular and the vortex shedding frequency is minimum. The airfoil can stabilize the vortex shedding process behind the upstream square cylinder. The Strouhal number of the square cylinder depends upon the nondimensional spacing normalized by the characteristic length of the cylinder. Once the spacing between the square cylinder and the airfoil becomes greater than the critical value, the airfoil does not provide any significant effect on the vortex shedding process behind the upstream cylinder. ESA

N87-10051 Texas Univ., Austin.
UNSTEADY FLOW OVER AN AIRFOIL INSIDE A WIND TUNNEL WITH AND WITHOUT TRANSPIRATION Ph.D. Thesis
W. J. TEDESCHI 1985 205 p
Avail: Univ. Microfilms Order No. DA8609435

This research uses the viscous/inviscid interaction model to calculate the lift and drag characteristics of a two-dimensional airfoil inside two types of wind tunnels. The first is a conventional solid-wall wind tunnel with an airfoil oscillating transversely to the freestream. In the second wind tunnel, an unsteady transverse flow field is produced by a time-varying fluid transpiration of the wind tunnel walls. Subsonic flows in the one to five million Reynolds number range are considered. A computer code based on the theoretical model formulated in this study is used to predict the unsteady flow field around the airfoil. The nonlinear inviscid flow problem is solved analytically for the disturbance velocity potential using a unqiue for Fourier transform method. The bounded influence coefficients which explicitly contain the airfoil thickness distribution

and wind tunnel geometry provide an advantage over traditional Panel methods. The viscous flow problem utilizes a finite-difference numerical formulation to solve the unsteady boundary layer equations. Dissert. Abstr.

N87-10052 Notre Dame Univ., Ind.
EXPERIMENTAL STUDY OF THE BOUNDARY LAYER ON A LOW REYNOLDS NUMBER AIRFOIL IN STEADY AND UNSTEADY FLOW Ph.D. Thesis
M. BRENDEL 1986 413 p
Avail: Univ. Microfilms Order No. DA8612989

An experimental study of the boundary layer on a Wortman FX63-137 airfoil at a Reynolds number of 100,000 and several angles of attack was conducted for steady and unsteady incompressibile flow. Pressure distributions and single-element hot-wire boundary layer surveys were obtained. A significant portion of the work consisted of the design, fabrication, and testing of an unsteady flow facility. Additionally, the design of data acquisition and data processing techniques for unsteady flow experiments were investigated. A benchmark test was conducted to validate the techniques and the test facility by studying the response of a laminar boundary layer to a periodic unsteady freestream. Results were found to agree with existing analytical and experimental data. The same techniques were then employed in the study of the airfoil boundary layer. Characteristics of the pressure distributions, boundary layer velocity profiles, integrated boundary layer thicknesses, and shape parameters were documented. Criteria for locating laminar separation, transition, and reattachment were developed and compared with flow visualization. These criteria were used to study the behavior of the separation bubble in unsteady flow. Dissert. Abstr.

N87-10330*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Wesseling (West Germany).
EXPERIMENTAL AND THEORETICAL DOPPLER-LIDAR SIGNATURES OF AIRCRAFT WAKE VORTICES
F. KOEPP and W. A. KRICHBAUMER *In* NASA. Langley Research Center 13th International Laser Radar Conference 3 p Aug. 1986
Avail: NTIS HC A15/MF A01 CSCL 01A

The DFVLR laser Doppler anemometer is a CO2 continuous wave homodyne system designed for boundary layer wind measurements. During the last three years, it was mainly used in the wake-vortex program at Frankfurt airport for determination of vortex strength, transport, and lifetime. The strategy for that special type of measurement was previously reported in detail along with single experimental results. Therefore, herein is given a short summary of the data concerning questions of air traffic control. In addition to the experimental activities a computer model describing wake-vortex behavior was installed. It allows the comparison of the measured data with the hydrodynamically predicted quantities. On the other hand, it leads to an improved procedure for future wake-vortex measurements. E.R.

N87-10832 British Aerospace Aircraft Group, Bristol (England). Aerodynamics Research Dept.
A BIBLIOGRAPHY OF AERODYNAMIC HEATING REFERENCES
J. R. DEANE and P. C. DEXTER Jul. 1982 80 p
(BAE-BT-13481; BAE-AERO-INFORM-33; ETN-86-97948) Avail: Issuing Activity

Almost 600 references on aerodynamic heating are listed in this bibliography. ESA

N87-10833 Kansas Univ., Lawrence.
AN EXPERIMENTAL INVESTIGATION OF DYNAMIC GROUND EFFECT Ph.D. Thesis
R. C. CHANG 1985 108 p
Avail: Univ. Microfilms Order No. DA8608382

A wind-tunnel investigation has been made at low speed to determine the dynamic ground effect for low-aspect-ratio wings with sharp leading edges at constant angles of attack. The three main purposes of this investigation were: (1) to develop a wind tunnel simulation method that could provide dynamic ground effect data, (2) to demonstrate that the dynamic ground effect wind-tunnel testing could produce data comparable to flight test data, and (3) to provide information on the physical mechanisms involved in dynamic ground effect for highly swept delta wings. The dynamic ground effect data obtained from the wind-tunnel simulation provided a closer approximation to the actual flight test data than do static test data. For highly swept (6 deg. to 75 deg.), low-aspect-ratio wings static ground effect data greatly overpredicted the increase in C sub L, C sub D and C sub M as height over the span decreased below .4. For low-swept (lambda sub LE less than 30 deg.) low-aspect-ratio wings the discrepancy was much less. The visual observations of the flow field confirmed that vortex lag existed for highly swept, low-aspect-ratio wings in dynamic ground effect. Dissert. Abstr.

N87-10834# Centre d'Etudes et de Recherches, Toulouse (France). Dept. dEtudes et de Recherches en Aerothermodynamique.
REPORT ON TESTS OF A CAST 10 AIRFOIL WITH FIXED TRANSITION IN THE T2 TRANSONIC CRYOGENIC WIND TUNNEL WITH SELF-ADAPTIVE WALLS
A. SERAUDIE, A. BLANCHARD, and J. F. BREIL Aug. 1985 266 p
(RT-OA-63/1685; DERAT-6/5019-DN) Avail: NTIS HC A12/MF A01

Described are tests on the CAST 10 airfoil in tripped-transition, carried out in the cryogenic and transonic wind-tunnel T2 fitted with self-adaptive walls. These tests follow those which were performed in natural transition and were presented in a previous note. Firstly, a complement was realized to pinpoint the location of the natural transition on the upper surface of the airfoil; this was done by a longitudinal exploration in the boundary layer. Secondly, in a first stage, the transition was only tripped on the lower surface with a carborundum strip of 0.045 mm thickness, situated at 5% of chord (T 1/2 D). These tests were performed here to separate the phenomena in relation to the lower surface and those in relation to the upper surface which occur in natural transition (TN). In a second stage, the transition was normally tripped on both sides of the profile (TD), likewise at x/c = 5% and h = 0.045 mm. The test configurations of the previous serial were experimented again and results obtained in the three cases (TN), (T 1/2 N) and (TD) were compared, in particular those concerned with the effect of the Reynolds number on aerodynamic coefficients of the airfoil. The gathering of the experimental values around a Reynolds number of 20 millions is observed; but before this number, the evolutions of the curves in the three cases tested are different. Author

N87-10835*# Sverdrup Technology, Inc., Arnold Air Force Station, Tenn.
LARGE PERTURBATION FLOW FIELD ANALYSIS AND SIMULATION FOR SUPERSONIC INLETS Final Report
M. O. VARNER, W. R. MARTINDALE, W. J. PHARES, K. R. KNEILE, and J. C. ADAMS, JR. Sep. 1984 126 p
(Contract NAS3-23682)
(NASA-CR-174676; NAS 1.26:174676) Avail: NTIS HC A07/MF A01 CSCL 01A

An analysis technique for simulation of supersonic mixed compression inlets with large flow field perturbations is presented. The approach is based upon a quasi-one-dimensional inviscid unsteady formulation which includes engineering models of unstart/restart, bleed, bypass, and geometry effects. Numerical solution of the governing time dependent equations of motion is accomplished through a shock capturing finite difference algorithm, of which five separate approaches are evaluated. Comparison with experimental supersonic wind tunnel data is presented to verify the present approach for a wide range of transient inlet flow conditions. Author

N87-10836*# Bihrle Applied Research, Inc., Jericho, N. Y.
LOW SPEED ROTARY AERODYNAMICS OF F-18 CONFIGURATION FOR 0 DEG TO 90 DEG ANGLE OF ATTACK: TEST RESULTS AND ANALYSIS
R. HULTBERG Washington NASA Aug. 1984 255 p
(Contract NAS1-16205)
(NASA-CR-3608; NAS 1.26:3608) Avail: NTIS HC A12/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a rotational flow environment, utilizing a rotary balance located in the Langley Spin Tunnel, are discussed and presented in tabular form for a 1/10 scale F-18 airplane model. The rotational aerodynamic characteristics were established for the basic airplane, as well as the influence of control deflections and the contribution of airplane components, i.e., body, wing, leading edge extension, horizontal and vertical tails, on these characteristics up to 90 deg angle of attack. Spin equilibrium conditions predicted using the measured data are also presented and compared with spin model and full scale flight results. Author

N87-10837*# Bihrle Applied Research, Inc., Jericho, N. Y.
ROTARY BALANCE DATA AND ANALYSIS FOR THE X-29A AIRPLANE FOR AN ANGLE-OF-ATTACK RANGE OF 0 DEG TO 90 DEG
J. N. RALSTON Washington NASA Aug. 1984 215 p
(Contract NAS1-16205)
(NASA-CR-3747; NAS 1.26:3747) Avail: NTIS HC A10/MF A01 CSCL 01A

The rotational aerodynamic characteristics are discussed for a 1/6 scale model of the X-29A airplane. The effects of rotation on the aerodynamics of the basic model were determined, as well as the influence of airplane components, various control deflections, and several forebody modifications. These data were measured using a rotary balance, over an angle of attack range of 0 to 90 deg, for clockwise and counter clockwise rotations covering an omega b/2V range of 0 to 0.4. Author

N87-10838*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF TAIL SPAN AND EMPENNAGE ARRANGEMENT ON DRAG OF A TYPICAL SINGLE-ENGINE FIGHTER AFT END
J. R. BURLEY, II and B. L. BERRIER Sep. 1984 136 p
(NASA-TP-2352; L-15742; NAS 1.60:2352) Avail: NTIS HC A07/MF A01 CSCL 01A

An investigation was conducted in the Langley 16 foot Transonic Tunnel to determine the effects of tail span and empennage arrangement on drag of a single engine nozzle/afterbody model. Tests were conducted at Mach numbers from 0.50 to 1.20, nozzle pressures frm 1.0 (jet off) to 8.0, and angles of attack from -3 to 9 deg, depending upon Mach numbers. Three empennage arrangements (aft, staggered, and forward) were investigated with several different tail spans. The results of the investigation indicate that tail span and position have a significant effect on the drag at transonic speeds. Unfavorable tail interference was largely due to the outer portion of the tail surfaces. The inner portion near the nozzle and afterbody did little to increase drag other than surface skin friction. Tail positions forward of the nozzle generally had lower tail interference. Author

N87-10839*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATIC INTERNAL PERFORMANCE OF SINGLE-EXPANSION-RAMP NOZZLES WITH THRUST-VECTORING CAPABILITY UP TO 60 DEG
B. L. BERRIER and L. D. LEAVITT Oct. 1984 144 p
(NASA-TP-2364; L-15766; NAS 1.60:2364) Avail: NTIS HC A07/MF A01 CSCL 01A

An investigation has been conducted at static conditions (wind off) in the static-test facility of the Langley 16-Foot Transonic Tunnel. The effects of geometric thrust-vector angle, sidewall containment, ramp curvature, lower-flap lip angle, and ramp length on the internal performance of nonaxisymmetric single-expansion-ramp nozzles were investigated. Geometric thrust-vector angle was varied from -20 deg. to 60 deg., and nozzle pressure ratio was varied from 1.0 (jet off) to approximately 10.0. Author

N87-10840*# Hamilton Standard, Windsor Locks, Conn.
EFFECT OF ANGULAR INFLOW ON THE VIBRATORY RESPONSE OF A COUNTER-ROTATING PROPELLER
J. E. TURNBERG and P. C. BROWN 15 Jan. 1985 75 p
(Contract NAS3-24222)
(NASA-CR-174819; NAS 1.26:174819) Avail: NTIS HC A04/MF A01 CSCL 01A

This report presents the results of a propeller vibratory stress survey on the Fairey Gannet aircraft aimed at giving an assessment of the difference in vibratory response between single and counter-rotating propeller operation in angular inflow. The survey showed that counter-rotating operation of the propeller had the effect of increasing the IP response of the rear propeller by approximately 25 percent over comparable single-rotation operation while counter-rotating operation did not significantly influence the IP response of the front propeller. Author

N87-10841*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC FLOW ANALYSIS FOR ROTORS. PART 2: THREE-DIMENSIONAL, UNSTEADY, FULL-POTENTIAL CALCULATION
I. C. CHANG Jan. 1985 27 p
(NASA-TP-2375; A-9682; NAS 1.60:2375) Avail: NTIS HC A03/MF A01 CSCL 01A

A numerical method is presented for calculating the three-dimensional unsteady, transonic flow past a helicopter rotor blade of arbitrary geometry. The method solves the full-potential equations in a blade-fixed frame of reference by a time-marching implicit scheme. At the far-field, a set of first-order radiation conditions is imposed, thus minimizing the reflection of outgoing wavelets from computational boundaries. Computed results are presented to highlight radial flow effects in three dimensions, to compare surface pressure distributions to quasi-steady predictions, and to predict the flow field on a swept-tip blade. The results agree well with experimental data for both straight- and swept-tip blade geometries. Author

N87-10842*# Rockwell International Corp., Los Angeles, Calif.
SUPERSONIC SECOND ORDER ANALYSIS AND OPTIMIZATION PROGRAM USER'S MANUAL
W. C. CLEVER Sep. 1984 223 p
(Contract NAS1-15820)
(NASA-CR-172342; NAS 1.26:172342) Avail: NTIS HC A10/MF A01 CSCL 01A

Approximate nonlinear inviscid theoretical techniques for predicting aerodynamic characteristics and surface pressures for relatively slender vehicles at supersonic and moderate hypersonic speeds were developed. Emphasis was placed on approaches that would be responsive to conceptual configuration design level of effort. Second order small disturbance theory was utilized to meet this objective. Numerical codes were developed for analysis and design of relatively general three dimensional geometries. Results from the computations indicate good agreement with experimental results for a variety of wing, body, and wing-body shapes. Case computational time of one minute on a CDC 176 are typical for practical aircraft arrangement. Author

N87-10843*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PILOTED SIMULATION STUDY OF THE EFFECTS OF AN AUTOMATED TRIM SYSTEM ON FLIGHT CHARACTERISTICS OF A LIGHT TWIN-ENGINE AIRPLANE WITH ONE ENGINE INOPERATIVE
E. C. STEWART, P. W. BROWN, and K. R. YENNI Nov. 1986 41 p
(NASA-TP-2633; L-16147; NAS 1.60:2633) Avail: NTIS HC A03/MF A01 CSCL 01A

A simulation study was conducted to investigate the piloting problems associated with failure of an engine on a generic light twin-engine airplane. A primary piloting problem for a light twin-engine airplane after an engine failure is maintaining precise control of the airplane in the presence of large steady control forces. To address this problem, a simulated automatic trim system which drives the trim tabs as an open-loop function of propeller slipstream measurements was developed. The simulated automatic trim system was found to greatly increase the controllability in asymmetric powered flight without having to resort to complex control laws or an irreversible control system. However, the trim-tab control rates needed to produce the dramatic increase in controllability may require special design consideration for automatic trim system failures. Limited measurements obtained in full-scale flight tests confirmed the fundamental validity of the proposed control law. Author

N87-10846# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
UNSTEADY AIRLOAD COMPUTATIONS FOR AIRFOILS OSCILLATING IN ATTACHED AND SEPARATED COMPRESSIBLE FLOW
R. HOUWINK Apr. 1985 12 p Presented at joint AGARD FDP and FMP Symposium on Unsteady Aerodynamics: Fundamentals and Applications to Aircraft Dynamics, Goettingen, West Germany, 6-9 May 1985 Sponsored by Netherlands Agency for Aerospace Research
(NLR-MP-85040-U; B8668292; ETN-86-98491) Avail: NTIS HC A02/MF A01

Developments in coupled inviscid flow-boundary layer computations are discussed for airfoils in unsteady motion in attached and separated subsonic and transonic flow. The applicability of quasi-simultaneous strong interaction coupling procedures for transonic small perturbation theory and boundary layer integral methods is illustrated for oscillating airfoils with shock-induced separation. The relevance of the predicted airloads for aeroelastic applications is illustrated using the analysis of an aeroelastic instability of a supercritical wing wind tunnel model. ESA

N87-10847# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
EULER FLOW SOLUTIONS FOR A TRANSONIC WIND TUNNEL SECTION
B. KOREN Jan. 1986 18 p Submitted for publication Sponsored by Netherlands Technology Foundation
(CWI-NM-R8601; B8667670; ETN-86-98505) Avail: NTIS HC A02/MF A01

Two dimensional Euler flow computations were performed for a wind tunnel section, designed for research on transonic shock wave boundary layer interaction. For the discretization of the Euler equations, a finite volume Osher discretization was applied. The solution method is a nonlinear multigrid iteration with a symmetric point Gauss-Seidel relaxation method. Initial finest grid solutions are obtained by full multigrid. Grid adaptation was applied to obtain a sharp shock. The mathematical quality of four different boundary conditions for the oulet flow is indicated. The solutions of two transonic flows with shock are presented: a choked and a non-choked flow. Both flow solutions show good shock capturing. ESA

N87-10849 Stanford Univ., Calif.
COMPUTATION OF TRANSONIC SEPARATED WING FLOWS USING AN EULER/NAVIER STOKES ZONAL APPROACH Ph.D. Thesis
U. KAYNAK 1986 186 p
Avail: Univ. Microfilms Order No. DA8612751

A computer program called Transonic Navier Stokes (TNS) has been developed which solves the Euler/Navier-Stokes equations around wings using a zonal grid approach. In the present zonal scheme, the physical domain of interest is divided into several subdomains called zones and the governing equations are solved interactively. The advantages of the Zonal Grid Approach are as follows: (1) the grid for any subdomain can be generated easily, (2) grids can be, in a sense, adapted to the solution, (3) different equation sets can be used in different zones, and (4) this approach allows for a convenient data base organization scheme. Using this code, separated flows on a NACA 0012 section wing and on the NASA Ames WING C have been computed. First, the effects of turbulence and artificial dissipation models incorporated into the code are assessed by comparing the TNS results with other CFD codes and experiments. Then a series of flow cases are described where data is available. The computed results, including cases with shock-induced separation, are in good agreement with experimental data. Finally, some futuristic cases are presented to demonstrate the abilities of the code for massively separated cases which do not have experimental data. Dissert. Abstr.

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A87-10866
CASE STUDY OF ROYAL AUSTRALIAN AIR FORCE P3B ORION AIRCRAFT GROUND OXYGEN FIRE INCIDENT
J. W. GRUBB (Embassy of Australia, Washington, DC) IN: Flammability and sensitivity of materials in oxygen-enriched atmospheres; Proceedings of the Symposium, Washington, DC, April 23, 24, 1985. Volume 2 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 171-179.

Data from the January 1986 RAAF ground fire which destroyed a P3B Orion aircraft are discussed. The fire occurred during the removal of an onboard oxygen cylinder; a diagram of the oxygen system is provided. Examination of the oxygen system revealed that the fire initiated in the manifold check valve (MCV) assembly due to a leaking poppet valve, the presence of contaminants in the system, and failure to bleed the system to 3.33 MPa before cylinder disconnection. The various contaminants detected, which include iron oxide dust, copper-based alloys, steel, Al, and corrosive products, are described. The source of the contamination, the effectiveness of the oxygen system filters, and the fitting of the poppet valves to the MCV assembly were investigated. It is noted that due to the findings the oxygen system was cleaned, a new type of poppet valve was incorporated into the system, and a cleaning and inspection program was developed. I.F.

A87-11368
FIRE OCCURRING AND EXPANDING IN CONNECTION WITH OILS IN AVIATION [FEUERENTSTEHUNG UND- AUSBREITUNG DURCH OELE IN DER LUFTFAHRT]
E. JANTZEN (DFVLR, Institut fuer technische Physik, Stuttgart, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), July 1986, p. 13-15. In German.

Investigations have shown that oils employed in an aircraft represent a possible cause for the start and the propagation of fire. Thus, fires, having their origin in the hydraulic system, caused a damage of approximately 160 million dollars in the U.S. Air Force during the period from 1970 to 1979. The present article is

concerned with investigations which have been conducted with the objective to reduce the hazards for the start and the propagation of a fire in connection with the hydraulic system of an aircraft, giving particular attention to studies performed by the DFVLR. The chemical structure of oils and their fire-related characteristics were considered along with basic studies regarding ignition and fire propagation, and tests and investigations concerning practical problems. Topics discussed are related to a device for the study of self-ignition at hot metal areas in the case of very small amounts of oil, fire-propagation studies with a high-speed camera, and the burning characteristics of various hydraulic oils. G.R.

A87-11900
THEORETICAL ASPECTS AND PRACTICAL QUESTIONS REGARDING THE ASSURANCE OF FLIGHT SAFETY [ZU EINIGEN THEORETISCHEN ASPEKTEN UND PRAKTISCHEN FRAGEN DER GEWAEHRLEISTUNG DER FLUGSICHERHEIT]
A. RIECHE (Berlin, Humboldt-Universitaet, East Germany) Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 22, no. 3-4, 1986, p. 151-155. In German. refs

Questions concerning the position of flight safety as a part of safety considerations in the general areas of traffic and production are examined, taking into account the assurance of the technical safety of aircraft and air traffic control ground installations, the maintenance of aircraft and ground installations, the employment of aircraft control and air traffic control technologies which provide conditions for the conduction of safe flights, and regulations which permit a safe termination of flights in certain emergency situations. Attention is given to flight safety and the safety requirements of society, flight safety and economics, flight safety and discipline, and the definition of the category 'flight safety'. G.R.

A87-12683#
CHARACTERIZING HEIGHT KEEPING ERROR DISTRIBUTION BASED ON INDIRECT OBSERVATION
S. NAGAOKA (Ministry of Transport, Electronic Navigation Research Institute, Mitaka, Japan) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 125-132. refs

The distributions of relative vertical distances are analyzed using vertical navigational error data collected at Sendai, Japan during 1978-1983. The modeling of the RVD distribution is described and the models are compared to empirical data. It is observed that the double exponential (DE) and double-double exponential (DDE) models best represent the RVD distribution and show the best correlation with the empirical data. The HKE distribution can also be expressed by DE and DDE models. The distribution characteristics of the HKE and the RVD are defined as: (1) symmetry about the zero mean, (2) unimodal with the mode being located at zero, and (3) the probability density function does not increase monotonically with respect to the magnitude of error. I.F.

N87-10053# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REEPORT, DELTA AIR LINES, INC., LOCKHEED L-1011-385-1, N726DA, DALLAS/FORT WORTH INTERNATIONAL AIRPORT, TEXAS, AUGUST 2, 1985 Aircraft Accident Report, 2 Aug. 1985
15 Aug. 1986 169 p
(PB86-910406; NTSB/AAR-86/05) Avail: NTIS HC A08/MF A01

On August 2, 1985, at 1805:52 central daylight time, Delta Air Lines flight 191, a Lockheed L-1011-385-1, N726DA, crashed while approaching to land on runway 17L at the Dallas Fort Worth International Airport, Texas. While passing through the rain shaft beneath a thunderstorm flight 191 entered a microburst which the pilot was unable to traverse successfully. The airplane struck the ground about 6,300 feet north of the approach end of runway 17L, hit a car on a highway north of the runway killing the driver, struck two water tanks on the airport, and broke apart. Except for a section of the airplane containing the aft fuselage and empennage, the remainder of the airplane disintegrated during the impact sequence, and a severe fire erupted immediately. Of the 163 persons aboard, 134 passengers and crewmwmbers were killed, 24 passengers and 3 cabin attendants survived. The National Transportation Safety Board determines that the probable causes of the accident were the flightcrew's decision to initiate and continue the approach into a cumulonimbus cloud which they observed to contain visible lightning; the lack of specific guidelines, procedures, and training for avoiding and escaping from low-altitude wind shear; and the lack of definitive, real-time wind shear hazard information. This resulted in the aircraft's encounter at low altitude with a microburst-induced, severe wind shear from a rapidly developing thunderstorm located on the final approach course. Author

N87-10054*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DOPPLER RADAR DETECTION OF WIND SHEAR
V. E. DELNORE, Comp. (PRC Kentron, Inc., Hampton, Va.) and V. A. MCCLELLAN (Research Triangle Inst., Research Triangle Park, N.C.) Sep. 1985 118 p Presented at a Meeting, Hampton, Va., 24-25 Sep., 1985; sponsored in part by FAA
(NASA-CP-2435; NAS 1.55:2435; FAA/PM-86/31) Avail: NTIS HC A06/MF A01 CSCL 01C

In response to the Nation's needs for decreasing the threat of violent weather phenomena to aviation, a two-day meeting was held. This meeting, which brought together representatives from NASA, the Federal Aviation Administration, and the avionics industry, focused on the applicability of Doppler radar techniques to the detection of low-level wind shear. B.G.

N87-10055# Federal Aviation Administration, Atlantic City, N.J.
CRASHWORTHINESS EXPERIMENT SUMMARY FULL-SCALE TRANSPORT CONTROLLED IMPACT DEMONSTRATION PROGRAM Final Report
D. JOHNSON and L. GARODZ Jun. 1986 629 p
(DOT/FAA/CT-85/20) Avail: NTIS HC A99/MF A01

On December 1, 1984, the Federal Aviation Adminstration (FAA), and NASA, conducted an air-to-ground impact test demonstration with a remotely piloted jet transport category aircraft. This demonstration, identified as the Full-Scale Transport Controlled Impact Demonstration (CID) Program, was the culmination of four years of effort by the two agencies. The major FAA objecvtives included the demonstration of antimisting fuel and a series of fire safety and structural type crashworithness experiments. The NASA demonstrated objectives also extended to the crashworthiness experiment area. A summary of the FAA structural experiments is provided which included an instrumented fuselage structure and an associated analytical KRASH model, on-board seat/cabin restraint and flight data recorder system installations, and a post-impact accident investigation exercise. The summary contains a description of each experiment, related pre and post test activities, and resulting data. Author

N87-10056# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 2 OF 1985 ACCIDENTS
7 May 1986 404 p
(PB86-916916; NTSB/AAB-86/16) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent HC $185.00/year; all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in brief format occurring in U. S. civil and foreign aviation operations during calendar year 1985. Approximately 200 general aviatiion and air carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The brief format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-10851 Central Bureau of Statistics, Voorburg (Netherlands). Hoofafdeling Statistieken van Verkeer en Vervoer.
AVIATION STATISTICS, 1984 [STATISTIEK VAN DE LUCHTVAART]
1985 70 p Partly in DUTCH and ENGLISH Original contains color illustrations
(ISBN-90-357-0386-3; ISSN-0168-552X; ETN-86-98074) Avail: Issuing Activity

Statistics on world aviation and Dutch aviation are given. Graphs showing passenger transport and goods transport are presented. Data concerning commercial and noncommercial flights, passengers, and mail transport are tabulated. Flight and transport from Dutch airports are listed. ESA

N87-10852# National Transportation Safety Board, Washington, D. C.
NATIONAL TRANSPORTATION SAFETY BOARD SAFETY RECOMMENDATION
11 Feb. 1986 17 p
Avail: NTIS HC A02/MF A01

Modifications were discussed for the following areas: detailed inspection of engine exhaust manifold assemblies, wye assemblies, turbo inlet elbow assemblies, and collector assemblies for cracks due to exhaust gas erosion in Cessna T310, 320, 340, 401, and 411 series aicraft and model 402, 402A, 402B, 414, 421, 421A, and 421B aircraft; fuel system contamination due to deteriorated sponge-filled fuel reservoir tanks; and weight calculation and balance for passenger loads that deviate from standard average weight. B.G.

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A87-10047
GLOBAL POSITIONING SYSTEM APPLICATIONS
T. S. LOGSDON and J. D. ASHLEY (Rockwell International Corp., Satellite Systems Div., Seal Beach, CA) IN: Space Congress, 23rd, Cocoa Beach, FL, April 22-25, 1986, Proceedings . Cape Canaveral, FL, Canaveral Council of Technical Societies, 1986, p. 8-1 to 8-9. refs

The Navstar GPS is a space-based radio-navigation system that employs dual-frequency L-band transmissions to provide continuous, worldwide navigation coverage to an unlimited number of users. The configuration, capabilities, and operation of the GPS satellites are described. The Navstar system has been tested and the operating ranges and accuracy levels of the system are compared with those of other radio-navigation systems. It is observed that the Navstar system is as accurate or more accurate than other navigation systems currently in use. The uses of the GPS satellites in military, air traffic control, time synchronization, offshore oil exploration, and iceberg tracking are discussed. I.F.

A87-10137
MILITARY AERONAUTICAL SATELLITE COMMUNICATIONS
D. CUMMINGS and C. G. WILDEY (Marconi Defence Systems, Ltd., Watford, England) IEE Proceedings, Part F - Communications, Radar and Signal Processing (ISSN 0143-7070), vol. 133, pt. F, no. 4, July 1986, p. 411-419. refs

The paper describes the development of Europe's first super high frequency (SHF) military aircraft satellite communications ('aerosatcoms') terminal. This development marks the accelerating international interest in both civil and military aerosatcoms which has been spurred by recent advances in space, microwave, modulation and antenna technologies. The paper examines the impact of these advances on the military aircraft project and discusses key design parameters, features and constraints. Author

A87-10143
STOCHASTIC MODELLING OF RADAR RETURNS
P. THOMAS (Bell-Northern Research, Montreal, Canada) and S. HAYKIN (McMaster University, Hamilton, Canada) IEE Proceedings, Part F - Communications, Radar and Signal Processing (ISSN 0143-7070), vol. 133, pt. F, no. 5, Aug. 1986, p. 476-481. NSERC-supported research. refs

The paper considers the stochastic modeling of radar returns. In particular, returns from a typical airport surveillance radar (ASR) system have been modeled as autoregressive-moving average (ARMA) processes. Both maximum-likelihood (ML)- and autocorrelation-based techniques have been used. Order selection algorithms were studied and modified to optimize their performance for short-data records necessitated by the nonstationary radar environment. Distinctively different models have been found for typical combinations of ground, weather and aircraft returns. Author

A87-10931
AIRBORNE RECONNAISSANCE IX; PROCEEDINGS OF THE MEETING, SAN DIEGO, CA, AUGUST 20, 21, 1985
F. R. LAGESSE, ED. (McDonnell Aircraft Co., Saint Louis, MO) and P. HENKEL, ED. (General Dynamics Corp., Saint Louis, MO) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 561), 1985, 179 p. For individual items see A87-10932 to A87-10950.
(SPIE-561)

The present conference considers topics in high altitude reconnaissance equipment and its application to various missions, the receipt, processing and exploitation of reconnaissance imagery, and issues related to the design and application of real-time image acquisitions equipment. Among the topics discussed are image resolution limits due to mechanical vibration, atmospheric effects on oblique reconnaissance, the piloting of unmanned air vehicles, the impact of microprocessors on reconnaissance hardware, the acoustooptic implementation of SIGINT systems for spread spectrum communications, data compression for IR reconnaissance, the synergism between tactical electronic support measures and imaging sensors, and the development status of real-time processing. O.C.

A87-10944
RAPID TARGET LOCATOR
J. BISBEE (Litton Industries, Itek Optical Systems Div., Lexington, MA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 89-94.

While airborne electrooptical reconnaissance systems can transmit an image in real time to an imagery interpreter's console, it takes a further 15 min for the interpreter to issue a report; the greatest delay in this process is the need to determine the target's location by means of an Analytical Photogrammetric Positioning System, which uses stereophotomaps to determine the coordinates of a point on the ground. An attempt has been made to reduce the time to the issuance of a report to 2 min without compromising accuracy, so that moving target location is accurate to about 100 ft in less than half a min. This Rapid Target Locator concept employs a library of digitized maps, together with automated correlation and continuous position estimates that are made on the basis of the aircraft's navigation equipment. O.C.

A87-10947
DATA COMPRESSION FOR IR RECONNAISSANCE
W. MCCRACKEN (Honeywell, Inc., Electro-Optics Div., Lexington, MA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 115-119.

Recent trends in airborne reconnaissance force the designers of IR reconnaissance sensors to study data compression methods

so that the sensors can be more efficiently interfaced with real time data links and with magnetic recorders. The previous successful efforts in compressing FLIR data are briefly noted. Infrared line scanners have only recently become candidates for the data compression. Some of the requirements and problems are noted for compressing line scan data. Applicable methods are presented, and a hybrid DPCM/Huffman Coder is described with some successful results. Author

A87-10948
PHOTOGRAMMETRIC TOOLS FOR PANORAMIC SECTOR SCAN IMAGERY IN THE VIDARS ANALYSIS STATION
F. W. LEBERL, M. STEVENS, E. KIENEGGER (VEXCEL Corp., Boulder, CO), V. KAUFMANN (Graz, Technische Universitaet und Forschungszentrum, Austria), and G. C. GUSTAFSON (James Madison University, Harrisonburg, VA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 120-130. refs

Computer-assisted photo-interpretation is a recent development supported by the advent of numerous interpretation stations. A unique universal station is 'VIDARS' which has recently been equipped with a new software system that incorporates complex photogrammetric mensuration capabilities. Photo-interpreters typically find it difficult to perform mensuration tasks; therefore the implementation of the photogrammetric functions must not burden the user with a need to understand photogrammetric theories. This paper illustrates a difficult application of VIDARS to sector-scan panoramic film imagery and will show how well the user can perform target positioning tasks within his interpretation work. Author

A87-10949
MANAGEMENT OF AIRBORNE RECONNAISSANCE IMAGES THROUGH REAL-TIME PROCESSING
N. H. ENDSLEY (Ball Corp., Ball Aerospace Systems Div., Boulder, CO) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 157-164. USAF-sponsored research. refs

Digital airborne reconnaissance images generated by electrooptical sensors are able to furnish photographic film-competitive resolution, as well as better spectral selectivity, increased dynamic range, and better radiometric accuracy than conventional film; the primary advantage to which attention is presently given, however, is the efficient real-time processing of images for immediate transmission to users. Digital resampling, or 'image warping', is discussed as a necessary component of future digital reconnaissance, since it allows reduced fabrication and alignment costs for multisensor systems while providing precise geometric correction and alignment of images. The use of hardware to implement an efficient general-purpose resampling processor is presented. O.C.

A87-11061
KNOWLEDGE-BASED TACTICAL TERRAIN ANALYSIS
J. GILMORE, D. HO, S. TYNOR, A. SEMECO, C.-C. TSANG (Georgia Institute of Technology, Atlanta) et al. IN: Applications of digital image processing VIII; Proceedings of the Meeting, San Diego, CA, August 20-22, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 182-189. refs

The performance of autonomous vehicle systems is currently limited by their inability to accurately analyze their surrounding environment. In order to function in a dynamic real world environment, an autonomous vehicle system must be capable of interpreting terrain based upon predetermined mission goals. This paper describes a concept of knowledge-based terrain analysis currently being developed to support the information needs of an autonomous helicopter system. The terrain analysis system consists of five integrated processing stages. Each process is discussed in detail and supported by a number of mission oriented examples. Author

A87-11337
FUNDAMENTALS OF NAVIGATION ACCORDING TO GEOPHYSICAL FIELDS [OSNOVY NAVIGATSII PO GEOFIZICHESKIM POLIAM]
I. N. BELOGLAZOV, G. I. DZHANDZHGAVA, and G. P. CHIGIN Moscow, Izdatel'stvo Nauka, 1985, 328 p. In Russian. refs

The theory of navigation and guidance systems using geophysical fields, as well as navigation equipment and techniques, are reviewed with reference to work published abroad. Topics discussed include surface geophysical fields, their characteristics, and measurement techniques; anomalous three-dimensional geophysical fields; and memory and data processing devices for navigation systems using geophysical fields. The discussion also covers the structure, the principle of operation, and software requirements of navigation systems using geophysical fields and synthesis of algorithms for estimating vertical motion parameters. V.L.

A87-11370
LASER REMOTE SENSING PROCEDURES PROVIDE AN AID TO AVIATION DURING THE APPROACH FOR LANDING [LASER-FERNERKUNDUNGSVERFAHREN HELFEN DER LUFTFAHRT BEIM LANDEANFLUG]
C. WERNER (DFVLR, Institut fuer Optoelektronik, Oberpfaffenhofen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), July 1986, p. 19-24. In German. refs

This paper presents a description of two laser remote sensing procedures. One method makes it possible to determine slant visibility with respect to the path of the approaching aircraft during fog. The second method was used for measurements providing information regarding the danger to which small aircraft landing shortly behind large aircraft are exposed on account of vortex evolution. Under conditions of bad weather, the Runway Visual Range (RVR) data transmitted to the pilot during the approach are not always very accurate. One of the laser methods discussed may provide a solution to this problem, and a device implementing the considered procedure has been tested at the airport Munich-Riem in West Germany. The optical radar procedure utilized is based on the use of a laser. The second method described, which is concerned with wind relations, is based on a utilization of the Doppler effect. Measurements with the developed device were started at the airport Frankfurt/Main in summer 1983. G.R.

A87-11662
THE METHODOLOGY AND TOOLS FOR PROCESSING RADAR DATA [METHODOLOGIE ET OUTILS POUR LES EVALUATIONS RADAR]
D. ALVAREZ (Direction Generale de l'Aviation Civile, Centre d'Etudes de la Navigation Aerienne, Orly, France) Navigation (Paris) (ISSN 0028-1530), vol. 34, July 1986, p. 300-321. In French.

The complexity of modern air traffic control radar networks and the data they provide, when combined with the large volume of traffic over industrialized nations, requires a high degree of automation in the signal processing systems. The automation is especially crucial for providing early warning of possible collision situations, i.e., automatically detecting and projecting aircraft separation distances which fall beneath a threshold value. The French have developed the CENA system which detects, decodes, filters, smooths and displays aircraft positions and associated data on ATC screens. The CENA system digests the data arriving from primary and secondary radar beacons and compares different flight paths with reference trajectories, taking into account the types of aircraft detected. Trained personnel continually monitor the system to ensure its reliability, including the limitation of displays to data essential for the performance of ATC tasks. M.S.K.

A87-11663
POLAR NAVIGATION ASSISTED BY SATELLITE [NAVIGATION POLAIRE ASSISTEE PAR SATELLITE]
G. BODENEZ and M. DAMENE Navigation (Paris) (ISSN 0028-1530), vol. 34, July 1986, p. 330-337. In French.

Aircraft flying polar routes experience navigation difficulties due to fading of the horizontal component of the earth's magnetic field and because of limitations on the capabilities of inertial gyroscopes. The option exists of improving polar navigation by access to navigation satellites. Numerical models are defined for calculating position data from GEO satellite signals and making corrections for atmospheric refraction of the signals. Techniques for generating accurate loxodromic maps to utilize the satellite signals are described. M.S.K.

A87-11664
COMBINED UTILIZATION OF LORAN AND GPS - THE BEST FROM EACH SYSTEM [UTILISATION COMBINEE DU LORAN ET DU GPS LE MEILLEUR DE CHAQUE SYSTEME]
P. BRAISTED, R. ESCHENBACH, and A. TIWARI (Trimble Navigation Co., Mountain View, CA) (Institute of Navigation, National Technical Meeting, Long Beach, CA, Jan. 21, 1986) Navigation (Paris) (ISSN 0028-1530), vol. 34, July 1986, p. 338-345. In French.

The Loran system has been functioning since the 1960s and furnishes comprehensive navigational reference data for the Northern Hemisphere. However, the established grid has gaps in the middle of the continents and the middle of the oceans and in all other locations furnishes data with accuracy to 5 n. mi. The GPS system will permit worldwide navigation by access to signals from four satellites whose positions are known. The GPS is to furnish positioning data accurate to 50 m, starting after 1987. The GPS system can furnish signals which are strong enough to calculate the phase of the Loran cycle, which is at times uncertain because of the low power of the Loran signals. The GPS provides global coverage, but periods will exist where the GPS signal cannot be accessed. Since the Loran signals are continuous in time, the Loran system can furnish navigational data when the GPS is not accessible. M.S.K.

A87-11806#
TRANSITION TO NEW SYSTEMS AND INTERNATIONAL PERSPECTIVES
J. S. SMIT (Rijksluchtvaartdienst, The Hague, Netherlands) IN: Radio Technical Commission for Aeronautics, Annual Assembly Meeting and Technical Symposium, Washington, DC, November 19-21, 1985, Proceedings . Washington, DC, Radio Technical Commission for Aeronautics, 1985, p. 119-130.

Although new technological developments can hold obvious benefits for the enhancement of safety and efficiency of air traffic, no new system can be realistically considered without defining the transition process. The ICAO established the Future Air Navigation Systems Committee to identify potential hardware and techniques for the improvement of communications, navigation and surveillance systems. FANS has recognized the potential of satellite-based navigation and communications relay systems and the MLS. The implementation of the systems on an international scale depends on their utility for international civil aviation. Criteria are defined on which to base selections among satellite navigation systems (NAVSTAR, GLONASS, GEOSTAR, etc.). None of the systems can become an international standard until an organization capable of operating and maintaining the system is established. Finally, impediments and possible venues which can be explored to develop internationally-used systems and implement them while other systems continue in use are discussed. M.S.K.

A87-11807#
FANS - A U.S. PERSPECTIVE
S. B. PORITZKY (FAA, Washington, DC) IN: Radio Technical Commission for Aeronautics, Annual Assembly Meeting and Technical Symposium, Washington, DC, November 19-21, 1985, Proceedings . Washington, DC, Radio Technical Commission for Aeronautics, 1985, p. 133-144.

The ICAO Future Air Navigation System (FANS) Committee was established to identify potential systems and techniques for improving communications, navigation and surveillance systems and to lay the groundwork for international standardization of the systems. Acceptance of a new system hinges on the perceived need and the willingness (and ability) to pay for it. The latter factor has been a constraining force in numerous developing areas of the world. Studies of the benefits of satellite-based navigation systems led to the identification of several areas in which international civil aviation can benefit from satellites: better position and altitude resolution in the 290-1000 ft altitude interval, improved data link communications, and improved performance standards and an airborne separation ensurance capability. The logistics which would have to be implemented to realize these goals with an internationally accepted standard satellite navigation system are discussed. M.S.K.

A87-12676
NAVIGATION AND ENVIRONMENT; PROCEEDINGS OF THE FIFTH INTERNATIONAL CONGRESS, TOKYO, JAPAN, OCTOBER 1-5, 1985
Congress sponsored by the International Association of the Institutes of Navigation, Japan Maritime Promoting Association, and Japanese Shipowners' Association. Tokyo, Japan Institute of Navigation, 1986, 341 p. For individual items see A87-12677 to A87-12690.

Papers are presented on hydrographic contributions to safety at sea from 1975-1985; laser airborne depth sounding in Australia; the electronic chart; disturbances to airborne navigation and communication systems caused by atmospheric statics; navigation by gradient of geophysical parameter; the safe distance of nautical equipment from magnetic compasses; monitoring of the terminal flight phases environment; and routing and the environment. Consideration is given to the global radio navigation system; the GPS; an integrated GPS/dead-reckoning system; the ring laser gyro dither positional pickoff; characterizing height keeping error distribution using indirect observations; the microwave landing system; air traffic control systems; the aircraft flight deck; the use of differential Loran-C in Norwegian offshore activities; multiradar tracking; and the identification of marine vessels from ship and shore. Topics discussed include interference of the aeronautical Navaids from FM broadcasting services; probability estimation of oil spills from a tanker; a unified certification system for merchant marine officers; human dynamic response to the oscillatory motion of fishing vessels in the application of the collision rate as a danger criterion for marine traffic; and the safety of modern shipping and requirements in hydrographic surveying and nautical charting. I.F.

A87-12678#
DISTURBANCES BROUGHT BY ATMOSPHERIC STATICS TO AIRBORNE NAVIGATION AND COMMUNICATION SYSTEMS
H. BONGRAIN (Navigation /Paris/, vol. 33, Oct. 1985, p. 442-464) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 35-42. Translation. Previously cited in issue 06, p. 691, Accession no. A86-18695.

A87-12680#
INTEGRATION OF GPS WITH OTHER RADIONAVIGATION SYSTEMS
G. F. SAGE (Navigation Technology, Inc., Cool, CA) and J. D. LUSE (Interstate Electronics Corp., Newport Beach, CA) (Navigation /Paris/, vol. 34, Apr. 1986, p. 196-206) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 89-99. Previously cited in issue 18, p. 2609, Accession no. A86-39560. refs

A87-12684#
THE U.S. FEDERAL RADIONAVIGATION PLAN
D. C. SCULL (DOT, Washington, DC) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 133-143. refs

The development of radio navigatiiton systems is examined. The roles of the DOD and DOT in planning radio navigation systems are discussed. The objectives of the Federal Radionavigation Plan, in particular the implementation of the GPS, are considered. The functions of radio beacons, Loran-C, VOR/DME, Omega, Tacan, ILS/MLS, and Transit are described; these systems are to be replaced by the GPS which will provide military and civil air, marine, and land navigation assistance. The technical, economic, and institutional issues related in civil use of GPS are studied. The formation of civil satellite navigation systems in the U.S. and Europe is proposed. I.F.

A87-12685#
A LOW COST COMMERCIAL GPS SET
N. B. HEMESATH (Rockwell International Corp., Cedar Rapids, IA) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 145-151.

The development of a low cost GPS for commercial use is discussed. The GPS is a space-based system which transmits on two RF channels, L1, L2, has two codes, C/A, P, and the number of tracking channels are equivalent to the number of satellites tracked simultaneously. The final constellation will consist of 18 satellites in six separate orbital planes of three satellites each; the deployment schedule for the system is examined. The cost and performance of GPS user equipment designed for commercial use are evaluated. A GPS set composed of the L1 channel, the C/A code, and one tracking channel is described and the set's performance satisfies the GPS specifications. I.F.

A87-12686#
FLIGHT EXPERIMENTS ON MLS ELEVATION GUIDANCE
K. KOREMURA and T. KATANO (Ministry of Transport, Electronic Navigation Research Institute, Mitaka, Japan) (Navigation /Paris/, vol. 34, Jan. 1986, p. 63-72) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 153-160. Previously cited in issue 11, p. 1480, Accession no. A86-27899.

A87-12687#
AUTOMATED FUNCTIONS FOR AIR TRAFFIC CONTROL SYSTEMS
M. LUCERTINI (CNR, IASI, Rome, Italy) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 161-169. refs

The aim of this paper is to give evidence that with suitable algorithms, parallel computing systems, and software optimization it is possible to provide a real-time complete conflict alert analysis for a sufficiently large number of aircraft. A strategy is presented to decompose the problem into subproblems such that parallel computation of subproblems will be possible. In particular the algorithmic structure is shown to be suitable for the implementation on a multiprocessor computer system. Author

A87-12689#
A NEW CONCEPT IN AIR TRAFFIC CONTROL - THE MULTI-RADAR TRACKING (MRT)
E. PASCARELLA, S. PALMIERI (Aeronautica Militare Italiana, Rome, Italy), and C. PETROSELLINI IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 191-200.

The multiradar tracking (MRT) system provides one position information on a single plan position indicator by detecting the different echoes of a single target arriving from multiple radar stations with partially superimposed coverages. The operation of the MRT, which is based on SSR data, and the configuration of the system are considered. The radar echoes processing and flight data updating with the MRT system are discussed. The performance of MRT operations in an air traffic control automatic system was evaluated at Ciampino Airport in Rome; it is observed that compared to a monoradar the multiradar operating algorithm improves the echoes performances, and that the system is capable of providing economical, safe, and efficient radar control for a large area. The development of a radar tracking system which will supply meteorological data for the entire Italian airspace is proposed. I.F.

A87-12690#
INTERFERENCE OF THE AERONAUTICAL NAVAIDS (FREQUENCY BAND 108-118 MHZ) FROM F.M BROADCASTING SERVICE (88-108 MHZ)
O. CAREL and J. M. LOSCOS (Direction Generale de l'Aviation Civile, Paris, France) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 259-267.

N87-10057 Southern Methodist Univ., Dallas, Tex.
A DECENTRALIZED FAULT-TOLERANT APPROACH TO ESTIMATION IN MULTI-SENSOR NAVIGATION SYSTEMS Ph.D. Thesis
B. D. BRUMBACK 1985 139 p
Avail: Univ. Microfilms Order No. DA8604722

This investigation considers the problem of designing estimation algorithms for aided-inertial navigation in which both global accuracy and reliability in the presence of soft sensor failures is required. The approach is to correlate subsets of available sensor data to create multiple estimates of the aircraft navigation state. A two-ellipsoid overlap test is used to determine which local estimates agree and which disagree. Knowledge of the underlying sensor set then provides information to determine which estimates are correct, and which sensors have failed. The estimates that are based on the unfailed sensors are then combined to obtain the global estimate. Monte Carlo simulation results are presented for a system composed of two inertial navigation systems and a Doppler radar. The soft failure considered in this application is an accelerometer bias shift. False alarm and detection probabilities, mean detection-time, and the estimation error of the fault-tolerant system are determined numerically. It is shown that the fault-tolerant approach yields improved performance, compared to a global filter, in the presence of the soft failure. Dissert. Abstr.

N87-10853# Radio Technical Commission for Aeronautics, Washington, D. C. Special Committee 153.
MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR AIRBORNE ILS GLIDE SLOPE RECEIVING EQUIPMENT OPERATING WITHIN THE RADIO FREQUENCY RANGE OF 328.6-335.4 MHZ
Jul. 1986 71 p Revised
(RTCA/DO-192; RTCA/DO-132A-REV) Avail: NTIS HC A04/MF A01; also available from RTCA Secretariat $25.00

This document was prepared by Special Committee 153 of the Radio Technical Commission for Aeronautics. It was approved by RTCA on July 18, 1986, and supersedes RTCA/DO-132A, Performance Standards Airborne ILS Glide Slope Receiving Equipment, November 2, 1978. RTCA is an association of aeronautical organizations of the United States from both

government and industry. Dedicated to the advancement of aeronautics, RTCA seeks sound technical solutions to problems involving the application of electronics and telecommunications to aeronautical operations. Its objective is the resolution of such problems by mutual agreement of its member organizations. The findings of RTCA are in the nature of recommendations to all organizations concerned. Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the Federal government organization or agency having statutory jurisdiction over matters to which the recommendations relate. In preparation of these standards RTCA SC-153 took into consideration comments received on behalf of the European Organization for Civil Aviation Electronics (EUROCAE) WG-5. Author

N87-10854*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.

POTENTIAL IMPACTS OF ADVANCED TECHNOLOGIES ON THE ATC CAPACITY OF HIGH-DENSITY TERMINAL AREAS

R. W. SIMPSON, A. R. ODONI, and F. SALAS-ROCHE Oct. 1986 175 p

(Contract NAG1-472)

(NASA-CR-4024; NAS 1.26:4024) Avail: NTIS HC A08/MF A01 CSCL 17G

Advanced technologies for airborne systems (automatic flight control, flight displays, navigation) and for ground ATC systems (digital communications, improved surveillance and tracking, automated decision-making) create the possibility of advanced ATC operations and procedures which can bring increased capacity for runway systems. A systematic analysis is carried out to identify certain such advanced ATC operations, and then to evaluate the potential benefits occurring over time at typical US high-density airports (Denver and Boston). The study is divided into three parts: (1) A Critical Examination of Factors Which Determine Operational Capacity of Runway Systems at Major Airports, is an intensive review of current US separation criteria and terminal area ATC operations. It identifies 11 new methods to increase the capacity of landings and takeoffs for runway systems; (2) Development of Risk Based Separation Criteria is the development of a rational structure for establishing reduced ATC separation criteria which meet a consistent Target Level of Safety using advanced technology and operational procedures; and (3) Estimation of Capacity Benefits from Advanced Terminal Area Operations - Denver and Boston, provides an estimate of the overall annual improvement in runway capacity which might be expected at Denver and Boston from using some of the advanced ATC procedures developed in Part 1. Whereas Boston achieved a substantial 37% increase, Denver only achieved a 4.7% increase in its overall annual capacity. Author

N87-10855# Lear Siegler, Inc., Grand Rapids, Mich. Instrument Div.

OPERATING AND SUPPORT HAZARD ANALYSIS FOR SELF-CONTAINED NAVIGATION SYSTEM LSI MODEL 6216A, B AND C, GROUP B

J. T. REEVES 30 May 1986 20 p

(Contract F09603-85-C-1224)

(AD-A169381; REPT-6216-019) Avail: NTIS HC A02/MF A01 CSCL 17G

This document constitutes the Operating and Support Hazard Analysis (OSHA) for the C-130 Self-Contained Navigation System (SCNS) Group LRUs. It provides a hazard assessment of use and maintenance of the individual LRUs provided by LSI. The purpose of an OSHA is to identify and control hazards to personnel and to the system, or related to production, installation, maintenance, test, operation, etc. This OSHA is limited to design of the Group B LRUs as the design affects operational use and maintenance safety of personnel working in or around the equipment, including ground and flight crews. The SCNS is comprised of a Doppler Velocity Sensor (DVS), Inertial Navigation System (INS), Integration Computation and Display System (ICDS), and the associated installation Group A kit to provide Doppler aided INS navigation, INS only, Doppler only and TAS/HDG navigation modes, and control of the various C-130 communication/navigation (comm/nav) systems. The SCNS ICDS consists of three Integrated Control Display Units (ICDU) and one Bus Integration Computer Unit (BICU) for all C-130 aircraft except that the HC-130H will have an additional ICDU for the radio control. GRA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A87-10574

PALMDALE AND THE BOMBER CONNECTION

Air International (ISSN 0306-5634), vol. 31, Aug. 1986, p. 65-73, 89.

The B-1B bomber is now in production in Palmdale, CA, and may be followed by the B-2 Advanced Technology Bomber. The area has been known for military aircraft production and 'black', classified programs since at least the 1950s. The Orbiters are also manufactured in one of the local facilities. The B-1B aircraft, which carries 161 defensive avionics systems, has a primary mission of low-altitude, supersonic penetration into enemy territory with nuclear bombs and cruise missiles. The all-weather aircraft is built of 42.5 percent aluminum, 17.6 percent titanium, 7 percent steel, 2-3 percent composites and 30.6 percent fiberglass. The aircraft will be based far enough inland to permit a 5 min scramble time to offset a 7 min time span between launch and arrival of hostile submarine-launched ballistic missiles. Numerous design details and demonstration and test flight programs being flown by the early production units are delineated. M.S.K.

A87-10575

YAKOVLEV FORGER

R. BRAYBROOK Air International (ISSN 0306-5634), vol. 31, Aug. 1986, p. 81-86.

Although it appears that the Soviets began development of a VTOL aircraft in the 1960s, the expense of the effort may have delayed the program. The concept of jet lifting was retained and tested in the Yak-38 Freehand, which displayed a high degree of automatic stability control but required a deep inset of the cockpit to maintain balance. The Yak-38 Forger was introduced on antisubmarine carriers in 1971 and was tracked at a speed of Mach 1.05 by radar. Numerous comparisons are made between the design features observed in photographs of the Forger and the Harrier aircraft, noting the incorporation of many positive features in the Forger that have only been proposed for the Harrier. Finally, projections are made of the mission scenarios and capabilities of the aircraft. M.S.K.

A87-10940

GROUND AND FLIGHT TESTS OF TORNADO RECONNAISSANCE POD

W. FRANKE (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 59-66.

This paper describes the efforts which have been performed to qualify the newly designed Tornado reconnaissance pod for its application to various missions. These efforts included comprehensive ground and flight tests. Reconnaissance Pods are designed so as not to limit the flight performance of the arcraft. On the other hand, reconnaissance equipments require a stable environment, which is in contrast to the ambient conditions of outboard stores on high performance fighter aircraft. To ensure that the designers fulfilled their tasks to match these conflicting

requirements to a good technical solution, the tests described in this paper have been carried out. Author

A87-10941
PILOTING OF UNMANNED AIR VEHICLES. II
R. E. CLAPP (Gould, Inc., Systems and Simulation Div., Melville, NY) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 67-73. refs

Attention is given to the unmanned air vehicle piloting requirements imposed by command-and-control sequences, visual displays, communications, and the design and operation of remote control stations. In order to prevent operator overwork, heuristic programs are incorporated by vehicle controls, leaving the operator to intervene only at the critical points of the mission. The vehicle is preprogrammed to fly to a series of selected points automatically, while operators monitor, update, or alter the flight programs as required. The testing hierarchy incorporated by the vehicle encompasses sensors and data links. O.C.

A87-11343
METHODS OF IN-FLIGHT AEROPHYSICAL STUDIES [METODY AEROFIZICHESKIKH ISSLEDOVANII V POLETE]
A. D. MIRONOV, A. N. ZAMIATIN, A. A. KOROLEV, A. V. RODNOV, and M. G. FOMIN Moscow, Izdatel'stvo Mashinostroenie, 1985, 112 p. In Russian. refs

The work describes aerophysical study methods used during flight tests to investigate phenomena that cannot be fully simulated in wind tunnel tests. These phenomena include flow past aircraft surfaces, the development of vortex wakes, the propagation of shock waves from a flying aircraft, sonic booms, and aircraft noise. Measurement equipment and experiment planning for the in-flight studies are discussed, and experimental results are presented. B.J.

A87-11661
DIRIGIBLES - FOR WHAT? [DES DIRIGEABLES - POUR QUOI FAIRE?]
M. DE BROSSARD Navigation (Paris) (ISSN 0028-1530), vol. 34, July 1986, p. 269-290. In French.

Lighter than air vehicles (LTA), until the late 1930s, were considered on even par with winged aircraft for many air transport operations. Safety and performance advantages gave winged aircraft advantages which only recently are again being challenged by LTAs. Air freight and groundside facilities costs and pollution levels are all lower with LTAs, which can operate out of areas with no airports. Safety is enhanced by using helium, no longer a rare gas, as the lifting agent. The dimensions and performance levels of classic rigid, semi-rigid and flexible airships of the past are reviewed, and projections are made of the performance levels which can be achieved with modern flexible LTAs serving passenger and freight transport roles. Numerical models are discussed for predicting the lifetime and designing the control laws for piloting and navigating modern LTAs. Finally, numerous photographs are provided of typical airships. M.S.K.

A87-11776
NUMERICAL METHODS FOR ENGINE-AIRFRAME INTEGRATION
S. N. B. MURTHY, ED. (Purdue University, West Lafayette, IN) and G. C. PAYNTER, ED. (Boeing Airplane Co., Seattle, WA) New York, American Institute of Aeronautics and Astronautics, Inc. (Progress in Astronautics and Aeronautics. Volume 102), 1986, 554 p. For individual items see A87-11777 to A87-11781.

Various papers on numerical methods for engine-airframe integration are presented. The individual topics considered include: scientific computing environment for the 1980s, overview of prediction of complex turbulent flows, numerical solutions of the compressible Navier-Stokes equations, elements of computational engine/airframe integrations, computational requirements for efficient engine installation, application of CAE and CFD techniques to complete tactical missile design, CFD applications to engine/airframe integration, and application of a second-generation low-order panel methods to powerplant installation studies. Also addressed are: three-dimensional flow analysis of turboprop inlet and nacelle configurations, application of computational methods to the design of large turbofan engine nacelles, comparison of full potential and Euler solution algorithms for aeropropulsive flow field computations, subsonic/transonic, supersonic nozzle flows and nozzle integration, subsonic/transonic prediction capabilities for nozzle/afterbody configurations, three-dimensional viscous design methodology of supersonic inlet systems for advanced technology aircraft, and a user's technology assessment. C.D.

A87-11780#
CFD APPLICATIONS TO ENGINE/AIRFRAME INTEGRATION
E. J. TINOCO and A. W. CHEN (Boeing Commercial Airplane Co., Seattle, WA) IN: Numerical methods for engine-airframe integration . New York, American Institute of Aeronautics and Astronautics, Inc., 1986, p. 219-255. refs

The use of CFD methods for the design and analysis of wing pylon-mounted engine/airframe configurations typical of subsonic transports is studied. The computational methods utilized include: a linear panel code for the analysis of subcritical flows about highly complex configurations; a full potential, finite volume wing/body/strut/nacelle code; a three-dimensional, time-dependent Euler formulation for isolated nacelles and for wing/body/nacelle/propfan configurations; and an axisymmetric explicit Navier-Stokes code for exhaust system analysis and exhaust plume calibration. Both the Euler isolated code nacelle code and the full potential code are iteratively coupled to a three-dimensional boundary layer method with shock wave/boundary layer interaction. A brief description of each computational method is given, followed by application examples. C.D.

A87-11781#
CFD - A USER'S TECHNOLOGY ASSESSMENT
G. C. PAYNTER and E. TJONNELAND (Boeing Military Airplane Co., Seattle, WA) IN: Numerical methods for engine-airframe integration . New York, American Institute of Aeronautics and Astronautics, Inc., 1986, p. 505-537. refs

Current CFD technology for propulsion integration is assessed, and areas where further research and development will improve the current technology in using CFD for installation design are defined. The need for a strategy that makes feasible the analysis of propulsion installation flow within the constraints of available computer memory and speed is discussed, and the zonal modeling strategy is defined as a way to satisfy this need. Examples of the use of zonal modeling are cited, the current capabilities of this model are assessed, and suggestions for its improvement are made. The development, acquisition, and application of CFD are discussed, and a user's assessment of current capability is given with regard to computer systems, algorithms, geometry and mesh generation, turbulence modeling, and experimental validation. C.D.

A87-11798
JAS39 GRIPEN - A SWEDISH SOLUTION TO A MULTI-ROLE NEED
B. WANSTALL Interavia (ISSN 0020-5168), vol. 41, Aug. 1986, p. 867-870.

The design and components of the lightweight, multirole combat aircraft, the JAS39 Gripen, are described. This interceptor, ground attack, and reconnaissance aircraft is single-engined, has a delta planform, canards are fully fly controls, advanced avionics, and a take-off weight of 8 tons. The engine is a modular low-bypass, reheated turbofan weighing 1050 kg with a 8210 kg thrust. The software for the aircraft, which is based on a standardized computing system, and the fly-by-wire flight control system are examined. The capabilities of the multimode pulse-Doppler radar are discussed. The arming of the aircraft is considered. I.F.

A87-11848
IMPACT RESISTANT HYBRID COMPOSITE FOR AIRCRAFT LEADING EDGES
S. C. NOLET and P. M. SANDUSKY (USAF, Sacramento Air Logistics Center, McClellan AFB, CA) SAMPE Quarterly (ISSN 0036-0821), vol. 17, July 1986, p. 46-53.

The Air Force A-10 aircraft has been exposed to a great number of bird strike incidents over its lifetime. Damage to the wing leading edge and substructure is common, resulting in excessive maintenance and downtime. A new design utilizing a hybrid laminate of graphite/epoxy and Kevlar/epoxy has proven very effective in preventing damage to the aircraft due to bird impact. The design utilizes a solid laminate construction because integral stiffeners and core designs have insufficient shear strengths to carry the extreme loading of impact. The laminate used in the leading edge design is quite thick at the nose section to prevent local buckling. A clevis joint is used in the new part to more efficiently carry vertical shear loads. Thermal 'spring-in' during manufacturing presented a major problem for installation of such a stiff part.
Author

A87-11898
THE CLASSIFICATION OF WIND SHEARS FROM THE POINT OF VIEW OF AERODYNAMICS AND FLIGHT MECHANICS [EINTEILUNG DER WINDSCHERUNGEN AUS DER SICHT DER AERODYNAMIK UND FLUGMECHANIK]
F. SEIDLER (Hochschule fuer Verkehrswesen, Dresden, East Germany) and G. HENSEL (Interflug Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany) Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 22, no. 3-4, 1986, p. 107-112. In German.

A study of international statistical data shows that in about three quarters of all serious accidents which occurred with jet propelled airliners wind shear was either one of the main causes of the accident or represented a major contributory cause. The present article is concerned with wind shear related problems. The necessity of a use of different concepts, definitions, and divisions is explained, and the concepts and definitions required for the division of wind and wind shear into different categories is discussed. A description of the context between meteorological and aerodynamics-flight mechanics concepts, definitions, and divisions is also provided. Attention is given to wind and wind components, general characteristics of wind shear and the meteorological terms, the basic types of wind shear for aerodynamics-flight mechanics investigations, special types of wind shear for aerodynamics-flight mechanics investigations, and possibilities regarding a change of the wind component. G.R.

A87-11899
DYNAMIC FLIGHT OPTIMIZATION [DYNAMISCHE FLUGOPTIMIERUNG]
P. HACKER (Interflug Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany) Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 22, no. 3-4, 1986, p. 146-150. In German. refs

The introduction of microprocessor technology provides new effective possibilities for the optimization of flight conditions, taking into account the utilization of complex mathematical procedures, such as the 'dynamic optimization'. Algorithms can be established as a basis for the calculation of flight conditions with the aid of flight planning installations and flight management systems. A mathematical model which is suitable for the required calculations on the available small computers is discussed along with the basic relations of dynamic optimization, the approximation of the fundamental characteristics, approaches for static optimization, the algorithm of dynamic optimization, and the implementation of the program. It is possible to determine the optimal flight speed with minimal fuel consumption. G.R.

A87-12138* Rice Univ., Houston, Tex.
GUIDANCE STRATEGIES FOR NEAR-OPTIMUM TAKE-OFF PERFORMANCE IN A WINDSHEAR
A. MIELE, T. WANG (Rice University, Houston, TX), and W. W. MELVIN (Delta Air Lines, Inc., Atlanta, GA) Journal of Optimization Theory and Applications (ISSN 0022-3239), vol. 50, July 1986, p. 1-47. refs
(Contract NAG1-516)

This paper is concerned with guidance strategies for near-optimum performance in a windshear. This is a wind characterized by sharp change in intensity and direction over a relatively small region of space. The take-off problem is considered with reference to flight in a vertical plane. First, trajectories for optimum performance in a windshear are determined for different windshear models and different windshear intensities. Use is made of the methods of optimal control theory in conjunction with the dual sequential gradient-restoration algorithm (DSGRA) for optimal control problems. In this approach, global information on the wind flow field is needed. Then, guidance strategies for near-optimum performance in a windshear are developed, starting from the optimal trajectories. Specifically, three guidance schemes are presented: (1) gamma guidance, based on the relative path inclination; (2) theta guidance, based on the pitch attitude angle; and (3) acceleration guidance, based on the relative acceleration. In this approach, local information on the wind flow field is needed.
Author

A87-12649
BRAKING PERFORMANCE OF AIRCRAFT TIRES
S. K. AGRAWAL Progress in Aerospace Sciences (ISSN 0376-0421), vol. 23, no. 2, 1986, p. 105-150. refs

This paper brings under one cover the subject of aircraft braking performance and a variety of related phenomena that lead to aircraft hydroplaning, overruns, and loss of directional control. Complex processes involving tire deformation, tire slipping, and fluid pressures in the tire-runway contact area develop the friction forces for retarding the aircraft; this paper describes the physics of these processes. The paper reviews the past and present research efforts and concludes that the most effective way to combat the hazards associated with aircraft landings and takeoffs on contaminated runways is by measuring and displaying in realtime the braking performance parameters in the aircraft cockpit.
Author

A87-12650
A REVIEW OF ADVANCED TURBOPROP TRANSPORT ACTIVITY
R. H. LANGE (Lockheed-Georgia Co., Marietta) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 23, no. 2, 1986, p. 151-166. refs

An overview is presented of propfan aircraft design concepts, system studies, and tests directed toward the resolution of technical issues related to advanced propfan transport aircraft. The system studies addressed include civil and military transport applications and data on the performance, noise, and operating costs of propfan aircraft design concepts. NASA propfan projects with industry, including the Propfan Test Assessment program, are also reviewed. C.D.

A87-13021*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LAMINAR FLOW CONTROL FOR TRANSPORT AIRCRAFT APPLICATIONS
R. D. WAGNER (NASA, Langley Research Center, Hampton, VA) National Aerospace Laboratory, Conference on Energy Efficient Aircraft Technology Towards 21st Century, Tokyo, Japan, May 30, 1986, Paper. 6 p. refs

The incorporation of laminar flow control into transport aircraft is discussed. Design concepts for the wing surface panel of laminar flow control transport aircraft are described. The development of small amounts of laminar flow on small commercial transports with natural or hybrid flow control is examined. Techniques for

eliminating the insect contamination problem in the leading-edge region are proposed. I.F.

N87-10060 Maryland Univ., College Park.
AEROELASTIC STABILITY OF COMPOSITE ROTOR BLADES IN HOVER Ph.D. Thesis
C. H. HONG 1985 144 p
Avail: Univ. Microfilms Order No. DA8608813

The aeroelastic stability of flap bending, lead-lag bending, and torsion of hingeless and bearingless composite blades in hover are investigated using a finite element theory based on Hamilton's principle. The hingeless blade is treated as a single cell laminated shell beam. Bearingless blade configuration is assumed as the one consisting of a single flexbeam with a wrap-around type torque tube and the pitch links located at the leading edge and the trailing edge of the torque tube. For analysis, the outboard main blade and the torque tube are assumed to be made of metals (isotroic materials), and the flexbeam is assumed to be a laminated I-section beam. The energy expressions and governing differential equations are derived for moderately large deflections. Quasisteady strip theory is used to evaluate the aerodynamic forces and the unsteady aerodynamic effects are introduced approximately through dynamic inflow modeling. Numerical results are calculated for the selected various hingeless and bearingless blade configurations, categorized as symmetric and antisymmetric, based on the lay-up in the laminates. For both the hingeless and bearingless blade configurations, systematic studies are made to identify the importance of the stiffness coupling terms on blade stability with changing fibers orientation and for different configurations.
Dissert. Abstr.

N87-10061# Aeronautical Research Labs., Melbourne (Australia).
ANALYSIS OF THE VIBRATION OF THE INPUT BEVEL PINION IN RAN WESSEX HELICOPTER MAIN ROTOR GEARBOX WAK143 PRIOR TO FAILURE
P. D. MCFADDEN Sep. 1985 51 p
(ARL-AERO-PROP-R-169; AR-004-049) Avail: NTIS HC A04/MF A01

Following the crash of an RAN Wessex helicopter caused by the catastrophic fatigue failure of the input spiral bevel pinion in the main rotor gearbox, routine recordings of the gearbox vibration have been analyzed by ARL. It has been shown that conventional spectral analysis of the vibration is unable to give adequate indication of the presence of the fatigue crack but that an alternative technique of vibration analysis called signal averaging can give warning of the crack 42 hours before failure. Enhancement of the signal average using a computer enables detection of the crack as early as 103 hours before failure. Author

N87-10062# National Aeronautical Lab., Bangalore (India). Systems Engineering Div.
EFFECTS OF FLAP POSITION ON LONGITUDINAL PARAMETERS OF HFB-320
R. V. JATEGAONKAR and S. BALAKRISHNA Feb. 1986 // p
(NAL-TM-SE-8602) Avail: NTIS HC A05/MF A01

Parameter estimation results to evaluate the effects of small changes in flap position on the longitudinal derivatives of HFB-320 aircraft are presented. Maximum likelihood estimation procedure is used for kinematic consistency checking of flight test data and also for estimation of aerodynamic derivatives. Linear and nonlinear models are used to estimate dimensional and non-dimensional derivatives directly. Author

N87-10063*# Florida Atlantic Univ., Boca Raton. Dept. of Mechanical Engineering.
TOWARD COMPARING EXPERIMENT AND THEORY FOR CORROBORATIVE RESEARCH ON HINGELESS ROTOR STABILITY IN FORWARD FLIGHT (AN EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF ISOLATED ROTOR-FLAP-LAG STABILITY IN FORWARD FLIGHT) Annual Report
G. GAONKAR Aug. 1986 33 p Prepared for Army Aviation Research and Development Command, Moffett Field, Calif.
(Contract NCC2-361)
(NASA-CR-179711; NAS 1.26:179711) Avail: NTIS HC A03/MF A01 CSCL 01C

For flap-lag stability of isolated rotors, experimental and analytical investigations are conducted in hover and forward flight on the adequacy of a linear quasisteady aerodynamics theory with dynamic inflow. Forward flight effects on lag regressing mode are emphasized. Accordingly, a soft inplane hingeless rotor with three blades is tested at advance ratios as high as 0.55 and at shaft angles as high as 20 degrees. The 1.62 m model rotor is untrimmed with an essentially unrestricted tilt of the tip path plane. In combination with lag natural frequencies, collective pitch settings and flap-lag coupling parameters, the data base comprises nearly 1200 test points (damping and frequency) in forward flight and 200 test points in hover. By computerized symbolic manipulation, a linear analytical model is developed in substall to predict stability margins with mode identificaton. To help explain the correlation between theory and data it also predicts substall and stall regions of the rotor disk from equilibrium values. The correlation shows both the strengthts and weaknesses of the theory in substall.
Author

N87-10064# Army Aviation Systems Command, St. Louis, Mo.
SUMMARY OF ARTIFICIAL AND NATURAL ICING TESTS CONDUCTED ON US ARMY AIRCRAFT FROM 1974 TO 1985 Final Report
H. W. CHAMBERS and J. Y. ADAMS Jul. 1986 223 p
(Contract DTFA03-80-A-00199)
(FAA/CT-85/26; TR-85-F-11) Avail: NTIS HC A10/MF A01

The U.S. Army Aviation Systems Command conducts airworthiness qualification testing on aircraft under artificial and natural icing conditions. A JCH-47C helicopter with a Helicopter Icing Spray System (HISS) installed is used for generating a simulated natural icing environment. The artificial icing tests are followed by natural icing tests to assure a wide variety of flight conditions are tested and to verify artificial icing test results. Also discussed is the use of deice and anti-ice systems; the impact of ice accretion and shedding characteristics, performance considerations, stability and control, and vibration characteristics; and the cloud parameters measurement equipment and test aircraft instrumentation used for documenting test data. The test methodology and requirements used for qualifying aircraft for flight into icing conditions, instrumentation, and special equipment are summarized, and the details for tests conducted are contained in the references. The report documents in part 14 years of U.S. Army experience in conducting inflight aircraft icing tests and is provided to the FAA under interagency agreement in the preparation of manuals and other documents relative to the certification of civil aircraft as appropriate. Author

N87-10065*# General Dynamics Corp., Fort Worth, Tex.
DESIGN AND FABRICATION OF THE NASA DECOUPLER PYLON FOR THE F-16 AIRCRAFT Final Report, Jan. 1982 - Aug. 1983
J. D. CLAYTON, R. L. HALLER, and J. M. HASSLER, JR. Jan. 1985 204 p
(Contract NAS1-16879)
(NASA-CR-172354; NAS 1.26:172354) Avail: NTIS HC A10/MF A01 CSCL 01C

The NASA Decoupler Pylon is a passive means of suppressing wing-store flutter. The feasibility of demonstrating this concept on the F-16 aircraft was established through model wind tunnel tests and analyses. As a result of these tests and studies a ship set of

Decoupler Pylons was designed and fabricated for a flight test demonstration on the F-16 aircraft. Basic design criteria were developed during the analysis study pertaining to pylon pitch stiffness, alignment system requirements, and damping requirements. A design was developed which utilized an electrical motor for the pylon alignment system. The design uses a four pin, two link pivot design which results in a remote pivot located at the center of gravity of the store when the store is in the aligned position. The pitch spring was fabricated from a tapered constant stress cantilevered beam. The pylon has the same external lines as the existing production pylon and is designed to use a MAU-12 ejection rack which is the same as the one used with the production pylon. The detailed design and fabrication was supported with a complete ground test of the pylon prior to shipment to NASA. Author

N87-10066# Boeing Military Airplane Development, Seattle, Wash.
VULNERABILITY METHODOLOGY AND PROTECTIVE MEASURES FOR AIRCRAFT FIRE AND EXPLOSION HAZARDS. VOLUME 3: ON-BOARD INERT GAS GENERATOR SYSTEM (OBIGGS) STUDIES. PART 1: OBIGGS GROUND PERFORMANCE TESTS Final Report, Aug. 1982 - Jul. 1984
C. L. ANDERSON Jan. 1986 200 p
(Contract F33615-78-C-2063)
(AD-A167357; D180-28862-VOL-3-PT-1;
AFWAL-TR-85-2060-V-3-PT-1) Avail: NTIS HC A09/MF A01
CSCL 01C

Results of performance evaluation tests of a molecular sieve (MSIGG) and a permeable membrane inert gas generator (PMIGG) system for airplane fuel tank inerting are presented. The IGG units, sized to inert the wing tanks of a KC-135, and the test facilities at Wright-Patterson AFB are described. Steady state performance envelope, endurance, and KC-135 mission simulation tests are conducted. The weight and fuel penalties of the MSIGG and the PMIGG installed in a KC-135 are compared. GRA

N87-10067# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
ENGINE-AIRFRAME INTEGRATION FOR ROTORCRAFT
Loughton, England May 1986 154 p Lecture Series held in St. Louis, Mo., 2-3 Jun. 1986, in Rome, Italy, 9-10 Jun. 1986, and in Marseilles, France, 12-13 Jun. 1986
(AGARD-LS-148; ISBN-92-835-1529-3) Avail: NTIS HC A08/MF A01

Topics addressed include numerous airframe integration aspects relating to rotor wing aircraft. Various areas of engine airframe integration, including the impact of advanced engine design variables to specific propulsion subsystems, will be discussed. Other propulsion system integration aspects such as engine/rotor/drive system torsional stability and transient response will also be discussed. Additional areas considering the specification and qualification requirements of propulsion items will be examined.

N87-10068# Sikorsky Aircraft, Stratford, Conn. Propulsion Systems.
ENGINE-AIRFRAME INTEGRATION CONSIDERATIONS FOR PRELIMINARY AIR VEHICLE PERFORMANCE ANALYSIS
R. C. FRAWLEY and H. N. SHOHET *In* AGARD Engine-Airframe Integration for Rotorcraft 21 p May 1986
Avail: NTIS HC A08/MF A01

Helicopter engine/airframe integration issues are examined from a preliminary design viewpoint with emphasis on those areas where an impact on aircraft power available and/or aerodynamics is involved. The areas of the helicopter propulsion system specifically addressed include: the engine air induction system considering aerodynamic performance, anti-icing, exhaust gas re-ingestion, and inlet particle separation; the engine exhaust system considering aerodynamic performance, engine compartment cooling, and exhaust ejector system; and lastly, engine bleed air extraction as it relates to environmental control systems and the trade studies associated with same. These subsystems are discussed in terms of basic design guidelines, interaction with other helicopter subsystems, system trade studies, and first order analytical design approaches adequate for preliminary design purposes. Author

N87-10069# Pisa Univ. (Italy). Dipt. de Energetica.
ENGINE-TRANSMISSION-STRUCTURAL AIRFRAME MEMBERS COMPATIBILITY
D. DINI *In* AGARD Engine-Airframe Integration for Rotorcraft 33 p May 1986
Avail: NTIS HC A08/MF A01

The sophistication of current turbine-powered helicopters have introduced many new problems involving the compatibility of the major multidegree of freedom systems: rotor, control, airframe, drive train, and powerplant. The solutions to the various problems were obtained from the application of basic engineering principles. Engine installation is described in the helicopter, particularly the A-129, i.e., power plant attachment, oil cooling system, engine control and monitoring, electric starting system, location of components and leading particulars, and anti-vibration devices. The design of the transmission system is dictated by the configuration of the helicopter. An aerodynamic analysis is conducted on the helicopter mission in order to obtain complete spectra of the rotor loads and moments as well as the maneuver loads and transient for maximum transmission reliability. The application of fiber reinforced resin composites to selected areas of the helicopter drive system will produce weight and cost savings as well as improvements in reliability and safety. These improvements which were demonstrated in airframe applications can be transferred to structural components in the drive system, with high weight saving. Author

N87-10070# Rolls-Royce Ltd., Watford (England).
IMPACT OF IPS AND IRS CONFIGURATIONS ON ENGINE INSTALLATION DESIGN
J. R. BALLARD *In* AGARD Engine-Airframe Integration for Rotorcraft 14 p May 1986
Avail: NTIS HC A08/MF A01

Helicopters operate in a variety of roles many of which pose severe problems to the engine due to ingestion of sand, ice, salt, and other foreign objects. It is possible to design a compromise engine intake which combats all these hazards to a limited degree. Engine design should be coordinated with both engine and airframe mounted separator performance characteristics to ensure that optimized designs can be offered to customers with very different operational requirements. A design method was outlined which would allow the erosion reduction characteristics of engine and airframe Intake Protection System (IPS) designs to be taken into account during engine design. The Infrared Suppression (IRS) designs can be integrated with IPS scavenge requirements to produce a low signature engine installation. B.G.

N87-10071# Army Aviation Systems Command, St. Louis, Mo. Engineering Dept.
ENGINE-AIRFRAME INTEGRATION FOR ROTORCRAFT: COMPONENT SPECIFICATIONS AND QUALIFICATION
J. A. RAY *In* AGARD Engine-Airframe Integration for Rotorcraft 10 p May 1986
Avail: NTIS HC A08/MF A01

Both past history and current principles associated with engine-airframe integration for rotorcraft are provided as related to component specification requirements and their individual qualification assurance. Component specification and qualification requirements have tended to be generic and standardized without consideration of actual usage, location, and exposure. As such, overall requirements have had problems of being overly restrictive in some cases and not exacting enough in others. The current trend in tailoring for specific applications as well as insuring system performance requirements by conducting early component/bench level tests will be discussed along with lessons learned from past efforts. Components involved in the overall engine-airframe integration effort such as pumps, fans, starter, valves, sensors,

infrared suppressors, inlet particle separators, and fuel cells will be discussed. Author

N87-10072# Garrett Turbine Engine Co., Phoenix, Ariz.
INFLUENCE OF ENGINE VARIABLES ON FUTURE HELICOPTER SYSTEMS
M. L. EARLY and P. K. ZEINER *In* AGARD Engine-Airframe Integration for Rotorcraft 24 p May 1986
Avail: NTIS HC A08/MF A01

A helicopter system defined for the year 2000 must make numerous assumptions about future technology and system requirements. In the case of propulsion system options, the required 5 to 15 year development cycle (from preliminary engine cycle studies through engine development to production) complicates the process of optimizing the engine/rotorcraft system. A well-disciplined approach to engine definiton studies to yield engine candidates that best use emerging technologies is illustrated. An advanced, single-engine helicopter requiring a 2000-shp powerplant was used a a base-line vehicle. Both simple and heat-recovery cycles were evaluated, using trade factors to establish engine effects on helicopter direct operating cost (DOC), the optimization parameter assumed for purposes of illustration. Author

N87-10073# Societe Nationale Industrielle Aerospatiale, Marignane (France). Helicopter Div.
HELICOPTER AIR INTAKE PROTECTION SYSTEMS
X. DELASERVETTE and P. CABRIT *In* AGARD Engine-Airframe Integration for Rotorcraft 20 p May 1986
Avail: NTIS HC A08/MF A01

The primary function of an engine air intake is to provide air supply with minimum pressure drop and distortion. Static or dynamic air intakes are selected according to both the type of engine air intake and the helicopter missions envisaged. The other function of an engine air intake is to protect the engine against foreign object ingestion, sand erosion, and the various atmospheric agents such as rain, snow, and ice. As a general rule, the air intake protection systems are all the more penalizing as regards performance as they are efficient. The best tradeoff is therefore between both functions. The dimensioning and test criteria for each function of an air intake is examined and then the various development stages are given for the SA 366 G1 Dauphin air intake as an example. Author

N87-10074# Army Aviation Systems Command, St. Louis, Mo. Engineering Dept.
ENGINE-AIRFRAME INTEGRATION FOR ROTORCRAFT: SYSTEM SPECIFICATIONS AND QUALIFICATION
J. A. RAY *In* AGARD Engine-Airframe Integration for Rotorcraft 10 p May 1986
Avail: NTIS HC A08/MF A01

Both past history and current principles associated with engine-airframe integration for rotorcraft are provided as related to system specification requirements and the resulting qualification assurance. System specification requirements have evolved through periods of few details and lack of definitive requirements to the opposite extreme of exacting details and extremely specific requirements. The current trend of performance related specifications is intended to enhance the freedom of design while meeting the essential mission related requirements. This has required a revised qualification program effort to insure essential requirements are being met throughout the develpment effort. Lessons learned in this evaluation as well as current methods will be discussed for overall engine-airframe integration system requirement. In particular, system qualification will be addressed for such areas as adverse environment requirements for icing, cold/hot temperatures and sand/dust; mission related requirements for engine response, infrared signature reduction, and crashworthiness; and basic engine integration requirements for torsional stability, vibration, and cooling. Author

N87-10858 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ENERGY MANAGEMENT OF 3-DIMENSIONAL MINIMUM-TIME INTERCEPT Ph.D. Thesis
H. G. VISSER 1985 124 p
Avail: Univ. Microfilms Order No. DA8605366

A real-time computer algorithm to control and optimize aircraft flight profiles is described and applied to a three-dimensional minimum-time intercept mission. The proposed scheme has roots in two well-known techniques; singular perturbations and neighboring-optimal guidance. Use of singular-perturbation ideas is made in terms of the assumed trajectory-family structure. A heading/energy family of prestored point-mass-model state-Euler solutions is used as the baseline in this scheme. The next step is to generate a near-optimal guidance law that will transfer the aircraft to the vicinity of this reference family. The control commands fed to the autopilot consist of the reference controls plus correction terms which are linear combinations of the altitude and path-angle deviations from reference values, weighted by a set of precalculated gains. In this respect the proposed scheme resembles neighboring-optimal guidance. However, in contrast to the neighboring-optimal guidance scheme, the reference control and state variables as well as the feedback gains are stored as functions of energy and heading in the present approach. A detailed description of the feedback laws and of some of the mathematical tools used to construct the controller is presented. Numerical examples, comparing open-loop optimal and approximate feedback solutions for a sample high-performance fighter, illustrate the attractiveness of the guidance scheme. Optimal three-dimensional flight in the presence of a terrain limit is studied in some detail. Dissert. Abstr.

N87-10859*# General Dynamics Corp., Fort Worth, Tex.
DESIGN AND FABRICATION OF THE NASA DECOUPLER PYLON FOR THE F-16 AIRCRAFT, ADDENDUM 2 Final Report, Jan. - Oct. 1984
J. D. CLAYTON, R. L. HALLER, and J. M. HASSLER, JR. Feb. 1985 99 p
(Contract NAS1-16879)
(NASA-CR-172494; NAS 1.26:172494) Avail: NTIS HC A05/MF A01 CSCL 01C

The decoupler pylons which were originally designed and assembled with bushings in the pivot joints were retrofitted with roller bearings. This retrofit, the supporting analyses and the fixture tests of the modified pylons are reported in this document. The loads and stress analysis was directed toward the redesigned parts which were the pylon links and pins. The loads and stress analysis indicates that the pylons with the bearing installation have reduced capacity with respect to the bushing design. Fixture tests of the redesigned pylons were conducted in the GD/FW facility. Breakout friction tests and vibration tests were conducted. The tests show that the joint friction is approximately one-half the level with bearings as compared with the bushing installation. The vibration test data was used to tune the pylon mathematical simulation and this revised pylon simulation was used to recompute airplane modes of vibration. These computed modes of vibration were used in complete airplane symmetric and antisymmetric flutter and aeroservoelastic analyses. Author

N87-10860*# General Dynamics Corp., Fort Worth, Tex.
DESIGN AND FABRICATION OF THE NASA DECOUPLER PYLON FOR THE F-16 AIRCRAFT, ADDENDUM 1 Final Report, Aug. - Oct. 1983
J. D. CLAYTON and R. L. HALLER Jan. 1985 70 p
(Contract NAS1-16879)
(NASA-CR-172355; NAS 1.26:172355) Avail: NTIS HC A04/MF A01 CSCL 01C

The results of the final analyses which were conducted using a revised structural simulation of the Decoupler Pylon are reported in this addendum. The simulation incorporates the previously published results of ground tests performed on the flight Decoupler Pylons mounted in a test fixture at General Dynamic's Fort Worth facility. The analyses show that the Decoupler Pylon will suppress

wing-store flutter for the GBU-8 flight test stores configuration on an F-16 airplane. The feasibility of carrying a B-61 on the pylons is also investigated with the conclusion that the pylons would need to be modified in order to demonstrate flutter suppression. The results of a ground vibration test performed on the 1/4 scale F-16 flutter model and a wind tunnel test with this model and a model Decoupler Pylon are given. Author

N87-10861*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
X-29A LONGITUDINAL AND DIRECTIONAL FORCE AND MOMENT SUPPLEMENTAL TRANSONIC WIND TUNNEL TEST RESULTS
A. H. BOWERS Aug. 1984 289 p
(NASA-TM-85909; H-1257; NAS 1.15:85909) Avail: NTIS HC A13/MF A01 CSCL 01C

Aerodynamic data from NASA Ames Research Center's 11-Foot Transonic Wind Tunnel are plotted for the 1/8-scale X-29A forward-swept wing aircraft model. Eleven configurations were tested to provide supplemental data to investigate single surface failure modes, complex nonlinearities, and model buildup. These data can be used for control system refinements, pilot training, flight planning, and aerodynamic model validation. Data are presented as corrected wind tunnel data without analysis to document results that are being used for the aerodynamic model. Author

N87-10862*# Kansas Univ. Center for Research, Inc., Lawrence.
PARAMETRIC ANALYSIS OF A PASSIVE CYCLIC CONTROL DEVICE FOR HELICOPTERS
H. KUMAGAI Oct. 1984 135 p
(Contract NCC2-175)
(NASA-CR-166608; NAS 1.26:166608; KU-FRL-568-1) Avail: NTIS HC A07/MF A01 CSCL 01C

A parametric study of a passive device which provides a cyclic longitudinal control moment for a helicopter rotor was performed. It utilizes a rotor blade tip which is structurally decoupled from the blade inboard section. This rotor configuration is generally called the Free-Tip Rotor. A two dimensional numerical model was used to review the Constant Lift Tip Rotor, a predecessor of the current configuration, and then the same model was applied to the Passive Cyclic Control Device. The Constant Lift Tip was proven to have the ability to suppress the vibratory lift loading on the tip around the azimuth and to eliminate a significant negative lift peak on the advancing tip. The Passive Cyclic Control Device showed a once-per-revolution lift oscillation with a large amplitude, while minimizing the higher harmonic terms of the lift oscillation. This once-per-revolution oscillation results in the cyclic moment to trim the rotor longitudinally. A rotor performance analysis was performed by a three dimensional numerical model. It indicated that the vortices shed from the junction between the tip and the inboard section has a strong influence on the tip, and it may severely limit the tip performance. It was also shown that the Free-Tip allows the inboard section to have a larger twist, which results in a better performance. Author

N87-10863# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
CORRELATION BETWEEN FLIGHT SIMULATION AND PROCESSING OF FLIGHT TESTS BASED ON INERTIAL MEASUREMENTS
A. M. H. NIEUWPOORT, J. H. BREEMAN, L. J. J. ERKELENS, and P. J. J. VANDERGEEST 19 Jul. 1985 23 p Presented at AGARD Flight Mechanics Panel Symposium of Flight Simulation, Cambridge, England, 3 Sep. - 3 Oct. 1985
(NLR-MP-85058-U; B8667020; ETN-86-98493) Avail: NTIS HC A02/MF A01

Flight tests and simulations were performed using conventional and dynamic techniques based on inertial measurements. The use of inertial sensors in flight testing implies that specific forces and body rates are determined which are directly employed in the flight path reconstruction procedure. This procedure uses the equations of motion governing flight. After this step aerodynamics model identification can take place. In flight simulation, the opposite process occurs. From the available aerodynamic and engine model specific forces and angular accelerations can be computed. Then the equations of motion can be integrated in order to determine the flight path. Consequently there is a strong similarity in the way flight test results are processed and reduced in order to obtain aerodynamic information and the way simulations are executed using a given model. ESA

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A87-10933
LONG RANGE E-O RECONNAISSANCE SYSTEM AND FLIGHT TEST RESULTS
F. PALAZZO (Fairchild Weston Systems, Inc., Imaging Systems Div., Syosset, NY) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 13-17.

Beginning 1977, Fairchild Weston Systems developed a long-range E-O Reconnaissance System. The goal was to develop and experimentally demonstrate the capabilities of a sensor using Charge Coupled Device (CCD) Time Delay and Integration (TDI) technology. It was shown to be possible to electronically subtract the background, due to haze, from each picture element (PIXEL) and amplify the remaining differences to enhance the reproduced scene. The large image signal-to-noise ratio required was obtained through the use of a TDI. An optically contiguous focal plane, built up of TDI chips, was integrated into a long focal length camera, which was testflown. This paper describes the experiment and the results obtained. Author

A87-10934
THE KS-147A LOROP CAMERA SYSTEM
O. OSTREM and J. G. HUGHES (Recon/Optical, Inc., CAI Div., Barrington, IL) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 18-25.

Attention is given to the design of the Long Range Oblique Photography ('LOROP') KS-147A camera carried by the RF-5E aircraft in a nose installation. Key design features are a seven-element, 1676-mm focal length f/5.6 lens, a two-axis gyrostabilized scan head, a passive isolation mount, a closed loop autocollimation autofocus, and a self-contained thermal system. In-flight resolution in excess of 70 lp/mm is achievable; the camera's modular design allows repackaging in numerous other configurations, as called for by the aircraft in question. O.C.

A87-10935
INTEGRATION OF THE KS-147A LOROP INTO THE RF-5E
R. L. WALKE and J. P. DUDA (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 26-33.

The RF-5E single-cockpit tactical reconnaissance aircraft was designed in 1981 to carry a variety of low, medium and high altitude sensor configurations mounted internally on interchangeable pallets. Presently, the high resolution, 66-inch focal length, f/5.6, KS0147A LOROP (Long Range Oblique Photographic) camera is being incorporated by the aircraft, to provide a standoff capability exceeding 30 nautical miles. This paper addresses the design process employed to mechanically and electrically integrate the KS-147A into the RF-5E, while maintainig the concept of

interchangeable sensor pallets. The paper will include a discussion of the design requirements imposed on the suppliers of the KS-147A camera and the Photographic Sensor Control System, as well as a detailed design discussion of the structural, electrical and environmental control components necessary to install the camera in the aircraft. Finally, the planned ground and flight test activities are presented. Author

A87-10936
OPERATIONAL USAGE OF THE KS-147A (LOROP) IN THE RF-5E
D. G. BURRIS (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 34-41.

The KS-147A Long Range Oblique Photographic (LOROP) Camera is being developed to satisfy an operational tactical reconnaissance requirement. This paper addresses that specific requirement and the capabilities of the KS-147A in the Northrop RF-5E to meet that need. Particular emphasis is given to specific flight planning parameters, maintenance preparations and ground requirements of the camera system, inflight considerations and typical mission profiles. The paper concludes with an assessment of the RF-5E/KS-147A Camera system to provide an effective tactical reconnaissance standoff capability. Author

A87-10937
EFFECTS OF ATMOSPHERE ON OBLIQUE RECONNAISSANCE
P. N. SLATER (Arizona, University, Tucson) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 42-46. refs

This paper shows how atmospheric scattering can affect the signal-to-noise ratio, the spatial resolution, and the noise equivalent reflectance difference of an oblique CCD reconnaissance camera operating in the pushbroom mode. An example is given that compares these quantities for 75 and 85 deg oblique imagery with the near-nadir case for a flat, horizontal target. The effect of imaging the target at various azimuths with respect to the sun is examined. Author

A87-10939
SINGLE OR DUAL POD CONCEPTS FOR TACTICAL RECONNAISSANCE
J. I. BERGGREN (FFV, Aero Engineering Div., Linkoping, Sweden) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 52-58.

An evaluation is made of the optimum tactical reconnaissance system meeting both high speed/low level penetration missions and standoff missions; single and dual pod system configurations are considered from tactical, technical, and economic viewpoints. Although a dual pod system allows LCCs to be minimized in cases where tactical requirements allow a minimization of the number of standoff sensors, the single pod system allows the selection of both standoff and penetration modes during a reconnaissance mission. O.C.

A87-10943
RECONNAISSANCE AND THE MICROPROCESSOR
J. L. CAPTAIN (Teledyne Ryan Aeronautical, San Diego, CA) and R. A. STURZ (Recon/Optical Inc., Pacific E/O Center, La Jolla, CA) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 85-88.

A comprehensive evaluation is made of the cumulative impact of microprocessors' application to reconnaissance systems, which began with the use of solid state logic devices for control and timing functions and proceeded, beginning in the mid-1970s, to involve microprocessor control of internal sensor-related functions. Attention is given to a typical state-of-the-art microprocessor application in forward motion compensation devices, which regulate the ability of sensors to track the image motion at their focal plane; this application has proven to be especially effective in the case of oblique-pointing sensors. O.C.

A87-10950
RECONNAISSANCE INTERFACE - THE NEAR REAL TIME IS NOW
W. G. FISHELL (Fairchild Communications and Electronics Co., Germantown, MD) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 165-172.

Reconnaissance interface products over the past ten years have focused on the interface between the aircraft, including its cockpit, and the peculiar interfaces required to control and annotate information in tactical reconnaissance sensors. Compared to older systems like those in the RF-4 which contains multiple boxes and analog interfaces, today's reconnaissance interface is much simpler in a single, highly reliable unit, controlled by its own programmable microprocessor. Furthermore, recent engineering development systems have demonstrated how this single, programmable unit can be adapted to a variety of sensors, including the recent mix and match requirement for electro optics and/or film type of sensors. This presentation provides a sampling of some of the many reconnaissance interface functions this unit can and does perform. Author

A87-12212#
EXPERT SYSTEMS FOR AIDING COMBAT PILOTS
B. M. ANDERSON, C. MCNULTY, and G. S. LYSTAD (Texas Instruments, Inc., Dallas) IN: Annual Aerospace Applications of Artificial Intelligence Conference, 1st, Dayton, OH, September 16-19, 1985, Proceedings . Dayton, OH, AAAIC Secretariat, 1985, p. 54-60. refs

The emergency procedures expert system (EPES) for handling emergency situations for tactical aircraft pilots is described. EPES is activated when the aircraft is damaged and loses capabilities, thereby initiating mission replanning. The system must provide advice as to whether or not to pursue a particular course of action, and must resolve conflicts between goals. The latter arise when opposing actions are specified by multiple emergencies. Performance of the system is illustrated by means of sample F-16 missions. In one scenario, the EPES must provide advice on correct actions when the canopy is lost and the towershaft fails, situations which require recommended airspeeds of a maximum of 180 and a minimum of 250 kt, respectively. The prosvision of mission options for sequential failures on a deepstrike mission is also described, and a block diagram is provided of the multiple expert system architecture. M.S.K.

A87-12218#
THE ASPRO PARALLEL INFERENCE ENGINE (A REAL-TIME EXPERT SYSTEM)
B. R. REED, J. H. SMIT, and R. W. LOTT (Goodyear Aerospace Corp., Digital Systems Dept., Akron, OH) IN: Annual Aerospace Applications of Artificial Intelligence Conference, 1st, Dayton, OH, September 16-19, 1985, Proceedings . Dayton, OH, AAAIC Secretariat, 1985, p. 248-259.

Design and functional of the Aspro flight qualified parallel processor are outlined. A block diagram is provided for the five functional subsystems of the Aspro architecture. The distribution of the three types of memory is described, along with register, arithmetic and array control functions, and the array hardware, which contains 1792 processing alements. Aspro weights 37 lb, occupies a volume of 0.44 cu ft and consumes 200 W power. Software such as Assembler, FORTRAN, a Librarian, and a Linker have been developed for Aspro and will also work in the VAX environment. Techniques be which Aspro is employed as a real-time expert system complete with parallel inferencing are described. Aspro is to be installed on the E-2C early warning aircraft to perform tracking command and control functions. M.S.K.

A87-12677#
LASER AIRBORNE DEPTH SOUNDING IN AUSTRALIA
M. F. PENNY, R. H. ABBOT, D. M. PHILLIPS, B. BILLARD, D. REES (Department of Defence, Electronics Research Laboratory, Adelaide, Australia) et al. IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 9-17.

A laser airborne depth sounder (LADS) designed for a hydrographic survey in Australian coastal waters is examined. The sounding pattern for LADS is 270 m wide and the spacing between adjacent soundings is 10 m. LADS contains a Nd:YAG laser, and the infrared and green laser pulses are utilized to calculate depth. The aircraft and ground analysis equipment are described. LADS was utilized to profile the Great Barrier Reef; to investigate the effects of ocean swell and layered turbid water off Fremantle in West Australia; and in South Australia gulf waters, the accuracy and depth error analysis were studied. The role of water turbidity in depth sounding performance is discussed. The LADS system must generate an accurate surface model, based on the observed reflections from the sea surface by the IR and green receiving channels, in order to calculate depth, and depth estimations for LADS are based on the propagation times of the subsurface beam and the velocity of light in water. The fixing of the sounder position, the navigation of LADS, and the on-ground analysis of the data are considered. I.F.

A87-12688#
THE EVOLUTION OF AIR TRANSPORT AIRCRAFT FLIGHT DECK
J. CASTIES (Thomson-CSF, Paris, France) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 171-179.

Improvements in aircraft flight decks made possible with advances in shadow-mask color tube and large scale integration technology are described. The capabilities and data provided by the electronic flight instrument system, which is composed of a primary flight display and a navigation display, and the electronic centralized aircraft monitor display system, which consists of two CRT display units, are examined. The implementation of an improved electronic instrument system and a side stick/fly-by-wire aircraft control system into the A 320 is discussed. I.F.

A87-12694
DATA PROCESSING AND CALIBRATION FOR AN AIRBORNE SCATTEROMETER
R. BERNARD, D. VIDAL-MADJAR, F. BAUDIN, and G. LAURENT (Centre de Recherches en Physique de l'Environnement Terrestre et Planetaire, Issy-les-Moulineaux, France) IEEE Transactions on Geoscience and Remote Sensing (ISSN 0196-2892), vol. GE-24, Sept. 1986, p. 709-716. CNES-ESA-supported research. refs

The ERASME-radar system has been designed to be easily mounted on small helicopters or aircraft. As it is used for research investigations on radar remote-sensing applications, it has to be well calibrated in every configuration, both absolutely and relatively for comparisons at different points of the swath. The data processing, which allows for antenna pattern correction and for flight parameters correction (pitch, roll, altitude), is described as an introduction to the calibration procedures: internal calibration, external calibration on corner reflectors for absolute calibration (within 1 dB), and a statistical approach which uses experimental data itself and analyzes the correlation between the processed data and recorded flight parameters. This method provides a way to check or adjust calibration for specific flight configurations, and allows a relative accuracy of better than 0.5 dB for data comparison within the radar swath. Such a method can be used to calibrate any airborne or spaceborne scatterometer when accurate antenna measurement is not feasible. Author

N87-10075# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.
PROCEEDINGS OF THE 13TH SYMPOSIUM ON AIRCRAFT INTEGRATED DATA SYSTEMS
Feb. 1986 586 p Symposium held in Hamburg, West Germany, 17-19 Sep. 1985
(DFVLR-MITT-86-04; ISSN-0176-7739; ETN-86-98176) Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The application of aircraft integrated data systems for monitoring and recording flight and aircraft condition and performance, to improve safety, reliability, and economy of aircraft operation was discussed. ESA

N87-10076# Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany).
A-310 AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) DESIGN PHILOSOPHY
H. KALBE *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 9-28 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The A-310 air data system customer requirements and integration problems were examined. The repercussions of these aspects on the system architecture are discussed, and a solution which covers the problems is presented. ESA

N87-10077# Hamilton Standard, Farmington, Conn.
AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS): EVOLUTION AND REVOLUTION
C. F. BUKOWSKI *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 29-45 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Development of aircraft integrated data systems (AIDS) from 1970 to the present is discussed. User desirable features are considered. Present and perceived AIDS integration/relationships with other aircraft systems, and the tools and resources necessary for implementation are treated. ESA

N87-10078# Nord-Micro Elektronic Feinmechanik G.m.b.H., Frankfort (West Germany).
MODERN AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) TECHNOLOGY EXEMPLIFIED ON THE A-320
D. WALDMANN and K. WNUK *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 47-74 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The hardware design, software organization, and data processing of the flight data interface unit (FDIU) and the data management unit (DMU) for the A-320 aircraft are described. The DMU and FDIU provide high flexibility and expansion capability to keep pace with airline requirements. For example, the units are equipped with EEPROM's of size 8 k by 8, but footprint, wiring, and memory management are provided for memory chips with higher capacity. In the DMU prewired spare board slots are provided for future air data system applications as there is the supervision of the structural health of aircraft components. Technologies like gate arrays and surface mounted devices are used so that the equipment shows important reduction in physical size, weight, and power consumption compared to the predecessor. ESA

N87-10079# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
EXPERIENCE WITH THE ONBOARD CHECKOUT AND MONITORING SYSTEM (OCAMS) OF A MILITARY AIRCRAFT RESULTING IMPROVEMENTS AND THE CONSEQUENCE FOR FUTURE DESIGN
K. NUMBERGER and K. PROBST *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 75-92 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The Onboard Checkout and Monitoring System was designed to provide for test and diagnosis of defects to avionic and certain nonavionic equipments. Experience showed what could be improved. Engine and structure monitoring must be improved, still more information would be useful to store, and it was realized that the high sensitivity of the BIT detected also very transient faults. In order to cover these problems, the data acquisition unit of the crash recorder system will be extended with an engine and structural life monitoring system. Using the opportunity of introducing a data communication bus into the avionic system, facilities for data collection, correlation, and event monitoring will be initiated. Based on this the principal structure of the monitoring and test systems of future aircraft can be designed. ESA

N87-10080# Plessey Co. Ltd., Havant (England).
INTEGRATED MONITORING SYSTEMS FOR TACTICAL AIRCRAFT
P. J. D. BRISTOWE and R. L. THOMPSON *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 93-124 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

An aircraft integrated monitoring system integrating previously stand alone avionic boxes in military aircraft, with consequent savings in equipment cost, weight, and volume is described. The crash-protected accident data recorder combines digital data recordings with 3 channels of voice. The data acquisition and processing unit combines the acquisition of accident data, and engine and structural parameters with the real-time implementation of engine and structural algorithms to determine component fatigue life. Other facilities include parameter exceedance monitoring, trend monitoring and event snapshots with simple latched displays for maintenance purposes. ESA

N87-10081# Civil Aviation Authority, Redhill (England). Airworthiness Div.
APPLICATION OF OPERATIONAL FLIGHT RECORDING TO HELICOPTERS
H. D. RUBEN *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 125-138 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Operational flight data recording tests were carried using helicopters. One helicopter carries a data recorder running continuously, and a second helicopter of a different type is being similarly equipped. The objective of the exercise is to establish real time utilization of the helicopter so that design assumptions, particularly with respect to fatigue, can be validated. It is too early to draw conclusions. ESA

N87-10082# Societe de Fabrication d'Instruments de Mesure, Massy (France).
THE AIRBORNE INTEGRATED DATA SYSTEM (AIDS) FOR THE AIRBUS A-310 ENGINE CONDITION MONITORING
C. JOUVENOT *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 139-160 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The A-310 aircraft integrated data system (AIDS) is developed in a single six modular common unit combining flight data acquisition unit and Data Management Unit (DMU) with no possible interaction between the two units. The system is controlled through a Central Data Unit (CDU) and programmed through a removable electrical module plugged in the CDU. A mass memory stores the data for immediate use after the flight. Outputs of DMU are to printer and digital AIDS recorder. Long term analysis reports for engine monitoring are engine cruise, and engine take-off trend reports as well as auxiliary power unit report. Short term analysis is done through engine real time, engine gas path limit exceedance, engine stall, engine divergence, engine start, and engine mechanical limit exceedance report. A prehistory of the data is printed or recorded after the report of the exceeded limit. ESA

N87-10083# British Airways, Heathrow (England).
CHOOSING AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) ARCHITECTURE SUITABLE FOR ENGINE HEALTH MONITORING (EHM) ON FUTURE GENERATION ENGINES
D. E. FOXLEY *In* DFVLR Proceedings of the 13 Symposium on Aircraft Integrated Data Systems p 161-176 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Airborne engine monitoring system architectures including air and ground elements are assessed. It is very desirable to perform the analysis function in the airborne computer, but it requires considerable effort to achieve, and it is probably unrealistic to expect an engine manufacturer to provide such a system to a diversity of airlines, many of whom do not wish to utilize it. What is important is that what they provide should not preclude incorporating it in an airborne computer. The approach for the V2500 engine is to provide only an analysis module and a plot module, leaving the airline to embed these into their system, whether it be a mainframe or dedicated one. Important interfaces such as file structure have not yet been defined. Even so, it is clear their system will need a mainframe or large minicomputer to run on, so perhaps the ultimate in transportable software will have to wait for another generation of equipment. ESA

N87-10084# Deutsche Lufthansa A.G., Hamburg (West Germany). Power Plant Engineering Div.
LUFTHANSA'S AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) BASED A-310 ENGINE CONDITION MONITORING SYSTEM: PROGRESS ACHIEVED BETWEEN THE 12TH AND 13TH AIDS SYMPOSIUMS
G. DIENGER *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 177-205 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The A-310 aircraft integrated data system which acquires, monitors, records, and prints data for aircraft/engine condition monitoring and trouble shooting is discussed. The data is fed-in and processed on-line by a comprehensive ground based diagnosis information system. Operational experience based on regular and ad hoc system reports, and development status are described. ESA

N87-10086# Technische Hochschule, Aachen (West Germany). Dept. of Aerospace Engineering.
WIND SHEAR MEASUREMENT ON BOARD A MORANE 893
H. NELLES *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 235-266 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

To investigate wind shear during flight, a pneumatic sensing device was developed and installed on board a single engine light aircraft. The device measures the difference in total pressure between two positions vertically displaced from the airplane. The mass flow rate created by the difference in pressure is measured by a hot-wire probe. The signal of this probe is a function of the wind shear. Results collected by this system compare favorably with those of a ground based sensing system and of a research aircraft. ESA

N87-10087# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Forschungszentrum.
PERFORMANCE MONITORING OF SENSORS IN HIGH RELIABLE FLIGHT CONTROL SYSTEMS USING DETERMINISTIC OBSERVERS
N. STUCKENBERG *In its* Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 261-284 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The output vector of a sensor set used in a flight control system of a transport aircraft was monitored by an observer. Since the observer includes a mathematical model of the aircraft, dynamic deviations in the sensor performance due to failures can be detected. This idea is used in a sensor concept which achieves a high reliability with less sensor hardware than conventional redundancy concepts. Flight test results show the feasibility of the concept under the constraint of disturbances and model inaccuracies. ESA

N87-10088# Flight Data Co., London (England).
THE IMPACT OF FLIGHT DATA ON AN AIRLINE: A CASE STUDY
P. WALLER *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 285-307 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

A medium size airline acquired a flight data recorder playback and analysis facility for three aircraft fleets. The effects on the user department are examined in relation to system accessibility. Analysis program developments resulting from the user becoming more aware of the possibilities are presented. Comparisons between this new user airline and others that have exploited flight recorder data over many years are drawn. ESA

N87-10089# Sundstrand Data Control, Inc., Redmond, Wash. Avionics System Div.
DATA RECOVERY TECHNIQUES, AN UPDATE
G. S. L. BENN *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 309-328 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Innovations in flight data recovery techniques are reviewed. Data presentation methods designed to offer the data specialist rapid acess and greater understanding of data are included. Hardware used to manipulate data, and use of personal computers to access and examine flight recorded information are described. Techniques resulting from improvements in flight and ground hardware and application software are proposed, including the use of artificial intelligence and three dimensional display technology. ESA

N87-10090# Deutsche Lufthansa Aktiengesellschaft, Frankfurt am Main (West Germany). Abteilung Flugbetriebstechnik.
SOFTWARE FOR FLIGHT RECORDER DATA PROCESSING DEVELOPED BY LUFTHANSA
H. A. KAISER *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 329-348 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Computer software to evaluate flight recorder data is described. Software to transcribe raw data to magnetic tape, to perform quality checks of the recorded data, to evaluate selectable parameters and their subsequent graphical display, and to display aircraft movement three dimensionally is available. ESA

N87-10091# Eurocontrol Agency, Brussels (Belgium).
THE AIR/GROUND TRANSFER OF AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) FOR AIR TRAFFIC CONTROL (ATC) PURPOSES: PRESENT EXPERIMENTS AND POSSIBLE FUTURE INTENTIONS
M. E. COX *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 349-372 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Use of SSR Mode S links for air traffic control (ATC) is discussed. Experiments indicate that data derived from aircraft in real time via the Mode S link can be very helpful in ATC related applications, including the enhancement of short-term meteorological forecast data. The work shows that digital aircraft can provide a range of potentially useful parameters that can be accessed via an ARINC 429 data port associated with the flight data acquisition system. It is believed that European ATC system requirements for aircraft data will expand rapidly with the implementation of Mode S, in the mid 1990's. By that date, however, there are likely to be applications which have yet to be evaluated to support dependent surveillance and approach and departure control. There may also be air/ground data channels, e.g., ACARS, ASDAR plus other satellite systems stemming from the PROSAT experiments. ESA

N87-10092# Trans World Airlines, Inc., Kansas City, Mo.
AIRLINE DATA ACQUISITION IN AN ACARS ENVIRONMENT
T. R. DEGNER *In* DFVLR Proceedings of te 13th Symposium on Aircraft Integrated Data Systems p 373-390 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The data acquisition system on TWA aircraft is described. It combines a tape-based system and an ACARS-based system. The tape-based system is plagued by low reliability, large data volume, long delays between events and analysis, and poor flexibility. An ACARS only system will allow removal of the airborne tape recorders and ground tape transmission units. The ACARS-based system allows real-time on-line data collection. This provides the user with a high-integrity system with great flexibility. The system design is being driven by user needs and the expected benefits. ESA

N87-10093# National Transportation Safety Board, Washington, D. C.
FLIGHT RECORDERS: NEW US REGULATIONS AND NEW INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) STANDARDS
C. A. ROBERTS and D. R. GROSSI *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 391-417 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

On January 8, 1985, the U.S. Federal Aviation Administration issued a Notice of Proposed Rulemaking regarding improved flight recorders. It called for: expanded-parameter digital recorders on new air carrier airplanes manufactured 2 yr after the rule is adopted, regardless of the date of original type certificate; digital recorders to replace foil recorders within 2 yr of the rule change, and 5 additional parameters within 7 yr; and voice recorders on certain commuter airplanes. The International Civil Aviation Organization (ICAO) recorder amendments were adopted in March 1985, and became effective on July 29, 1985. The upgraded U.S. recorder requirements and the ICAO amendments are assessed. ESA

N87-10094# Lear Siegler, Inc., Grand Rapids, Mich. Instrument Div.
DATA COMPRESSION TECHNIQUES FOR MULTIFUNCTION FLIGHT DATA RECORDERS
F. SAGGIO, III *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 419-443 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Basic principles of data compression systems are discussed, emphasizing multifunction flight data recording applications. The categorization of data compression methods is discussed, and reversible and irreversible compression techniques are described. Algorithm selection and development, and optimization of data labeling and formatting techniques are considered. Data decompression principles are introduced, and multifunction flight data recording applications which embody data compression techniques are highlighted. By using the spare computing capability of the onboard microprocessor, more functions may be added, or new applications may be possible. ESA

N87-10095# Fairchild Weston Systems, Inc., Sarasota, Fla.
THE FAIRCHILD CVDR: A NEW COMBINATION VOICE AND DATA RECORDER
H. F. NAPFEL and B. J. HAWKINS *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 445-474 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

The Fairchild cockpit voice and data recorder developed to meet the SAE Aerospace Standard 8039 for Type 3 recorders for general aviation is described. It is designed to meet or exceed TSO C-51a and DO160B environment and survivability requirements. It records data and voice simultaneously. Calibration data and time are stored on recording medium for life for later data verification. Microprocessor circuitry provides exceptional flexibility and reliability of data storage. It features automatic test of voice recorder function at power-up and continuous verification of flight data recording function during operation. No manual testing is required. It uses internal GMT for data/voice correlation. The tape stops automatically after detection of nonflying status. It has complete ARINC 542 and ARINC 542 expanded parameter compatibility. It records last 33 min of each flight for voice and data, and last 8 hr of excerpted data for previous flight correlation. ESA

N87-10096# Federal Aviation Administration, Atlantic City, N.J.
THE BOEING B 720 AIRCRAFT CONTROLLED IMPACT DEMONSTRATION (CID): FLIGHT DATA RECORDER/COCKPIT VOICE RECORDER EXPERIMENT
L. J. GARODZ and G. G. LEROY (Lockheed Aircraft Service, Inc., Ontario, Calif.) *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 475-507 Feb. 1986
(Contract DOT/FAA/CT-85/28P)
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

A controlled crash was used to evaluate the adequacy and usefulness of state-of-the-art Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) recorded data in postcrash aircraft accident investigation and analysis, particularly in human factors/crashworthiness. The crash shows a gross design deficiency in TSO-C51a specification, regarding recorder performance when recording data under relatively low g-loads, well within human tolerance limits, which may be experienced in unusual attitude flight. The experiment reveals that sampling rates are too low for certain aircraft performance parameter signals, particularly aircraft linear accelerations and pitch and roll attitude. Either the sampling rates should be increased or the attitude information pitch rate and roll-rate signals should be recorded. It is proved that a separate power supply (battery pack and static inverter) can properly operate an FDAU and three DFDR's even after basic aircraft electrical power is no longer available. ESA

N87-10097# Naval Air Test Center, Patuxent River, Md.
UNITED STATES NAVY - CANADIAN FORCES SOLID STATE FLIGHT DATA RECORDER/CRASH POSITION LOCATOR EXPERIMENT ON THE B-720 CONTROLLED IMPACT DEMONSTRATION
D. M. WATTERS *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 509-530 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

A solid state flight data recorder/crash position locator (SSFDR/CPL) was developed, configured for and crash tested in the FAA/NASA Boeing B-720. The SSFDR/CPL system contains nonvolatile memory and a CPL radio beacon airfoil. The CPL/RBA provides a selectable overt and covert locating capability. The SSFDR/CPL was ejected from the B-720 upon crash and radiated the overt emergency signals for 5 to 10 sec before silenced by a fuel induced short in the transmitter. The SSFDR was subjected to the worst case fuel fire from the crash, but no data were lost. ESA

N87-10098# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
COMPARATIVE EVALUATION OF REDUNDANT FLIGHT DATA RECORDED BY A DIGITAL AIRCRAFT INTEGRATED DATA SYSTEM RECORDER (DAR) ON BOARD AN AIRBUS A-310 AIRCRAFT
O. WEBER and G. ROSENAU *In its* Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 531-567 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

Flight data collected during two A-310 flights by a digital AIDS recorder were analyzed. Sixty-four standard data words and 137 data words which could be selected from the ARINC 429 bus as desired were recorded per second. From a flight-mechanical standpoint, redundant data from different sources are analyzed for take-off, landing, and en route. The characteristics of the standard A-310 AIDS are compared to those of the A-300 AIDS and the potential benefit of additional data to a reliable reconstruction of a flight is shown. The reconstruction of the motion state of the aircraft is more complete than with the older equipment; a completely satisfactory reconstruction of the flying motion, however, is not possible in cases where measured values of the flow angles are required. ESA

N87-10099# Technische Univ., Brunswick (West Germany).
INVESTIGATIONS ON A DIGITAL BIT SYNCHRONIZER FOR A DETAILED FLIGHT DATA RECOVERY
H. D. VONLAUE *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 569-584 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

A flight recorder digital bit synchronizer to process (with cross correlation considering several bits) even distorted signals as occur after aircraft crashes, was developed. Reliability of the recovered bits was measured. Results show that bit synchronization based on correlation permits a more reliable bit recognition in critical cases than previous procedures. One disadvantage of the procedure is the large amount of calculation involved. The hardware developed, however, achieves a processing speed of 20 k baud. ESA

N87-10864*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GROUND-BASED TIME-GUIDANCE ALGORITHM FOR CONTROL OF AIRPLANES IN A TIME-METERED AIR TRAFFIC CONTROL ENVIRONMENT: A PILOTED SIMULATION STUDY
C. E. KNOX and N. IMBERT (Office National d'Etudes et de Recherches Aerospatiales, Toulouse, France) Nov. 1986 36 p (NASA-TP-2616; L-16116; NAS 1.60:2616) Avail: NTIS HC A03/MF A01 CSCL 01D

The rapidly increasing costs of flight operations and the requirement for increased fuel conservation have made it necessary to develop more efficient ways to operate airplanes and to control air traffic for arrivals and departures to the terminal area. One concept of controlling arrival traffic through time metering has been jointly studied and evaluated by NASA and ONERA/CERT in piloted simulation tests. From time errors attained at checkpoints, airspeed and heading commands issued by air traffic control were computed by a time-guidance algorithm for the pilot to follow that would cause the airplane to cross a metering fix at a preassigned time. These tests resulted in the simulated airplane crossing a metering fix with a mean time error of 1.0 sec and a standard deviation of 16.7 sec when the time-metering algorithm was used. With mismodeled winds representing the unknown in wind-aloft forecasts and modeling form, the mean time error attained when crossing the metering fix was increased and the standard deviation remained approximately the same. The subject pilots reported that the airspeed and heading commands computed in the guidance concept were easy to follow and did not increase their work load above normal levels. Author

N87-10865# Air Force Human Resources Lab., Brooks AFB, Tex.
LOW-COST AVIONICS SIMULATION FOR AIRCREW TRAINING Interim Report, Jan. 1984 - Jun. 1985
B. J. EDWARDS Jul. 1986 26 p (AD-A169198; AFHRL-TR-85-38) Avail: NTIS HC A03/MF A01 CSCL 09E

This report documents the evaluation of a low-cost microcomputer based avionics system trainer as a substitute for aircraft-based training. The training was provided to C-141 pilots to train them to perform several procedural tasks associated with the operation of the Fuel Savings Advisory System (FSAS). This system is being retrofitted on C-141 and C5A aircraft. Operational aircrews must be trained to operate the FSAS in order to be mission qualified. This report documents an experiment in which trainees learned to operate the FSAS, either in the aircraft or via the low-cost alternative. Results showed both groups required the same amount of training time to learn to perform the tasks. Thus, the low-cost alternative was shown to be an effective substitute for the aircraft for training the FSAS tasks. A cost analysis comparing the two training methods shows the low-cost trainer is capable of avoiding more than 8 million dollars in training costs if it is employed to train current C-141 and C-5A aircrews in the FSAS tasks. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboa rd auxiliary power plants for aircraft.

A87-10899
NATURAL FREQUENCY ANALYSIS OF COMPRESSOR ROTOR BLADES
S. K. SANE, C. S. GURUJEE, A. R. MALPANI, and C. M. P. FERNANDES (Indian Institute of Technology, Bombay, India) IN: Finite elements in computational mechanics - FEICOM '85; Proceedings of the International Conference, Bombay, India, December 2-6, 1985. Volume 2 . Oxford, Pergamon Press, 1985, p. 645-654. refs

The vibrational response of a transonic compressor rotor blade with a high degree of twist is investigated analytically and experimentally. A first-stage formulation of the blade geometry is derived; FEM analysis is performed using eight-node isoparametric elements, 12-node isoparametric elements, and two modified versions of the helicoidal element of Walker (1978); and the analytical results are compared with values obtained experimentally (by clamping the blade rigidly in a root-clamp block and exciting it electromagnetically) in a table. It is found that the 12-node isoparametric element has the best convergence and gives the most accurate results, whereas the helicoidal elements fail to converge satisfactorily. T.K.

A87-12965#
A TEST RESEARCH FOR IMPROVING THE PERFORMANCE OF V-TYPE FLAMEHOLDER USED IN AN AFTERBURNER
H. TAN and J. WANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Engineering Thermophysics, vol. 7, May 1986, p. 179-181. In Chinese, with abstract in English.

This paper describes the V-type flameholder with gaps used in a jet engine afterburner. It was found from model tests that the recovery coefficient of total pressure increased, the quenching limit for poor fuel was extended, and the combustion efficiency improved. The unit fuel consumption rate decreased about 1 percent under full-scale engine tests. Author

A87-13008#
CONDITION MONITORING OF LARGE COMMERCIAL TURBOFAN ENGINES
B. VAN DE WATER (Qantas Airways, Ltd., Sydney, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 33, 34.

A development history and current status evaluation are presented for large, high bypass turbofan engine condition monitoring techniques that assess compressor erosion and damage, combustor and turbine oxidation, and roller bearing spalling and fatigue. Attention is given to borescopes, magnetic chip detectors, SEM, and vibration monitoring. Effective condition monitoring has been instrumental in the prevention of in-flight failures and the maximization of MTBFs. A tabulation of reasons for major disassembly and heavy maintenance in a major airline's JT9D and RB211 engines over the course of 1984 is presented. O.C.

N87-10085# Philips Zentrallaboratorium G.m.b.H., Hamburg (West Germany).
A SYSTEM THEORETICAL BASED METHOD FOR MODULE FAILURE DIAGNOSTIC OF TURBINE ENGINES
M. ROESNICK *In* DFVLR Proceedings of the 13th Symposium on Aircraft Integrated Data Systems p 207-233 Feb. 1986
Avail: NTIS HC A25/MF A01; DFVLR, Cologne, West Germany, DM 150

A method for module failure diagnostic of turbine engines based on gas path analysis is presented. An effective failure diagnostic of all main modules is possible by a system theoretical based method. The basis of the method is a reduced model, gained by a degree of observability. The application of the state estimation and analytical redundancy guarantees that the failure diagnostic method is applicable even if the measurements are disturbed by random and systematic errors. Simulation results of the JT9D engine are presented. ESA

N87-10100*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RESPONSE OF A SMALL-TURBOSHAFT-ENGINE COMPRESSION SYSTEM TO INLET TEMPERATURE DISTORTION
T. J. BIESIADNY, G. A. KLANN (Army Research and Technology Labs., Cleveland, Ohio.), and J. K. LITTLE Sep. 1984 28 p
(NASA-TM-83765; E-2198; NAS 1.26:83765; USAAVSCOM-TR-84-C-13) Avail: NTIS HC A03/MF A01 CSCL 21E

An experimental investigation was conducted into the response of a small-turboshaft-engine compression system to steady-state and transient inlet temperature distortions. Transient temperature ramps range from less than 100 K/sec to above 610 K/sec and generated instantaneous temperatures to 420 K above ambient. Steady-state temperature distortion levels were limited by the engine hardware temperature list. Simple analysis of the steady-state distortion data indicated that a particle separator at the engine inlet permitted higher levels of temperature distortion before onset of compressor surge than would be expected without the separator. Author

N87-10866*# Lockheed-Georgia Co., Marietta.
PTA TEST BED AIRCRAFT ENGINE INLET MODEL TEST REPORT, REVISED
J. P. HANCOCK May 1985 81 p
(Contract NAS3-24339)
(NASA-CR-174845; NAS 1.26:174845; LG85ER0012-REV) Avail: NTIS HC A05/MF A01 CSCL 21E

The inlet duct test for the Propfan Testbed Assessment (PTA) program was completed in November 1984. The basic test duct was designed using the Lockheed QUADPAN computational code. Test objectives were to experimentally evaluate, modify as required, and eventually verify satisfactory performance as well as duct/engine compatibility. Measured total pressure recovery for the basic duct was 0.993 with no swirl and 0.989 for inflow with a 30 degree simulated swirl angle. This compared to a predicted recovery of 0.979 with no swirl. Measured circumferential distortion with swirl, based on a least-square curve fit of the data, was 0.204 compared to a maximum allowable value of 0.550. Other measured distortion parameters did as well or better relative to their respective maximum allowable values. The basic duct configuration with no refinements is recommended for the PTA inlet as a minimum cost installation. Author

N87-10867# Rolls-Royce Ltd., Derby (England).
FUTURE AERO-ENGINE CONTROL SYSTEMS, WHY FADEC? COST, DESIGN CYCLE TIMESCALE, RELIABILITY, WEIGHT AND SIZE TARGETS
H. F. CANTWELL 14 Feb. 1986 13 p
(PNR-90298; ETN-86-98015) Avail: NTIS HC A02/MF A01

The requirements for a civil aircraft gas turbine control system are summarized. The advantages of full authority digital electronic control over hydromechanical concepts are outlined. ESA

N87-10868# Rolls-Royce Ltd., Derby (England).
ENGINE PERFORMANCE MONITORING FOR AIRLINES
J. A. CHANTRY 6 Mar. 1986 15 p
(PNR-90305; ETN-86-98016) Avail: NTIS HC A02/MF A01

The costs and benefits of engine performance monitoring are recalled. The Rolls Royce engine monitoring system is described. ESA

N87-11200*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AEROTHERMAL MODELING PROGRAM, PHASE 2
E. J. MULARZ *In its* Turbine Engine Hot Section Technology, 1984 4 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 21E

The accuracy and utility of current aerothermal models for gas turbine combustors must be improved. Three areas of concern are identified: improved numerical methods for turbulent viscous recirculating flows; flow interaction; and fuel injector-air swirl characterization. Progress in each area is summarized. B.G.

N87-11207*# General Electric Co., Fairfield, Conn. Aircraft Engine Business Group.
COMPONENT SPECIFIC MODELING
M. L. ROBERTS *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 12 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 21E

Modern jet engine design imposes extremely high loadings and temperatures on hot section components. A series of interdisciplinary modeling and analysis techniques which were specialized to address three specific components (combustor burner liners, hollow air-cooled turbine blades, and air-cooled turbine vanes) were developed and verified. These techniques will incorporate data as well as theoretical methods from many diverse areas, including cycle and performance analysis, heat transfer analysis, linear and nonlinear stress analysis, and mission analysis. Building on the proven techniques already available in these fields, the new methods developed will be integrated to predict temperature, deformation, stress, and strain histories throughout a complete flight mission. B.G.

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A87-10519*# Princeton Univ., N. J.
OPTIMAL FLIGHT PATHS THROUGH MICROBURST WIND PROFILES
R. F. STENGEL (Princeton University, NJ) and M. L. PSIAKI Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 629-635. FAA-supported research. Previously cited in issue 21, p. 3052, Accession no. A85-43872. refs
(Contract NGL-31-001-252)

A87-11369
MANEUVER OPTIMIZATION IN THE CASE OF COMBAT AIRCRAFT [MANOEVEROPTIMIERUNG VON KAMPFFLUGZEUGEN]
E. BERGER, W. GRIMM, P. HILTMANN, K. MORITZ, and K. WELL (DFVLR, Institut fuer Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), July 1986, p. 16-19. In German.

Digital and manned air combat simulation studies have shown that pilots have not enough time to concentrate on essential decisions, because the various tasks related to target detection, target recognition, and weapon and aircraft control demand too much of their attention. The present article is concerned with the possibility to help the pilot on the basis of the calculation of optimal

or suboptimal real-time control operations, taking into account the feasibility of an employment in a scenario simulation performed with the aid of an onboard computer. It has been found that the calculations involved in the determination of the precise optimal solutions require often too much time. For this reason, use is made of approximate and suboptimal solutions. Attention is given to two approaches which require a system reduction procedure, time-minimal and range-maximal trajectories in the vertical plane, a three-dimensional mission involving the interception of a target in minimal time, and pursuit and escape maneuvers in the case of two aircraft equipped with missiles. G.R.

A87-12082
NON-LINEAR STABILITY ANALYSIS OF AIRCRAFT AT HIGH ANGLES OF ATTACK
N. SRI NAMACHCHIVAYA (Illinois, University, Urbana) and S. T. ARIARATNAM (Waterloo, University, Canada) International Journal of Non-Linear Mechanics (ISSN 0020-7462), vol. 21, no. 3, 1986, p. 217-228. refs

The pitching motion of an aircraft in steady flight at a high angle of attack is investigated analytically in the framework of nonlinear stability theory. The approximations adopted by Hui and Tobak (1984) are applied, but the method of averages is used instead of the Fredholm-alternative approach. Both Hopf and degenerate Hopf (DH) bifurcations are predicted, and two periodic DH paths with different frequencies are identified and characterized. The DH paths are found to be either both stable or both unstable. Numerical results are presented in graphs for the DH regime of both flat-plate and double-wedge airfoils, and the bifurcating periodic motion in the double-wedge case is shown to be unstable. T.K.

A87-12268
THE LATERAL DYNAMIC STABILITY AND CONTROL OF A LARGE RECEIVER AIRCRAFT DURING AIR-TO-AIR REFUELLING
A. W. BLOY, P. J. LAMONT, H. A. ABU-ASSAF, and K. A. M. ALI (Manchester, Victoria University, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, June-July 1986, p. 237-243. refs

The lateral dynamic stability and control of a large receiver aircraft was considered during air-to-air refuelling. A simple aerodynamic model was developed in order to determine the aerodynamic forces and moments acting on the receiver aircraft due to the tanker aircraft's vortex field. These forces and moments were then expressed in derivative form and included in the linearized equations of motion. Solution of these equations revealed a divergent oscillation, characteristic of air-to-air refueling and consisting mainly of bank and sideways displacements. An approximation to this mode, which highlights two important aerodynamic derivatives was made. The values of these derivatives depend mainly on the vertical separation between the tanker and receiver aircraft and the ratio of the tanker-to-receiver aircraft wing spans. In flight, it appears that the pilot controls the divergent mode by frequent alternate movements of the ailerons. Author

N87-10102*# Textron, Inc., Irvine, Calif.
TECHNOLOGY REVIEW OF FLIGHT CRUCIAL FLIGHT CONTROL SYSTEMS (APPLICATION OF OPTICAL TECHNOLOGY)
H. A. REDIESS and E. C. BUCKLEY Sep. 1984 48 p
(Contract NAS1-17403)
(NASA-CR-172332; NAS 1.26:172332) Avail: NTIS HC A03/MF A01 CSCL 01C

The survery covers the various optical elements that are considered in a fly-by-light flight control system including optical sensors and transducers, optical data links, so-called optical actuators, and optical/electro-optical processing. It also addresses airframe installation, maintenance, and repair issues. Rather than an in-depth treatment of optical technology, the survey concentrates on technology readiness and the potential advantages/disadvantages of applying the technology. The information was assembeld from open literature, personal interviews, and responses to a questionnaire distributed specifically for this survey. Not all of the information obtained was consistent, particularly with respect to technology readiness. The synthesis of information into the perception of the state-of-technology is presented. Author

N87-10103*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
IN-FLIGHT TOTAL FORCES, MOMENTS AND STATIC AEROELASTIC CHARACTERISTICS OF AN OBLIQUE-WING RESEARCH AIRPLANE
R. E. CURRY and A. G. SIM Oct. 1984 30 p
(NASA-TP-2224; H-1181; NAS 1.60:2224) Avail: NTIS HC A03/MF A01 CSCL 01C

A low-speed flight investigation has provided total force and moment coefficients and aeroelastic effects for the AD-1 oblique-wing research airplane. The results were interpreted and compared with predictions that were based on wind tunnel data. An assessment has been made of the aeroelastic wing bending design criteria. Lateral-directional trim requirements caused by asymmetry were determined. At angles of attack near stall, flow visualization indicated viscous flow separation and spanwise vortex flow. These effects were also apparent in the force and moment data. Author

N87-10870*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTERFERENCE EFFECTS OF THRUST REVERSING ON HORIZONTAL TAIL EFFECTIVENESS OF TWIN-ENGINE FIGHTER AIRCRAFT AT MACH NUMBERS FROM 0.15 TO 0.90
F. J. CAPONE and M. L. MASON Oct. 1984 104 p
(NASA-TP-2350; L-15811; NAS 1.60:2350) Avail: NTIS HC A06/MF A01 CSCL 01C

An investigation was conducted in the Langley 16 foot Transonic Tunnel to determine the interference effects of thrust reversing on horizontal tail effectiveness of a twin engine, general research fighter model at approach and in-flight speeds. Twin vertical tails at three longitudinal locations were tested at a cant angle of 0 deg. One configuration was also tested at a cant angle of 20 deg. Two nonaxisymmetric nozzle reverser concepts were studied. Test data were obtained at Mach numbers of 0.15, 0.60, and 0.90 and at angles of attack from -3 to 9 deg. Nozzle pressure ratios varied from jet off to 7.0, depending upon Mach number. At landing approach speed (Mach number 0.15), thrust reverser operation usually resulted in large variations (up to 70% increase) in horizontal tail effectiveness as nozzle pressure ratio was varied at zero angle of attack or as angle of attack was varied at constant nozzle pressure ratio. There was always a decrease in effectiveness at Mach numbers of 0.60 and 0.90 as a result of reverser operation. Author

N87-10871*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT-DETERMINED AERODYNAMIC DERIVATIVES OF THE AD-1 OBLIQUE-WING RESEARCH AIRPLANE
A. G. SIM and R. E. CURRY Oct. 1984 40 p
(NASA-TP-2222; H-1179; NAS 1.60:2222) Avail: NTIS HC A03/MF A01 CSCL 01C

The AD-1 is a variable-sweep oblique-wing research airplane that exhibits unconventional stability and control characteristics. In this report, flight-determined and predicted stability and control derivatives for the AD-1 airplane are compared. The predictions are based on both wind tunnel and computational results. A final best estimate of derivatives is presented. Author

N87-10872# Societe Nationale Industrielle Aerospatiale, Toulouse (France). Div. Avions.
EFFICIENCY OF VARIOUS CONTROL SURFACES IN STEADY AND UNSTEADY FLOW
R. BARREAU, R. DESTUYNDER, and G. ANDERS 2 Sep. 1985 71 p In FRENCH Presented at 61st AGARD Meeting on Structures and Materials Panel Subcommittee on Aeroelasticity, Oberammergau, West Germany, 9 Sep. 1985 Original language document was announced as A86-24633
(SNIAS-861-111-101; JBE/SB-443.524/85; ETN-86-97139)
Avail: NTIS HC A04/MF A01

The three dimensional subsonic and transonic flow steady and unsteady effects associated with the action of control surfaces (ailerons, flaps and spoilers) were studied experimentally to improve the efficiency of aircraft control design. Large models provided with a large number of measuring points were tested in a wind tunnel. It is shown that the design of control surfaces applied to supercritical wings requires precautions. ESA

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RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

A87-12585
TRANSFORMATION OF A PLANE UNIFORM SHOCK INTO CYLINDRICAL OR SPHERICAL UNIFORM SHOCK BY WALL SHAPING
Y. SAILLARD, H. BARBRY, and C. MOUNIER (CEA, Villeneuve-Saint-Georges, France) IN: Shock waves and shock tubes; Proceedings of the Fifteenth International Symposium, Berkeley, CA, July 28-August 2, 1985 . Stanford, CA, Stanford University Press, 1986, p. 147-153. refs

A theoretical method is presented for the calculation of the wall shape of a shock tube, which changes an initial plane shock of uniform strength into a cylindrical or spherical shock of uniform strength in some solid angle and without Mach reflections. This method uses Whitham's theory of shocks in characteristic form. It has been numerically treated and gives the complete shock evolution during its propagation into the convergent section of the shock tube. The nozzle geometry and shock amplifications theoretically expected are indicated and one sample of numerical results is given. Author

A87-12646
HIGH TEMPERATURE HEAT TRANSFER FOR GAS TURBINES USING SHOCK TUBES
H. T. NAGAMATSU and R. E. DUFFY (Rensselaer Polytechnic Institute, Troy, NY) IN: Shock waves and shock tubes; Proceedings of the Fifteenth International Symposium, Berkeley, CA, July 28-August 2, 1985 . Stanford, CA, Stanford University Press, 1986, p. 901-908. refs

External local heat transfer rates were measured at the stagnation region for circular cylinders, over a flat plate with and without a pressure gradient, and in the junction region of a flat plate and circular cylinder mounted normal to the plate over a temperature range of 350 and 2500 K and various Reynolds and Mach numbers anticipated in advanced gas turbines. Thin film platinum heat gages were used to measure the local heat flux for laminar, transition and turbulent boundary layers. Hot wires were used to measure the turbulence level after the incident and reflected shock waves in the test section. The experimental heat flux data were correlated with the laminar and turbulent theories and the transition phenomenon was examined. Author

N87-10104# National Aeronautical Lab., Bangalore (India). Aerodynamics Div.
TUNNEL INTERFERENCE FROM PRESSURE MEASUREMENTS ON CONTROL SURFACES
R. GOPINATH Aug. 1983 27 p
(AE-TM-8-83) Avail: NTIS HC A03/MF A01

Interference due to tunnel walls has been evaluated from pressure measurements on control surfaces by a method due to Capelier, Chevallier and Bouniod, using a simple exponential type of decay for extrapolating the pressure coefficients beyond the measurement stations to + or - infinity, respectively. The method has been validated against data presented at an AGARD meeting on Transonic Test Sections at NASA Langley, which discussed the merits of the various methods for evaluating the wall interference from pressure measurements. Author

N87-10874 British Aerospace Aircraft Group, Warton (England). Wind Tunnel Dept.
PRACTICAL EVALUATION OF WALL PRESSURE SIGNATURE CORRECTION METHODS IN THE 2.7M X 2.1M LOW SPEED WIND TUNNEL
J. G. PROCTOR Jan. 1986 69 p
(BAE-ARG-204; ETN-86-97943) Avail: Issuing Activity

The chart and matrix methods of using wind tunnel wall static pressure distribution to calculate blockage and lift effects were assessed using pressure rails in a low speed wind tunnel. The use of tapped rails for pressure measurement proves suitable. Overall sampling rate is slow. Corrections for two larger flat plates agree well with published data. Conventional techniques are, however, as good. Compared to the standard, aircraft-model blockage corrections are lower than expected, possibly due to experimental technique. Incidence correction due to lift effect does not agree well with current methods, and care must be taken in the selection of singularity span. The methods cannot be considered as a viable replacement for current techniques. The results for the aircraft model at high incidence are disappointing, and the cause is not identified. ESA

N87-10875 British Aerospace Aircraft Group, Bristol (England). Civil Div.
PROP-FAN SLIPSTREAM EFFECTS USING STATIC SIMULATORS: LOW SPEED TASK, PHASE 1 Final Report
A. C. WILLMES 5 Jul. 1985 49 p
(BAE-B59R/R-D/610/13498; RA/6/16/85; ETN-86-97944)
Avail: Issuing Activity

A device to produce a 14 inch diameter simulated prop fan slipstream was built and tested in a low speed wind tunnel. Tests were carried out with the simulator in front of a Vanguard model and an A320 model. Both models were tested with high lift systems deployed. Separate and combined effects of slipstream swirl and supervelocity components were investigated. The technique is considered to be established. Data for swept and straight wing aircraft at a variety of flap configurations is available. ESA

N87-10876*# National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICAL FACILITIES ASSESSMENT
F. E. PANARANDA, comp. Nov. 1985 204 p
(NASA-RP-1146; NAS 1.61:1146) Avail: NTIS HC A10/MF A01
CSCL 14B

A survey of the free world's aeronautical facilities was undertaken and an evaluation made on where the relative strengths and weaknesses exist. Special emphasis is given to NASA's own capabilities and needs. The types of facilities surveyed are: Wind Tunnels; Airbreathing Propulsion Facilities; and Flight Simulators Author

N87-10878# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Entwurfsaerodynamik.
THE HIGH SPEED CASCADE WIND TUNNEL: STILL AN IMPORTANT TEST FACILITY FOR INVESTIGATIONS ON TURBOMACHINERY BLADES
H. HOHEISEL Mar. 1986 36 p In GERMAN; ENGLISH summary
(DFVLR-MITT-86-11; ISSN-0176-7739; ETN-86-98179) Avail: NTIS HC A03/MF A01; DFVLR, Cologne, West Germany DM 14

The importance of the high speed cascade wind tunnel was demonstrated. Starting from the conception of this wind tunnel and the requirements for cascade wind tunnels in which compressible flows have to be studied, the usability and qualification of this test facility for research work is described with examples of turbine and compressor cascade investigations. Necessary additional equipment is discussed. ESA

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications; spacecraft communications; command and tracking; spacecraftdesign; testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

N87-10169*# Energy Science Labs., Inc., San Diego, Calif.
GUIDEBOOK FOR ANALYSIS OF TETHER APPLICATIONS Final Report
J. A. CARROLL Mar. 1985 47 p
(Contract NAS8-35499)
(NASA-CR-178904; NAS 1.26:178904) Avail: NTIS HC A03/MF A01 CSCL 22A

This guidebook is intended as a tool to facilitate initial analyses of proposed tether applications in space. The guiding philosophy is that a brief analysis of all the common problem areas is far more useful than a detailed study in any one area. Such analyses can minimize the waste of resources on elegant but fatally flawed concepts, and can identify the areas where more effort is needed on concepts which do survive the initial analyses. The simplified formulas, approximations, and analytical tools included should be used only for preliminary analyses. For detailed analyses, the references with each topic and in the bibliography may be useful. B.G.

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

A87-10294
COMPOSITE MATERIALS FOR AIRCRAFT STRUCTURES
B. C. HOSKIN, ED. and A. A. BAKER, ED. (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) New York, American Institute of Aeronautics and Astronautics, Inc., 1986, 245 p. No individual items are abstracted in this volume.

The use of composite materials for aircraft structural and aeronautical applications is examined. The basic theory of fiber reinforcements, and the physical and mechanical properties of composite and resin systems are described. The component forms and manufacturing procedures for composites, the basic theory for composite structural analysis, and the use of adhesively bonded and mechanically fastened joints are considered. The effects of environmental factors on the composites' durability, the damage tolerance of fiber composite laminates, nondestructive and repair procedures, aircraft applications, and airworthiness considerations are discussed. I.F.

A87-10859
FLAMMABILITY AND SENSITIVITY OF MATERIALS IN OXYGEN-ENRICHED ATMOSPHERES; PROCEEDINGS OF THE SYMPOSIUM, WASHINGTON, DC, APRIL 23, 24, 1985. VOLUME 2
M. A. BENNING, ED. (Air Products and Chemicals, Inc., Allentown, PA) Symposium sponsored by ASTM. Philadelphia, PA, American Society for Testing and Materials , 1986, 243 p. For individual items see A87-10860 to A87-10867.

Papers concerned with the design and operation of oxygen systems are presented. Emphasis is given to the ignition of metals and alloys by high-velocity particles; the ignition of metals and alloys in gaseous oxygen by frictional heating; a model of metal ignition which includes the effect of oxide generation; the calculation of ignition and combustion temperatures using laser heating; and the use of the accelerating rate calorimeter in oxygen compatibility testing. Topics treated include the behavior of fire spreading along high-temperature mild steel and aluminum cylinders in oxygen; the burn propagation rates of metals and alloys in gaseous oxygen; the flammability of carbon steel determined by pressurized oxygen index measurements; and the RAAF P3B Orion aircraft ground oxygen fire incident. Also discussed are cleaning methods and procedures for military oxygen equipment, the threshold sensitivities of tests to detect oil film contamination in oxygen equipment; a new detector system that enables fully instrumental operation of oxygen reciprocating compressors; and quantitative low-tech measurement of fluid nonvolatile residue. I.F.

A87-11372
PROPERTIES AND PROCESSING OF FIBER-REINFORCED POLYETHERETHERKETONE (PEEK) [EIGENSCHAFTEN UND VERARBEITUNG VON FASERVERSTAERKTEM POLYETHERETHERKETON /PEEK/]
G. KEMPE (DFVLR, Institut fuer Bauweisen- und Konstruktionsforschung, Stuttgart, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), July 1986, p. 29-33. In German.

The employment of composite structural components is steadily increasing in aircraft construction. Studies have been conducted with the objective to use for such applications also thermoplastic materials. The best results with respect to resistance against higher temperatures and chemicals have been obtained with carbon-fiber-reinforced PEEK. The characteristics of this material were investigated, taking into account also suitable processing approaches. Attention is given to a DSC (Differential Scanning Calorimetry) diagram, the advantages of a processing temperature in the temperature range from 383 to 400 C, a study of the effects of temperature and time, various types of bending tests, fracture energy relations, the advantages of carbon fiber (CF) PEEK compared to CF epoxy, and details regarding proposed manufacturing procedures. G.R.

A87-11791
AERONAUTICAL MANUFACTURERS REQUIREMENTS FOR NEW MATERIALS
G. HILAIRE (Aerospatiale, Laboratoire Central, Suresnes, France) Materiaux et Techniques (ISSN 0032-6895), vol. 74, May-June 1986, p. 213-217. In English and French.

Fuel price increases over the past decade have encouraged aircraft manufacturers to increase flight efficiency through improvements in the engines, aerodynamics or material weight. For weight savings, the primary candidate materials for airframe manufacturers are light alloys such as Al-Li and organic matrix composites such as CFRP. Utilization of a new material requires a database on the static strength, fatigue strength, toughness, corrosion and shock resistance, and electrical properties.

Processing techniques must be developed and perfected with regards to quality control and cost. The latter is evaluated in terms of material expenditures, processing expenses, the opportunities to eliminate waste, and ensuring that the use of the material is appropriate. M.S.K.

A87-11844
NICKEL COATED GRAPHITE FIBER CONDUCTIVE COMPOSITES
R. E. EVANS, D. E. HALL, and B. A. LUXON (American Cyanamid Co., Chemical Research Div., Stamford, CT) SAMPE Quarterly (ISSN 0036-0821), vol. 17, July 1986, p. 18-26. refs

Nickel Coated Graphite (NCG) fiber, consisting of a thin continuous plating of high purity nickel over an aerospace-grade graphite core, offers 'performance added' features by combining the light weight and high structural reinforcement of graphite fiber with the thermal and electrical conductivity of nickel. These NCG filaments, which are composite constructions in their own right, can be processed and impregnated with thermosetting or thermoplastic resins in the same manner that graphite fiber tows are processed and impregnated to produce roving, tape or fabric prepreg. Therefore, NCG fibers can be readily integrated into structural laminate assemblies using established composites manufacturing practices. Author

A87-12096#
SUPERPLASTICITY IN AEROENGINE TITANIUM ALLOY VT-9 AND ITS MODIFIED COMPOSITIONS
A. DUTTA and N. C. BIRLA (Defence Metallurgical Research Laboratory, Hyderabad, India) Defence Science Journal (ISSN 0011-748X), vol. 36, April 1986, p. 179-190. refs

The alloy (Ti-6.5Al-3.3 Mo-1.6Zr-0.3Si) is a Soviet composition designated VT-9. The excellent superplastic characteristics found in this alloy prompted the exploration of the possible use of Si-free VT-9 in sheet form for superplastic forming. An optimum thermomechanical processing produced a microstructure that resulted in an elongation of 1700 percent at a fairly high deformation rate (.002/sec). Thus, the same aeroengine alloy (VT-9) can be used for superplastically formed airframe parts in the Si-free condition. The present study also shows that for making the forming process commercially viable, deformation temperature could be lowered by temporarily alloying with hydrogen in a particular concentration range (0.1 to 0.2 wt pct). Author

A87-12647* National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.
FIBER-REINFORCED SUPERALLOY COMPOSITES PROVIDE AN ADDED PERFORMANCE EDGE
D. W. PETRASEK (NASA, Lewis Research Center, Cleveland, OH), D. L. MCDANIELS, L. J. WESTFALL, and J. R. STEPHENS Metal Progress (ISSN 0026-0665), Aug. 1986, 5 p.

Fiber reinforcements are being explored as a means to increasing the performance of superalloys past 980 C. Fiber-reinforced superalloys (FRS), particularly tungsten FRS (TFRS) are candidate materials for rocket-engine turbopump blades for advanced Shuttle engines and in airbreathing and other rocket engines. Refractory metal wires are the reinforcement of choice due to tolerance to fiber/matrix interactions. W alloy fibers have a maximum tensile strength of 2165 MPa at 1095 C and a 100 hr creep rupture strength at stresses up to 1400 MPa. A TFRS has the potential of a service temperature 110 C over the strongest superalloy. Manufacturing processes being evaluated to realize the FRS components are summarized, together with design features which will be introduced in turbine blades to take advantage of the FRS materials and to extend their surface life. M.S.K.

A87-12651
PROGRESS IN ADVANCED MATERIALS AND PROCESSES: DURABILITY, RELIABILITY AND QUALITY CONTROL; PROCEEDINGS OF THE SIXTH INTERNATIONAL EUROPEAN SAMPE CONFERENCE, SCHEVENINGEN, NETHERLANDS, MAY 28-30, 1985
G. BARTELDS, ED. (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) and R. J. SCHLIEKELMANN, ED. Conference sponsored by SAMPE, Ciba-Giegy, Hercules, Inc., Ministry of Economic Affairs of the Netherlands, et al. Amsterdam and New York, Elsevier (Materials Science Monographs. Volume 29), 1985, 319 p. (For individual items see A87-12652 to A87-12667.

Papers are presented on improvements in quality control methods for advanced materials; certification for composite airplane structures; the uses of the aramide aluminum laminate; the adhesion of Al joints; in-service environmental effects on carbon fiber composite material; and durability airplane paint schemes. Topics discussed include the tensile characteristics of coreless silicon carbide fiber; an improved aramid fiber for aerospace applications; the correlation between microscopic properties of interface and mechanical performance of epoxy-carbon composites; the development of a toughened bismaleimide resin; and advances in toughness of structural composites based on interleaf technology. Consideration is given to a two-stage tape placement system; gasoline engine components; Ariane 4 and composites; and advances in the resin injection process. Also discussed are the glass transition temperature for carbon fiber-reinforced materials; the applications of holographic NDT; the influence of artificial aging and prestrain on the corrosion behavior of a high strength Al alloy; high temperature thermoplastic foam; ultra-high modulus composite materials; and the absolute properties of thermosets during cure. I.F.

A87-12652
CERTIFICATION PROBLEMS FOR COMPOSITE AIRPLANE STRUCTURES
D. CHAUMETTE (Avions Marcel Dassault-Breguet Aviation, Saint-Cloud, France) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 19-28.

Basic regulations for fighter and civil transport composite aircraft structures are examined. The development of the regulations for composite material airframes is discussed. The sensitivity of composites to low energy impact damages and the existence of 'no growth' types damages in composites are analyzed; consideration is given to a correlation between inspection intervals and residual strength of the composite structures. The role of static tests in the designing of composite structures is described. It is determined that there is a need to evaluate the 5-8 percent scatter that occurs in the static tests in order to design the most reliable composite structures. I.F.

A87-12659
IN-SERVICE ENVIRONMENTAL EFFECTS ON CARBON FIBRE COMPOSITE MATERIAL
L. A. JONES (British Aerospace, PLC, Future Projects Dept., Hatfield, England) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 103-114.

The effects of long periods of airline service on carbon fiber composite (CFC) skinned flap deflector plates and CFC tailplane bullet fairing access panels are analyzed. The composition and manufacturing of the flap deflector plate made with CFC skins bonded to an Al alloy substructure and the bullet fairing access panel composed of a skin, a frame, and a reinforcing angle are described. Preflight and post-flight component, and rail and lap shear tests were conducted. The effect of moisture on the components is examined. It is observed that the deflector plates

failed as a result of shear induced by torsion on the component, which was initiated by delamination of skins at trailing edges, and the access panels failed due to an attachment bolt pulling through the skin. It is noted that the degradation in properties are more significant when the resin not the fiber is predominant, and there is no indication of increasing degradation with length of time in service. I.F.

A87-12660
IMPROVED DURABILITY AIRLINE PAINT SCHEMES
R. W. BLACKFORD (Imperial Chemical Industries, PLC, London, England) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 115-124.

Methods for improving the durability of polyurethane finishes are analyzed. The effects of cleaners, polishes, and paint formulation on airliner operating conditions are examined. The mechanism which causes surface degradation of polyurethane finishes under weathering conditions is described. Changes in appearance caused by resin breakdown are considered and modifications to the polyurethane surface which will reduce surface degradation are proposed. The use of cleaners/polishes which contain abrasive and polymeric materials to clean the aircraft surface is discussed. I.F.

A87-12661
ADVANCES IN TOUGHNESS OF STRUCTURAL COMPOSITES BASED ON INTERLEAF TECHNOLOGY
R. B. KRIEGER, JR. (American Cyanamid Co., Engineering Materials Dept., Havre de Grace, MD) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 189-199.

The use of interleaf technology to improve the toughness of structural composites is examined. Compression after impact and hot-wet compression tests were applied to quasi-isotropic laminates in order to evaluate toughness. Impact failure modes in epoxy formulations are studied. It is observed that the low resin content in composites produces thin resin bonds between plies resulting in thin stiff bonds; the addition of a tough resin interleaf (CYCOM HST-7) between each ply of the composite eliminates the thin stiff bonds and enhances the composite toughness. The critical parameters for the CYCOM HST-7 are a 41 percent resin content and on ultimate strength of 66,000 psi compression at 200 F. The weight saving possible with the interleaf is evaluated and compared with Al, and it is detected that the CYCOM HST-7 proviides a 45 percent weight advantage over Al in the hot-wet compression. I.F.

A87-12667
DEVELOPMENT OF A TOUGHENED BISMALEIMIDE RESIN PREPREG FOR CARBON FIBER COMPOSITES
P. A. STEINER, M. BLAIR, G. GONG, J. MCKILLEN, and J. BROWNE (Hysol Grafil Co., Pittsburgh, CA) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 297-308. refs

A toughened bismaleimide resin, LR 100-740, which can be used in dry environments up to 260 C and humid environments up to 177 C, can be autoclave cured at a temperature of 179 C under a pressure of .59 MPa, and has improved fracture toughness for use in aircraft structures is developed. The resin modulus, flexural mode, tan delta, and viscosity of the LR 100-740 resin were evaluated. The resin is applied to Grafil high strain XA-S carbon fibers and Grafil intermediate modulus Apollo IM carbon fibers. The low resin content (30 percent) required for development of the prepregs and the maintenance of tack allow the use of bleeder free cure procedures for the formation of the prepregs. The mechanical and physical properties of the two prepregs are examined. Various procedures for during laminates are evaluated. The effects of moisture and high temperature on the composites are investigated. It is observed that the prepregs are useful at 177 and 232 C for a long-time period and at 260 C for a short time. I.F.

A87-12882
FRACTOGRAPHIC ASPECTS OF THE CYCLIC FRACTURE TOUGHNESS OF 35KHN3MFA STEEL IN VACUUM, AIR, AND HYDROGEN [FRAKTOGRAFICHESKIE ASPEKTY TSIKLICHESKOI TRESHINOSTOIKOSTI STALI 35KHN3MFA V VAKUUME, VOZDUKHE I VODORODE]
IU. V. ZIMA and L. IU. KOZAK (AN USSR, Fiziko-Mekhanicheskii Institut, Lvov, Ukrainian SSR) Fiziko-Khimicheskaia Mekhanika Materialov (ISSN 0430-6252), vol. 22, May-June 1986, p. 50-58. In Russian. refs

The microscopic characteristics of fatigue crack growth in a rotor steel, 35Kh3MFA, in vacuum, air, and hydrogen are investigated using a scanning electron microscope. In particular, the formation of fatigue striations is examined in relation to the crack closure effect, and it is shown that there is no exact correlation between the two phenomena. It is suggested that the formation of striations is largely determined by structural sensitivity of crack closure, while the modifying effect of the medium depends on its nature and physicochemical parameters. V.L.

A87-12901
A METHOD FOR CALCULATING THE SUSCEPTIBILITY OF JET FUELS TO SMOKING [RASCHETNYI METOD OTSENKI SKLONNOSTI REAKTIVNYKH TOPLIV K DYMLENIIU]
A. F. FINASHOV and N. F. DUBOVKIN Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 7, 1986, p. 38, 39. In Russian.

A method for calculating the susceptibility of jet fuels to smoking is developed on the basis of the assumption that this property is determined mainly by the elemental and group hydrocarbon composition, density, and viscosity of the fuel. This assumption is verified experimentally for several hydrocarbon fuels using a model combustion chamber of a gas turbine engine, and an empirical formula for determining the degree of smoking is obtained. It is shown that the calculated results agree with experimental data to within 10-25 percent, depending on the excess air ratio, with a confidence level of 0.95. V.L.

A87-12902
THICKENED OILS [ZAGUSHCHENNYE MASLA]
A. I. AKHMEDOV, S. N. RUSTAMOVA, and N. D. ISMAILOVA (AN ASSR, Institut Khimii Prisadok, Baku, Azerbaidzhan SSR) Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 7, 1986, p. 43-45. In Russian. refs

The properties of thickened oils currently used for automobile, tractor, ship, and aircraft engines are briefly reviewed, as are some new thickening additives. The new thickeners are mostly copolymers of isobutylene and alkyl methacrylates with stabilizing comonomers (vinylaromatic and carbocyclic compounds). It is emphasized that the high viscosity index of thickened oils must be combined with good low-temperature properties. Some of the thickened oils reviewed allow cold starts at temperatures as low as -35 C. V.L.

A87-12928
ALUMINA-COCRALY MATERIAL AS AN IMPROVED INTERMEDIATE LAYER FOR GRADED CERAMIC GAS-PATH SEALING IN AEROTURBINE ENGINES
H. E. EATON and R. C. NOVAK (United Technologies Research Center, East Hartford, CT) Ceramic Engineering and Science Proceedings (ISSN 0196-6219), vol. 7, July-Aug. 1986, p. 727-736.
(Contract F33615-83-C-5026)

Ceramic gas-path sealing is being used as shrouding in the turbine section of aircraft gas turbine engines to increase efficiency and performance. A graded design overcomes the thermal expansion mismatch between the metallic substrate and the

abradable/thermally insulating ceamic top layer. Stabilized zirconia is the top layer material of choice due to its high temperature capability, and zirconia-metallics are used for the intermediate layer compositions. An alumina-metallic intermediate layer composition has been demonstrated to have improved stability in comparison to the zirconia based system. Author

A87-12971#
TESTING OF FE-CU-BASE ABLATIVE COMPOSITES. II [BADANIE KOMPOZYTOW ABLACYJNYCH NA OSNOWIE FE-CU. II]
R. KROL Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 41, March 1986, p. 5-7. In Polish. refs

The in-flight thermal loading of rocket and aircraft components employing ablative materials is examined. The ablation phenomenon is defined, and examples of ablative materials are given. Test results on an Fe-Cu-base ablative composite are discussed. A method for calculating the specimen-wall temperature distribution, the pressure required for liquid-metal flow, and the efficiency of heat absorption by the composite in the ablation process is described. B.J.

A87-13009#
NEW MATERIALS IN GAS TURBINE TECHNOLOGY
G. R. JOHNSTON (Department of Defence, Materials Research Laboratories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 35-38. refs

The present evaluation of materials developed for use in gas turbines places emphasis on novel, next-generation materials applicable to state-of-the-art engines. Attention is given to the results of engine trials conducted by Australia's Defense Science and Technology Organization to assess manufacturer-specified protective coatings on first stage, high pressure turbine blades. Comparisons are made between these data and those for commercially available coatings in the same engines. Recommendations for changes in coatings are made on the basis of these comparison results. O.C.

A87-13010#
ADVANCED FIBRE COMPOSITES AND OTHER NEW MATERIALS FOR AIRFRAME APPLICATIONS
A. A. BAKER (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 39-43. refs

The present development status evaluation for high performance composite materials applicable to airframe structures gives emphasis to state-of-the-art graphite-reinforced epoxy matrix composites, which currently dominate the field. Composite primary structure property impacts on weight, acquisition and maintenance costs, and aerodynamic performance, are noted. Comparisons are made with the performance levels and high temperature characteristics promised by metal-matrix composites and advanced metallic alloy systems. Application of these materials in sporting goods and vehicles are also assessed. O.C.

N87-10180# British Aerospace Aircraft Group, Weybridge (England).
INVESTIGATION INTO THE ATTENUATION AND VELOCITY OF ACOUSTIC EMISSIONS IN CARBON FIBER COMPOSITE AIRCRAFT STRUCTURES
R. F. C. HALL Sep. 1985 99 p
(Contract A93B/1362)
(BAE-KGT-R-GEN-01349; BR97843; ETN-86-97947) Avail: NTIS HC A05/MF A01

The attenuation and propagation velocity of acoustic emission signals in carbon fiber composite honeycomb, monolithic multispar, and integral stringer type constructions were investigated. Very high attenuations are found. Variations in velocity depend on ply orientation, and the substructure arrangement. Metal substructures reduce the measured velocity compared with carbon fiber substructures. Studies which introduced a pointed brass probe used as a source of simulated emission result in a considerable decrease in the overall velocities measured. This phenomenon applies particularly to the flat plate specimens and, to a lesser extent, to the honeycomb type of structure. ESA

N87-10182*# Sikorsky Aircraft, Stratford, Conn.
FLIGHT SERVICE EVALUATION OF COMPOSITE HELICOPTER COMPONENTS Annual Report, Oct. 1983 - Dec. 1985
G. H. MARDOIAN and M. B. EZZO Sep. 1986 66 p
(NASA-CR-178149; NAS 1.26:178149; SER-510237; AR-3)
Avail: NTIS HC A04/MF A01 CSCL 11D

This report presents an assessment of composite helicopter tail rotor spars and horizontal stabilizers, exposed to the effects of the environment, after up to five and a half years of commercial service. This evaluation is supported by test results of helicopter components and panels which have been exposed to outdoor environmental effects since September 1979. Full scale static and fatigue tests have been conducted on graphite/epoxy and Kevlar/epoxy composite components obtained from Sikorsky Model S-76 helicopters in commercial operations in the Gulf Coast region of Louisiana. Small scale static and fatigue tests are being conducted on coupons obtained from panels under exposure to outdoor conditions in Stratford, Connecticut and West Palm, Florida. The panel layups are representative of the S-76 components. Additionally, this report discusses the results of moisture absorption evaluations and strength tests on the S-76 components and composite panels with up to five years of outdoor exposure.
Author

N87-10209# Products Research and Chemical Corp., Glendale, Calif. Research and Development Lab.
POLYMER SYSTEMS FOR RAPID SEALING OF AIRCRAFT STRUCTURES AT LOW TEMPERATURE Final Report, Sep. 1981 - Aug. 1983
L. MORRIS, M. WILLIAMS, and N. CHAMPLIN 1 Nov. 1985 40 p
(Contract N62269-81-C-0741; F61-542)
(AD-A167667; NADC-85158-60) Avail: NTIS HC A03/MF A01 CSCL 11A

Materials examined for low temperature, rapid curing, fuel and water resistant sealants included hot melts, UV activated, moisture curing, and anaerobic polymers. Two component polymers utilizing urethane cures, oxidation, and mercaptan-epoxy additions were evaluated. Epoxy cures of mercaptan terminated polythioethers gave excellent low temperature cures along with practical application times. Physical and chemical properties were examined and found to essentially meet requirements of MIL-S-85420 (AS). Storage stability was excellent. GRA

N87-10973*# Douglas Aircraft Co., Inc., Long Beach, Calif.
CRITICAL JOINTS IN LARGE COMPOSITE AIRCRAFT STRUCTURE Contractor Report, Nov. 1981 - Jan. 1983
W. D. NELSON, B. L. BUNIN, and L. J. HART-SMITH Washington NASA Aug. 1983 41 p Presented at the 6th Conference on Fiberous Composites in Structural Design, New Orleans, La., 24-27 Jan. 1983
(Contract NAS1-16857)
(NASA-CR-3710; NAS 1.26:3710; DP-7266) Avail: NTIS HC A03/MF A01 CSCL 11D

A program was conducted at Douglas Aircraft Company to develop the technology for critical structural joints of composite wing structure that meets design requirements for a 1990 commercial transport aircraft. The prime objective of the program was to demonstrate the ability to reliably predict the strength of large bolted composite joints. Ancillary testing of 180 specimens generated data on strength and load-deflection characteristics which provided input to the joint analysis. Load-sharing between fasteners in multirow bolted joints was computed by the nonlinear analysis program A4EJ. This program was used to predict strengths

of 20 additional large subcomponents representing strips from a wing root chordwise splice. In most cases, the predictions were accurate to within a few percent of the test results. In some cases, the observed mode of failure was different than anticipated. The highlight of the subcomponent testing was the consistent ability to achieve gross-section failure strains close to 0.005. That represents a considerable improvement over the state of the art. Author

N87-10974*# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-10 COMPOSITE VERTICAL STABILIZER GROUND TEST PROGRAM Contractor Report, Dec. 1980 - May 1982
J. M. PALMER, JR., C. O. STEPHENS, and J. O. SUTTON Washington NASA Aug. 1983 38 p Presented at the 6th Conference on Fiberous Composites in Structural Design, New Orleans, La., 24-27 Jan. 1983
(Contract NAS1-14869)
(NASA-CR-3715; NAS 1.26:3715; DP-7269) Avail: NTIS HC A03/MF A01 CSCL 11D

A review of the structural configuration and ground test program is presented. Particular emphasis is placed on the testing of a full-scale stub box test subcomponent and full span ground test unit. The stub box subcomponent was tested in an environmental chamber under ambient, cold/wet, and hot/wet conditions. The test program included design limit static loads, fatigue spectrum loading to approximately two service lifetimes (with and without damage), design limit damage tolerance tests, and a final residual strength test to a structural failure. The first full-scale ground test unit was tested under ambient conditions. The test unit was to have undergone static, fatigue, and damage tolerance tests but a premature structural failure occurred at design limit load during the third limit load test. A failure theory was developed which explains the similarity in types of failure and the large load discrepancy at failure between the two test articles. The theory attributes both failures to high stress concentrations at the edge of the lower rear spar access opening. A second full-scale ground test unit has been modified to incorporate the various changes resulting from the premature failure. The article has been assembled and is active in the test program. Author

N87-10975*# Douglas Aircraft Co., Inc., Long Beach, Calif.
CRITICAL COMPOSITE JOINT SUBCOMPONENTS: ANALYSIS AND TEST RESULTS
B. L. BUNIN Washington NASA Sep. 1983 155 p
(Contract NAS1-16857)
(NASA-CR-3711; NAS 1.26:3711; ACEE-26-TR-3074) Avail: NTIS HC A08/MF A01 CSCL 11D

This program has been conducted to develop the technology for critical structural joints of a composite wing structure meeting design requirements for a 1990 commercial transport aircraft. A prime objective of the program was to demonstrate the ability to reliably predict the strength of large bolted composite joints. Load sharing between bolts in multirow joints was computed by a nonlinear analysis program (A4FJ) which was used both to assess the efficiency of different joint design concepts and to predict the strengths of large test articles representing a section from a wing root chord-wise splice. In most cases, the predictions were accurate to within a few percent of the test results. A highlight of these tests was the consistent ability to achieve gross-section failure strains on the order of 0.005 which represents a considerable improvement over the state of the art. The improvement was attained largely as the result of the better understanding of the load sharing in multirow joints provided by the analysis. The typical load intensity on the structural joints was about 40 to 45 thousand pound per inch in laminates having interspersed 37 1/2-percent 0-degree plies, 50-percent + or - 45-degrees plies and 12 1/2-percent 90-degrees plies. The composite material was Toray 300 fiber and Ciba-Geigy 914 resin, in the form of 0.010-inch thick unidirectional tape. Author

N87-10985# Federal Aviation Administration, Atlantic City, N.J.
AN INVESTIGATION OF THE FAA VERTICAL BUNSEN BURNER FLAMMABILITY TEST METHOD Final Report
P. CAHILL Aug. 1986 15 p
(DOT/FAA/CT-86/22) Avail: NTIS HC A02/MF A01

The vertical Bunsen burner test method, as specified in appendix F of the Federal Aviation Regulations - Part 25, was evaluated in order to update and clarify certain problem areas. Burner fuel, flame temperature and flame placement were investigated. It was determined that: (1) methane gas can be used as a replacement of alternative to B-gas, (2) a minimum flame temperature specification is meaningless without specifying thermocouple wire thickness, and (3) placing the flame at the midpoint of the lower edge of the front face results in a more realistic and severe evaluation of the specimen's flammability properties. Author

N87-10990# European Space Agency, Paris (France).
RESULTS OF WIND TUNNEL TESTS ON EXTERNAL COMBUSTION
B. SCHAEFER Dec. 1985 52 p Transl. into ENGLISH from "Ergebnisse von Windkanalversuchen zur Aussenverbrennung" (Cologne, West Germany) Original language document was announced as N86-15643
(ESA-TT-959; DFVLR-FB-85-35; ETN-86-98245) Avail: NTIS HC A04/MF A01; original German version available at DFVLR, Cologne, West Germany DM 56

Wind tunnel tests on external combustion were carried out to study the flow distribution on a flat plate in a supersonic flow for spoiler optimization and combustion efficiency. The influence of spoiler geometry, mass flow rate and injection angle on flow distribution was studied. The separation area can be enlarged with the spoiler inclination against the flow. Resistance problems and mass flow rate against a split overture are reduced with a hole-line flow nozzle. The area of increased pressure is enlarged by injecting hydrogen in the recirculation area before the spoiler and by igniting the mixture. The cross force after ignition is five times as strong as the spoiler action. ESA

N87-10994 British Aerospace Aircraft Group, Bristol (England). Advanced Manufacturing Research Dept.
INTERNATIONAL CONFERENCE - SUPERPLASTICITY IN AEROSPACE ALUMINIUM
K. S. BROAD, comp. 23 Jul. 1985 12 p Conference held in Bedford, England, 12-15 Jul. 1985
(BAE-S85/AMR/0066; ETN-86-97945) Avail: Issuing Activity

The use of superplastic aluminum in aerospace was discussed. Superplastic forming to produce cost effective lightweight parts was considered. Limitations from microstructural fractures and resultant properties were covered, particularly the problem of cavitation. Special processing techniques and the evolution of alloys to overcome limitations were treated. ESA

N87-11003# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Abteilung Korrosion.
GALVANIC CORROSION BETWEEN CARBON FIBER REINFORCED PLASTICS AND METALLIC AERONAUTICAL MATERIALS
T. FOURRIER and H. BUHL Apr. 1986 86 p
(DFVLR-FB-86-16; ISSN-0171-1342; ETN-86-98184) Avail: NTIS HC A05/MF A01; DFVLR, Cologne, West Germany DM 27

The electrochemical behavior of carbon fiber reinforced plastics (CFRP) and the galvanic corrosion between CFRP and metallic aeronautical alloys were investigated. Rest potentials, mixed potentials, galvanic current densities, and polarization curves were measured. Influence of parameters such a pH-value, electrolyte agitation, distance between the samples, and area ratio was studied. Aluminium alloys (2024, 7010, 7050, 7075, 8090) show a high sensitivity to galvanic corrosion with CFRP; Ti-6A1-4V is the only alloy with uncritical galvanic corrosion behavior with CFRP. ESA

N87-11004# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
CORROSION AND CORROSION PREVENTION IN AIRCRAFT STRUCTURES
W. G. J. THART Mar. 1985 25 p In DUTCH; ENGLISH summary Presented at PBNA Course on Corrosion Prevention, Utrecht, Netherlands, 16-23 Apr. and 7-14 May 1985
(NLR-MP-85029-U; B8667275; ETN-86-98490) Avail: NTIS HC A02/MF A01

Materials used in aircraft and the operational environments which cause the different kinds of corrosion are presented. The corrosion-sensitive parts of aircraft structures are discussed. Measures to provide optimal corrosion prevention (choice of materials, metallic coatings, surface treatment, painting) are reviewed. Measures to be taken during the design phase and during maintenance are outlined. ESA

N87-11014# Federal Aviation Administration, Atlantic City, N.J.
AVGAS/AUTOGAS COMPARISON: WINTER FUELS Interim Report
A. M. FERRARA Jul. 1986 53 p
(DOT/FAA-CT-86/21) Avail: NTIS HC A04/MF A01

This report describes dynamometer tests which simulated conditions found in a general aviation aircraft. In these tests, automobile gasoline was tested and compared with aviation gasoline. The tendency for vapor lock and detonation was measured as a function of gasoline grade, Reid Vapor Pressure, and the age of the fuel. Author

N87-11181*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBUSTION OVERVIEW
D. F. SCHULTZ *In its* Turbine Engine Hot Section Technology, 1984 6 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 21B

The objective of this effort is to develop improved analytical models of the internal combustor flow field and liner heat transfer as a means to shorten combustor development time and increase turbine engine hot section life. A four-element approach was selected to meet this objective. First, existing models were utilized to determine their deficiencies. Supporting research was then commenced to improve the exisiting models. While the research effort is in progress, the models are being refined to improve numerics and numerical diffusion. And lastly, the research results and improved numerics will be integrated into existing models. Author

N87-11182*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SURFACE PROTECTION
S. R. LEVINE *In its* Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 11F

The surface protection subproject consists of three major thrusts: airfoil deposition model; metallic coating life prediction; and thermal barrier coating (TBC) life prediction. The time frame for each of these thrusts and the expected outputs are presented. Further details are given for each thrust such as specific element schedules and the status of performance; in-house, via grant, or via contract. B.G.

N87-11193*# General Electric Co., Fairfield, Conn.
EFFECTS OF SURFACE CHEMISTRY ON HOT CORROSION LIFE
R. E. FRYXELL and B. K. GUPTA (TRW, Inc., Cleveland, Ohio) *In* NASA. Lewis Research Center Turbine Engine Hote Section Technology, 1984 14 p Oct. 1984
(Contract NAS3-23926)
Avail: NTIS HC A17/MF A01 CSCL 11F

Hot corrosion life prediction methodology based on a combination of laboratory test data and field service turbine components, which show evidence of hot corrosion, were examined. Components were evaluated by optical metallography, scanning electron microscopy (SEM), and electron micropulse (EMP) examination. B.G.

N87-11194*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COATING LIFE PREDICTION
J. A. NESBITT and M. A. GEDWILL *In its* Turbine Engine Hot Section Technology, 1984 12 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 11G

Hot-section gas-turbine components typically require some form of coating for oxidation and corrosion protection. Efficient use of coatings requires reliable and accurate predictions of the protective life of the coating. Currently engine inspections and component replacements are often made on a conservative basis. As a result, there is a constant need to improve and develop the life-prediction capability of metallic coatings for use in various service environments. The purpose of this present work is aimed at developing of an improved methodology for predicting metallic coating lives in an oxidizing environment and in a corrosive environment. Author

N87-11195*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INTRODUCTION TO LIFE MODELING OF THERMAL BARRIER COATINGS
R. A. MILLER *In its* Turbine Engine Hot Section Technology, 1984 6 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 11G

Thermal barrier coatings may be applied to air-cooled turbine section airfoils to insulate such components from hot gases in the engine. The coatings, which typically consist of about 0.01 to 0.04 cm of zirconia-yttria ceramic over about 0.01 cm of NiCrAlY or NiCrAlZr alloy bond coat, allow increased gas temperatures or reduced cooling air flows. This, in turn, leads to marked improvements in engine efficiency and performance. However, certain risks are associated with designing for maximum benefits, and eventually a point is reached where coating loss would immediately jeopardize the underlying component. Therefore, designers must be able to accurately predict the life of a given bill-of-material coating in any particular design. The results of an in-house aeronautics, base research and technology program which is designed to provide the first steps towards developing mission-capable life-prediction models are outlined. Author

N87-11204*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLAME RADIATION
J. D. WEAR *In its* Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 21B

Total radiation and heat flux data was obtained on a combustor liner by advanced instrumentation. If the results obtained by the special instrumentation are considered to be representative of the total radiation and heat flux, then the effect of variation of engine operating parameters and of fuel type can be more easily obtained. The special instrumentation used for these investigations consisted of five total radiometers and two total heat flux gages. The radiometers were arranged axially and circumferentially through sliding air seals in the outer liner. The two heat flux gages were welded in the outer liner between two circumferential radiometers. Static pressures were obtained on both the cold and the hot side of the outer liner in the area of the heat flux gages. Liner metal temperatures were also obtained. The combustor inlet pressure was varied over a nominal range of 0.5 to 2.07 MPa, inlet air temperature from 550 to 670 K, and fuel-air ratio from about 0.015 to 0.040. The two fuels tested were ASTM Jet A and a fuel designated as ERBS V. Results of the tests are discussed. B.G.

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ENGINEERING

Includes engineering (general); communications and radar; electronics and electrical engineering; mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A87-10115
DECAY OF END EFFECTS IN GRAPHITE/EPOXY BOLTED JOINTS
L. CARLSSON, P. SINDELAR, and S. NILSSON (Flygtekniska Forsoksanstalt, Bromma, Sweden) Composites Science and Technology (ISSN 0266-3538), vol. 26, no. 4, 1986, p. 307-321. refs

The local disturbances introduced into the strength of a material by a fastener bolt in a single-row bolted joint in a graphite/epoxy composite plate loaded in tension are examined. Consideration is given to plates with constant thickness and to plates with a transition from a thicker to thinner cross section. Unlike procedures followed for isotropic metal plates, account is taken of anisotropy in the plate materials within the finite element formulation. The models show that the characteristic decay length, i.e., the distance over which a nonequilibrated cross-sectional stress decays to a negligible value, is proportional to the square root of the ratio of the elasticity to the applied stress. A simplified formula is defined for quantifying the decay rate for a constant thickness material. The models show that the decay length is significantly less in a component with a reduction in thickness. M.S.K.

A87-10121
SPECIFICATION OF GAS TURBINE DISC FORGINGS
R. H. JEAL (Rolls-Royce, Ltd., Derby, England) Materials Science and Technology (ISSN 0267-0836), vol. 2, July 1986, p. 721-727.

The cost of failures in gas turbine discs, both in human life and financial terms, is particularly high, and it has always been recognized that the component must be fully specified against the design requirement, and totally predictable in operation. This was originally achieved by making a reproducible forging consistent with the design strength assumptions and which approached the engineer's model of the material as 'elastic, isotropic, and free from defects'. Today's improved understanding of materials behaviour in terms of the relationship between material property and microstructure, together with the designer's need for higher-strength materials, has led to an approach which now recognizes the role of both structure and 'defects' within the forging. This, and the need to improve the the cyclic properties of components, is now imposing on the forger complex microstructural and quality requirements that can be met only by process control and by a move towards closer-to-size and more complex shape requirements. Future materials needs are discussed in relation to controlling the discontinuity behaviour, together with the change in philosophy that this is bringing to the control of the manufacturing process. Author

A87-10124
FORGING OF BLADES FOR GAS TURBINES
D. C. WRIGHT and D. J. SMITH (Doncasters Monk Bridge, Ltd., Leeds, England) Materials Science and Technology (ISSN 0267-0836), vol. 2, July 1986, p. 742-747.

The forging of Ni-based superalloy gas turbine blades has progressed to the point where precision methods can cost-effectively yield dimensionally accurate products, retaining competitiveness with casting methods. Attention is presently given to forged blade performance and economic requirements, quality standards, alloy forgeability criteria, stages in forged blade manufacture, grain flow characteristics encountered in upsetting and extrusion, and the configuration of state-of-the-art hydraulic screw presses. Future trends in computer-aided forging and design processes, materials, and techniques are projected. O.C.

A87-10516#
TENSION ANALYSIS OF STIFFENED AIRCRAFT STRUCTURES
M. MOHAGHEGH (Boeing Commercial Airplane Co., Seattle, WA) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FL, April 15-17, 1985, Technical Papers. Part 1, p. 665-672) Journal of Aircraft (ISSN 0021-8669), vol. 23, Aug. 1986, p. 609, 610. Previously cited in issue 13, p. 1896, Accession no. A85-30298.

A87-10720
A COMPUTER-AIDED NONDESTRUCTIVE INSPECTION SYSTEM
R. C. ADDISON, JR., J. M. F. LEE, A. H. MUIR, JR., and A. W. THIELE (Rockwell International Science Center, Thousand Oaks, CA) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 789-799. Research supported by the Rockwell International Corp.
(Contract F33657-81-C-0210)

Attention is given to a computer-aided nondestructive inspection system designed for improving the speed and quality of the ultrasonic evaluation of diffusion-bonded parts of the B-1B aircraft. The system consists of a host computer, a data acquisition and multi-axis control (DAMAC) system, and a custom mechanical scanning system. The host computer uses menu-driven software to provide a user-friendly interface for the operator; an array processor permits the acquisition of entire waveforms for subsequent analysis. In order to eliminate time-consuming part alignment procedures, the DAMAC permits raster scans to be performed on parts that lie at arbitrary orientation with respect to the tank. In addition, the DAMAC controls the ultrasonic pulser-receiver and synchronizes the data acquisition with the scanning motions. The custom mechanical scanning system contains three servo-controlled linear axes capable of vector movements within a 10 x 16 x 3 ft volume; the scanning speed is 20 ips. K.K.

A87-10721
COMPUTERIZED ULTRASONIC TEST INSPECTION ENHANCEMENT SYSTEM FOR AIRCRAFT COMPONENTS
R. G. PARENT (Lockheed-Georgia Co., Marietta) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 801-809.

Attention is given to the computerized ultrasonic test inspection enhancement (CUTIE) system which was designed to meet the following program goals: (1) automation of the inspection technique and evaluation of the discontinuities for aircraft components while maintaining reasonable implementation costs and reducing the overall inspection costs; and (2) design of a system which would allow for easy modification so that new concepts could be implemented. The system's ultrasonic test bridge, C-scan recorder, computer control, and ultrasonic flaw detector are described. Consideration is also given to the concurrent development of an eight element array transducer (for increasing the inspection rate) and a high-speed data acquisition system (for signature analysis). K.K.

A87-10727
MANUFACTURING TECHNOLOGY FOR NONDESTRUCTIVE EVALUATION (NDE) SYSTEM TO IMPLEMENT RETIREMENT FOR CAUSE (RFC) PROCEDURES FOR GAS TURBINE ENGINE COMPONENTS
D. L. BIRX and D. G. DOOLIN (Systems Research Laboratories, Inc., Dayton, OH) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 877-884.

A87-10728
EVALUATION OF CAPTURED WATER COLUMN TECHNOLOGY FOR ADVANCED ULTRASONIC SIZING TECHNIQUES
G. M. LIGHT, W. R. VAN DER VEER (Southwest Research Institute, San Antonio, TX), D. S. STUBBS, and W. C. HOPPE (Systems Research Laboratories, Inc., Dayton, OH) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 885-892.
(Contract F33615-81-C-5002)

A87-10730
RFC AUTOMATED INSPECTION OVERVIEW
D. A. STUBBS and W. C. HOPPE (Systems Research Laboratories, Inc., Dayton, OH) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 901-910.
(Contract F33615-81-C-5002)

The RFC Inspection System uses eddy current and ultrasonic techniques to perform automatic inspection of gas turbine engine components. Current flaw size requirements are 0.010 inch (length) x 0.005 inch (depth) surface connected cracks and 0.020 inch diameter penny shaped, maloriented internal voids. Successful and reliable detection of these small flaws requires sophisticated inspection equipment and techniques. Details of both the eddy current and ultrasonic inspections is presented along with the philosophy and reasons supporting each component of the inspections. Inspection components presented include: part dimensioning, probe calibration, adaptive scanning, threshold detection, signal processing, and flaw position correlation. Additional material is presented highlighting the problems and solutions associated with a sophisticated, automatic inspection system. Author

A87-10732
PREDICTIVE MODELS AND RELIABILITY IMPROVEMENT IN ELECTROMAGNETIC NONDESTRUCTIVE EVALUATION
R. E. BEISSNER (Southwest Research Institute, San Antonio, TX) IN: Review of progress in quantitative nondestructive evaluation. Volume 5A - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 919-926; Discussion, p. 927. refs
(Contract W-7405-ENG-82; F33615-82-C-5020)

Examples are provided which show how the use of theoretical models can improve the reliability of electromagnetic NDE. These models can aid in the following: (1) selection of an inspection method, (2) verification of an NDE method, and (3) development and analysis of an inspection plan in terms of probability of detection data. The present examples refer to the use of the electric current perturbation probe in the inspection of aircraft engine components. Recommendations for future model development include an investigation of the right angle corner problem. There is also a need for improved models of the eddy current/flaw interaction and their extension to more complex defect shapes. K.K.

A87-10750* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
QUANTITATIVE THERMAL DIFFUSIVITY MEASUREMENTS OF COMPOSITES
D. M. HEATH, W. P. WINFREE, J. S. HEYMAN, W. E. MILLER (NASA, Langley Research Center, Hampton, VA), and C. S. WELCH (NASA, Langley Research Center, Hampton; College of William and Mary, Williamsburg, VA) IN: Review of progress in quantitative nondestructive evaluation. Volume 5B - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 1125-1132.

A remote radiometric technique for making quantitative thermal diffusivity measurements is described. The technique was designed to make assessments of the structural integrity of large composite parts, such as wings, and can be performed at field sites. In the measurement technique, a CO2 laser beam is scanned using two orthogonal servo-controlled deflecting mirrors. An infrared imager, whose scanning mirrors oscillate in the vertical and the horizontal directions, is used as the detector. The analysis technique used to extract the diffusivity from these images is based on a thin infinite plate assumption, which requires waiting a given period of time for the temperature to equilibrate throughout the thickness of the sample. The technique is shown to be accurate to within two percent for values of the order of those for composite diffusivities, and to be insensitive to convection losses. I.F.

A87-10765
NONDESTRUCTIVE INSPECTION OF COMPOSITE STRUCTURES BY LOW-VELOCITY IMPACT
R. D. ADAMS, A. M. ALLEN (Bristol, University, England), and P. CAWLEY (Imperial College of Science and Technology, London, England) IN: Review of progress in quantitative nondestructive evaluation. Volume 5B - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 1253-1258.

A prototype instrument, called 'Tapometer', has been designed on the basis of the coin-tap-test principle, incorporating both time-domain and frequency-domain methods of comparing mechanical impulses on good and bad areas of a structure. The Tapometer technique will work wherever the 'coin-tapping' can be used but, unlike the coin-tap test, it is quantitative and recordable. In addition, the Tapometer is used without a couplant between the tapping head and the test structure, presenting a great advantage in tests of many honeycomb and fiber-reinforced composites. The Tapometer was used successfully to detect delaminations in solid carbon-fiber-reinforced plastics, and defects in honeycomb sandwich panels, bonded aluminum structures, crushed cores in helicopter rotor blades, and massive rubber/steel/polyester composite tubes. I.S.

A87-10768
VARIATIONS IN ULTRASONIC BACKSCATTER ATTRIBUTED TO POROSITY
D. E. YUHAS, C. L. VORRES, and R. ROBERTS (Magnaflux Corp., Elk Grove Village, IL) IN: Review of progress in quantitative nondestructive evaluation. Volume 5B - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 1275-1284. refs
(Contract W-7405-ENG-82)

In the present approach to composite porosity determination from ultrasonic backscatter data, the insonification of composites at nonperpendicular incident angles reduces specular surface reflection and yields backscatter characteristics that are dependent on the angular relation between the direction of sound propagation and fiber orientation. Attention is given to the nature of ultrasonic backscatter from graphite/epoxy composites, under the working hypothesis that the scattering from porosity may be isotropic relative to the more directed scattering of the fibers. O.C.

A87-10791
ELECTROMAGNETIC METHODS TO DETECT CORROSION IN AIRCRAFT STRUCTURES
S. N. ROWLAND, G. BURKHARDT, and A. S. BIRRING (Southwest Research Institute, San Antonio, TX) IN: Review of progress in quantitative nondestructive evaluation. Volume 5B - Proceedings of the Twelfth Annual Review, Williamsburg, VA, June 23-28, 1985 . New York, Plenum Press, 1986, p. 1549-1556. refs

The application of electromagnetic methods to the detection of corrosion is examined. The operation and capabilities of the electric current perturbation and remote field eddy current techniques designed to detect and measure corrosion between layers, and the dark field eddy current method for detecting corrosion around fasteners are described. Diagrams of the corrosion between layers and the three electromagnetic experimental arrangements are provided. I.F.

A87-10867
CLEANING METHODS AND PROCEDURES FOR MILITARY OXYGEN EQUIPMENT - INVESTIGATION RESULTS
D. W. SCHROLL (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Flammability and sensitivity of materials in oxygen-enriched atmospheres; Proceedings of the Symposium, Washington, DC, April 23, 24, 1985. Volume 2 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 180-203. refs

Over the past several years a number of briefings have been given at the Oxygen Standardization Coordinating Group concerning cleaning methods and procedures for military oxygen equipment. Of particular concern has been the diversity of methods, cleaning compounds, and cleanliness criteria that exist in the military and industry in the manufacture, shipment, aircraft installation, and maintenance of military oxygen equipment. This is discussed in some depth in this paper. Author

A87-10898
A HIGHER ORDER BEAM ELEMENT FOR VIBRATION OF BEAMS WITH DISCONTINUITIES
G. SUBRAMANIAN (Indian Institute of Technology, Madras, India) and T. S. BALASUBRAMANIAN (National Aerospace Laboratory, Bangalore, India) IN: Finite elements in computational mechanics - FEICOM '85; Proceedings of the International Conference, Bombay, India, December 2-6, 1985. Volume 2 . Oxford, Pergamon Press, 1985, p. 627-634.

A higher-order beam element for the analysis of vibration in beams with step, spring, lumped-mass, or inertial discontinuities is developed and demonstrated. The element employs four degrees of freedom per node (deflection, slope, bending moment, and shear force) and permits treatment of axial-force effects. The numerical results of applications to problems involving spring-supported beams, axially loaded discontinuous beams, beams with concentrated masses and inertias, a stepped helicopter rotor blade, a model launch vehicle, and a launch-vehicle-model supporting sting are presented in tables. T.K.

A87-10900
NATURAL FREQUENCY ANALYSIS OF PRETWISTED PLATES
S. K. SANE, C. S. GURUJEE, A. R. MALPANI, V. N. SHARMA, and C. M. P. FERNANDES (Indian Institute of Technology, Bombay, India) IN: Finite elements in computational mechanics - FEICOM '85; Proceedings of the International Conference, Bombay, India, December 2-6, 1985. Volume 2 . Oxford, Pergamon Press, 1985, p. 655-663. refs

The vibrational behavior of turret-lathe-pretwisted rectangular plates of thickness 5.86, 4.89, 3.16, and 1.47 mm and aspect ratio 0.75, 1.00, 1.50, 2.00, and 2.50 is investigated experimentally and analytically. Eight-node isoparametric quadrilateral, 12-node isoparametric, helicoidal (Walker, 1978), and triangular finite elements are employed in the analysis, and the results are compared with those obtained by electromagnetic and electrodynamic excitation of the rigidly clamped plates in tables and graphs. Superior results are obtained using the 12-node isoparametric element (at the cost of more computational work in formulating the stiffness and mass matrices) or the helicoidal element (at the cost of more work at the eigenvalue-evaluation stage). T.K.

A87-10971
A NONPERTURBING BOUNDARY-LAYER TRANSITION DETECTION
J. E. OHARE (Calspan Corp., Arnold Air Force Station, TN) IN: High speed photography, videography, and photonics III; Proceedings of the Meeting, San Diego, CA, August 22, 23, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 58-63.

A laser interferometer technique is being applied to the characterization of boundary-layer conditions on models in supersonic and hypersonic wind tunnels in the von Karman Facility at Arnold Engineering Development Center (AEDC). The Boundary-Layer Transition Detector (BLTD), based on lateral interferometry, is applicable for determining the turbulence frequency spectrum of boundary layers in compressible flow. The turbulence, in terms of air density fluctuations, is detected by monitoring interferometric fringe phase shifts (in real time) formed by one beam which passes through the boundary layer and a reference beam which is outside the boundary layer. This technique is nonintrusive to the flow field unlike other commonly used methods such as pitot tube probing and hot-wire anemometry. Model boundary-layer data are presented at Mach 8 and compared with data recorded using other methods during boundary-layer transition from laminar to turbulent flow. Spectra from the BLTD reveal the presence of a high-frequency peak during transition, which is characteristic of spectra obtained with hot wires. The BLTD is described along with operational requirements and limitations. Author

A87-11112#
MODELING AND ANALYSIS OF THE DYNAMICS OF A DRILL PENETRATING A THIN PLATE
P. G. REINHALL and D. W. STORTI (Washington, University, Seattle) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 53, Sept. 1986, p. 690-694. refs
(Contract NSF MEA-84-04862)
(ASME PAPER 86-WA/APM-33)

A simplified model of the drilling process which is useful in understanding the problem of noncircular-hole production is proposed. The dynamics of a drill penetrating a circular hole in a rigid plate are studied analytically and numerical methods are then used to include the effects of material removal. It is shown that certain drill trajectories which lead to noncircular holes can be stabilized by material removal. Based on these findings, careful drill-speed selection is recommended as a means of minimizing the probability of noncircular hole production, and it is pointed out that even this solution may not be sufficient for the case of very soft or composite plate materials. Author

A87-11113#
EFFECT OF TANGENTIAL TORQUE ON THE DYNAMICS OF FLEXIBLE ROTORS
K. B. YIM (Sundstrand Corp., Rockford, IL), S. T. NOAH, and J. M. VANCE (Texas A&M University, College Station) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 53, Sept. 1986, p. 711-718. refs
(Contract NSF MEA-81-15330)
(ASME PAPER 86-WA/APM-23)

The effect of tangential load torque on the dynamics of rotors has been studied analytically using both cantilevered and between-bearing rotor models. External damping, distributed shaft mass, and gyroscopic moments are taken into account. A number of analytical approaches, including the classical method and a modified transfer matrix method have been utilized and they all gave results with excellent agreement. For realistic levels of torque, the major effect is found to be on the whirl stability of the system. Stability is found to depend most strongly on the dimensionless ratio of torque to damping, and on the mode shape. Author

A87-11127#
A REDUNDANCY MANAGEMENT PROCEDURE FOR FAULT DETECTION AND ISOLATION
A. RAY (Pennsylvania State University, University Park) and M. DESAI (Charles Stark Draper Laboratory, Inc., Cambridge, MA) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434), vol. 108, Sept. 1986, p. 248-254. refs

This paper presents the theoretical basis of a novel redundancy management procedure developed for fault detection and isolation (FDI) in strategic processes such as spacecraft, aircraft, and nuclear plants where multiply-redundant measurements are available for individual variables. The set of redundant measurements may comprise both direct sensor outputs and analytically derived measurements. The redundancy management procedure presented in this paper is essentially independent of the fault detection strategy and measurement noise statistics, and builds upon the

concept of partitioning the set of measurements into 'consistent' and 'inconsistent' subsets for purposes of estimation and fault isolation, respectively. The proposed procedure is suitable for real-time applications using commercially available microcomputers and its efficacy has been verified on-line in operating nuclear reactors. Author

A87-11336
DAMPING OF THE VIBRATIONS OF DEFORMABLE BODIES [DEMPFIROVANIE KOLEBANII DEFORMIRUEMYKH TEL]
V. V. MATVEEV Kiev, Izdatel'stvo Naukova Dumka, 1985, 264 p. In Russian. refs

Methods for determining the damping characteristics and for describing the mechanical hysteresis of the vibration of deformable bodies are examined. The results of a comprehensive study of the damping properties of a wide class of metal materials and highly stressed structural elements are generalized with allowance for production and service related factors. Methods for increasing the reliability of machine elements by reducing the level of vibration-induced stresses are discussed. V.L.

A87-11481#
A STUDY ON THE AXIALLY CURVED MIXED-FLOW VANELESS DIFFUSERS
T. SAKAI (Tokyo Science University, Japan), T. AWAI, and T. NAKAGAWA JSME, Bulletin (ISSN 0021-3764), vol. 29, June 1986, p. 1759-1764.

The flow patterns and pressure-recovery factors (PRFs) of one purely conical and three axially curved vaneless diffusers for mixed-flow turbomachines are determined experimentally at Reynolds numbers 200,000-210,000 in a test rig including a blower, two surge tanks, and a rotating screen (imparting swirl to the air entering the diffuser). The results are presented in tables, graphs, and diagrams and characterized in detail. The PRF and effectiveness of the simple curved diffuser are found to be lower than those of the conical diffuser, but addition of inner-wall guide fences is shown to improve the performance significantly. T.K.

A87-11492#
NUMERICAL ANALYSIS WITH GENERALIZED J-INTEGRAL
M. WANG and L. XU Northwestern Polytechnical University, Journal, vol. 4, July 1986, p. 297-304. In Chinese, with abstract in English. refs

A finite element model is presented for obtaining numerical solutions to a generalized J-integral for structures experiencing complex loading. The stresses can include thermal, body force and external loads singly or in combination. Implementation of the model in a computer program is demonstrated, along with the outputs of the stress/strain field, the numerical values of the generalized J-integral, the stress intensity factor, and predictions of the crack extension. The model is useful for predicting the fatigue life of aircraft engine components and electric generators. M.S.K.

A87-11501
CONFERENCE ON NUMERICAL METHODS IN FLUID MECHANICS, 6TH, GOETTINGEN, WEST GERMANY, SEPTEMBER 25-27, 1985, PROCEEDINGS
D. RUES, ED. and W. KORDULLA, ED. (DFVLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, West Germany) Conference supported by the Gesellschaft fuer angewandte Mathematik und Mechanik, DFG, DFVLR, et al. Brunswick, West Germany, Friedr. Vieweg und Sohn (Notes on Numerical Fluid Mechanics. Volume 13), 1986, 418 p. For individual items see A87-11502 to A87-11546.

Papers are presented on implicit and semiimplicit methods for the compressible Navier-Stokes equations, a multigrid Marker-and-Cell algorithm for three-dimensional flow computation, solution of the Euler equations for missile configurations, and a finite difference Galerkin method for the solution of the Navier-Stokes equations. Also considered are an application of the two-dimensional time-marching Euler code to transonic turbomachinery flow, a numerical method for vortex sheet roll-up, the conjugate gradient method applied to turbulent flow calculations, and numerical experiments with a total variation diminishing MacCormack scheme. Other topics include partially-parabolic calculations of three-dimensional viscous flow through turbomachinery cascades, implicit finite-difference simulation of separated hypersonic flow over an indented nosetip, stability of collocation-Chebyschev schemes with application to the Navier-Stokes equations, and numerical experiments with inviscid vortex-stretched flow around a cranked delta wing. Papers are also presented on large eddy simulation of atmospheric turbulence, application of patched meshes to viscous and inviscid flows, higher-order flux difference splitting schemes for the Euler equations using upstream interpolations, and the efficient use of vector computers with emphasis on computational fluid dynamics. R.R.

A87-11503
IMPLICIT AND SEMI-IMPLICIT METHODS FOR THE COMPRESSIBLE NAVIER-STOKES EQUATIONS
M. O. BRISTEAU (Institut National de Recherche en Informatique et an Automatique, Rocquencourt, France), B. MANTEL, J. PERIAUX, C. POULETTY (Avions Marcel Dassault Breguet Aviation, Saint-Cloud, France), R. GLOWINSKI (Paris VI, Universite; Institut National de Recherche en Informatique et an Automatique, Rocquencourt, France) et al. IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 9-22. refs
(Contract DRET-83-403)

Several methods for the numerical simulation of compressible viscous flows modeled by the unsteady Navier-Stokes equations and using finite elements are presented. The full Navier-Stokes system and a model obtained by assuming that the total enthalpy is constant are compared using a fully implicit scheme of gear type and splitting operator techniques which decouple the various physical effects. A direct method based on a cascade of Poisson problems is used for the generalized Stokes problem, and either highly stable rational Runge-Kutta techniques using dynamic relaxation or quasi-Newton/conjugate gradient algorithms superlinearly convergent are employed to solve the nonlinear subproblems. Numerical simulations of two-dimensional transonic and supersonic flows around a NACA0012 airfoil are in good agreement with available measurements, though stiff test cases and three-dimensional computations require self-adaptive refinement procedures to provide sensitive improvement of the solution where accuracy is needed. R.R.

A87-11522
EXPERIENCES WITH AN UNFACTORED IMPLICIT PREDICTOR-CORRECTOR METHOD
W. KORDULLA (DFVLR, Institut fr Theoretische Stroemungsmechanik, Goettingen, West Germany) IN: Conference on Numerical Methods in Fluid Mechanics, 6th, Goettingen, West Germany, September 25-27, 1985, Proceedings . Brunswick, West Germany, Friedr. Vieweg und Sohn, 1986, p. 185-192. refs

A finite volume formulation of MacCormack's (1985) predictor-corrector scheme using flux-splitting for the convection terms and central differencing for the viscous terms is described which is combined with a relaxation scheme based on the line-Gauss-Seidel method. Results for supercritical flow past a RAE2822 airfoil, using a C-type mesh, are presented, and second-order accurate spatial discretization was employed to obtain accurate results and fast convergence to steady state. No artificial numerical diffusion is employed, and accurate stagnation point pressures are found. The Cp-distribution for the fine mesh exhibits oscillations in the region of supersonic flow, and the fine mesh solution experiences increasing covergence with increasing time step, taking about 2.25 times more time for convergence than that of the coarse mesh. Good prediction of lift and drag is found for the coarse mesh solution, while the fine mesh solution is about 8 and 5 percent off, respectively, in comparison with experimentally observed values. R.R.

A87-11792
AERONAUTICAL RESEARCH SPIN-OFFS ON THE DEVELOPMENT OF CIVIL APPLICATIONS FOR ALUMINIUM ALLOYS
N. HURET and Y. DE BONY (Cegedur Pechiney, Departement Techniques Avancees, Paris, France) Materiaux et Techniques (ISSN 0032-6895), vol. 74, May-June 1986, p. 219-225. In English and French.

Several examples are discussed of the transfer of aeronautical Al metallurgy to civil applications. The development of Al alloys and forming techniques for aerospace applications is traced from WW II to the present, noting the spin-off of heavy plate shaping technologies to use in high speed presses and casings for injection molding machines. Techniques employed to produce precision-drawn Al tubes employed in the Airbus 300 have found applications as lightweight structural elements in a hang glider, for bow arrows, and for other sporting goods. M.S.K.

A87-11800
AVIONICS IN THE SUB-MICROSCOPIC WORLD
J. RHEA Interavia (ISSN 0020-5168), vol. 41, Aug. 1986, p. 907, 908, 911, 912.

The development of very high-speed integrated circuits (VHSICs) is considered. The reduced feature size of these circuits results in less weight, volume, and power, and therefore increased performance for radars, and electronic countermeasure systems. The use of VHSICs in operational weapon system and the application of a high-speed circuit to an airborne signal processor are examined. The formation of submicron 'super chips' which will operate at speeds of 50-100 MHz and be 1-1/2 inches on the side is analyzed. The use of GaAs technology to develop microwave/millimeter wave integrated circuits which will have gigahertz operating speed capabilities and reduced size is described. These circuits will increase the central processing power of weapons systems; various applications for these ICs are proposed. Research in the area of ultrapure crystal growth in space is discussed. I.F.

A87-11843
AUTOMATICALLY WOVEN THREE-DIRECTIONAL COMPOSITE STRUCTURES
P. S. BRUNO, D. O. KEITH, and A. A. VICARIO, JR. (Hercules Aerospace Co., Magna, UT) SAMPE Quarterly (ISSN 0036-0821), vol. 17, July 1986, p. 10-17.

Three-directional (3-D) fiber reinforced composites were demonstrated with advantages for certain missile and space structures. The applications range from carbon-carbon (c-c) to carbon-epoxy structures. Three-D carbon fiber preforms were woven using automated techniques developed by Aerospatiale of France and then impregnated and processed into c-c or carbon-epoxy structures. Demonstrated structures include c-c ITEs and exit cones for rocket nozzles and carbon-epoxy adapter rings for rocket cases. Other potential applications, including satellite truss joints and meteroid impact shields for Space Station components, are identified. Advantages of these structures include automated fabrication, improved mechanical properties, and greater raliability. Author

A87-12133#
EXPANSION OF FLOW DUE TO RESISTANCE OF A WIRE GAUZE PLACED IN A PARALLEL-SIDED CHANNEL
A. ITO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 34, June 1986, p. 308-315. In Japanese, with abstract in English. refs

This paper describes the analytical and experimental study of flow expansion due to the resistance of a wire gauze placed in a parallel-sided channel. First, Taylor's source model was improved by introducing source-strength correction, and flow profiles and drag coefficients were calculated for various gauze heights. Next, measurements were also made on flow profiles and drag coefficients for resistance coefficients up to 20 in a smoke wind-tunnel. Consequently, agreement between calculated and measured values was obtained. Furthermore, flow observation and velocity-distribution measurements were carried out for a model diffuser with a high resistance coefficient wire gauze. Author

A87-12445
A REINFORCING BAND NEAR THE FLANGE OF A HEATED CYLINDRICAL CASING [BANDAZHNOE KOL'TSO U FLANTSA NAGREVAEMOI TSILINDRICHESKOI OBOLOCHKI]
A. G. ZGUROVSKII and I. I. MARINETS Problemy Prochnosti (ISSN 0556-171X), July 1986, p. 70-72. In Russian. refs

It is shown that by using an additional reinforcing band near the flange of a cyclindrical casing heated by internal gas flow, it is possible to reduce the thermal stresses in the casing due to a cold rigid flange to the level of stresses produced by reinforcing bands. The stress-reducing effect of such a band is demonstrated with reference to an exhaust pipe of an aircraft power plant. V.L.

A87-12648
HIGH SPEED FLOW VISUALISATION
P. J. BRYANSTON-CROSS (Warwick, University, Coventry, England) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 23, no. 2, 1986, p. 85-104. refs

Three whole-field instantaneous flow visualization methods are reviewed. Laser fluorescence and pulsar laser velocimetry are very briefly considered, while holographic interferometry is treated in detail. This method, its theory, and its applicability to both two-dimensional and three-dimensional visualization are summarized, and its applications to three-dimensional visualization of a rotating compressor, an annular turbine cascade EPFL, and radial turbomachinery are examined. Its utilization in the two-dimensional holographic visualization of transonic flow, in two-dimensional steam turbine base flow research, and in visualizing structures within the boundary layer is addressed. C.D.

A87-12656
HOW TO MAINTAIN A CONSISTENT QUALITY IN YOUR BONDING PROCESS?
G. CARLSSON (SAAB-Scania AB, Linkoping, Sweden) IN: Progress in advanced materials and processes: Durability, reliability and quality control; Proceedings of the Sixth International European SAMPE Conference, Scheveningen, Netherlands, May 28-30, 1985 . Amsterdam and New York, Elsevier, 1985, p. 61-70.

Bonding of aircraft structures brings a lot of problems to the manufacturer. The nature of adhesives and the bonding processes' sensitivity to humidity, temperature, and contamination make it necessary to keep all parameters in the process under close control, and eliminate as many possibilities of random deviations as possible. This paper describes one approach to the problem, showing an automated line for surface treatment and a through-transmission ultrasonic tester for a 100-percent inspection of all bonded areas. Author

A87-12894
THE POSSIBILITY OF THE NONDISTURBING MOTION OF A BODY IN A FLUID [O VOZMOZHNOSTI NEVOZMUSHCHAIUSHCHEGO DVIZHENIIA TELA V ZHIDKOSTI]
V. I. MERKULOV (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), June 1986, p. 37-44. In Russian.

The body shape and the control actions resulting in zero perturbations beyond the limits of the control surface are determined analytically, and it is shown that such conditions are satisfied for some doubly connected systems. In this case, control is reduced to vortex generation on part of the control surface. The required vortex sheet can be provided by wings that flap in accordance with a certain law. The motion of such bodies near a free surface does not produce waves or wave drag. V.L.

A87-13003#
COMPUTER INTEGRATED MANUFACTURING
R. C. BECKETT (Commonwealth Aircraft Corp., Ltd., Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 5-12.

Attention is given to a proprietary system for computer-based design, manufacturing, quality control and production control. The six areas of computerized process application encompass airframe manufacturing, airframe modification and repair, engineering design and development, aircraft engine component manufacturing, gas turbine assembly/testing and repair/overhaul, and high technology foundry operations. It is noted that increased use of computer control results in businesses' greater capital intensiveness, with computer systems that have a shorter effective economic life than has been historically typical. O.C.

A87-13007#
ADVANCES IN THE VIBRATION MONITORING OF GEARS AND ROLLING ELEMENT BEARINGS
P. D. MCFADDEN (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 27-32.

The early detection of failure in mechanical systems is presently approached from the viewpoint of a recently gained understanding of the vibration generated by rolling element bearings that contain spalling defects as well as by gears with fatigue cracks. A defect's impact excites resonances that can be detected by a transducer mounted on the casing of the mechanism; bandpass filtering of the signal allows one of the resonances to be isolated and demodulated, leaving a train of impulses caused by the impacts. Although this technique has been developed for close monitoring of aircraft propulsion systems, it is applicable to other mechanical systems. O.C.

A87-13011#
STRUCTURAL DESIGN WITH NEW MATERIALS
B. C. HOSKIN (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Preprints . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 44-47. refs

Attention is given to the development status of the advanced structural design methods which complement state-of-the-art lightweight materials' use in aircraft primary structures. The ways in which the introduction of fiber-reinforced polymer matrix composites has affected airframe structure design and analysis procedures are characterized. Attention is given to single-ply mechanics, symmetric, orthotropic and quasi-orthotropic laminate properties, the laminate stress-strain law, and such in-service composite structure factors as environmental effects, near-invisible impact damage, and fatigue. O.C.

A87-13015#
THE BALANCE BETWEEN THEORETICAL, COMPUTATIONAL AND EXPERIMENTAL WORK IN TURBOMACHINES
J. H. HORLOCK (Open University, Milton Keynes, England) IN: Joint National Symposium on the Influence of Aviation on Engineering and the Future of Aeronautics in Australia, Melbourne, Australia, August 8, 9, 1985, Supplementary Papers . Barton, Australia/Brookfield, VT, Institution of Engineers/Brookfield Publishing Co., 1985, p. 1-13. refs

The interrelation between theoretical, computational and experimental work in turbomachine flow is discussed, including both work related to the flow description of an existing machine, and work in the design of a high efficiency machine. The development of theoretical and computational methods in turbomachine flow, and the various assumptions made, are first considered, following which the increased role of experimental studies due to the introduction of such techniques as laser anemometry is discussed. Examples of the interaction of these approaches are given including the general numerical solution of the inviscid equations of motion (Stuart and Heatherington, 1974), the development of actuator-disk theory and its stimulation of the detailed measurement of the flow within turbomachines, and the observation of a large free area of separated flow in the flow through compressor cascades at high incidence leading to analytical approaches assuming a free streamline. R.R.

A87-13026
RESONANT AND NON-RESONANT ACOUSTIC PROPERTIES OF ELASTIC PANELS. I - THE RADIATION PROBLEM
F. G. LEPPINGTON, E. G. BROADBENT (Imperial College of Science and Technology, London, England), K. H. HERON, and S. M. MEAD (Royal Aircraft Establishment, Farnborough, England) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0080-4630), vol. 406, no. 1831, Aug. 8, 1986, p. 139-171. refs

An elastic panel is excited by a time harmonic force and the power flow is calculated, averaged over a frequency band and all source positions. The two-dimensional problem is investigated asymptotically, for frequencies that are sufficiently high to ensure that many panel modes are near resonance. The asymptotic results are different according as the frequency is above or below the coincidence value; in the latter case account has to be taken of both resonance and nonresonance contributions to the power flow. A transition formula is given for frequencies near coincidence and the results agree well with numerical calculations. Corresponding results are given for the three-dimensional problem of the rectangular panel and previous theory is justifed and extended.
Author

N87-10016# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
STUDY OF THREE-DIMENSIONAL SEPARATION ON A SPHEROID AT INCIDENCE
Y. ISHU and Y. OSHIMA (Ochanomizu Women's Univ., Tokyo (Japan).) *In its* Proceedings of the Symposium on Mechanics for Space Flight, 1985 9 p 1985
Avail: NTIS HC A12/MF A01

Experimental observation of flow separation on a spheroid at various angles of attack was carried out in low Reynolds number flow using a water channel by flow visualization method. Color oil method was adapted to make the surface separation pattern visible, and hydrogen bubble method was effective for visualization of the flow field around the model. The results support the three-dimensional separation criteria proposed by Maskell, Wang, and Han and Patel, and mechanism of the flow interaction with the longitudinal vortices along the body surface is made clear.
Author

N87-10029# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
REPORT OF THE INTERNATIONAL SYMPOSIUM ON COMPUTATIONAL FLUID DYNAMICS, TOKYO
K. OSHIMA *In its* Proceedings of the Symposium on Mechanics for Space Flight, 1985 8 p 1985
Avail: NTIS HC A12/MF A01

The International Symposium on Computational Fluid Dynamics-Tokyo was held on Sept. 9 thru 12, 1985 at Kenchiku Kaikan of Tokyo. Based on the recommendation given by the International Advisory Committee Members a few distinguished CFD scientists were asked to present a review paper on each specialized field, and 23 out of them were able to accept the invitation. They were noted as INVITED on the Program. Total of 97 abstracts of contributed papers were submitted, and, based on referee reports made by all the International Advisory Committee Members, 75 of them were accepted for presentation. Out of these 98 papers including the invited ones, 35 came from USA, 28 from Japan

and 35 from rest of the world. All of these papers are listed.
E.R.

N87-10244 Pennsylvania State Univ., University Park.
AN EXPERIMENTAL INVESTIGATION OF END-WALL FLOWFIELD OF A COMPRESSOR ROTOR Ph.D. Thesis
K. N. SACHIDANANDAMURTHY 1985 266 p
Avail: Univ. Microfilms Order No. DA8606379

An investigation of the end-wall flowfield in a single-stage compressor rotor is presented. The main emphasis of the investigation was to measure the flowfield in detail in a low-speed compressor rotor. A single-channel laser Doppler velocimeter (LDV) was used to measure the flowfield in the tip clearance region. The investigation was carried out for two tip clearances (clearance/chord = 1.78 and 3.4 percent). In addition, the relative stagnation pressure field, corresponding to a tip clearance of 1.78 percent, was also measured using a Kiel probe to supplement the LDV measurement. The measurements showed that the leakage flow originated at about one-quarter-chord location. Past quarter-chord location, the inteaction between the leakage flow and the annulus-wall boundary layer resulted in unconventional and skewed boundary layer profiles. Inside the rotor passage, the leakage flow effects were augmented by the leakage flow emanating from the entire blade chord length. Downstream of the rotor, the interaction between the leakage flow and the rotor wake resulted in rapid wake decay at higher radii. The leakage flow which was intense at larger clearance might have rapidly smoothed the irregularities downstream of the rotor.

N87-10262 Iowa State Univ. of Science and Technology, Ames.
APPLICATION OF A POTENTIAL CODE TO GENERAL STEADY FLOWS IN THREE DIMENSIONS Ph.D. Thesis
A. A. RANGWALLA 1986 88 p
Avail: Univ. Microfilms Order No. DA8615078

A low order panel method is described for the calculation of incompressible unsteady inviscid flow over general configurations. The numerical method is based upon piecewise constant doublet and source distributions. The wake and the geometry of the body are made to evolve with time. The unperturbed flow is chosen as the internal Dirichlet boundary condition and the source distribution is determined by the external Neumann boundary condition. The application of the Kutta condition for this formulation is straightforward. Two cases are examined. One is the impulsive start of a finite rectangular wing and the other is the interference between a propeller and a wing. The development of the circulation near the root for the first case is compared with the theoretical solution of an impulsively started two dimensional flat plate. The numerical results are very well behaved. The results for the interference between a propeller and a wing did conform with physical expectations. Also, this case is sufficiently general and has many aerodynamic features that either have not been solved or were solved for special cases. Dissert. Abstr.

N87-10391*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TESTING OF UH-60A HELICOPTER TRANSMISSION IN NASA LEWIS 2240-KW (3000-HP) FACILITY
A. M. MITCHELL, F. B. OSWALD, and H. H. COE Aug. 1986 30 p
(NASA-TP-2626; E-2941; NAS 1.60:2626) Avail: NTIS HC A03/MF A01 CSCL 13I

The U.S. Army's UH-60A Black Hawk 2240-kW (3000-hp) class, twin-engine helicopter transmission was tested at the NASA Lewis Research Center. The vibration and efficiency test results will be used to enhance the data base for similar-class helicopters. Most of the data were obtained for a matrix of test conditions of 50 to 100 percent of rated rotor speed and 20 to 100 percent of rated input power. The transmission's mechanical efficiency at 100 percent of rated power was 97.3 and 97.5 percent with its inlet oil maintained at 355 and 372 K (180 and 210 F), respectively. The highest vibration reading was 72 g's rms at the upper housing side wall. Other vibration levels measured near the gear meshes are reported. Author

N87-10400*# Boeing Commercial Airplane Co., Seattle, Wash.
FAULT TOLERANT CONTROL LAWS Final Report
U. L. LY and J. K. HO 1986 113 p
(Contract NAS1-17635)
(NASA-CR-178094; NAS 1.26:178094) Avail: NTIS HC A06/MF A01 CSCL 14D

A systematic procedure for the synthesis of fault tolerant control laws to actuator failure has been presented. Two design methods were used to synthesize fault tolerant controllers: the conventional LQ design method and a direct feedback controller design method SANDY. The latter method is used primarily to streamline the full-state Q feedback design into a practical implementable output feedback controller structure. To achieve robustness to control actuator failure, the redundant surfaces are properly balanced according to their control effectiveness. A simple gain schedule based on the landing gear up/down logic involving only three gains was developed to handle three design flight conditions: Mach .25 and Mach .60 at 5000 ft and Mach .90 at 20,000 ft. The fault tolerant control law developed in this study provides good stability augmentation and performance for the relaxed static stability aircraft. The augmented aircraft responses are found to be invariant to the presence of a failure. Furthermore, single-loop stability margins of +6 dB in gain and +30 deg in phase were achieved along with -40 dB/decade rolloff at high frequency. Author

N87-10404# National Aeronautical Lab., Bangalore (India). Structures Div.
EFFECT OF STATIC INPLANE LOADS AND BOUNDARY CONDITIONS ON THE FLUTTER OF FLAT RECTANGULAR PANELS
A. JOSHI and B. R. SOMASHEKAR Feb. 1986 38 p
(NAL-TM-ST-8604) Avail: NTIS HC A03/MF A01

Presented are investigations of the problem of flutter of initially stressed rectangular panels having various types of boundary conditions including the elastic end restraint. Using the Galerkins modal analysis technique the solutions are obtained for various cases of panel aspect ratio, thickness ratio, and elastic stiffness of the support. The results show that the flutter mode is primarily determined by the first and the second vibration modes. The results also show that the effect of elastic end can be reasonably accurately modelled by simple closed form analytical expressions.
Author

N87-10405# British Aerospace Aircraft Group, Weybridge (England). Structures Dept.
THE EFFECTS OF TEMPERATURE AND LOADING RATE ON R-CURVES USING THE CLWL TECHNIQUES
S. NOWAK Jul. 1985 66 p
(Contract A93B/1391)
(BAE-MSM-R-GEN-0544; BR97093; ETN-86-97946) Avail: NTIS HC A04/MF A01

The effects on crack growth resistance curves of typical aircraft temperature and loading rate variations were investigated. The crack line wedge loaded specimen was used and 2 aluminum alloys, specifications 7475T761 and BSL72 were considered. It is found that at low temperature or high strain rates the resistance to crack growth of 7475T61 is considerably reduced, whereas that of BSL72 benefits slightly. The combined effect of low temperature and high strain rates is shown to further increase the difference between the two alloys. ESA

N87-11017# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. fuer Theoretische Stroemungsmechanik.
ADVANCED METHOD FOR COMPUTING THE FLOW AROUND WINGS WITH REAR SEPARATION AND GROUND EFFECT
K. JACOB Jan. 1986 65 p
(DFVLR-FB-86-17; ISSN-017-1342; ETN-86-98276) Avail: NTIS HC A04/MF A01; DFVLR, Cologne, West Germany DM 21.50

A method for computing the subsonic flow around wings with moderate to high aspect ratio and low sweep at high angles of attack was improved by introducing the curved basic flow concept. It was extended to include the ground effect by utilizing the reflected

image concept. The state of the art is presented, and theoretical results are compared with measurements. Conclusions concerning the scope of the method are drawn. ESA

N87-11020# Rolls-Royce Ltd., Derby (England).
NET SHAPE FORMING: THE ROUTE TO LOW COST COMPONENTS. THE VIEW POINT OF THE AEROSPACE INDUSTRY
J. A. MOORE 6 Mar. 1986 25 p Presented at Institution of Production Engineers Seminar, London, England, 21 Nov. 1985
(PNR-90306; ETN-86-98017) Avail: NTIS HC A02/MF A01

Aerospace products which give the most benefit from Nett and near Nett purchases, and where it is recognised that even though their volume may be low their value is extremely light, are discussed. Turbine blades, nozzle guide vanes, casings, rings, fabrications, and major rotating components are cited. ESA

N87-11128# Air Force Armament Lab., Eglin AFB, Fla.
THREE-DIMENSIONAL UNSTEADY EULER EQUATIONS SOLUTIONS ON DYNAMIC GRIDS Final Technical Report, Jan. - Jun. 1985
D. M. BELK, J. M. JANUS, and D. L. WHITFIELD Apr. 1986 30 p
(AD-A168041; AD-E801301; AFATL-TR-86-21) Avail: NTIS HC A03/MF A01 CSCL 20D

A method is presented for solving the three-dimensional unsteady Euler equations on dynamic grids based on flux vector splitting. The equations are cast in curvilinear coordinates and a finite volume discretization is used for handling arbitrary geometries. The discretized equations are solved using an explicit upwind second-order predictor corrector scheme that is stable for a CFL of 2. Characteristic variable boundary conditions are developed and used for unsteady impermeable surfaces and for the far-field boundary. Dynamic-grid results are presented for an oscillating airfoil and for a store separating from a reflection plate. For the cases considered of stores separating from a reflection plate, the unsteady aerodynamic forces on the store are significantly different from forces obtained by steady-state aerodynamics with the body inclination angle changed to account for plunge velocity. GRA

N87-11129# Air Force Academy, Colo. Research Lab.
VISUALIZATION OF THREE-DIMENSIONAL FORCED UNSTEADY SEPARATED FLOW
M. ROBINSON, H. HELIN, F. GILLIAM, J. RUSSELL, and J. WALKER 1986 11 p
(AD-A168939; FJSRL-TJ-86-0007) Avail: NTIS HC A02/MF A01 CSCL 20D

Three-dimensional unsteady flow separation was visualized for a semi-infinite span wing pitched upward at a constant rate from 0 to 60 deg angles of attack. Initially, many of the same complex flow perturbations, including the formation of leading and trailing edge vortices observed from two-dimensional flow separation were evident. Using the semi-infinite wing, the flow field was further complicated by a wing tip vortex that developed orthogonal to the separation induced leading and trailing edge vortices. The tip flow distorted the development of the initially two-dimensional inboard, leading edge vortex. The simple pitching motion history permitted resolution of the development of individual vortices as a function of airfoil motion parameters. Also, vortex-vortex interactions were examined between separation-induced vortices and wingtip vortices. The interactions were characterized for time periods that extended well beyond the actual pitching motions. Author (GRA)

N87-11144*# United Technologies Corp., East Hartford, Conn.
HOT SECTION VIEWING SYSTEM
W. W. MOREY Sep. 1984 141 p
(Contract NAS3-23156)
(NASA-CR-174773; NAS 1.26:174773; R84-925830-33) Avail: NTIS HC A07/MF A01 CSCL 14B

This report covers the development and testing of a prototype combustor viewing system. The system allows one to see and record images from the inside of an operating gas turbine combustor. The program proceeded through planned phases of conceptual design, preliminary testing to resolve problem areas, prototype design and fabrication, and rig testing. Successful tests were completed with the viewing system in the laboratory, in a high pressure combustor rig, and on a Pratt and Whitney PW20307 jet engine. Both film and video recordings were made during the tests. Digital image analysis techniques were used to enhance images and bring out special effects. The use of pulsed laser illumination was also demonstrated as a means for observing liner surfaces in the presence of luminous flame. Author

N87-11149# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung fuer Flugversuchstechnik.
DIGITAL DATA RECORDING ON FLOPPY DISKS APPLIED FOR ON-BOARD USE IN HELICOPTERS
R. HOLLAND, H. MEYER, and P. PFLEGING May 1986 37 p In GERMAN; ENGLISH summary
(DFVLR-MITT-86-10; ISSN-0176-7739; ETN-86-98178) Avail: NTIS HC A03/MF A01; DFVLR, Cologne, West Germany DM 16.50

A direct data recording system for helicopter flight tests was developed. The system stores the flight test data in an onboard mass memory. It fulfills the requirements imposed by the high vibration level of helicopters, and by the limited space and weight possibilities. Hardware configuration, software, and terminal are described. The system can be easily built and used. Comparisons with analog data recording shows an improvement of data quality. ESA

N87-11175 Cirrus Computers Ltd., Fareham (England).
INVESTIGATION OF OPTIMAL COMPLEXITY OF BITE AND ITS EFFECTS ON RELIABILITY, MAINTAINABILITY, MONITORING AND FAULT PREDICTION
W. R. MOORE and R. I. DAMPER Mar. 1984 47 p
(ETN-86-97976) Avail: Issuing Activity

The application of Built-in-Test (BIT) techniques in the maintenance of military and aircraft electronic systems is reviewed. Despite the relative ease with which BIT can be added, and the apparently good performance claimed by designers, there are clear indications that BIT very often fails in practice in its aims of easy maintainability with lowskilled labor. A particular problem is the rate of false-alarms, where fault-free units are removed unnecessarily and there is evidence that the overall maintenance costs could be lower with less sophisticated BIT. The optimum level of BIT is, however, very difficult to predict and a convincing case can be made for the BIT specification to be developed in an interactive way throughout the course of design, development, commissioning and field operation, in the light of the available technology and of the whole maintenance strategy. Against this background, BIT deployment is seen as much a management problem, as a technical one. ESA

N87-11179*# Vigyan Research Associates, Inc., Hampton, Va.
STRESS ANALYSIS OF PATHFINDER-2 MODELS Final Report, 28 Feb. 1980 - 30 Jun. 1984
S. C. MEHROTRA and C. T. L. MILLS Oct. 1984 39 p
(Contract NAS1-16114)
(NASA-CR-172458; NAS 1.26:172458) Avail: NTIS HC A03/MF A01 CSCL 20K

Stress analysis of the Pathfinder 2 fighter model was performed to determine a method for leading- and trailing-edge attachment that gives acceptable stress levels. Structural modeling of the wing was done using the finite element code SPAR. For the models studied, one ordinary lap joint was found to be satisfactory for the leading-edge flap, however, the alternating surface segmented lap joint method fo attachment was necessary for the trailing-edge flap to obtain acceptable stress levels. Author

N87-11180*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TURBINE ENGINE HOT SECTION TECHNOLOGY, 1984
Oct. 1984 400 p Conference held in Cleveland, Ohio, 23-24 Oct. 1984
(NASA-CP-2339; E-2267; NAS 1.55:2339) Avail: NTIS HC A17/MF A01 CSCL 20K

Presentations were made concerning the hot section environment and behavior of combustion liners, turbine blades, and waves. The presentations were divided into six sessions: instrumentation, combustion, turbine heat transfer, structural analysis, fatigue and fracture, and surface properties. The principal objective of each session was to disseminate research results to date, along with future plans. Topics discussed included modeling of thermal and fluid flow phenomena, structural analysis, fatigue and fracture, surface protective coatings, constitutive behavior, stress-strain response, and life prediction methods.

N87-11183*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FATIGUE AND FRACTURE: OVERVIEW
G. R. HALFORD *In its* Turbine Engine Hot Section Technology, 1984 4 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20K

A brief overview of the status of the fatigue and fracture programs is given. The programs involve the development of appropriate analytic material behavior models for cyclic stress-strain-temperature-time/cyclic crack initiation, and cyclic crack propagation. The underlying thrust of these programs is the development and verification of workable engineering methods for the calculation, in advance of service, of the local cyclic stress-strain response at the critical life governing location in hot section compounds, and the resultant crack initiation and crack growth lifetimes. B.G.

N87-11184*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOST TURBINE HEAT TRANSFER OVERVIEW
J. E. ROHDE *In its* Turbine Engine Hot Section Technology, 1984 6 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20D

Improved methods of predicting airfoil local metal temperatures require advances in the understanding of the physics and methods of analytically predicting the following four aerothermal loads: hot gas flow over airfoils, heat transfer rates on the gas-side of airfoils, cooling air flow inside airfoils, and heat transfer rates on the coolant-side of airfoils. A systematic building block research approach is being pursued to investigate these four areas of concern from both the experimental and analytical sides. Experimental approaches being pursued start with fundamental experiments using simple shapes and flat plates in wind tunnels, progress to more realistic cold and hot cascade tests using airfoils, continue to progress in large low-speed rigs and turbines and warm turbines, and finally, combine all the interactive effects in tests using real engines or real engine type turbine rigs. Analytical approaches being pursued also build from relatively simple steady two dimensional inviscid flow and boundary layer heat transfer codes to more advanced steady two and three dimensional viscous flow and heat transfer codes. These advanced codes provide more physics to model better the interactive effects and the true real-engine environment. Author

N87-11186*# Pratt and Whitney Aircraft, East Hartford, Conn.
DEVELOPMENT OF HEAT FLUX SENSORS IN TURBINE AIRFOILS
W. H. ATKINSON and R. R. STRANGE *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 14B

The objective is to develop heat flux sensors suitable for use on turbine airfoils and to verify the operation of the heat flux measurement techniques through laboratory experiments. The requirements for a program to investigate the measurement of heat flux on airfoils in areas of strong non-one-dimensional flow were also identified. B.G.

N87-11187*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LASER ANEMOMETERS OF HOT-SECTION APPLICATIONS
R. G. SEASHOLTZ, L. G. OBERLE, and D. H. WEIKLE *In its* Turbine Engine Hot Section Technology, 1984 11 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 14B

Laser anemometers are being developed for use in the turbine facilities at Lewis that are involved in the Turbine Engine Hot Section Technology Program. The status of the program is given along with some results accomplished since 1983. B.G.

N87-11188*# United Technologies Research Center, East Hartford, Conn.
HIGH TEMPERATURE STATIC STRAIN GAGE PROGRAM
C. HULSE, R. BAILEY, and H. GRANT (Pratt and Whitney Aircraft, East Hartford, Conn.) *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 6 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 14B

Development of electrical resistance strain gages for static strain measurements of nickel or cobalt superalloy parts inside a gas turbine engine on a test stand was inititated. Measurements of this type are of great importance because without reliable knowledge of the stresses and strains which exist in specific components, it will be difficult to fully appreciate where improvements in design and materials can be implemented. The first part of this effort consists of a strain gage alloy development program which will be followed by an investigation of complete strain gage systems. Efforts to date are summarized. B.G.

N87-11189*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EVALUATION RESULTS OF THE 700 DEG C CHINESE STRAIN GAGES
H. F. HOBART *In its* Turbine Engine Hot Section Technology, 1984 8 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 14B

There is a continuing interest and need for resistance strain gages capable of making static strain measurements on components located in the hot section of gas turbine engines. A paper by Tsen-tai Wu describes the development and evaluation of high temperature gauges fabricated from specially developed Fe-Cr-Al-V-Ti-Y alloy wire. Several of these gages and a quantity of P12-2 ceramic adhesive were purchased for evaluation. Nine members of the aircraft turbine engine community were invited to participate in an evaluation of these gages. Each participant was sent one strain gage, a small amount of ceramic adhesive, instructions for mounting the gage on a test beam, and a set of suggestions for the experiment. Data on gage factor variation with temperature, apparent strain, and drift are discussed. Author

N87-11199*# Pratt and Whitney Aircraft, East Hartford, Conn.
THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT
J. DEMASI and K. SHEFFLER *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 14D

The objective of this program is to develop an integrated life prediction model accounting for all potential life-limiting Thermal Barrier Coating (TBC) degradation and failure modes including spallation resulting from cyclic thermal stress, oxidative degradation, hot corrosion, erosion, and foreign object damage (FOD). The mechanisms and relative importance of the various degradation and failure modes will be determined, and the methodology to predict predominant mode failure life in turbine airfoil application will be developed and verified. An empirically based correlative model relating coating life to parametrically expressed driving forces such as temperature and stress will be employed. The two-layer TBC system being investigated, designated PWA264, currently is in commercial aircraft revenue service. It consists of an inner low pressure chamber plasma-sprayed NiCoCrAlY metallic bond coat

underlayer (4 to 6 mils) and an outer air plasma-sprayed 7 w/o Y2O3-ZrO2 (8 to 12 mils) ceramic top layer. B.G.

N87-11202*# Garrett Corp., Phoenix, Ariz.
NASA DILUTION JET MIXING, PHASE 3
R. SRINIVASAN, G. MYERS, and C. WHITE *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 11 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20D

Many of the gas turbine combustors in operation use multiple rows of dilution jets, and some have geometries that are different from circular holes. The data base available in literature is generally applicable to a single row of circular holes. Tests were performed with uniform mainstream conditions for several orifice plate configurations. Temperature and pressure measurements were made in the test section at 4 axial and 11 transverse stations. These measurements were made with a 60-element rake probe. Test results for some of these cases are discussed. B.G.

N87-11206*# General Electric Co., Fairfield, Conn. Aircraft Engine Business Group.
THE 3D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS
M. L. ROBERTS, R. L. MCKNIGHT, L. T. DAME, and P. C. CHEN *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 3 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20D

Advanced 3-D inelastic structural/stress analysis methods and solution strategies for more accurate and yet more cost-effective analysis of combustors, turbine blades, and vanes are being developed. The approach is to develop four different theories, one linear and three higher order with increasing complexities including embedded singularities. Progress in each area is reported. B.G.

N87-11211*# Southwest Research Inst., San Antonio, Tex.
CONSTITUTIVE MODELING FOR ISOTROPIC MATERIALS
U. S. LINDHOLM *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 8 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20K

A state-of-the-art review of applicable constitutive models with selection of two for detailed comparison with a wide range of experimental tests was conducted. The experimental matrix contained uniaxial and biaxial tensile, creep, stress relaxation, and cyclic fatigue tests at temperatures to 1093 C and strain rates from .0000001 to .001/sec. Some nonisothermal cycles will also be run. The constitutive models will be incorporated into the MARC finite element structural analysis program with a demonstration computation made for advanced turbine blade configuration. In the code development work, particular emphasis is being placed on developing efficient integration algorithms for the highly nonlinear and stiff constitutive equations. Another area of emphasis is the appropriate and efficient methodology for determing constitutive constants from a minimum extent of experimental data. Author

N87-11214*# General Electric Co., Fairfield, Conn. Aircraft Engine Business Group.
ELEVATED TEMPERATURE CRACK GROWTH
K. S. KIM, J. F. YAU, R. H. VANSTONE, and J. H. LAFLEN *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20K

Critical gas turbine engine hot section components such as blades, vanes, and combustor liners tend to develop minute cracks during early stages of operations. The ability of currently available path-independent (P-I) integrals to correlate fatigue crack propagation under conditions that simulate the turbojet engine combustor liner environment was determined. To date, an appropriate specimen design and a crack displacement measurement method were determined. Alloy 718 was selected as the analog material based on its ability to simulate high temperature behavior at lower temperatures in order to facilitate experimental measurements. Available P-I integrals were reviewed and the best approaches are being programmed into a finite element post processor for eventual comparison with experimental data. The experimental data will include cyclic crack growth tests under thermomechanical conditions, and, additionally, thermal gradients. B.G.

N87-11217*# Connecticut Univ., Storrs.
BIAXIAL CONSTITUTIVE EQUATION DEVELOPMENT
E. H. JORDAN and K. P. WALKER *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 7 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20K

In developing the constitutive equations an interdisciplinary approach is being pursued. Specifically, both metallurgical and continuum mechanics considerations are recognized in the formulation. Experiments will be utilized to both explore general qualitative features of the material behavior that needs to be modeled and to provide a means of assessing the validity of the equations being developed. The model under development explicitly recognizes crystallographic slip on the individual slip systems. This makes possible direct representation of specific slip system phenomena. The present constitutive formulation takes the anisotropic creep theory and incorporates two state variables into the model to account for the effect of prior inelastic deformation history on the current rate-dependent response of the material. B.G.

N87-11221*# United Technologies Research Center, East Hartford, Conn.
MEASUREMENT OF AIRFOIL HEAT TRANSFER COEFFICIENTS ON A TURBINE STAGE
R. P. DRING and M. F. BLAIR *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 8 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20D

The primary basis for heat transfer analysis of turbine airfoils is experimental data obtained in linear cascades. A detailed set of heat transfer coefficients was obtained along the midspan of a stator and a rotor in a rotating turbine stage. The data are to be compared to standard analyses of blade boundary layer heat transfer. A detailed set of heat transfer coefficients was obtained along the midspan of a stator located in the wake of a full upstream turbine stage. Two levels of inlet turbulence (1 and 10 percent) were used. The analytical capability will be examined to improve prediction of the experimental data. B.G.

N87-11225*# Pratt and Whitney Aircraft, East Hartford, Conn.
COOLANT PASSAGE HEAT TRANSFER WITH ROTATION, A PROGRESS REPORT
F. C. KOPPER *In* NASA. Lewis Research Center Turbine Engine Hot Section Technology, 1984 10 p Oct. 1984
Avail: NTIS HC A17/MF A01 CSCL 20D

The objective of this 36-month experimental and analytical program is to develop a heat transfer and pressure drop database, computational fluid dynamic techniques, and correlations for multipass rotating coolant passages with and without flow turbulators. The experimental effort will be focused on the simulation of configurations and conditions expected in the blades of advanced aircraft high pressure turbines so that the effects of Coriolis and buoyancy forces on the coolant side flow can be rationally included in the design of turbine blades. Author

N87-11226# George Washington Univ., Washington, D.C. School of Engineering and Applied Science.
STOCHASTIC CRACK PROPAGATION WITH APPLICATIONS TO DURABILITY AND DAMAGE TOLERANCE ANALYSES Final Report, Jun. 1983 - Feb. 1985
J. N. YANG, W. H. HSI, and S. D. MANNING Sep. 1985 263 p (Contract F33615-83-K-3226)
(AD-A168040; AFWAL-TR-85-3062) Avail: NTIS HC A12/MF A01 CSCL 20K

Various stochastic models for fatigue crack propagation under either constant amplitude or spectrum loadings have been

investigated. These models are based on the assumption that the crack growth rate is a lognormal random process, including the general lognormal random process, lognormal white noise process, lognormal random variable, and second moment approximations, such as Weibull, gamma, lognormal and Gaussian closure approximations. Extensive experimental data have been used for the correlation study with various stochastic models. These include fastener hole specimens under fighter or bomber spectrum loadings and center-cracked specimens under constant amplitude loads. The data sets for the fastener hole specimens cover adequately different loading conditions, environments, load transfers and crack size range. It is shown that the white noise process is definitely not a valid model for fatigue crack propagation. GRA

N87-11231# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

RELEVANCE OF SHORT FATIGUE CRACK GROWTH DATA FOR DURABILITY AND DAMAGE TOLERANCE ANALYSES OF AIRCRAFT

A. F. BLOM Mar. 1986 19 p Presented at Engineering Foundation Second International Conference on Small Fatigue Cracks, Santa Barbara, Calif., 5-10 Jan. 1986 Submitted for publication Sponsored by Swedish Board for Technical Development

(FFA-TN-1986-23; ETN-86-97857) Avail: NTIS HC A02/MF A01

Starting from damage tolerance requirements and proceeding over the experimental and numerical means to verify these requirements, it is concluded that the relevance of short fatigue crack studies is limited to durability of the airframe. For engines, the behavior of short cracks is crucial if a damage tolerant design is to be considered. It is suggested that any type of analysis involving short cracks has to be probabilistic. Such a technique is described. ESA

N87-11233# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

FATIGUE FRACTURE IN STEEL LANDING GEAR COMPONENTS

R. J. H. WANHILL 7 Jun. 1985 14 p Sponsored by the Royal Netherlands Air Force Scientific Research Division of the Directorate of Material

(NLR-MP-85050-U; B8668293; ETN-86-98492) Avail: NTIS HC A02/MF A01

The characteristics of fatigue and overload fracture in high strength low alloy steel landing gear forgings were investigated. Fatigue fracture was characterized by microserrated acicular ridges and to a lesser extent by striation marks. Overload fracture was by microvoid coalescence (dimples). After corrosion due to outdoor exposure it is possible to identify fatigue fracture, but overload dimples are much less evident. Constant amplitude and block program (flight-by-flight) fatigue crack propagation rates are well correlated by root mean values of the stress intensity factor range. This is encouraging for analytical estimation of service failure crack propagation lives. ESA

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GEOSCIENCES

Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A87-10116

REACTION TO AIRCRAFT NOISE IN RESIDENTIAL AREAS AROUND AUSTRALIAN AIRPORTS

R. B. BULLEN, A. J. HEDE, and E. KYRIACOS (National Acoustic Laboratories, Sydney, Australia) Journal of Sound and Vibration (ISSN 0022-460X), vol. 108, July 22, 1986, p. 199-225. refs

A large-scale of community reaction to aircraft noise was conducted around five Australian airports, involving interviews with over 3500 residents and the use of intensive and detailed noise measurement data. The major purpose of the study was to produce a valid and reliable dose/response relationship which could serve as a guide for planners, airport authorities and regulatory authorities. Features of the study include assessment of noise exposure by using measurement-based corrections to standard noise level figures for each aircraft type, and the use of a complex scale for assessment of noise reaction (although simpler measures are included for comparison with previous studies). Much of the dose/response analysis involves binary dependent variables, and probit analysis is used in this case in preference to standard regression analysis. A dose/response function is found which predicts the proportion of residents in an area whose reaction exceeds a defined threshold with a standard error of 4.6 dB. Approximately half this error can be explained by error in the measured variables, the rest being due to real inter-area differences in noise reaction. The only personal characteristic which can unambiguously be shown to substantially affect noise reaction is sensitivity to noise in general, which explains about 11 percent of the variance in measured individual noise reaction, compared with about 13 percent for noise exposure. Author

A87-10117

COMPARISON OF THE EFFECTIVENESS OF MEASURES OF AIRCRAFT NOISE EXPOSURE BY USING SOCIAL SURVEY DATA

R. B. BULLEN and A. J. HEDE (National Acoustic Laboratories, Sydney, Australia) Journal of Sound and Vibration (ISSN 0022-460X), vol. 108, July 22, 1986, p. 227-245. refs

Results from a social survey of reaction to aircraft noise are used to investigate the effectiveness of various measures of noise exposure. The measures tested include the equal energy index, models involving a logarithmic trade-off of noise level and number of events, 'peak-level' models and other non-standard noise descriptors. Analysis methods involve the use of probit analysis to investigate the relative efficiency of the various measures in predicting noise reaction. The results from this investigation indicate that the usual equal energy index gives a prediction of noise reaction which is more accurate than most alternatives, and can be improved only marginally when using the noise exposure variables available in this study. The largest improvement in the predictive power of the equal-energy index is gained by adding to it a linear term in the number of noise events. Time-of-day weightings used in most existing noise exposure measures are shown to be less than optimal. Author

A87-12679#
MONITORING OF TERMINAL FLIGHT PHASES ENVIRONMENT OBSERVATIONS AND MODELS
S. PALMIERI, R. COZZI, and G. CASU (Aeronautica Militare Italiana, Ispettorato Telecomunicazioni e Assistenza al Volo, Rome, Italy) IN: Navigation and environment; Proceedings of the Fifth International Congress, Tokyo, Japan, October 1-5, 1985 . Tokyo, Japan Institute of Navigation, 1986, p. 61-68.

The Doppler sodar, which is capable of providing continuous monitoring of the three-dimensional wind speed, was evaluated at the Pantelleria Airport in Tunisia from August-October 1984. The sodar provides three-dimensional wind speed, wind direction, and echo intensity data every few minutes (5-10) with a vertical resolution of 20-50 m. The sodar data reveal a relation between wind shear, and height and time. The effects of sea-breeze and topography are studied using a simple mesoscale model based on a continuity equation. It is noted that sodar is useful for the analysis of wind shear and is capable of detecting downbursts. I.F.

N87-10659*# National Aeronautics and Space Administration, Washington, D.C.
NASA AND FAA LAUNCH WIND SHEAR RESEARCH PROJECT
D. J. RAHN 9 Oct. 1986 2 p
(NASA-NEWS-REL-86-143) Avail: NTIS HC A02 CSCL 04B

The National Aeronautics and Space Administration and the Federal Aviation Administration have signed a memorandum of agreement calling for a joint 5-year, $24 million research project to develop technology for airborne wind-shear detection and avoidance. The most dangerous type of wind shear, the microburst, is a small intense downdraft which, upon striking the ground, spreads out into a circular vortex radiating in all directions. When encountered at low levels on approach or takeoff, the pilot usually has little time to react correctly to maintain the desired flight path or even react enough to survive. Between 1964 and 1985, there were at least 26 accidents and 3 incidents involving 626 fatalities and 235 injuries where wind shear was the direct cause or a contributing factor. The NASA/FAA research project will cover five major areas: technology assessment, present position sensor integration, hazard characterization, pilot factors in wind shear and effects of heavy rain. This represents a consensus approach among the aviation community. Researchers will thoroughly assess the application of technologies such as Doppler and laser radar for airborne equipment to detect the wind-shear danger with the intent of avoiding it. They also will look at the current reactive systems that tell a pilot he is in wind shear and offer the crew guidance information to facilitate a safe exit from wind shear. Another goal is to develop a better understanding of the complex wind structure of a microburst. Author

N87-10665# National Oceanic and Atmospheric Administration, Boulder, Colo. Wave Propagation Lab.
SURFACE MEASUREMENTS OF GUST FRONTS AND MICROBURSTS DURING THE JAWS (JOINT AIRPORT WEATHER STUDIES) PROJECT: STATISTICAL RESULTS AND IMPLICATIONS FOR WIND SHEAR DETECTION, PREDICTION AND MODELING
A. J. BEDARD and J. LEFEBVRE Apr. 1986 123 p
(PB86-200847; NOAA-TM-ERL-WPL-135) Avail: NTIS HC A06/MF A01 CSCL 04B

During the 1982 Joint Airport Weather Studies Project (JAWS), the authors identified 168 microbursts, 20 macrobursts, and 99 gust fronts using surface sensors in the vicinity of Denver's Stapleton Airport. The report reviews aspects of these measurements important to the problem of understanding and detecting wind shear hazardous to aircraft. GRA

N87-11242# Toulouse Univ. (France). Lab. d'Aerologie.
AIRBORNE MEASUREMENT METHODS APPLIED TO THE DETERMINATION OF BOUNDARY CONDITIONS AT THE SEA SURFACE: THE TOSCANE EXPERIMENT [METHODES DE MESURES AEROPORTEES APPLIQUEES A LA DETERMINATION DES CONDITIONS AUX LIMITES SUR LA MER: EXPERIENCE TOSCANE]
P. DURAND, F. SAID, and A. DRUILHET *In* ESA Proceedings of the Third International Colloquium on Spectral Signatures of Objects in Remote Sensing p 23-28 Dec. 1985 In FRENCH Sponsored by Inst. National d'Astronomie et de Geophysique
Avail: NTIS HC A25/MF A01

Two light aircraft were used to collect data on average boundary layer conditions at the sea surface and on turbulent air flow over the sea. The method for calculating turbulent flow is presented. Advantages and disadvantages of the aircraft for this type of data collection are discussed, particularly problems related to perturbations of information on the absolute speed of the aircraft. Consequences for the calculation of wind parameters and motion transfer are outlined. A solution which allows the turbulent horizontal kinetic energy global vertical motion transfer to be reconstructed is given. The relation between parameters calculated at the average flight altitude of 50 m and the conditions at the real boundary layer is considered. ESA

N87-11252# Canada Centre for Remote Sensing, Ottawa (Ontario).
THE C AND KU BAND SCATTEROMETER RESULTS FROM CANADIAN PARTICIPATION IN THE ESA PROMESS OCEAN MEASUREMENT CAMPAIGN
A. L. GRAY and R. K. HAWKINS *In* ESA Proceedings of the Third International Colloquium on Spectral Signatures of Objects in Remote Sensing p 77-82 Dec. 1985 Sponsored by ESA and Innotech Aviation
Avail: NTIS HC A25/MF A01

Multipolarized C and Ku-band fanbeam scatterometer and X(VV) and C(VV) SAR data were collected by aircraft during the ESA PROMESS ocean backscatter experiment. The C(VV) and Ku(HH) scatterometer data for incidence angles from 10 to 58 deg for straight flight lines and from 15 to 55 deg for circle flights is described. For light to moderate winds it is shown that there are significantly larger changes in Ku backscatter than at C band for the same change in wind speed. For the more important moderate to high speed wind regime however, the advantage Ku-band data has over C-band decreases and, on the basis of backscatter sensitivity, satisfactory performance can be expected from the ERS-AMI wind scatterometer. Results for C(VV) and Ku(HH) indicate that both frequencies respond in approximately the same way to a changing azimuth angle between the radar look and wind directions. ESA

N87-11433 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Physik der Atmosphaere.
ICE ACCRETION DEPENDENCE ON CLOUD PHYSICAL PARAMETERS [DER EISANSATZ IN ABHAENGIGKEIT VON WOLKENPHYSIKALISCHEN PARAMETERN]
H. E. HOFFMANN and R. ROTH *In* Deutscher Wetterdienst Reports of Meteorology, No. 23: Proceedings of the German Meteorologists Conference on the Global Climate and Our Environment p 162-163 1986 In GERMAN
Avail: Issuing Activity

Ice deposition was investigated in order to determine flight limitations due to icing, and to verify forecasting methods and ice accretion models. A Do-28 aircraft was equipped for icing research to determine the cloud physical parameters, liquid water content, temperature, particle size, and particle phase. The effects of the icing-relevant cloud physical parameters on the accretion of ice below the Ludlam limit were determined by regression. ESA

N87-11434 Deutscher Wetterdienst, Offenbach am Main (West Germany).
ICE ACCRETION CALCULATIONS ON CYLINDRICAL RODS FOLLOWING THE BAIN MODEL, AND COMPARISON WITH EXPERIMENTAL RESULTS (FUCHS, SCHICKEL, KALUZA, UWIRA, 1985) [EISANSATZBERECHNUNGEN AN ZYLINDRISCHEN STAEBEN NACH DEM BAIN-MODELL UND VERGLEICH MIT EXPERIMENTELLEN ERGEBNISSEN]
W. FUCHS *In its* Reports of Meteorology, No. 23: Proceedings of the German Meteorologists Conference on the Global Climate and Our Environment p 164- 165 1986 In GERMAN
Avail: Issuing Activity

Measurements were performed from a DO-28 aircraft in zones of natural icing in order to determine the parameters required for the model of Bain (1980) which calculates the icing degree on cylindrical rods. These parameters are atmospheric pressure and temperature, size and number of cloud elements, flow velocity, and rod diameter. The Bain model simplifies a model for pure water clouds. Good agreement is found between calculated and measured icing velocities. ESA

N87-11437 Freie Univ., Berlin (West Germany).
THE INFLUENCE OF WEATHER-ACTIVE FRONTS ON VISUAL FLIGHT CONDITIONS [DER EINFLUSS VON WETTERAKTIVEN FRONTEN AUF SICHTFLUGBEDINGUNGEN]
M. GEB, C. LINDEMANN, and W. WEHRY *In* Deutscher Wetterdienst Reports of Meteorology, No. 23: Proceedings of the German Meteorologists Conference on the Global Climate and Our Environment p 170-171 1986 In GERMAN
Avail: Issuing Activity

Structured information describing the effects of weather-active fronts on visual flight conditions was provided. A potential cloud lower level and the effective ridge height of a wood were considered to determine dangerous levels of visual perception. The leeward and windward side are recognized. The results show that it is necessary to evaluate a broader set of cases with weather-active fronts, and to incorporate experiences of local weather advisers, fine-mesh radar data, and special flight measurements. ESA

N87-11461 Technische Univ., Hanover (West Germany). Inst. fuer Meteorologie und Klimatologie.
STATISTICS OF WIND SHEAR DUE TO NOCTURNAL BOUNDARY LAYER JET AIRSTREAMS IN NORTH GERMANY [EINE STATISTIK DER MIT NAECHTLICHEN GRENZCHICHTSTRAHLSTROEMEN VERBUNDENEN WINDSCHERUNG IN NORDDEUTSCHLAND]
K. P. WITTICH, J. HARTMANN, and R. ROTH *In* Deutscher Wetterdienst Reports of Meteorology, No. 23: Proceedings of the German Meteorologists Conference on the Global Climate and Our Environment p 222-223 1986 In GERMAN
Avail: Issuing Activity

Shear wind statistics were prepared for air traffic safety. The shear statistics are based on 14 nocturnal wind profiles. These nights were characterized by a boundary layer jet airstream whose wind maximum was 1.5 times the geostrophic ground wind, or even higher. Wind and temperature profile measurements with a 5 m vertical resolution were performed. It is shown that the nocturnal stabilization of the ground level atmosphere and the formation of a boundary layer jet stream cause an increase of the wind shear. Increasing temperature gradients cause increased shear within certain limits. Strong time variations of wind field and temperature gradients are correlated with high shear. ESA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A87-10879
CSA/NASTRAN - A GENERAL PURPOSE PROGRAM FOR STRUCTURAL ANALYSIS
R. NARAYANASWAMI and J. G. COLE (Computerized Structural Analysis and Research Corp., Northridge, CA) IN: Finite elements in computational mechanics - FEICOM '85; Proceedings of the International Conference, Bombay, India, December 2-6, 1985. Volume 1 . Oxford, Pergamon Press, 1985, p. 23-38. refs

CSA/NASTRAN is an advanced proprietary version of the NASTRAN general purpose computer program for the analysis of structures by the displacement approach of the finite element method. This paper discusses the organization of the NASTRAN program, its analysis capabilities, and details of enhancements available in the CSA/NASTRAN program. The paper concludes with a list of NASTRAN applications in the various industries that has made the program and other proprietary versions of the program, like CSA/NASTRAN, a standard for structural analysis. Author

A87-11779#
A SURVEY OF COMPOSITE GRID GENERATION FOR GENERAL THREE-DIMENSIONAL REGIONS
J. F. THOMPSON (Mississippi State University, Mississippi State) IN: Numerical methods for engine-airframe integration . New York, American Institute of Aeronautics and Astronautics, Inc., 1986, p. 52-85. refs

Three dimensional composite grids for code construction in computational fluid dynamics applied to aircraft configurations are studied. The theory of the grids is addressed, discussing interface continuity, discontinuous and continuous grid lines or slope, and interface difference representations of such grid lines and slopes. Image points are discussed along with boundary point distributions and surrounding image layers.Current research results on discontinuous grid lines, overlaid grids, continuous grid lines, continuous grid line slope, surface grids, and general codes are reviewed. C.D.

A87-12211
ANNUAL AEROSPACE APPLICATIONS OF ARTIFICIAL INTELLIGENCE CONFERENCE, 1ST, DAYTON, OH, SEPTEMBER 16-19, 1985, PROCEEDINGS
J. R. JOHNSON, ED. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Conference sponsored by NCR, VEDA, Inc., Boeing Military Airplane Co., et al. Dayton, OH, AAAIC Secretariat, 1985, 359 p. For individual items see A87-12212 to A87-12220.

Topics of interest at the forefront of the development and implementation of artificial intelligence (AI) systems are detailed. Consideration is given to AI applications in the avionics displays in fighter aircraft, in manufacturing and in ground-based Shuttle navigation monitoring systems. An implementation of LISP on a SIMD is described, along with frame-based knowledge representation for processing planning. Progress in the use of expert systems in an advisory role for the design of video display units and for trouble-shooting system problems in a tactical fighter is assessed. Finally, design and performance features and aplications of the ASPRO parallel processor inference engine are summarized. M.S.K.

A87-12217#
TECHNICAL DIAGNOSIS BY AUTOMATED REASONING
D. ALLEN and K. RADER (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Annual Aerospace Applications of Artificial Intelligence Conference, 1st, Dayton, OH, September 16-19, 1985, Proceedings . Dayton, OH, AAAIC Secretariat, 1985, p. 185-194.

Features and applications of an automated diagnostic program (IN-ATE/2) which includes a rule-based heuristic search strategy for aiding a technician trouble-shooting a system element are described. The element is represented as a logic model, which permits the system to generate its own rule base. Introduction of a true rulebase, i.e., expert knowledge, changes the program to a true expert system. The logic model consists of a topological model of the system being examined. Output is a recommended optimum sequence of tests based on a binary decision tree. The goal of the output is to isolate the fault as quickly and cheaply as possible, and to identify the point at which tests must be made with individual components. A sample application of IN-ATE/2 to trouble-shoot a problem in the circuitry of an F-5 aircraft is outlined. Planned enhancements and implementations of the IN-ATE/2 are discussed. M.S.K.

N87-10017# Chiba Univ. (Japan). Faculty of Engineering.
IMAGES OF THREE DIMENSIONAL FLOWS IN COMPUTER GRAPHICS
N. NISHIKAWA, A. SUZUKI, and S. AKIYAMA *In* Tokyo Univ. Proceedings of the Symposium on Mechanics for Space Flight, 1985 11 p 1985
Avail: NTIS HC A12/MF A01

The numerical results are shown in graphic images for three dimensional boundary-layer flows. It is shown that the presentation of images, especially in solid model graphics, allows the utilization of the widest band width sense in an effective manner to create physical or geometrical models and to understand their behavior in simulated environments. As the results, external streamlines and limiting streamlines obtained with finite difference calculations are given for paraboloid, and for the front half region of wing-ellipsoid combination. Author

N87-11513# Massachusetts Inst. of Tech., Cambridge. Dept. of Elec. Engineering and Computer Sciences.
SIGNAL PROCESSING AND INTERPRETATION USING MULTILEVEL SIGNAL ABSTRACTIONS
E. E. MILIOS Jun. 1986 221 p
(Contract N00014-81-K-0742; NSF ECS-84-07285)
(AD-A169166; TR-516) Avail: NTIS HC A10/MF A01 CSCL 09B

This thesis advances multilevel signal abstractions as a useful conceptual framework in signal processing. More specifically, multilevel abstractions for one-dimensional harmonic spectra are developed and demonstrated to be useful in combining heuristics with algorithmic techniques in a variety of signal processing problems associated with real helicopter data, such as adjusting spectral estimation parameters and tracking fundamental frequency and power of helicopter spectra. Furthermore, multilevel abstractions for two-dimensional wavenumber spectra are used as the basis for a diagnosis system that searches for inappropriate parameter settings in an array processing system for direction determination. The diagnosis system illustrates the use of multilevel single abstractions in automating reasoning about complex signal processing systems. GRA

N87-11530# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
REAL TIME DEBUGGING SOFTWARE PACKAGE FOR FLIGHT SIMULATOR SOFTWARE SYSTEM WITH VARIABLE LABELED COMMON BLOCKS
H. W. G. DEJONGE 2 May 1985 18 p In DUTCH; ENGLISH summary Presented at the Netherlands Society for Informatics, and the Foundation Informatics Research in the Netherlands Symposium, Utrecht, Netherlands, 1-2 Apr. 1985
(NLR-MP-85013-U; B8667024; ETN-86-98489) Avail: NTIS HC A02/MF A01

The support of software development by the application of system defined variables is surveyed. The large software system consists of a large number of modules that share access to data in the direct addressable memory by the use of labeled common blocks in which variable names for addressing fields are used freely. It is proposed to introduce a common-definition file for the management of common variable names, defined on system level, in a similar way as a data dictionary is used for the management of data in data bases. A common-definition file can be applied for the creation of consistent sources for compilation, interactive debugging, and selection of variables for monitoring and recording of data during program execution. A software system which applies access to such a common-definition files is operational.The system is used for software development in FORTRAN 5. ESA

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A87-10293
MECHANICS OF FLOW-INDUCED SOUND AND VIBRATION. VOLUME 1 GENERAL CONCEPTS AND ELEMENTARY SOURCE. VOLUME 2 - COMPLEX FLOW-STRUCTURE INTERACTIONS
W. K. BLAKE (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) Orlando, FL, Academic Press, Inc. , 1986. Vol. 1, 457 p.; vol. 2, 567 p. refs

Physical and mathematical analyses of the vibration and sound induced by different types of fluid flow are presented in a comprehensive introduction intended primarily for practicing engineers. The elementary concepts are explained, and chapters are devoted to the theory of sound and its generation by flow; shear-layer instabilities, flow tones, and jet noise; dipole sound from cylinders; the fundamentals of flow-induced vibration and noise; bubble dynamics and cavitation; hydrodynamically induced cavitation and bubble noise; turbulent wall-pressure fluctuations; structural response to turbulent wall flow and random sound; noise radiation from pipe and duct systems; noncavitating lifting sections; and noise from rotating machinery. Graphs, diagrams, drawings, and tables of numerical data are provided. T.K.

A87-10444
THE MECHANICS OF DYNAMICALLY TUNABLE GYROSCOPES [MEKHANIKA DINAMICHESKI NASTRAIVAEMYKH GIROSKOPOV]
L. Z. NOVIKOV and M. IU. SHATALOV Moscow, Izdatel'stvo Nauka, 1985, 248 p. In Russian. refs

The theory of dynamically tunable gyroscopes, which are widely used in modern inertial navigation systems, is presented. The discussion covers generalized schemes of dynamically tunable gyroscopes including gyroscopes with a single-axis elastic suspension, gyroscopes with a nonsymmetric rotor, and gyroscopes with a rotating elastic suspension. All theoretical results are illustrated by specific calculation examples. V.L.

A87-11766* Florida State Univ., Tallahassee.
RECENT ADVANCES IN AEROACOUSTICS
A. KROTHAPALLI, ED. (Florida State University, Tallahassee) and C. A. SMITH, ED. (NASA, Ames Research Center, Moffett Field, CA) New York, Springer-Verlag, 1986, 522 p. For individual items see A87-11767 to A87-11774.

The state of the art in theoretical and numerical models and experimentation on broadband noise propagation from high speed aircraft components such as jets and helicopter blades is detailed. Attention is given to noise produced by jets, shear layers and turbulence and to the acoustic properties of rotors. The generation and propagation of acoustic noise are discussed in terms of the evolution of concepts for flow-tone generation to include hydrodynamic instabilities. Consideration is also given to techniques for experimental studies and theoretical models for nonlinear features of acoustic propagation of broadband noise and acoustic propagation in partially-choked or soft-walled ducts. M.S.K.

A87-11768* Florida State Univ., Tallahassee.
ON BROADBAND SHOCK ASSOCIATED NOISE OF SUPERSONIC JETS
C. K. W. TAM (Florida State University, Tallahassee) IN: Recent advances in aeroacoustics . New York, Springer-Verlag, 1986, p. 25-51. refs
(Contract NAG3-182)

The characteristics and generation mechanisms of noise associated with the interactions of turbulence with the quasi-periodic broadband shock cells of supersonic jet engines are reviewed. The noise possesses broadband spectra and directionality that are completely different from noise caused by turbulence. Experimental data have shown that broadband noise is most prominent in the forward arc, with peak frequencies being a function of the observation angle and the pressure mismatch in the engine. The noise originates in the engine as turbulence-shock interactions occur during downstream movement. Features of the phased point-source array model and the large turbulence structures-shock cells interaction model are defined and model predictions are compared with experimental data on noise sources. Only a scaling of the noise component is found to be currently possible. More complete characterization depends on consideration of the jet temperature and analysis of turbulence-shock interactions, broadband shock and screech tones and shock noise in several flow configurations. M.S.K.

A87-11769* Cornell Univ., Ithaca, N.Y.
ANALYSES OF BROADBAND NOISE MECHANISMS OF ROTORS
A. R. GEORGE (Cornell University, Ithaca, NY) IN: Recent advances in aeroacoustics . New York, Springer-Verlag, 1986, p. 87-127. NASA-supported research. refs

The various source mechanisms which generate broadband noise on a range of rotors are reviewed. Analyses of these mechanisms are presented and compared to existing experimental data. The sources considered are load fluctuations due to inflow turbulence, due to turbulent blade boundary layers passing the trailing edge, and due to tip vortex formation turbulence. Vortex shedding noise due to laminar boundary layers and blunt trailing edges is not considered in detail as it can be avoided in most cases. Present analyses are adequate to predict the spectra from a wide variety of experiments on fans, helicopter rotors, and wind turbines to within about 5 to 10 dB. Better knowledge of the inflow turbulence improves the accuracy of the predictions. Inflow turbulence noise depends strongly on ambient conditions and dominates at low frequencies. Trailing edge and tip vortex noise are important at higher frequencies if inflow turbulence is weak. Boundary layer trailing edge noise increases slowly with angle of attack but not as rapidly as tip vortex formation noise. Tip noise can be important at high angles of attack for wide chord, square edge tips. Author

A87-11770*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE EVOLUTION OF METHODS FOR NOISE PREDICTION OF HIGH SPEED ROTORS AND PROPELLERS IN THE TIME DOMAIN
F. FARASSAT (NASA, Langley Research Center, Hampton, VA) IN: Recent advances in aeroacoustics . New York, Springer-Verlag, 1986, p. 129-147. refs

Linear wave equation models which have been used over the years at NASA Langley for describing noise emissions from high speed rotating blades are summarized. The noise sources are assumed to lie on a moving surface, and analysis of the situation has been based on the Ffowcs Williams-Hawkings (FW-H) equation. Although the equation accounts for two surface and one volume source, the NASA analyses have considered only the surface terms. Several variations on the FW-H model are delineated for various types of applications, noting the computational benefits of removing the frequency dependence of the calculations. Formulations are also provided for compact and noncompact sources, and features of Long's subsonic integral equation and Farassat's high speed integral equation are discussed. The selection of subsonic or high speed models is dependent on the Mach number of the blade surface where the source is located. M.S.K.

A87-11771*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HELICOPTER IMPULSIVE NOISE - THEORETICAL AND EXPERIMENTAL STATUS
F. H. SCHMITZ and Y. H. YU (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) IN: Recent advances in aeroacoustics . New York, Springer-Verlag, 1986, p. 149-243. refs

The theoretical and experimental status of helicopter impulsive noise is reviewed. The two major source mechanisms of helicopter impulsive noise are addressed: high-speed impulsive noise and blade-vortex interaction impulsive noise. A thorough physical explanation of both generating mechanisms is presented together with model and full-scale measurements of the phenomena. Current theoretical prediction methods are compared with experimental findings of isolated rotor tests. The noise generating mechanisms of high speed impulsive noise are fairly well understood - theory and experiment compare nicely over Mach number ranges typical of today's helicopters. For the case of blade-vortex interaction noise, understanding of noise generating mechanisms and theoretical comparison with experiment are less satisfactory. Several methods for improving theory/experiment are suggested. Author

A87-11773
NONLINEAR ACOUSTIC PROPAGATION OF BROADBAND NOISE
D. G. CRIGHTON (Leeds University, England) IN: Recent advances in aeroacoustics . New York, Springer-Verlag, 1986, p. 411-454. refs

Data on nonlinear broadband jet noise propagation are reviewed, along with several theoretical modeling approaches. The data were obtained with groundside microphones at set distances below the flight path of aircraft in constant climb gradients. Although the data were coontaminated by the jet configurations, acoustic tests in laboratory conditions have confirmed the existence of nonlinear noise effects and shown that they may be cumulative. One model is described which employs an expansional amplitude such as frequency or range to identify frequency distortions at the peak frequency. Account is taken of attenuation, spreading, and spreading nonuniformity effects. A nonlinear plane wave signal evolution model utilizes gaussian statistics to generate an exact solution, but cannot account for attenuation or to make corrections for high frequencies. Finally, the effects of shock waves on the acoustics signals are considered, and data are cited for the presence of nonzero skewness in jet noise signals, which can be described with frequency dispersion terms in the plane wave signal evolution model. M.S.K.

A87-12995
SOURCES AND OBSERVERS IN MOTION, II - ACOUSTIC RADIATION FROM A SMALL RIGID BODY IN ARBITRARY MOTION. III - ACOUSTIC RADIATION FROM NON-COMPACT RIGID BODIES MOVING AT HIGH SPEED
S. E. WRIGHT (Electric Power Research Institute, Palo Alto, CA) and D. J. LEE (Stanford University, CA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 108, Aug. 8, 1986, p. 379-387, 389-403. refs

The time-variant theory of sound propagation developed by Wright (1982 and 1986) is extended from motion in a straight line to arbitrary motion (of a compact source) and to the case of a noncompact body such as a helicopter or propeller blade. The relation between surface displacement and fluid flux sources and the behavior of a point source are analyzed; the special cases of a nonvarying compact source and a compact body in circular motion are discussed; the onset of chord and span noncompactness is described; and formulations for distributed-source interference are derived. The results of numerical computations are presented in graphs and compared with experimental measurements in some cases. The radiated acoustic signature in the compact-body case is shown to be dependent on the speed and direction of flight and not on the body shape. In the case of the rotating blade, the blade profile is found to affect the acoustic signature significantly only at tip speeds in excess of M = 0.9. T.K.

A87-12996
SOURCES AND OBSERVERS IN MOTION. IV - ACOUSTIC MEASUREMENTS ON AEROFOILS MOVING IN A CIRCLE AT HIGH SPEED
S. E. WRIGHT (Electric Power Research Institute, Palo Alto, CA) and W. CROSBY (Stanford University, CA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 108, Aug. 8, 1986, p. 405-413. refs

Recently a rotor aerodynamics and noise facility has been constructed at Stanford University. The experimental approach is to rotate blade elements from a quiet, rigid rotor arm in good anechoic conditions. The capabilities and limitations of this technique are considered, together with initial data. It is concluded that the approach provides a simple and inexpensive method of investigating rotor aerodynamics and noise from windmilling speeds through to high subsonic velocities. Author

N87-10748# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
NUMERICAL AND EXPERIMENTAL STUDY OF DYNAMICS OF TWO-DIMENSIONAL BODY
N. IZUTSU Mar. 1986 67 p
(ISAS-619; ISSN-0285-6808) Avail: NTIS HC A04/MF A01

Autorotation of a two-dimensional elliptic cylinder around its spanwise axis fixed perpendicularly to a uniform flow was numerically simulated by means of a discrete vortex-blob method. The results were compared with those of the experiments by a wind tunnel and a water channel, which were carried out in both the autorotating state and the forced rotating state with constant angular velocities driven by a stepping motor. The behavior and the interaction of the vortices shed behind the rotating elliptic cylinder were studied, making use of visualization of the numerical simulation results. Moreover, animation of the displayed image was made to illustrate the vortex interaction processes. Based on the moment of inertia and the thickness ratio of the cylinder, the starting condition of the autorotation was determined based on the mechanism of the autorotation. The driving force is produced by eliminating the vortex created behind the retreating edge. By means of graphic simulation utilizing a color coded vorticity display and animation, processes of the merging, rearrangement, interaction and splitting of the vortices in the wake of the rotating wing were visualized making these processes clearly understandable. Author

N87-10750*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PREDICTION OF HELICOPTER ROTOR DISCRETE FREQUENCY NOISE: A COMPUTER PROGRAM INCORPORATING REALISTIC BLADE MOTIONS AND ADVANCED ACOUSTIC FORMULATION
K. S. BRENTNER Oct. 1986 94 p
(NASA-TM-87721; L-16130; NAS 1.15:87721) Avail: NTIS HC A05/MF A01 CSCL 20A

A computer program has been developed at the Langley Research Center to predict the discrete frequency noise of conventional and advanced helicopter rotors. The program, called WOPWOP, uses the most advanced subsonic formulation of Farassat that is less sensitive to errors and is valid for nearly all helicopter rotor geometries and flight conditions. A brief derivation of the acoustic formulation is presented along with a discussion of the numerical implementation of the formulation. The computer program uses realistic helicopter blade motion and aerodynamic loadings, input by the user, for noise calculation in the time domain. A detailed definition of all the input variables, default values, and output data is included. A comparison with experimental data shows good agreement between prediction and experiment; however, accurate aerodynamic loading is needed. Author

N87-10752*# General Electric Co., Cincinnati, Ohio.
FREE JET FEASIBILITY STUDY OF A THERMAL ACOUSTIC SHIELD CONCEPT FOR AST/VCE APPLICATION: DUAL STREAM NOZZLES Final Report
B. A. JANARDAN, J. F. BRAUSCH, and R. K. MAJJIGI Washington NASA Mar. 1985 203 p
(Contract NAS3-22137)
(NASA-CR-3867; E-2392; NAS 1.26:3867) Avail: NTIS HC A10/MF A01 CSCL 20A

The influence of selected geometric and aerodynamic flow variables of an unsuppressed coannular plug nozzle and a coannular plug nozzle with a 20-chute outer stream suppressor were experimentally determined. A total of 136 static and simulated flight acoustic test points were conducted with 9 scale model nozzles. Also, aerodynamic measurements of four selected plumes were made with a laser velocimeter. The presence of the 180 deg shield produced different mixing characteristics on the shield side compared to the unshield side because of the reduced mixing with ambient air on the shielded side. This resulted in a stretching of the jet, yielding a higher peak mean velocity up to a length of 10 equivalent diameters from the nozzle exit. The 180 deg shield in community orientation around the suppressed coannular plug nozzle yielded acoustic benefit at all observer angles for a simulated takeoff. While the effect of shield-to-outer stream velocity ratio was small at angles up to 120 deg, beyond this angle significant acoustic benefit was realized with a shield-to-outer stream velocity ratio of 0.64. Author

N87-10753*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
FREE-JET ACOUSTIC INVESTIGATION OF HIGH-RADIUS-RATIO COANNULAR PLUG NOZZLES Final Report
P. R. KNOTT, B. A. JANARDAN, R. K. MAJJIGI, P. K. BHUTIANI, and P. G. VOGT Washington NASA Oct. 1984 218 p
(Contract NAS3-20619)
(NASA-CR-3818; E-2177; NAS 1.26:3818; R83AEB574) Avail: NTIS HC A10/MF A01 CSCL 20A

The experimental and analytical results of a scale model simulated flight acoustic exploratory investigation of high radius ratio coannular plug nozzles with inverted velocity and temperature profiles are summarized. Six coannular plug nozzle configurations and a baseline convergent conical nozzle were tested for simulated flight acoustic evaluation. The nozzles were tested over a range of test conditions that are typical of a Variable Cycle Engine for application to advanced high speed aircraft. It was found that in simulate flight, the high radius ratio coannular plug nozzles maintain their jet noise and shock noise reduction features previously observed in static testing. The presence of nozzle bypass struts

will not significantly affect the acousticn noise reduction features of a General Electric type nozzle design. A unique coannular plug nozzle flight acoustic spectral prediction method was identified and found to predict the measured results quite well. Special laser velocimeter and acoustic measurements were performed which have given new insights into the jet and shock noise reduction mechanisms of coannular plug nozzles with regard to identifying further benificial research efforts. Author

N87-11576*# Pope (L. D.), Woodlands, Tex.
PROPELLER AIRCRAFT INTERIOR NOISE MODEL UTILIZATION STUDY AND VALIDATION
L. D. POPE Sep. 1984 248 p
(Contract NAS1-17281)
(NASA-CR-172428; NAS 1.26:172428; REPT-84-001) Avail: NTIS HC A11/MF A01 CSCL 20A

Utilization and validation of a computer program designed for aircraft interior noise prediction is considered. The program, entitled PAIN (an acronym for Propeller Aircraft Interior Noise), permits (in theory) predictions of sound levels inside propeller driven aircraft arising from sidewall transmission. The objective of the work reported was to determine the practicality of making predictions for various airplanes and the extent of the program's capabilities. The ultimate purpose was to discern the quality of predictions for tonal levels inside an aircraft occurring at the propeller blade passage frequency and its harmonics. The effort involved three tasks: (1) program validation through comparisons of predictions with scale-model test results; (2) development of utilization schemes for large (full scale) fuselages; and (3) validation through comparisons of predictions with measurements taken in flight tests on a turboprop aircraft. Findings should enable future users of the program to efficiently undertake and correctly interpret predictions. Author

N87-11577*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
AN EXPERIMENTAL INVESTIGATION OF THE INTERIOR NOISE CONTROL EFFECTS OF PROPELLER SYNCHROPHASING
J. D. JONES and C. R. FULLER Oct. 1986 103 p
(Contract NAG1-390)
(NASA-CR-178185; NAS 1.26:178185) Avail: NTIS HC A06/MF A01 CSCL 20A

A simplified cylindrical model of an aircraft fuselage is used to investigate the mechanisms of interior noise suppression using synchrophasing techniques. This investigation allows isolation of important parameters to define the characteristics of synchrophasing. The optimum synchrophase angle for maximum noise reduction is found for several interior microphone positions with pure tone source excitation. Noise reductions of up to 30 dB are shown for some microphone positions, however, overall reductions are less. A computer algorithm is developed to decompose the cylinder vibration into modal components over a wide range of synchrophase angles. The circumferential modal response of the shell vibration is shown to govern the transmission of sound into the cylinder rather than localized transmission. As well as investigating synchrophasing, the interior sound field due to sources typical of propellers has been measured and discussed. Author

N87-11578# Rolls-Royce Ltd., Derby (England).
AIRCRAFT NOISE MEASUREMENT: THE 1.2 METRE MICROPHONE HEIGHT SAGA
M. J. T. SMITH 18 Feb. 1986 7 p Presented at Internoise 86, Boston, Mass., Jul. 1986
(PNR-90315; ETN-86-98020) Avail: NTIS HC A02/MF A01

The spectral differences in noise measurements on a range of aircraft types, when using microphones placed in a variety of locations between ground level and 10m were studied. Results show that an inverted microphone configuration, on an easily portable plate, can be specified to eliminate the severe ground interference effects experienced with the International Standard 1.2m high microphone. The move towards such a system by ICAO, for propeller powered light aircraft noise certification, is approved. A move away from the 1.2m system used in the certification of other types of aircraft should be encouraged. Further work should be conducted to confirm the ideal microphone-to-plate separation for jet powered aircraft, and to examine whether the otherwise minimal deviations from pressure-doubling can be further reduced. ESA

N87-11579 Stanford Univ., Calif.
SEPARATION OF AIRBORNE AND STRUCTUREBORNE NOISE RADIATED BY PLATES CONSTRUCTED OF CONVENTIONAL AND COMPOSITE MATERIALS WITH APPLICATIONS FOR PREDICTION OF INTERIOR NOISE PATHS IN PROPELLER DRIVEN AIRCRAFT Ph.D. Thesis
M. C. MCGARY 1986 315 p
Avail: Univ. Microfilms Order No. DA8612765

The anticipated application of advanced turboprop propulsion systems and the use of composite materials in primary structure is expected to increase the interior noise of future aircraft to unacceptably high levels. The absence of technically and economically feasible noise source-path diagnostics tools has been a prime obstacle in the development of efficient noise control treatments for propeller driven aircraft. A new diagnostic method which permits the separation and prediction of the fully coherent airborne and structureborne components of the sound radiated by plates or thin shells has been developed. Analytical and experimental studies of the proposed method were performed on plates constructed of both conventional and composite materials. The results of the study indicate that the proposed method can be applied to a variety of aircraft materials, could be used in flight, and has fewer encumbrances than the other diagnostic tools currently available. The study has also revealed that the noise radiation of vibrating plates in low frequency regime due to combined airborne and structureborne inputs possesses a strong synergistic nature. The large influence of the interaction between the airborne and structureborne terms has been hitherto ignored by researchers of aircraft interior noise problems. noise problems. Dissert. Abstr.

N87-11615# Rolls-Royce Ltd., Derby (England). Materials Engineering Group.
COST EFFECTIVE SINGLE CRYSTALS
M. J. GOULETTE, P. D. SPILLING, and R. P. ARTHEY 18 Feb. 1986 11 p
(PNR-90319; ETN-86-98021) Avail: NTIS HC A02/MF A01

Cost effectiveness constraints in aerospace single crystal technology were met by improving single crystal casting techniques, alloy development, and orientation measurement. The first led to the adoption of the technically more difficult seeding technique as a result of its greater flexibility. The second resulted in the development of a series of three alloys to meet specific turbine applications. The third requirement was met by the development of a rapid and accurate orientation Laue measurement technique (SCORPIO) suitable for the production environment. ESA

N87-11616# Rolls-Royce Ltd., Derby (England). Metallurgical Research Labs.
DEVELOPMENT OF SINGLE CRYSTAL ALLOYS FOR SPECIFIC ENGINE APPLICATIONS
D. A. FORD and R. P. ARTHEY 17 Feb. 1986 11 p
(PNR-90320; ETN-86-98022) Avail: NTIS HC A02/MF A01

A comprehensive family of alloys which meets the requirements of particular engine applications was developed. Alloy SRR is a high strength alloy to replace DS MM002 in applications where increased creep, tensile, and fatigue strength are required; RR2000 is designed for blades requiring low density or high impact resistance; RR2060 was developed as a nozzle guide vane alloy, with exceptional resistance to environmental attack and thermal fatigue. ESA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

A87-10508
THE ROLE OF CHOICE OF LAW IN DETERMINING DAMAGES FOR INTERNATIONAL AVIATION ACCIDENTS
K. S. CAGLE Journal of Air Law and Commerce (ISSN 0021-8642), vol. 51, Summer 1986, p. 953-1006. refs

The increase in international air travel has not prompted uniformity among the laws governing damage awards to passengers injured in international flight. An investigation is conducted regarding the various agreements and regulations which may be involved in the determination of damages for international flight accidents. An analysis is performed of the liability limits available under the Warsaw system and the manner in which they are applied. Flights not covered by the Warsaw system are also considered, taking into account the foreign laws limiting liability, American approaches regarding the choice of law analysis, and foreign approaches to choice of law analysis. It is found that the choice of law analysis can lead to widely divergent damage awards. Attention is given to efforts to amend the Warsaw Convention and the Hague Protocol in Guatemala City in 1971, the Montreal Protocols adopted in 1975, and an alternative which provides uniformity among damage awards in international transportation. G.R.

A87-10509
KEEP YOUR EYE ON THE BIRDIE - AIRCRAFT ENGINE BIRD INGESTION
R. A. MICHAEL Journal of Air Law and Commerce (ISSN 0021-8642), vol. 51, Summer 1986, p. 1007-1035. refs

In connection with the increasing speed of modern aircraft, the problem referred to as 'bird strike' has become a hazard to aircraft. This is particularly true in the case of turboprop and jet aircraft. This article is concerned with the hazard posed to aircraft when birds are ingested into aircraft engines. A description is presented of federal regulations which recognize the hazard that birds pose to aircraft by requiring aircraft engines to continue operation following bird ingestion. Bird ingestion crashes and cases are discussed, taking into account the 'Boston Electra' litigation, the 'Executive Aviation' litigation, the 'Miree' litigation, the 'Hawaiian Airlines' litigation, and the modern trend. Attention is given to the various theories of liability proposed by plaintiffs, the legal defenses available, and possible methods and procedures for avoiding bird ingestion. G.R.

A87-10510
THE CRASH OF DELTA FLIGHT 191 - ARE THE NIGHTMARES COMPENSABLE?
R. PERLMAN Journal of Air Law and Commerce (ISSN 0021-8642), vol. 51, Summer 1986, p. 1037-1084. refs

On August 2, 1985, a wide-bodied airliner carrying 162 people was involved in an aviation accident during its final descent into Dallas/Fort Worth airport. There were only 31 survivors. The present Comment is concerned with the causes of action available in Texas which may allow survivors and witnesses of the crash to recover damages for emotional distress. The question of a bystander's right of recovery in Texas for damages caused by the negligent infliction of emotional distress is considered, taking into account the general situation in Texas, and the application of bystander rules in aircraft cases. Cases related to pain and suffering actual damages are also considered, giving attention also to the unique pain and suffering caused by the terrifying fear that death is imminent, which is often called preimpact fear. The application of emotional distress damages to the bystanders and survivors of the considered flight is discussed. G.R.

A87-10942
INTEGRATED LOGISTICS FOR RECONNAISSANCE SYSTEMS
E. A. VINTHEDEN (Forsvaret Materielverk, Stockholm, Sweden) IN: Airborne reconnaissance IX; Proceedings of the Meeting, San Diego, CA, August 20, 21, 1985 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1985, p. 74-84.

Baselines are presented for a logistics reconnaissance system management program, emphasizing LCC and having a view to the most severe operational conditions. An attempt is made to develop fixed price, LCC-guaranteed multirole aircraft logistics for the year 2000 which incorporate an automated early warning feature and employ a mix of logistics personnel in the field; this personnel mix should encompass conscripts with comparatively little specialized knowledge. O.C.

A87-11804#
THE SYSTEM ENGINEERING AND INTEGRATION CONTRACT - AN OVERVIEW
S. L. COPPS (Martin Marietta Corp., Air Traffic Control Div., Washington, DC) IN: Radio Technical Commission for Aeronautics, Annual Assembly Meeting and Technical Symposium, Washington, DC, November 19-21, 1985, Proceedings . Washington, DC, Radio Technical Commission for Aeronautics, 1985, p. 65-93.

The systems engineering and integration actions which are being and have been implemented for realization of the National Airspace System (NAS) are summarized. The NAS is a modernization of the entire U.S. ATC system to improve current performance and to prepare for future demands. The project is a joint FAA/Martin-Marietta (prime contractor) effort which is requiring full integration of activities of private industry with established FAA practices. The private sector is furnishing the engineering and sytems integration and management expertise necessary to accomplish the $11.7 billion project under FAA guidance and monitoring. A block diagram is provided of the management hierarchy. The NAS plan is updated each year to track progress and changes in the Plan. The task is complicated by the need to maintain the existing ATC sytem while installing the new equipment and training the operators. The feat is being handled by following a master transition plan which directs and monitors the progress and the interrelatedness of each sub-project of the Plan. M.S.K.

A87-11805#
PROJECT MANAGEMENT SUPPORT
D. A. HARTEL (ARINC Research Corp., National Airspace Systems Div., Annapolis, MD) IN: Radio Technical Commission for Aeronautics, Annual Assembly Meeting and Technical Symposium, Washington, DC, November 19-21, 1985, Proceedings . Washington, DC, Radio Technical Commission for Aeronautics, 1985, p. 99-106.

The functions and activities of the Project Management Support (PMS) group, which was established to ensure that the technical, schedule and cost objectives of the 90 projects of the National Airspace System Plan are accomplished are described. The PMS personnel come from private industry and the Federal government. The group reviews and documents technical specifications, implements management control systems for individual and interdependent projects, devises critical path schedules for the various projects, and provides logistics support, including audits of project contractors. Also, the PMS on occassion provides technical direction, i.e., guidance on the interpretation of technical specifications. The functions of the group are illustrated through a description of activities for the NADIN II data switching resources project for establishing a packet-switched network for data communications in the NAS. M.S.K.

N87-10774# Committee on Appropriations (U. S. Senate).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Department of Housing and Urban Development-Independent Agencies Appropriation Bill, 1987 p 64-70 1986
Avail: US Capitol, Senate Document Room

The appropriations for research, development, and procurement activities of NASA are discussed. B.G.

N87-10779# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AIR FORCE TECHNICAL OBJECTIVE DOCUMENT FISCAL YEAR 1987
W. E. BERNER and A. M. SALUS Dec. 1985 77 p Supersedes AFWAL-TR-84-4000
(AD-A167324; AFWAL-TR-85-4000; AFWAL-TR-84-4000) Avail: NTIS HC A05/MF A01 CSCL 01C

This technical objective document describes the technical program in materials to meet future Air Force operational needs. The technology program is divided into ten focal areas which encompass the full spectrum of materials capabilities required for future aircraft, missile, space and electronic systems. These ten areas are: Thermal Protection Materials and Structures; Metallic Structural Materials; Nonmetallic Structural Materials; Nondestructive Evaluation; Aerospace Propulsion Materials; Nonstructural Materials; Electromagnetic Windows and Electronic Materials; Laser Hardened Materials; Computer Aided Manufacturing/Manufacturing R&D; and Systems Support. GRA

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SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

N87-10791 Cornell Univ., Ithaca, N.Y.
INFRARED EMISSION LINES FROM PLANETARY NEBULAE Ph.D. Thesis
M. A. SHURE 1985 156 p
Avail: Univ. Microfilms Order No. DA8525805

The ionic abundances and electron temperatures in the central regions of a number of planetary nebulae were determined using infrared fine-structure lines in the 15 to 40 micron range. The 91 cm telescope of the NASA Kuiper Airborne Observatory was used to measure the following lines: (S III) 18.71, (Ar III) 21.83, (Ne V) 24.28, (O IV) 25.87, (S III) 33.47, and Ne (III) 36.02 microns. Line emission was integrated over the entire emitting region in a total of twenty-two planetary nebulae, ranging from medium to high excitation. All except the (Ar III) line were detected at greater than 3 sigma. Although optical emission lines were used for decades to derive both abundances and temperatures, use of the infrared lines offer two distinct advantages over the optical lines: infrared line emission is insensitive to temperature; and the high excitation ions O(IV) and Ne(V) prove regions closer to the central star than do the bright optical lines. As a consequence, abundances derived from infrared lines do not require accurate temperatures for nebulae, in contrast to the case for temperature-sensitive optical lines. Infrared ionic abundances are therefore potentially much more accurate than the optical abundances. By comparing integrated radio free-free emissions to the infrared line fluxes, abundances were determined for nineteen nebulae.
Dissert. Abstr.

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GENERAL

A87-11339
SCIENTIFIC PROBLEMS OF AVIATION AND SPACE: HISTORY AND PRESENT STATE [NAUCHNYE PROBLEMY AVIATSII I KOSMONAVTIKI: ISTORIIA I SOVREMENNOST']
B. V. RAUSHENBAKH, ED. Moscow, Izdatel'stvo Nauka, 1985, 200 p. In Russian. No individual items are abstracted in this volume.

Papers are presented on such topics as Chaplygin's studies on wing aerodynamics, Isaev's spacecraft engine designs, the automation of design work in aviation, current problems in the testing of aircraft engines, ways to reduce effective thrust loss in supersonic aircraft powerplants, and air-flow stability in gas turbine engine compressors. Attention is also given to the numerical theory of the motion of the earth and Venus according to Venera probe observations, solar-sail rotor dynamics, the effect of additional degrees of freedom on the dynamics of a gravity gradient satellite with a magnetic damper, and numerical and analytical theories of the motion of the outer satellites of Jupiter. Questions of law and international cooperation pertaining to space are also considered.
B.J.

N87-10827*# National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICS AND SPACE REPORT OF THE PRESIDENT
1985 148 p
(NASA-TM-89239; NAS 1.15:89239; GPO-495-812) Avail: NTIS HC A07/MF A01 CSCL 05B

The achievements and activities of the United States aeronautics and space programs for 1985 are examined. The activities are listed by the sponsoring government agency. B.G.

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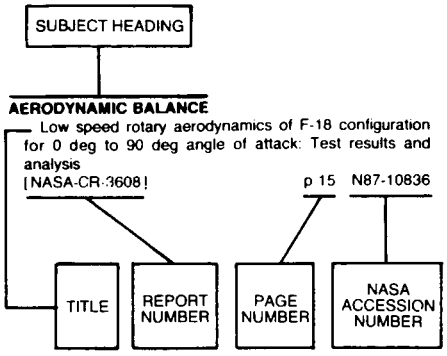

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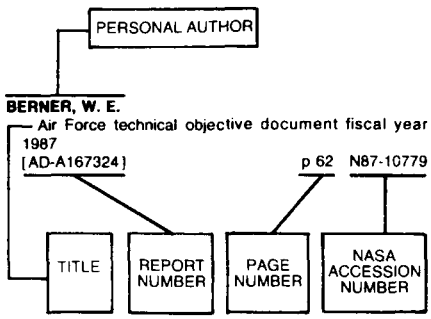

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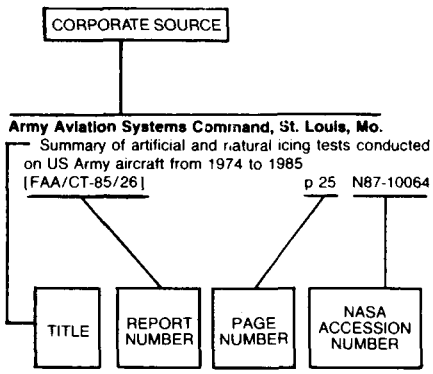

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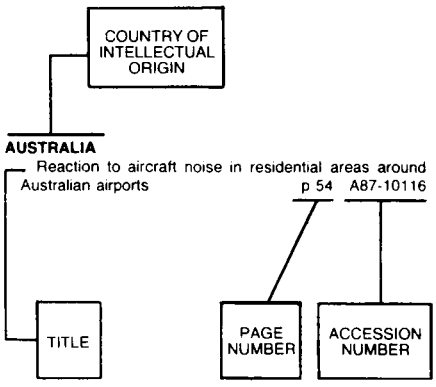

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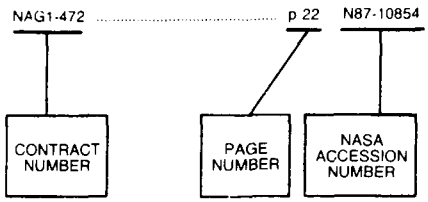

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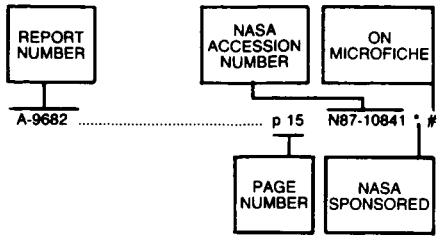

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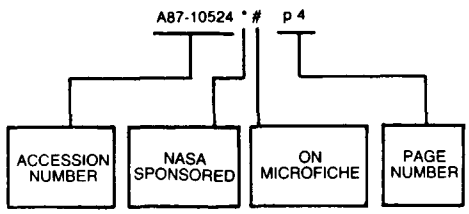

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