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A Continuing Bibliography with Indexes

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National Aeronautics and Space Administration

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STAR (N-10000 Series)	N84-14109 - N84-16114
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NASA SP-7037(173)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 173)

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 March 1984 in

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

NASA Scientific and Technical Information Branch 1984
National Aeronautics and Space Administration
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INTRODUCTION

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

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 704 reports, journal articles, and other documents originally announced in March 1984 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.

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

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at $8.50 per document. Microfiche[(1)] of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents.

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(1) A microfiche is a transparent sheet of film, 105 by 148 mm in size containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26.1 reduction).

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GENERAL AVAILABILITY

All publications abstracted in this bibliography are available to the public through the sources as indicated in the category sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

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N84-10017*# Kansas Univ., Lawrence. Flight Research Lab.
A LIFTING SURFACE THEORY IN ROTATIONAL FLOW Topical Report, Jun. 1981 - Dec. 1982
M. J. SHIAU and C. E. LAN Oct. 1983 74 p refs
(Contract NAG1-75)
(NASA-CR-172233; NAS 1.26:172233; CRINC-FRL-467-2) Avail: NTIS HC A04/MF A01 CSCL 01A

The partial differential equation for small disturbance steady rotational flow in three dimensions is solved through an integral equation approach. The solution is obtained by using the method of weighted residuals. Specific applications are directed to wings in nonuniform subsonic parallel streams with velocity varying in vertical and spanwise directions and to airfoils in nonuniform freestream. Comparison with limited known results indicates that the present method is reasonably accurate. Numerical results for the lifting pressure of airfoil, lift, induced drag, and pitching moments of airfoil, lift, induced drag, and pitching moments of elliptic, rectangular, and delta wings in a jet, wake, or monotonic sheared stream are presented. It is shown that, in addition to the effect of local dynamic pressures, a positive velocity gradient tends to enhance the lift. Author

TYPICAL CITATION AND ABSTRACT FROM *IAA*

AIAA ACCESSION NUMBER — AVAILABLE ON MICROFICHE — TITLE — AUTHOR — AUTHOR'S AFFILIATION — TITLE OF PERIODICAL — PUBLICATION DATE

A84-10131#
EXPERIMENTAL INVESTIGATION OF CURVATURE EFFECTS ON VENTILATED WALL JETS
R. M. EL-TAHER (King Abdulaziz University, Jeddah, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 21, Nov. 1983, p. 1505-1511. refs

The results of an experimental study for a ventilated plane jet attaching to an offset plane surface or to an offset convex surface of circular cross section are presented. The results demonstrate the dependence of the rate of entrainment through the gap, the location of the attachment point, the growth of the length scale, and the decay of the maximum velocity on the wall curvature. Moreover, the effect of wall curvature on the mean velocity, the turbulence velocity components, and the Reynolds shear stress in the different zones of the jet are investigated. Author

AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 173)

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AERONAUTICS (GENERAL)

A84-16160
A TEST PILOT'S LOOK AT AGRICULTURAL AVIATION
C. H. TUOMELA (California Agricultural Aircraft Association, Sacramento, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 42-56.

Various types of agricultural aircraft used in the world, their mission capabilities, and potential markets for U.S. manufacturers are outlined. The U.S. companies currently produce 16 different models of agricultural aircraft in support of a $140 billion cash crop. The aircraft are used primarily for dispensing liquid or solid chemicals to enhance crop growth. Current research is directed at reducing the droplets of sprays to a mist and to controlling drift of the spray. Work is also proceeding on reducing the drag associated with the dispensing system for dust chemicals such as fertilizers, while at the same time increasing the effective flight speed. Three typical agricultural aircraft are reviewed from a pilot's point-of-view, with emphasis on safety factors and currently unacceptable parasitic drag effects which reduce fuel efficiency. M.S.K.

A84-16172
THE AIR FORCE FLIGHT TEST CENTER - CRADLE OF POSTWAR AVIATION
P. W. ODGERS (USAF, Flight Test Center, Edwards AFB, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 260-268.

The history of flight testing at Edwards Air Force Base is surveyed. Particular consideration is given to the early history of Muroc; the wartime employment of the base as a flight testing center for new experimental aircraft, especially jet aircraft; the period of the so-called supersonic breakthrough; the increasing diversification of flight testing (the period of the 1960's), particularly in the area of hypersonic flight; and the Space Shuttle period. B.J.

A84-16526
NAECON 1983; PROCEEDINGS OF THE NATIONAL AEROSPACE AND ELECTRONICS CONFERENCE, DAYTON, OH, MAY 17-19, 1983. VOLUMES 1 & 2
Conference sponsored by the Institute of Electrical and Electronics Engineers, Itek Corp., Computer Sciences Corp., et al. New York, Institute of Electrical and Electronics Engineers, 1983, p. Vol. 1, 748 p.; vol. 2, 817 p.

Topics discussed include the all electric aircraft; aerospace power systems development; electromagnetic compatibility; robotics; CAD/CAM; air data systems; navigation systems; controls and displays; Kalman filtering and signal processing applications; flat panel display technology; airborne image processing and targeting application; airborne automatic target recognition/acquisition; pointing, tracking, and stabilization; airborne radar and fire control technology; airborne computers and multiplex; advanced avionics systems; and digital systems. Consideration is also given to maintenance trainers, visual and electrooptical sensor simulation; software management and engineering techniques; human/machine system analysis; workload assessment; environmental interactions; physiological/medical interfaces; AFTI/F-16 flight development summary; integrated control; flying qualities; and flight management. B.J.

A84-16899
NEUTRAL AXIS OFFSET EFFECTS DUE TO CRACK PATCHING
R. JONES (Defence Science and Technology, Organization, Aeronautical Research Laboratories, Melbourne, Australia) Composite Structures (ISSN 0263-8223), vol. 1, no. 2, 1983, p. 163-174. refs

Due to a variety of factors, cracks initiate and propagate in many aircraft components. These factors may include poor design, inappropriate choice of materials, and/or unexpectedly demanding operating conditions. By reinforcing components after the discovery of cracks of subcritical size, a very cost-effective extension of the safe life of an aircraft can often be achieved. The employed procedure involves the application of boron fiber reinforced plastic patches. However, the placement of a patch on only one side of the structure can lead to a displacement of the neutral axis, and the efficiency of the patch is reduced. The present investigation confirms that simple formulae may be employed to predict the stress intensity factors. It is also shown that unbalanced laminates may be used to counter the increase in the stress intensity factors due to the induced bending field. G.R.

A84-17118
REPAIR INVESTIGATION FOR BISMALEIMIDE STRUCTURE
R. C. KNIGHT (Vought Corp., Dallas, TX) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 223-237. Navy-sponsored research.

This paper reports on an investigation of repair techniques for graphite/bismaleimide nacelle structure. Repair concepts were generated for three baseline damages which are common in the ground handling environment of the Navy fleet. Repair procedures were developed for the most promising concepts for repair of the three baseline damages. The repair procedures were evaluated through a structural test program which addressed the effects of thermal cycling on repair strength. Repair concepts, procedures, and the results of the test program are presented. Author

A84-17119
REPAIR OF POST-BUCKLED ADVANCED COMPOSITE FUSELAGE STRUCTURE
K. CUSTAVSON and N. CORVELLI (Grumman Aerospace Corp., Bethpage, NY) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 238-248.
This paper presents potential repair techniques and material requirements necessary to succesfuly implement a repair of post-buckled integrally stiffened graphite/epoxy structure in the field. Under previous efforts, structure of this type, applicable to aircraft fuselage panels, has been developed, fabricated, and successfully tested to Navy subsonic patrol aircraft requirements. The natural next step was to show its practicality, in a threat environment, by demonstrating its repairability. Repair techniques developed for fuselage skin panels as well as integrally bonded stiffeners are presented. The effects of increased local stiffness characteristics of the repaired area on the adjacent structure and overall load distribution are also evaluated. The design and repair techniques are validated by fabrication and testing (static and fatigue) of elements and a full-scale fuselage subcomponent to realistic subsonic vertical/short takeoff and landing aircraft loadings. Author

A84-17149
MANUFACTURE OF THE ARMY/BELL ADVANCED COMPOSITE HELICOPTER AIRFRAME
R. G. ANDERSON (Bell Helicopter Textron, Fort Worth, TX) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 647-657.
Bell Helicopter Textron Inc. is broadening the technical frontiers of composites by the development of a complete advanced composite helicopter airframe. The program, designated ACAP, is being conducted under a U.S. Army contract. Three airframes for tool proof, structural test and flight will be roduced. The flight vehicle will use Bell's Model 222 dynamics. The objective of ACAP is to demonstrate the use of advanced composites in a fully militarized airframe. Basic design requirements: included ballistic tolerance, reduced radar cross section and crashworthiness. The ACAP criteria were also used to design a metal airframe as a base-line to which cost and weight analyses could be compared. This paper reviews the tooling and manufacturing approaches used along with an innovative design to surpass the ACAP requirements of a 17 percent reduction in cost and a 22 percent reduction in weight. Author

A84-17167
AIRCRAFT PAINTING FACILITY
C. B. REYMANN (Hayes International Corp., Birmingham, AL) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 947-953.
The laminar flow of ventilation air is presented as a positive way to control overspray and stagnant air pockets and to ensure complete movement of all ventilating air through the paint hanger. A discussion of the options for directing laminar air flow across a complete building cross section gives the optimum installation configuration incorporating these options. Special arrangements are considerd for positioning the painters in a way that allows ready access to all aircraft surfaces without walking on the surface. Attention is called to the feature whereby approximately 80 percent of the ventilation air is reused through return air plenums. The safety and health aspects are discussed in detail. The protection is provided by a toxic gas analyzer that monitors air purity and stops the paint spray air supply when a certain predetermined level is reached. C.R.

A84-17192
BONDED REPAIR CENTER
W. M. SCARDINO (USAF, Materials Laboratory, Wright-Patterson AFB, OH) and L. E. MEADE (Lockheed-Georgia Co., Marietta, GA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1292-1305. refs
The program plans for an industry study entitled 'Manufacturing Technology for Integration of Advanced Repair Bonding Techniques' are discussed. The adhesive bonding technology needs of U.S. Army repair facilities are being defined by subcontractor companies. Attention is being given to surface preparation procedures, corrosion resistant primers, and more durable adhesives. Accompanying techniques include NDI tests, improved processing specifications, and elimination of poor bonding practices such as bonding to clad aluminum. Integrated CAM architecture is being developed for repair of the F-111, followed by establishment of repair/network operations on full size structural components. A honeycomb repair center will then be formed for flight-worthy major bonded assemblies. Finally, the mil-spec handbook on bonded repairs will be updated. M.S.K.

A84-17537
MATHEMATICAL MODEL FOR PREDICTING MANHOURS SAVINGS FROM ON-BOARD DIAGNOSTICS AND BIT/BITE
M. F. JORDAN and V. M. KESHISHIAN (Northrop Corp., Hawthorne, CA) IN: Technology advances in engineering and their impact on detection, diagnosis and prognosis methods; Proceedings of the Thirty-sixth Meeting, Scottsdale, AZ, December 6-10, 1982 . Cambridge and New York, Cambridge University Press, 1983, p. 81-86.
Many of the trade-offs made in the design of an aircraft impact its maintainability. A mathematical model for predicting the impact on maintenance manhours of on-board diagnostics, built-in test and built-in test equipment (OBD/BIT/BITE) has been developed for use in conceptual aircraft design. The model can be used to estimate the reduction in maintenance manhours attributable to incorporation of OBD/BIT/BITE in the aircraft design. It is a deterministic model which uses historical data as a basis for parameter estimates. The major parameters are failure rates, detection probability of OBD/BIT/BITE, and troubleshooting percentages of the total maintenance manhours. The model provides a method for comparing alternatives in the conceptual design process and results in general estimates of OBD/BIT/BITE efficiency. Author

A84-17542
ADVANCES IN DESIGN AND TESTING FOR FAILURE PREVENTION IN AIRCRAFT
D. H. JAGGER (Airbus Industrie, Blagnac, Haute-Garonne, France) IN: Technology advances in engineering and their impact on detection, diagnosis and prognosis methods; Proceedings of the Thirty-sixth Meeting, Scottsdale, AZ, December 6-10, 1982 . Cambridge and New York, Cambridge University Press, 1983, p. 173-185.
Examples are given of recent work in Europe on the design and testing of advanced aircraft systems and structural components, based on their application in the Airbus Industrie A310 aircraft program. The paper begins with a section on the development of the aircraft maintenance programs, showing the approach used to achieve safety and good economic reliability in service. To illustrate failure prevention methods, examples of hydromechanical design, digital avionics testing, and structural design against fatigue are discussed, showing aspects of advanced technology application. Author

A84-17974#
RESEARCH TOWARDS AND DEVELOPMENT OF AEROSPACE VEHICLE NOISE CERTIFICATION WITH EMPHASIS ON PROPELLER AIRCRAFT AND HELICOPTERS
H. H. HELLER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Enwurfsaerodynamik, Brunswick, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 18 p. refs
(AIAA PAPER 84-0247)

A84-18146#
LITT - AN IMPLEMENTATION FOR ASW FLIGHT STIMULATION
J. E. SCHWAGER (IBM Federal Systems Div., Owego, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 4 p.
(AIAA PAPER 84-0518)

This paper describes the LAMPS Interactive Tactical Tester (LITT) which provided a landbased alternate means of conducting open ocean ASW flight tests during the Navy LAMPS ship-helicopter development program. LITT stimulates the LAMPS airborne and shipboard ASW acoustic equipments with simulated ASW signals which acoustically substitute for the ocean, sonobuoys, and submarine threats. The simulation/stimulation elements are discussed and related to the operational ASW problem. Examples of flight test implementations are given and the trainer potential is cited. By stimulating the real LAMPS equipment to function in operationally equivalent ASW conditions, LITT has achieved a built-in solution for crew proficiency training.
Author

A84-18508
INTERNATIONAL AEROSPACE CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY, OXFORD UNIVERSITY, OXFORD, ENGLAND, MARCH 23-25, 1982, PROCEEDINGS. VOLUMES 1 & 2
Conference sponsored by the Atomic Energy Research Establishment, U.S. Navy, and U.S. Air Force;. Abingdon, Oxon, England, Culham Laboratory, 1982, Vol. 1, 378 p.; vol. 2, 216 p.
(Contract AF-AFOSR-82-0011)

Topics discussed include the properties of natural lightning; analytical techniques for hazard assessments; lightning testing and experimental techniques; and interaction with aircraft. Papers are presented on the definition of lightning magnitude, on electrical phenomena associated with deep tropical convection, on neutralized electrical charges location during triggered lightning flashes, and on a self-consistent model for return strokes, currents and fields. Attention is also given to an experimental and theoretical evaluation of a fast-risetime high current lightning indirect effects simulator, to direct-strike lightning electromagnetic environments on aircraft exteriors and their stimulation, to atmospheric electric field and aircraft potential variation in flight, and to transient electromagnetic fields on a delta-wing aircraft model with injected currents.
C.R.

N84-14110*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A FLIGHT TEST OF LAMINAR FLOW CONTROL LEADING-EDGE SYSTEMS
M. C. FISCHER, A. S. WRIGHT, JR., and R. D. WAGNER Dec. 1983 17 p refs Presented at the AIAA Aircraft Design, Systems and Operations Meeting, Fort Worth, Tex., 17-19 Oct. 1983
(NASA-TM-85712; NAS 1.15:85712) Avail: NTIS HC A02/MF A01 CSCL 01B

NASA's program for development of a laminar flow technology base for application to commercial transports has made significant progress since its inception in 1976. Current efforts are focused on development of practical reliable systems for the leading-edge region where the most difficult problems in applying laminar flow exist. Practical solutions to these problems will remove many concerns about the ultimate practicality of laminar flow. To address these issues, two contractors performed studies, conducted development tests, and designed and fabricated fully functional leading-edge test articles for installation on the NASA JetStar aircraft. Systems evaluation and performance testing will be conducted to thoroughly evaluate all system capabilities and characteristics. A simulated airline service flight test program will be performed to obtain the operational sensitivity, maintenance, and reliability data needed to establish that practical solutions exist for the difficult leading-edge area of a future commercial transport employing laminar flow control.
Author

N84-14112# Michigan State Univ., East Lansing. Dept. of Metallurgy, Mechanics and Materials Science.
EXTENDING THE LIFETIME OF OPERATIONAL SYSTEMS THROUGH CORROSION TRACKING AND PREDICTION Final Report, Sep. 1979 - Feb. 1983
R. SUMMITT, F. T. FINK, R. SUTER, and N. SAMSAMI Wright-Patterson AFB, Ohio AFWAL Oct. 1983 153 p
(Contract F33615-79-C-5122; AF PROJ. 2418)
(AD-A133931; AFWAL-TR-83-4090) Avail: NTIS HCA08/MFA01 CSCL 01C

Corrosion tracking using the USAF Maintenance Data Collection System was extended to the B-52 fleet, another system of large but elderly aircraft in USAF inventory. This and a study of the C-141A fleet show that MDCS data, together with PACER LIME environmental severity ratings, could provide a basis for optimizing corrosion maintenance, extending operational life of the systems and minimizing overall costs. MDCS is seriously defective, however, and these benefits can not be realized with current data. Changes in USAF maintenance policy, essentially the adoption of reliability-centered, phased inspections, also have produced a different MDCS. These changes are not suitable to the unique problems of corrosion, although the new system may be an improvement with respect to other maintenance requirements.
GRA

N84-14113# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE FIRST PEEK AT CHINA'S NEW FIGHTERS FOR THE EIGHTIES, THE JIAN-8 AND JIAN-12
22 Sep. 1983 7 p Transl. into ENGLISH from Conmilit (China), no. 2, Feb. 1983 p 32-33
(AD-A133785; FTD-ID(RS)T-0452-83) Avail: NTIS HCA02/MFA01 CSCL 01C

The Jian-8 and Jian-12 aircraft are briefly described. Both aircraft can fly over Mach 2. The Jian-8 is powered by two Chinese-built Soviet Tumansky R-11 jet engines and is a variable geometry swing wing fighter. The Jian-12 is powered by a single British Rolls Royce Spey engine and is a delta wing fighter. Weapon systems for the two aircraft are also described.
M.G.

N84-14114# Federal Aviation Agency, Washington, D.C. Office of Aviation Policy and Plans.
THE 8TH FAA FORECAST CONFERENCE PROCEEDINGS Annual Report
Feb. 1983 85 p Conf. held at Arlington, Va., 24 Feb. 1983
(AD-A132646; FAA-APO-83-7) Avail: NTIS HCA05/MFA01 CSCL 01B

The Eighth Annual Aviation Forecast Conference was held on February 24, 1983, in Arlington, Virginia. The general theme of the presentation was Aviation-Forecasting: The State of the Art. The speakers addressed the problems associated with and the expectations of aviation forecast methodologies and their impact on the aviation industry. It was generally agreed that the key problem areas center on economic fluctuations and the need to continue to improve and refine the methodologies used in aviation forecasting.
GRA

N84-14115# Logistics Management Inst., Washington, D. C.
THE AIRCRAFT AVAILABILITY MODEL: CONCEPTUAL FRAMEWORK AND MATHEMATICS
T. J. OMALLEY Jun. 1983 111 p
(Contract MDA903-81-C-0166)
(AD-A132927; AD-F630031; LMI-AF201) Avail: NTIS HCA06/MFA01 CSCL 01C

The Aircraft Availability Model (AAM) is an analytical model and decision support system that relates expenditures for the procurement and depot repair of recoverable spares to aircraft availability rates, by weapon system. The AAM is based on standard probabilistic and marginal analysis concepts of inventory systems theory. It addresses both the multi-echelon aspect of supply (e.g., depots and bases), and the multi-indenture relations that exist among components. The report provides a complete description of the AAM: what the model does, how it does it, and the underlying mathematics. A description of the U.S. Air Force application to the programming, budgeting, and allocation of resources for recoverable spares is included. Author (GRA)

N84-15025# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
AEROACOUSTICS: TEN YEARS OF RESEARCH
1983 313 p refs Proc. of Lecture Series, Rhode Saint Genese, Belgium, 18-22 Apr. 1983
(VKI-LS-1983-05) Avail: NTIS HC A14/MF A01

Noise certification of propeller aircraft and helicopters; helicopter rotor noise generation; experimental methods in compressor noise studies; noise source location/assessment techniques; shock associated noise in convergent nozzles; sound generation in turbulent shear flows; and instrumentation and signal analysis in aeroacoustics research were discussed.

N84-15026# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
RESEARCH TOWARDS AND DEVELOPMENT OF AEROSPACE VEHICLE NOISE CERTIFICATION WITH EMPHASIS ON PROPELLER AIRCRAFT AND HELICOPTERS
H. H. HELLER *In* Von Karman Inst. for Fluid Dynamics Aeroacoustics: Ten Years of Res. 100 p 1983 refs
Avail: NTIS HC A14/MF A01

Noise certification of aerospace vehicles and the research necessary to develop appropriate noise standards are discussed. The ICAO specifications for controlling aircraft noise emission and immission (ANNEX 16 to the Convention on International Civil Aviation) are treated. Noise certification of heavy (commuter and transport) and light (sports and recreational) propeller driven airplanes and helicopters is outlined. Noise certification, data acquisition and evaluation are considered. Considerations towards changing, consolidating and improving the present schemes and procedures are assessed. Author (ESA)

N84-15033# Federal Aviation Administration, Washington, D.C. Office of Management Systems.
CENSUS OF US CIVIL AIRCRAFT. CALENDAR YEAR 1982 Annual Report
31 Dec. 1982 308 p
(AD-A133161; FAA-AMS-220) Avail: NTIS HCA14/MFA01 CSCL 01C

This report presents information about the U.S. civil aircraft fleet. It includes detailed tables of air carrier aircraft and an inventory of registered aircraft by manufacturer and model, and general aviation aircraft by state and country of the owner. Author (GRA)

N84-15034# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
ADVANCED CONCEPTS FOR AVIONICS/WEAPON SYSTEM DESIGN, DEVELOPMENT AND INTEGRATION
Loughton Oct. 1983 484 p refs In ENGLISH and FRENCH Symp. held in Ottawa, 18-22 Apr. 1983
(AGARD-CP-343; ISBN-92-835-0337-6) Avail: NTIS HC A21/MF A01

New design and development strategies are considered to achieve the technical and performance benefits expected of highly advanced and integrated avionics/weapons system in an economic and timely manner. The applicable design and development concepts being considered are as follows: design of the overall system to satisfy the operational requirements; parallel design and development activities in relevant disciplines; retention of design and application flexibility and growth in subsystems by means of appropriate data processing and subsystem inter/intracommunications structure; planning of logistic support elements including reliability, maintainability and supportability as well as life cycle cost considerations; and comprehensive integrated ground testing prior to airborne evaluation of the weapons systems.

N84-15076# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
FLIGHT MECHANICS AND SYSTEM DESIGN LESSONS FROM OPERATIONAL EXPERIENCE
Loughton Oct. 1983 344 p refs In ENGLISH and FRENCH Symp. held in Athens, 10-13 May 1983
(AGARD-CP-347; ISBN-92-835-0342-2) Avail: NTIS HC A15/MF A01

Lessons in design and safety learned from operational experience, incidents, and accidents are discussed. Flight data recording systems, adverse flight conditions, survivability after failure, and the man-machine interface are specifically addressed.

02

AERODYNAMICS

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

A84-15914#
MIXED FINITE DIFFERENCE COMPUTATION OF EXTERNAL AND INTERNAL TRANSONIC FLOW FIELD OF INLETS
S. LUO, H. SHEN, M. JI, Z. XING, S. DONG, and A. HAN Northwestern Polytechnical University, Journal, vol. 1, July 1983, p. 1-13. In Chinese, with abstract in English. refs

A mixed finite difference method for calculating the axisymmetric external and internal transonic flow field of Pitot-type single-cone inlets is presented. The governing equation is the velocity potential equation written in cylindrical coordinates. An orthogonal nonuniform mesh parallel to the axial and radial directions is taken such that mesh intersections lie on the nacelle surface to exactly satisfy the boundary condition at that surface. The influence of the size of the computation region on the convergence stability of the calculations is discussed. Mixed finite difference schemes for partial derivatives of the axial and radial coordinates are employed. For each mesh intersection, the resulting finite difference equations are linearized, obtaining a set of linear equations. Calculations are performed for different free-stream Mach numbers and for two Pitot-type inlets and one single-cone inlet. The resulting parameter values are in good agreement with experimental data. C.D.

A84-16054#
QUASI-DOUBLET-LATTICE METHOD FOR OSCILLATING THIN AIRFOILS IN SUBSONIC FLOW
S. ANDO and A. ICHIKAWA (Nagoya University, Nagoya, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 26, Nov. 1983, p. 163-173. refs

Nonsteady aerodynamics of thin airfoils in subsonic flow is investigated by two kinds of 'quasi-doublet-lattice method' (QDLM). One contains a special device for a chordwise logarithmic singularity (CLS) resulting from the kernel function, while the other does not. This device improves the convergence characteristics of solutions drastically. A kind of 'error index' is introduced, which enables us to compare numerous data in a precise and compact manner.
Author

A84-16070
THE RIGID WALL BOUNDARY PROBLEM FOR AERODYNAMICS EQUATIONS
Z. LIN (Fudan University, Shanghai, People's Republic of China) Scientia Sinica, Series A - Mathematical, Physical, Astronomical and Technical Sciences (ISSN 0253-5831), vol. 26, Sept. 1983, p. 931-945. refs

The solution of the aerodynamics equations for the rigid wall boundary problem is addressed using a special construction of the equations such that the normal derivatives of the solution on the boundary can be directly controlled by the tangent derivatives. Previous results are improved on and the existence and uniqueness theorem of the continuously differentiable solution is proved.
C.D.

A84-16274
A MULTI-VORTEX MODEL OF LEADING-EDGE VORTEX FLOWS
A. J. PEACE (East Anglia, University, Norwich, England) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 3, Nov.-Dec. 1983, p. 543-565. Research supported by the Science and Engineering Research Council. refs

A multi-vortex model of the vortex sheets shed from the sharp leading edges of slender wings is considered. The method, which is developed within the framework of slender-body theory, is designed to deal with those situations in which more than one centre of rotation is formed on the wing, for example on a slender wing with lengthwise camber or with a strake. Numerical results are presented, firstly for situations where comparison can be made with a vortex sheet model and secondly for cases, such as those described above, where a vortex sheet model is unable to describe the flow. Where comparison is available, agreement is good and in the cases where more than one vortex system is present interesting interactions are obtained.
Author

A84-16830
NOTE ON THE BOX METHOD AND THE LINEAR SEGMENT METHOD IN THE INTEGRAL EQUATION OF THIN AEROFOIL THEORY
T. KIDA (Osaka Prefecture, University, Sakai, Japan) and T. TAKE (Shiga Prefectural Junior College, Hikone, Japan) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 36, Feb. 1983, p. 127-145. refs

A theoretical note on the discrete methods, the box method and the linear segment method, for solving the Cauchy integral equation of the steady thin aerofoil theory, is presented in this paper. Several important points concerning the box method and the linear segment method are obtained. In the box method, the choice of the collocation points is very sensitive to the numerical accuracy, the most appropriate choice is a value of some 83 percent, and the singularities in the solution are automatically generated and does not require external imposition such as the Kutta condition. In the linear segment method, the Kutta condition is needed, to obtain a unique solution, the choice of the collocation points is not so sensitive to the accuracy, and its accuracy is of the order of the inverse of the number of the divided box.
Author

A84-16839
FINITE DIFFERENCE COMPUTATION OF THE AERODYNAMIC INTERFERENCE OF WING-PYLON-STORE COMBINATIONS AT TRANSONIC SPEEDS
N.-Q. PAN, W.-F. WANG, S.-J. XU, and Z.-X. HUANG (China Precision Machinery Corp., Beijing, People's Republic of China) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 37, March 1983, p. 1-13.

The present computational method for determining the aerodynamic interference at work in wing-pylon-store configurations is based on the mixed finite difference method introduced by Murman and Cole (1971), although its governing steady flow, transonic, small disturbance potential equation is derived without the assumption of small disturbances in the longitudinal direction. The boundary condition on the surface of the wing-pylon-store configuration is satisfied, together with the Kutta condition for the vortex sheets. The computer program which executes these calculations can produce all flow field requirements, including perturbation potential, downwash speed, sidewash speed, pressure distributions, and aerodynamic coefficients. The three examples to which the method is applied indicate its convergence and degree of agreement with wind tunnel test values.
O.C.

A84-16845
THROUGHFLOW ANALYSIS OF AXIAL FLOW TURBINES
V. K. GARG (Indian Institute of Technology, Kanpur, India) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 37, April 1983, p. 129-137. refs

The development of a streamline curvature throughflow program to predict the flow through an axial flow turbine is described. The program can be used to predict the performance of the turbine at both design and off-design conditions. Comparison of the predictions of the program with flow measurements in a single-stage and in a two-stage turbine shows reasonably good agreement.
Author

A84-16849
NUMERICAL COMPUTATION OF TRANSONIC FLOWS OVER AIRFOILS AND CASCADES
X.-H. ZHOU and F.-Y. ZHU (Northwestern Polytechnical University, Xian, People's Republic of China) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 37, May 1983, p. 277-288. refs

In this paper the transonic flows over airfoils and cascades are computed by means of the time-dependent finite-volume method. The computed results are in good agreement with experimental data. The effect of applying a variable time step as large as is locally allowed by stability as well as a refined-mesh approach on the convergence rate are investigated. The authors adopt the requirement of constant stagnation enthalpy along a streamline instead of the energy equation in the governing equations, derive the stability conditions for difference equation, and find that the stability is improved.
Author

A84-16854
COMPUTATION OF SUPERSONIC INVISCID FLOW AROUND WINGS WITH A DETACHED SHOCK WAVE
G. P. VOSKRESENSKII (Akademiia Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 38, May 1983, p. 45-61. refs

The numerical method for computing inviscid supersonic flow around the front part of the arbitrary planform wings was presented in the studies by Voskresensky and Ivanova (1977) and Voskresensky (1979). The aim of this paper, which is the extension of the previous ones, is to present a numerical method for computing the flow field above the remaining parts of the wing - the wingtip section and the central section of the wing. Here the problems are formulated for a three-dimensional steady gas-dynamic system of equations written in special curvilinear coordinates. Complicated physical domains of the solution are mapped on simple computational domains. For approximation of the differential equations the finite-difference second-order implicit schemes are used. The approximation of the wing surfaces is made with the help of the local cubic splines. According to the obtained algorithms calculations were made for the wing with elliptical planform and thick airfoil at freestream M = 2 and freestream M = 3.5 with the angle of attack of 5 deg. Author

A84-16863
A MIXED FINITE ELEMENT METHOD FOR SOLVING TRANSONIC FLOW EQUATIONS
M. AMARA (Ecole Polytechnique, Palaiseau, Essonne, France), P. JOLY, and J. M. THOMAS (Paris VI, Universite, Paris, France) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 39, July 1983, p. 1-18. refs

A mixed finite element method for solving the transonic flow equations is proposed. A two-dimensional flow past a profile is considered, assuming that the flow is steady, inviscid, and irrotational. For a given density, this method permits the computation of the stream function and the velocity. An artificial density method for calculating the density in the supersonic zones is also proposed. C.D.

A84-16910
THE CONSTRUCTION OF MODELS FOR SUPERSONIC JET FLOWS [O MODEL'NYKH POSTROENIIAKH DLIA SVERKHZVUKOVYKH STRUINYKH TECHENII]
V. G. DULOV IN: Supersonic gas jets . Novosibirsk, Izdatel'stvo Nauka, 1983, p. 118-127. In Russian. refs

Methods are proposed for simulating flows of complex gas-dynamic structure which occur during the impingement of a get on an obstacle. The flows considered involve hydrodynamic discontinuities, large parameter gradients, and significant hypersonic effects. The simplified models proposed here allow quantitative estimates of flow parameters and a qualitative analysis of the principal properties. V.L.

A84-16913
NUMERICAL MODELING OF NONSTATIONARY SUPERSONIC JET FLOW OVER AN OBSTACLE [CHISLENNOE MODELIROVANIE NESTATSIONARNOGO OBTEKANIIA PREGRADY SVERKHZVUKOVYM STRUINYM POTOKOM]
A. I. RUDAKOV and G. M. RUDAKOVA IN: Supersonic gas jets . Novosibirsk, Izdatel'stvo Nauka, 1983, p. 140-155. In Russian. refs

The interaction between an underexpanded supersonic jet and an obstacle is investigated numerically for various flow parameters, with particular attention given to nonstationary interaction. It is shown that a circulating-flow zone exists in front of the obstacle in the case of strongly pulsating interaction with a peripheral maximum. The analysis of the flows is carried out using a second-order finite-difference scheme. V.L.

A84-16916
THE MODELING OF STALLED FLOWS IN THE SHOCK LAYER OF OBSTACLES IN NONUNIFORM FLOW [MODELIROVANIE OTRYVNYKH TECHENII V UDARNOM SLOE PREGRAD, OBTEKAEMYKH NERAVNOMERNYM POTOKOM]
I. A. BELOV, S. A. ISAEV, A. IU. MITIN, and V. V. TSYMBALOV IN: Supersonic gas jets . Novosibirsk, Izdatel'stvo Nauka, 1983, p. 172-178. In Russian. refs

The nonstationary difference scheme of Godunov is used to model the interaction between nonuniform supersonic flows and obstacles of various shapes. Problems in which nonuniform flow is represented by a jet issuing from a nozzle into a slipstream are analyzed. Attention is also given to problems in which flow is made nonuniform by placing nozzles in the path of a uniform flow in front of an obstacle to form a wake-type flow. V.L.

A84-16917
THE EFFECT OF A SLIPSTREAM ON THE LIFT AND DRAG CHARACTERISTICS OF A WING OF FINITE SPAN [O VLIIANII SPUTNOI STRUI NA NESUSHCHIE SVOISTVA I SOPROTIVLENIE KRYLA KONECHNOGO RAZMAKHA]
V. M. SUPRUN IN: Supersonic gas jets . Novosibirsk, Izdatel'stvo Nauka, 1983, p. 178-182. In Russian.

On the basis of a nonlinear theory for a jet wing, a flow model is constructed which describes the nonlinear effect of drag on the lifting force due to the influence of the slipstream. Formulas for the lift coefficient and drag of a wing of finite span are obtained to a second approximation. V.L.

A84-16918
CERTAIN PROBLEMS OF THREE-DIMENSIONAL HYPERSONIC FLOW [NEKOTORYE PROBLEMY PROSTRANSTVENNOGO GIPERZVUKOVOGO OBTEKANIIA]
V. M. BELOLIPETSKII, V. G. DULOV, A. I. RUDAKOV, and V. A. SHCHEPANOVSKII IN: Supersonic gas jets . Novosibirsk, Izdatel'stvo Nauka, 1983, p. 182-195. In Russian. refs

Hypersonic flows over thin bodies are investigated in the near and far regions. New classes of aircraft configurations are created using gas-dynamic design techniques. A mathematical model for the problem of the optimization of a hypersonic aircraft configuration is examined. V.L.

A84-16928
SAIL THEORY [K TEORII PARUSA]
M. A. BRUTIAN and P. L. KRAPIVSKII Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 268, no. 3, 1983, p. 563-565. In Russian.

The problem of the continuous flow past a sail of an ideal incompressible fluid moving in two-dimensional stationary flow is considered. Whereas in earlier studies (Thwaites, 1961; Nielsen, 1963; Keller and Vanden-Broeck, 1981) the stress arising in the material was considered constant, a linear relationship is considered to exist here between the stress and the elongation. The solution, in dimensionless variables, depends on two parameters, namely the angle of attack and the Weber number. The latter is equal to (2)(rho)(U-squared)/f, where rho is the density, U the speed at infinity, and f the proportionality constant between the stress and elongation. An asymptotic solution as the Weber number approaches zero and the angle of attack takes on arbitrary values is sought. C.R.

A84-16951
A PARACHUTE OPENING THEORY WITH ALLOWANCE FOR FLOW PAST THE PARACHUTE AND ITS PERMEABILITY [TEORIIA RASKRYTIIA KUPOLA PARASHIUTA S UCHETOM OBTEKANIIA EGO PRI NALICHII PRONITSAEMOSTI]
R. KHUDAIBERDIEV (Tashkentskii Politekhnicheskii Institut, Tashkent, Uzbek SSR) Akademiia Nauk Uzbekskoi SSR, Doklady (ISSN 0134-4307), no. 7, 1983, p. 18-20. In Russian.

A84-17401#
FREE-FLIGHT AND WIND-TUNNEL DATA FOR A GENERIC FIGHTER CONFIGURATION
G. L. WINCHENBACH (USAF, Direct Fire Weapons Div., Eglin AFB, FL), R. L. USELTON (Calspan Field Services, Inc., Arnold Air Forcg Station, TN), W. H. HATHAWAY (General Electric Co., Armament and Electrical Systems Dept., Burlington, VT), and R. M. CHELEKIS (USAF, Armament Laboratory, Eglin AFB, FL) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 5-13. refs

Previously cited in issue 19, p. 2971, Accession no. A82-39130

A84-17403#
COMPUTATION OF THREE-DIMENSIONAL BOUNDARY LAYERS ON FUSELAGES
E. H. HIRSCHEL (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 23-29. refs
Previously cited in issue 05, p. 586, Accession no. A83-16725

A84-17405*# Informatics, Inc., Palo Alto, Calif.
COMPUTATIONS AND AEROELASTIC APPLICATIONS OF UNSTEADY TRANSONIC AERODYNAMICS ABOUT WINGS
P. GURUSWAMY (Informatics General Corp., Palo Alto, CA) and P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 277-289) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 37-43. refs
Previously cited in issue 13, p. 2016, Accession no. A82-30157

A84-17407#
AERODYNAMICS OF VERY SLENDER RECTANGULAR WING BODIES TO HIGH INCIDENCE
E. S. LARSON (Flugtekniska Forsoksanstalten, Stockholm, Sweden) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 50-53. Research supported by the Defence Materiel Administration. refs
Results from slender body theory and linearized theory have been used to formulate semiempirical expressions for steady, symmetric aerodynamic coefficients of a family of slender wing-body combinations up to angles of attack of about 50 deg. The wing planform is restricted to rectangular wings with an exposed aspect ratio of less than 0.5. The results indicate the capability of slender body theory and linearized theory to provide a basis for the construction of short-cut methods, usable in an early stage of project design where flow situations are still too complicated to be handled by more advanced theories. In order to obtain the present result, it has been necessary to make use of subjective assumptions and an empirical correlation. The result, therefore, is not unique. It is, however, a step toward a practical analytic representation of the symmetric aerodynamic characteristics of the family of wing-body combinations treated. Author

A84-17415#
MINIMUM INDUCED DRAG OF WINGS WITH CURVED PLANFORM
D. WEIHS (Technion - Israel Institute of Technology, Haifa, Israel) and J. ASHENBERG Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 89-91. refs
Lifting-line theory is employed to minimize induced drag for wings with a curved center line, such as those with either forward or backward sweep. The theory is applied to planforms with an aspect ratio much greater than unity, slight deviations from planarity, and a minimum radius of curvature. The finite radius of curvature constrains the discussion to a consideration of a self-induced component of downwash on the lifting line. A core radius term is defined and obtained by computation of the induced drag twice, in the downstream Trefftz plane and independently on the wing. Spanwise circulation is calculated as a Fourier series. Examples are given for swept forward and back parabolic lifting lines, and for a minimized drag for elliptical, rectangular, and triangular chord distributions gained through controlling the airfoil twist. M.S.K.

A84-17428#
UNSTEADY TURBULENT BOUNDARY LAYERS IN ADVERSE PRESSURE GRADIENTS
E. E. COVERT and P. F. LORBER (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 22-28. refs
(Contract AF-AFOSR-80-0282)
Previously cited in issue 15, p. 2344, Accession no. A82-31937

A84-17429#
SUPERSONIC COMPRESSIVE RAMP WITHOUT LAMINAR BOUNDARY-LAYER SEPARATION
G. EMANUEL (Oklahoma, University, Norman, OK) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 29-34. refs
Similar, laminar, boundary-layer theory for a two-dimensional or axisymmetric body is extended by a derivation that yields explicit equations for the wall shape. Isentropic edge conditions are assumed, which results in a differential equation for the pressure gradient parameter beta. The solution of this equation, when beta is constant, parametrically yields the wall shape with the edge Mach number as the parameter. A two-dimensional wall shape is determined when the freestream is supersonic. For a compressive turn, the boundary layer does not separate if beta is not too negative. In this case, the magnitude of beta depends on the ratio of wall temperature to the freestream stagnation temperature. For this application a criterion is provided for the validity of the isentropic edge assumption. A transformation is given for axisymmetric body shapes. Author

A84-17430#
A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF A TRANSONIC PROJECTILE FLOWFIELD
C. J. NIETUBICZ (U.S. Army, Ballistics Research Laboratories, Aberdeen Proving Ground, MD), G. R. INGER (West Virginia University, Morgantown, WV), and J. E. DANBERG (Delaware, University, Newark, DE) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 35-41. refs
(Contract DAAG29-78-G-0057)
Previously cited in issue 06, p. 796, Accession no. A82-17783

A84-17437*# Pennsylvania State Univ., University Park.
THREE-DIMENSIONAL TURBULENT BOUNDARY-LAYER DEVELOPMENT ON A FAN ROTOR BLADE
B. LAKSHMINARAYANA, C. HAH, and T. R. GOVINDAN (Pennsylvania State University, University Park, PA) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 83-89. refs
(Contract NSG-3266)
Previously cited in issue 15, p. 2347, Accession no. A82-31965

A84-17448*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NONUNIQUE SOLUTIONS TO THE TRANSONIC POTENTIAL FLOW EQUATION
M. D. SALAS, C. R. GUMBERT (NASA, Langley Research Center, Hampton, VA), and E. TURKEL AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 145, 146. refs
Steinhoff and Jameson (1981) have shown that within a certain range of angle of attack and freestream Mach number, numerical solutions of the full-potential equation for flow past an airfoil are not unique. This study was mainly concerned with showing that the anomaly is inherent to the partial-differential equation governing the flow and not a result of its discrete representation. Steinhoff and Jameson conjectured that the anomaly may have a physical basis. The present investigation has two objectives. Results are to be presented which indicate that the anomaly is due to a breakdown in the potential approximation, rather than a phenomenon associated with the inviscid flowfield. The second objective is to show that the lift coefficient, predicted by the potential equation, is a smooth but multivalued function of the angle of attack. G.R.

A84-17451#
BEHAVIOR OF THE FLOW THROUGH A NUMERICALLY CAPTURED SHOCK WAVE
D. NIXON (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 150, 151.
(Contract F49620-79-C-0054)
The most common method of predicting transonic flow involves currently the numerical solution of the potential equation representing conservation of mass by means of a shock capturing

algorithm. In a shock capturing algorithm the shock is represented by a finite velocity gradient spread over several mesh points, rather than by a discontinuity. The two types of finite difference algorithms employed include nonconservative algorithms which do not conserve mass through the shock wave, and conservative algorithms which do conserve mass. The present investigation is concerned with aspects of mass conservation during the shock capture in a conservative algorithm. It is concluded that a conservative algorithm conserves mass merely at the end points of the shock capture region. However, there is an increase in mass followed by a decrease in the shock region. G.R.

A84-17454#
A UNIFORMLY VALID ASYMPTOTIC SOLUTION FOR UNSTEADY SUBRESONANT FLOW THROUGH SUPERSONIC CASCADES
O. O. BENDIKSEN (Princeton University, Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 154-157. refs

Bendiksen (1980) has obtained low-frequency approximations of unsteady flow through supersonic cascades with a subsonic leading-edge locus. These solutions have a singularity at an interblade phase angle sigma=0, arising from the collapse of the superresonant region to the point k = sigma=0 as the reduced frequency k approaches 0. For all k greater than 0, the singular point sigma=0 lies not in the superresonant but in the subresonant region. The present investigation has the objective to show that a uniformly valid low-frequency expansion for the subresonant region can be obtained by suitably redefining the underlying limit process k approaches 0. G.R.

A84-17455#
RULE OF FORBIDDEN SIGNALS IN A TWO-DIMENSIONAL SUPERSONIC COMPRESSOR CASCADE
D. C. PRINCE, JR. AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 157-159. Research supported by the General Electric Co. refs

A review is provided of some two-dimensional supersonic compressor cascade data which demonstrate obedience to the 'Rule of Forbidden Signals' over substantial portions of both suction and pressure surfaces. The investigation shows also that a two-dimensional method of characteristics (MOC) analysis without boundary-layer allowance predicts the surface pressures in the zone of silence extremely well. Attention is given to progress at refining previous MOC analyses for more realistic representation of experimental shock structures, taking into account aspects of shock-induced boundary-layer separation. G.R.

A84-17456#
COMMENT ON 'A NEW SOLUTION METHOD FOR LIFTING SURFACES IN SUBSONIC FLOW'
W. P. RODDEN AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 160. refs

A84-17596
AN INVERSE COUPLING ALGORITHM FOR MODELLING A SHOCK WAVE-BOUNDARY LAYER INTERACTION [ALGORITHME DE COUPLAGE INVERSE POUR LE CALCUL D'UNE INTERACTION ONDE DE CHOC DE COUCHE LIMITE]
D. A. DE LA CHEVALERIE (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers, France) Academie des Sciences (Paris), Comptes Rendus, Serie II Mecanique, Physique, Chimie, Sciences de l'Univers, Sciences de la Terre (ISSN 0249-6305), vol. 297, no. 3, Sept. 26, 1983, p. 189-192. In French.

An inverse coupling algorithm is defined for calculating the interaction between a shock wave and a boundary layer in order to account for realistic pressure terms. A functional equation is formulated for the pressure terms, and a gradient is introduced. A Jacobian matrix is configured for the nonviscous flow in terms of a pressure-curvature relation. An example is presented in terms of a small pressure fluctuation on the pressure gradient of the boundary layer. The algorithm is demonstrated to accelerate the speed of convergence without lengthening the calculations significantly at each iteration. M.S.K.

A84-17597
AN UNSTEADY SEPARATED FLOW OF AN INCOMPRESSIBLE FLUID AROUND AN AIRFOIL - COMPARISON BETWEEN NUMERICAL AND EXPERIMENTAL RESULTS [SUR L'ECOULEMENT INSTATIONNAIRE DECOLLED'UN FLUIDE INCOMPRESSIBLE AUTOUR D'UN PROFIL - UNE COMPARAISON CALCUL-EXPERIENCE]
T. P. LOC, O. DAUBE (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, Essonne, France), P. MONNET, and M. COUTANCEAU (Poitiers, Universite, Poitiers, France) Academie des Sciences (Paris), Comptes Rendus, Serie II Mecanique, Physique, Chimie, Sciences de l'Univers, Sciences de la Terre (ISSN 0249-6305), vol. 297, no. 3, Sept. 26, 1983, p. 197-201. In French.

A numerical solution was obtained for the complete Navier-Stokes equations covering the abrupt onset and subsequent flowfield around an ellipse with a 10 percent relative thickness, and the predictions were compared with flow visualization results for a NACA 0012 airfoil. The flow featured an Re of 1000-3000. Solid particles were injected into the flow for streak photography visualizations, and the airfoil was kept at a high angle of attack. The unsteady Navier-Stokes equations included a stream function and a turbulence function, with the solution produced by a mixed method based on Hermitian relations, and discretization. The results demonstrate that the numerical model accurately simulated the velocity profile, separation, recirculation, and other structures of the visualized flow. M.S.K.

A84-17707
FLOW PAST A ROTATING AND A STATIONARY CIRCULAR CYLINDER NEAR A PLANE SCREEN. I - AERODYNAMIC FORCES ON THE CYLINDER [OBTEKANIE VRASHCHAIUSHCHEGOSIA I NEPODVIZHNOGO KRUGOVOGO TSILINDRA VBLIZI PLOSKOGO EKRANA. I - AERODINAMICHESKIE SILY NA TSILINDRE]
V. M. KOVALENKO, N. M. BYCHKOV, G. A. KISEL, and N. D. DIKOVSKAIA (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk (ISSN 0134-2428), Oct. 1983, p. 50-59. In Russian. refs

The lift and drag of a circular cylinder located normal to a flow near a plane screen of finite length are investigated experimentally as a function of the flow velocity, the rotation direction and speed of the cylinder, and the distance between the cylinder and the screen. The experiments are carried out under low-turbulence conditions in a Reynolds number range that includes the critical values. The principal laws governing changes in the aerodynamic forces are determined. It is shown that the effect of the screen is particularly pronounced at a relative distance, h/d, equal to 0.1 or less. V.L.

A84-17826*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ALGEBRAIC GRID GENERATION FOR WING-FUSELAGE BODIES
R. E. SMITH, E. L. EVERTON, and R. A. KUDLINSKI (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0002)

An algebraic procedure for the generation of boundary-fitted grids about wing-fuselage configurations is presented. A wing-fuselage configuration is specified by cross sections and mathematically represented by Coons' patches. A configuration is divided into sections so that several grid blocks that either adjoin each other or partially overlap each other can be generated, and each grid has six surfaces that map into a computational cube. Grids are first determined on the six boundary surfaces and then in the interior. Grid curves that are on the surface of the configuration are derived using plane-patch intersections, and single-valued functions relating approximate arc lengths along the curves to computational coordinates define the distribution of grid points. The two-boundary technique and transfinite interpolation are used to determine the boundary surface grids that are not on the configuration, and transfinite interpolation with linear blending functions is used to determine the interior grids. Author

A84-17827#

A BLOCK-STRUCTURED FINITE ELEMENT GRID GENERATION SCHEME FOR THE ANALYSIS OF THREE-DIMENSIONAL TRANSONIC FLOWS

A. ECER, J. SPYROPOULOS, and I. H. TUNCER (Purdue University, Indianapolis, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract AF-AFOSR-80-0258)
(AIAA PAPER 84-0004)

A finite element grid generation scheme is presented. This scheme was developed in particular for generating computational grids to analyze transonic flows around complex three-dimensional configurations. It provides simple numerical tools in automatically generating grids for a three-dimensional geometry, yet allows someone to control the description of appropriate grids for particular flow regions. It is based on a block structure for both the definition of the geometry and the generation of the grid. The user constructs the grid gradually with increasing details and can interactively make modifications on an existing grid with minimum restrictions. In this paper, the applications of the developed grid generation scheme is provided for a wing-body combination and for a more complex aircraft configuration. Author

A84-17829#

EXPERIMENTAL STUDIES OF SPONTANEOUS AND FORCED TRANSITION ON AN AXISYMMETRIC BODY

J. T. KEGELMAN and T. J. MUELLER (Notre Dame, University, Notre Dame, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(Contract DAAG29-78-G-1012; DAAG29-80-C-0127)
(AIAA PAPER 84-0008)

An experimental investigation of spontaneous and forced transition on a secant-ogive-nose axisymmetric body was conducted for length Reynolds numbers between 315,000 and 1,030,000. Several different transition modes were observed and documented using smoke flow visualization and hot-wire anemometry. Sound was used to control the frequency and enhance the amplitude of the disturbances in the boundary layer during the forced transition studies. Three different mechanisms of transition originated as a viscosity-conditioned Tollmien-Schlichting (T-S) instability. The evolution of these instability waves depended on Reynolds number, the frequency of the disturbance and the amplitude of the disturbance. A change in the nonlinear development of the secondary instability (the vortex truss structure) could be induced by changing only the amplitude of the T-S waves, keeping all other conditions constant. The frequency spectra from a hot wire placed in this flowfield showed an abrupt decrease in the power spectral density (PSD) of the subharmonic of the T-S wave frequency as the amplitude of the disturbance is increased. Mean and fluctuating velocity profiles and the mean pressure distribution along the body are also presented. Author

A84-17830*# Systems and Applied Sciences Corp., Hampton, Va.

EFFECTS OF STREAMWISE VARIATIONS IN NOISE LEVELS AND SPECTRA ON SUPERSONIC BOUNDARY-LAYER TRANSITION

F.-J. CHEN (Systems and Applied Sciences Corp., Hampton, VA), I. E. BECKWITH, and T. R. CREEL, JR. (NASA, Langley Research Center, High-Speed Aerodynamics Div., Systems and Applied Sciences Corp., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract NAS1-17296)
(AIAA PAPER 84-0010)

Transition data for sharp cones in two quiet wind tunnels at Mach numbers 3.5 and 5.0 have been correlated in terms of noise parameters with data from several conventional wind tunnels and from the flight data for the AEDC transition cone. The noise parameters were developed to account for the large axial variations of the rms stream noise and the high frequency noise spectra that occurred in the quiet tunnels for some test conditions. The correlation results indicated transition in the quiet tunnels was dominated by the local stream noise that was incident on the cone boundary layer upstream of the neutral stability point. The correlation results also suggested that the energy in high frequency components of the quiet tunnel noise spectra had significant adverse effects on transition when the noise was incident on the boundary layer both upstream and downstream of the neutral stability point. Author

A84-17831#

FLOW FIELD STUDIES OF A TRANSPORT AIRPLANE

M. C. SUNSERI, H. C. SEETHARAM, and M. D. MACK (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p.
(AIAA PAPER 84-0012)

Experiments were conducted on a half-model transport airplane at low speeds in order to obtain a better understanding of the three-dimensional flow fields associated with the wing of a modern transport. The collected data includes force and moment measurements and complete total pressure and velocity field surveys. The development of separated flow regions with increasing angle of attack creates dramatic changes in spanwise flow leading to the formation of part-span vortices. Flow field surveys indicate that the part-span vortices originate near the wing leading edge just above the viscous layer. When the vortices form over the wing, the magnitude of the freestream velocity component of the vortex cores is greater than the freestream velocity itself. The core velocities drop to less than the freestream level as the vortices move into the wake. The rotational characteristics of the vortices seem to persist well into the wake. Author

A84-17832#

EXPERIMENTS AND COMPUTATION ON TWO-DIMENSIONAL TURBULENT FLOW OVER A BACKWARD FACING STEP

R. E. WALTERICK, J. I. JAGODA, C. R. J. RICHARDSON, W. A. DE GROOT, W. C. STRAHLE, and J. E. HUBBARTT (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(Contract F49620-82-C-0013)
(AIAA PAPER 84-0013)

Measurements are made of two components of velocity and shear stress on a turbulent incompressible two-dimensional flow over a backward facing step in a confining channel. A turbulent kinetic energy-dissipation rate of turbulence energy method of calculation was developed which produces good agreement with experiments for both time mean and turbulence quantities. Reattachment length is particularly well predicted. Sensitivity of this flow to geometrical details and initial conditions has been numerically investigated and found to be high; consequently, comparison with other data sets is difficult. Fluctuations of the order of 2 percent were found in a region of the flow which should not have been vortical, and acoustic motions due to an unsteady recirculatory flow are suspected. Author

A84-17838*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NUMERICAL INVESTIGATION OF UNSTEADY INLET FLOW FIELDS

T. HSIEH, A. B. WARDLAW, JR., P. COLLINS (U.S. Naval Surface Weapons Center, Silver Spring, MD), and T. COAKLEY (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. Navy-sponsored research. refs

(AIAA PAPER 84-0031)

The flow field within an unsteady, two-dimensional inlet is studied numerically, using a two dimensional Navier Stokes and a one-dimensional inviscid model. Unsteadiness is introduced by varying the outflow pressure boundary condition. The cases considered include outflow pressure variations which were a single pressure pulse, a rapid increase and a sine function. The amplitude of the imposed exit plane pressure disturbance varied between 1 percent and 20 percent of the mean exit pressure. At the higher levels of pressure fluctuation, the viscous flow field results bore little resemblance to the inviscid ones. The viscous solution included such phenomena as shock trains and bifurcating separation pockets. The induced velocity at the outflow plane predicted by the viscous model differs significantly from accoustical theory or small perturbation results. Author

A84-17839#

ANALYTICAL AND EXPERIMENTAL STUDIES ON NATURAL LAMINAR FLOW NACELLES

J. L. YOUNGHANS and D. J. LAHTI (General Electric Co., Cincinnati, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs

(AIAA PAPER 84-0034)

High speed proof of concept testing of a scale model natural laminar flow nacelle has been conducted with favorable results. Both isolated and installed tests have been conducted in the 16-Foot Wind Tunnel at NASA Langley to assess the feasibility of natural laminar flow to reduce nacelle external friction drag. Laminar flow drag reduction was verified in the isolated nacelle testing by force balance data as well as momentum rake integration. The installed nacelle drag reduction was measured by force balance only. Acenaphthene was utilized as a flow visualization tool to indicate the axial extent of laminar flow on the nacelle during both isolated and installed testing. The flow visualization data confirmed the presence of a significant region of laminar flow on the nacelle forebody as was also deduced by the measured drag reductions. Author

A84-17840#

A FINITE VOLUME METHOD FOR TWO DIMENSIONAL TRANSONIC POTENTIAL FLOW THROUGH TURBOMACHINERY BLADE ROWS

J. V. SOULIS (Thrace, University, Xanthe, Greece) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs

(AIAA PAPER 84-0035)

The 2D transonic flow through turbomachinery blades has been treated. The exact transonic flow equation is solved on a mesh constructed from small area elements. A transformation is introduced through which distorted squares of the physical plane are mapped into computational squares. Two sets of overlapping elements are used. While the thermodynamic properties are calculated at the primary element centers the flux balance is established on the secondary elements. For transonic flows an artificial compressibility term (upwind density gradient) is added to density in order to produce the desired directional bias in the hyperbolic region, while the entropy does not increase across mass conservative shock jump regions. Comparisons with experiments and/or other numerical and analytical solutions for various turbomachinery configurations show that the 2D finite-volume approach is a comparatively accurate, reliable and fast method for inviscid transonic flow predictions through turbomachinery blade rows. Author

A84-17841*# Pennsylvania State Univ., University Park.

THE APPLICATION OF VORTEX THEORY TO THE OPTIMUM SWEPT PROPELLER

B. W. MCCORMICK (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs

(Contract NAS3-22251)

(AIAA PAPER 84-0036)

It is shown that an optimum propeller generating a swept wake must satisfy the Betz condition, at least to a first order. A numerical solution for swept propellers generating a rigid helicoidal wake is formulated and some results are presented. These results indicate that sweep has a significant effect on Goldstein's kappa factor, particularly at high advance ratios typical of those at which advanced turboprops operate. Author

A84-17845#

CHARACTERISTICS OF SEPARATED FLOW AIRFOIL ANALYSIS METHODS

J. D. BLASCOVICH (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs

(AIAA PAPER 84-0048)

A correlation study was performed to determine the engineering value of several current computational methods which analyze airfoils with separated flow. The computer programs used were the CLMAX code from Analytical Methods, Inc., the TRANSEP code from Texas A&M University, the BARNWELL code from NASA Langley Research Center, and the KORNDSEP code from Grumman Aerospace. Experimental data from six airfoils were used to determine the accuracy of each of the above methods. The airfoils are the NASA GA(W)-1, NASA GA(W)-2, NASA A-1, NACA 4412, NACA 65-213, and NACA 0012. Both subsonic and transonic trailing edge separation cases were investigated. The results indicate that no method is capable of accurately predicting all of the cases investigated. The most consistent codes appear to be the CLMAX and BARNWELL programs. Author

A84-17847#

NUMERICAL SOLUTION OF THE EULER EQUATIONS FOR FLOW PAST AN AIRFOIL IN GROUND EFFECT

J. E. DEESE and R. K. AGARWAL (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. Research supported by the McDonnell Douglas Independent Research and Development Program. refs

(AIAA PAPER 84-0051)

Transonic flowfields around the NACA-0012 airfoil, the 12 percent-thick Joukowski airfoil in ground effect, and the Korn 75-06-12 airfoil are computed by solving Euler equations on body-conforming curvilinear grids. A modular solution aproach is adopted wherein an algebraically generated grid is coupled with the flow solver. The Euler equations are solved by the method developed by Jameson, Schmidt, and Turkel. The considerable control provided by the algebraic grid-generation method is utilized in achieving an efficient distribution of grid points in the flow domain. Highly accurate solutions are obtained for subsonic and transonic flows past the airfoils, with and without ground effect. Author

A84-17848#
CLARK-Y AIRFOIL PERFORMANCE AT LOW REYNOLDS NUMBERS
J. F. MARCHMAN, III (Virginia Polytechnic Institute and State University, Blacksburg, VA) and T. D. WERME American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p.
(AIAA PAPER 84-0052)

A wind-tunnel investigation of the low Reynolds number aerodynamics of a Clark-Y airfoil was performed at Re = 50,000-200,000. Pressure distributions were measured for angles of attack ranging from 0 to 28 deg at each Reynolds number and the results integrated to obtain CL and CD plots. The results revealed that the Clark-Y airfoil performs well at these low Reynolds numbers, obtaining maximum CL values above 1.0 and low pre-stall drag coefficients. There was little evidence of any hysteresis effect in stall. Author

A84-17849#
AIRFOIL OPTIMIZATION
K. P. MISEGADES (Dornier GmbH, Friedrichshafen, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. Sponsorship: Bundesministerium de Verteidigung. refs
(Contract BMVG-T/RF-41/A0039/A1439)
(AIAA PAPER 84-0053)

This paper describes the development and application of a computer program for the optimization of airfoils. Through the modification of a desired part of the contour, any one of a number of possible parameters, such as Cl or Cd, can be maximized or minimized, with or without constraints placed upon new configurations. The example of drag reduction of the GA(W)-1 airfoil is presented, showing significant improvement at both design and off-design conditions. The program is unique in that it employs the approximate optimization technique of Vanderplaats (1979), an aerodynamic code for subsonic and transonic viscous flows about airfoils, as well as a geometry modification technique based on trigonometric splines. Author

A84-17857#
THE STABILITY OF AN ELLIPTIC JET
D. MILLER (Pennsylvania State University, State College, PA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0068)

The effect of small disturbances on the flow from an elliptical jet nozzle is analyzed. The assumption that the disturbances are small in comparison with the steady characteristics of the flow, together with the assumption that the steady and unsteady flow can be superimposed,allows the momentum and continuity equations to be linearized. When the perturbation quantities are assumed to take the form of an exponential function of time and axial distance multiplied by a function which depends upon cross-sectional location only, the stability equation in Cartesian coordinates results. A change of variables to elliptical cylindrical coordinates allows the stability equation to be written in a form for which a separable solution exists. The separable solution can be expressed both inside the potential core and outside the jet shear layer by Bessel Function product series. The solution through the shear layer must satisfy a homogenous differential operator, therefore an eigenvalue problem results in which the potential core solution must be matched to the solution outside of the jet. A computer program was developed which calculates the temporal and spatial modes which satisfy the eigenvalue problem. Author

A84-17859#
EFFICIENT GRID GENERATION FOR AXIAL TURBOMACHINERY CASCADES
S. R. KENNON (Texas, University, Austin, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. Research supported by the University of Texas. refs
(AIAA PAPER 84-0071)

A fast computer program was developed that generates boundary-fitted quasi-orthogonal two-dimensional periodic computational O-type grids applicable to axial turbomachinery cascade flow-field calculations. The grid generating technique is based on a sequence of conformal mappings and nonorthogonal coordinate stretching and shearing transforms. A periodic strip of the cascade flow-field is mapped conformally onto a deformed oval using a series of mapping functions, the entire sequence being explicit and analytically invertible. The final step of opening the deformed oval into a near rectangle is performed using simple polar coordinates. This sequence does not require iterative inversion of the mapping functions. It also avoids conformal mapping onto an exact circle that involves use of the fast Fourier transforms. Consequently, the present grid generation technique for cascades is considerably faster than other known techniques, and is applicable to both compressor and turbine realistically shaped airfoil cascade geometries. In addition, the flow-field boundary may be prescribed by the user, making the technique also applicable to geometries such as free airfoils, multiple element airfoils, and airfoils in a wind tunnel. Author

A84-17860#
VARIABLE GEOMETRY AIRFOILS USING INFLATABLE SURFACES
J. W. HARRIS and D. B. WITMER (Iowa State University of Science and Technology, Ames, IA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0072)

A study was conducted to determine the feasibility of using inflatable surfaces, similar to those used for deicing on present day aircraft, to improve airfoil characteristics. This study examines inflatable upper surfaces starting at the leading edge and extending to a mid-chord position, with the shape of the variable surface controlled by internal pressure. The inflatable surfaces were evaluated through the use of an aerodynamic numerical analysis and supported by wind tunnel testing. The inflation modifications to airfoil geometry were found to show improvements to pressure distribution, lift, and drag characteristics for low speed flight at a Reynolds number of one million. The results of the evaluations were weighed against estimated costs and weight factors to judge feasibility. Author

A84-17864#
A GUIDED PROJECTILE/MORTAR AERODYNAMIC CONTROL CONCEPT - THE TRAILING RING-TAIL
P. A. MURAD (Bendix Corp., Guidance Systems Div., Teterboro, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 16 p. refs
(AIAA PAPER 84-0077)

The trailing ring-tail concept for the guidance and/or stabilization of missiles and projectiles whose configurational constraints severely limit more conventional approaches is presently discussed, for the cases of a cannon-launched 155-mm cannon projectile and an 81-mm mortar projectile. An aerodynamic performance analysis is conducted for the 155-mm projectile, assuming despin capability, aerodynamic static stability, and control and maneuver requirements. The results indicate that a 100-lb, 42-in. long projectile can easily develop the requisite maneuver capability at low velocity conditions. O.C.

A84-17867#
VISCOUS MODELING AND COMPUTATION OF LEADING AND TRAILING-EDGE VORTEX CORES OF DELTA WINGS
B. LAKSHMANAN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract N62269-80-65-02024)
(AIAA PAPER 84-0082)

A Finite-Difference method is presented here for calculating steady axially symmetric motion of an incompressible fluid at large Reynolds number. Approximations of the boundary-layer type are employed to reduce the Navier-Stokes equations to a pair of non-linear parabolic equations. Along with the governing equations, initial conditions are specified at some upstream cross section and boundary conditions are specified at the axis of symmetry and on the outer bounding surface. The governing equations are replaced by a set of quasilinear finite-difference equations. The solution is obtained by a marching technique, which proceeds step-by-step in the axial direction. At each axial station, the finite difference equations are solved using an iterative technique. The developed technique is very stable and efficient. Numerical examples include trailing-edge vortex and a leading-edge vortex. The computed velocity profiles and vortex-core sizes are in good agreement with the available numerical data. Author

A84-17870#
AERODYNAMICS OF A SIMPLE CONE-DERIVED WAVERIDER
R. T. BROADAWAY (Oklahoma, University, Norman, OK) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract F08635-80-K-0340)
(AIAA PAPER 84-0085)

Conical waveriders are of interest as prospective lifting bodies for future long-range missile designs. A limiting case of this class of bodies lends itself well to simple analysis. Optimum bodies are developed and the effects of various geometric parameters are determined along with the associated changes in vehicle performance. Skin friction is introduced and its effects shown. Finally, a comparison is made to the caret waverider, pointing out the relative advantages of both designs. Author

A84-17873*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN IMPLICIT FORM FOR THE OSHER UPWIND SCHEME
M. M. RAI (NASA, Ames Research Center; Informatics General Corp., Moffett Field, CA) and S. R. CHAKRAVARTHY (Rockwell International Science Center, Thousand Oaks, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 15 p. refs
(AIAA PAPER 84-0088)

Conservative upwind schemes for the Euler equations, such as the Osher scheme, accurately resolve flow discontinuities and correctly model the physics of the problem. However, these schemes require many more arithmetic operations per integration step than simple central-difference schemes and hence result in large computing times. An implicit version of the first-order- and second-order-accurate Osher schemes in two spatial dimensions and generalized coordinates is developed in this study. Because implicit schemes permit the use of large integration steps, in many cases they require fewer integration steps to reach steady-state (especially in calculations on grids with widely varying mesh-cell sizes). The implicit scheme developed in this study accelerated convergence speeds by almost an order of magnitude in the problems considered. Test cases include quasi-one-dimensional nozzle flow and supersonic flow past a cylinder. Author

A84-17874#
IMPROVEMENTS IN TECHNIQUES FOR THE NUMERICAL SIMULATION OF STEADY TRANSONIC FLOWS
D. M. CAUSON and P. J. FORD (Salford, University, Salford, Lancs., England) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(AIAA PAPER 84-0089)

A Euler solver based on the time-split MacCormack scheme has been improved for computing steady, inviscid transonic flows. Particular well-known deficiencies are the appearance of saw-tooth oscillations in the vicinity of captured shock profiles and associated spurious entropy production in regions where the flow is expanding. The improved algorithm uses the finite-volume concept, split operators and a switching process which implements the MacCormack scheme in subsonic regions of the flowfield and an explicit upwind scheme in supersonic regions. Appropriately constructed transition operators couple the two schemes at the switch points to preserve the conservation property. The weaker stability bound of the upwind scheme improves the rate of convergence, particularly for mixed flows having a supersonic mainstream. Results are presented which demonstrate the improved shock capturing capability with minimal added dissipation. The results relate principally to aircraft forebodies. Author

A84-17875*# North Carolina State Univ., Raleigh.
TRANSONIC FLOW CALCULATIONS USING A FLUX VECTOR SPLITTING METHOD FOR THE EULER EQUATIONS
C. M. SEAFORD and H. A. HASSAN (North Carolina State University, Raleigh, NC) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(Contract NCC1-22)
(AIAA PAPER 84-0090)

A study of the flux vector splitting method of Steger and Warming for the solution of the time dependent Euler equations in strong conservation law form for arbitrary two-dimensional geometries is presented. The procedure employed here differs from that of Buning and Steger in that it uses a different algorithm and employs implicit boundary conditions. Moreover, the method, as implemented here, does not contain any explicit smoothing or any adjustable parameters. Calculations were carried out for an NACA 0012 airfoil at various Mach numbers and angles of attack, and cylinders. Steady symmetric solutions were obtained for the full cylinder at a freestream Mach number of .5 without imposing a symmetry condition. In general, good agreement with other methods was obtained. Author

A84-17876*# Princeton Univ., N. J.
MULTIGRID SOLUTION OF THE EULER EQUATIONS FOR AIRCRAFT CONFIGURATIONS
A. JAMESON and T. J. BAKER (Princeton University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV. Jan. 9-12, 1984. 12 p. refs
(Contract NAG1-186; NAG2-96; N00014-81-K-0379)
(AIAA PAPER 84-0093)

A multigrid scheme for solving the Euler equations is presented. The method has been successfully applied to two-dimensional airfoil calculations on both O-type and C-type meshes. In three dimensions the scheme has proved equally effective and calclations of flows over wing/body combinations are possible with convergence achieved in less than 100 cycles. Author

A84-17877#
TRANSONIC SHOCK INTERACTION WITH A TANGENTIALLY-INJECTED TURBULENT BOUNDARY LAYER
G. R. INGER (West Virginia University, Morgantown, WV) and A. DEANE American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 17 p. refs
(Contract NR PROJECT 061-274)
(AIAA PAPER 84-0094)

A non-asymptotic triple deck theory of transonic shock/turbulent boundary layer interaction is described which takes into account the influence of upstream tangential injection on a curved wall. In addition to Reynolds number and the shock strength, the theory is parameterized by arbitrary values of the incoming boundary layer shape factor, wall jet maximum velocity ratio and the non-dimensional height of this ratio; results of a comprehensive parametric study are then presented. It is shown that the wall jet effects significantly reduce both the streamwise scale and displacement thickening of the interaction zone. While increasing the upstream and downstream skin friction levels, these effects also reduce the minimum interactive Cf and thus hasten the onset of incipient separation at the shock foot. Author

A84-17878#
EFFECTS OF MACH NUMBER ON UPSTREAM INFLUENCE IN SHARP FIN-INDUCED SHOCK WAVE TURBULENT BOUNDARY LAYER INTERACTION
D. S. DOLLING (Princeton University, Princeton, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(Contract F49620-81-K-0018)
(AIAA PAPER 84-0095)

The effects of freestream Mach number on upstream influence in the conically symmetric region of three dimensional sharp fin-induced shock wave turbulent boundary layer interaction have been examined. The available data are restricted to Mach numbers of 3 and 6, with some additional results from the current experiment at Mach 2. The results show that the angle of the line of upstream influence is a linear function of the inviscid shock wave angle and that the slope of this line is independent of the Mach number. Although the data from the current Mach 2 experiments are insufficient for determining a general upstream influence scaling law, as was derived in earlier studies at Mach 3, the results do indicate that the latter relationship will require modification. Author

A84-17880#
EFFECTS OF LOCAL BOUNDARY LAYER SUCTION ON SHOCK-BOUNDARY LAYER INTERACTION AND SHOCK-INDUCED SEPARATION
P. KROGMANN, E. STANEWSKY (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer experimentelle Stroemungsmechanik, Goettingen, West Germany), and P. THIEDE (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0098)

An experimental investigation of the effects of local boundary layer suction on shock-boundary layer interaction and shock-induced separation has been conducted in the DFVLR 1 m x 1 m Transonic Wind Tunnel Goettingen utilizing an advanced transonic airfoil. Three different methods of suction were applied in the shock region. Their effectiveness in comparison to the basic closed-surface airfoil will be evaluated from surface pressure distribution, wake and boundary layer measurements. It will be shown that local boundary layer suction in the shock region delays the development of shock-induced separation and considerably improves the overall aerodynamic characteristics. Moreover, two of the configurations investigated, viz., a double slot and a perforated strip with a cavity underneath showed even without suction a most favorable 'passive' effect on shock boundary layer interaction and the overall flow development, thus offering a very promising means for extending the range of applicability of transonic airfoils. Author

A84-17881*# Case Western Reserve Univ., Cleveland, Ohio.
EXPERIMENTAL STUDIES ON TWO DIMENSIONAL SHOCK BOUNDARY LAYER INTERACTIONS
S. A. SKEBE, I. GREBER (Case Western Reserve University, Cleveland, OH), and W. R. HINGST (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(Contract NAG3-61; NAG3-102)
(AIAA PAPER 84-0099)

Experiments have been performed on the interaction of oblique shock waves with flat plate boundary layers in the 30.48 cm x 30.48 cm (1 ft. x 1 ft.) supersonic wind tunnel at NASA Lewis Research Center. High accuracy measurements of the plate surface static pressure and shear stress distributions as well as boundary layer velocity profiles were obtained through the interaction region. Documentation was also performed of the tunnel test section flow field and of the two-dimensionality of the interaction regions. The findings provide detailed description of two-dimensional interaction with initially laminar boundary layers over the Mach number range 2.0 to 4.0. Additional information with regard to interactions involving initially transitional boundary layers is presented over the Mach number range 2.0 to 3.0 and those for initially turbulent boundary layers at Mach 2.0. These experiments were directed toward providing well documented information of high accuracy useful as test cases for analytic and numerical calculations. Flow conditions encompassed a Reynolds number range of 4.72E6 to 2.95E7 per meter. The shock boundary layer interaction results were found to be generally in good agreement with the experimental work of previous authors both in terms of direct numerical comparison and in support of correlations establishing laminar separation characteristics. Author

A84-17882#
TRANSONIC AIRFOIL AND WING FLOWFIELD MEASUREMENTS
F. W. SPAID (McDonnell Douglas Research Laboratories, St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 31 p. refs
(AIAA PAPER 84-0100)

Results of several experiments on transonic flow about airfoils and wings are reviewed. These experiments were primarily intended to provide data to support the development of methods for numerical computation of aerodynamic flowfields. Previously unpublished measurements of the upper-surface boundary-layer on a transport wing model at a subcritical condition are included. Comparisons among two-dimensional experimental data and results of numerical computation of trailing-edge flows indicate that the computation scheme should properly reflect the elliptic nature of the trailing-edge region and that adequate grid resolution must be incorporated. Some results from related nonsteady experiments are also presented. These experiments are intended to characterize the dynamic mechanisms associated with buffeting, but the data also assist in interpreting the wing boundary-layer measurements. Author

A84-17883#
EXPERIMENTAL INVESTIGATION OF A SIMULATED COMPRESSOR AIRFOIL TRAILING EDGE FLOWFIELD
R. W. PATERSON (United Technologies Research Center, East Hartford, CT) and H. P. WEINGOLD (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract N00019-80-C-0633)
(AIAA PAPER 84-0101)

The objective of the study was to provide experimental data that could be used to develop computational procedures for predictng the turbulent separated blunt trailing edge flowfield. In this connection, a large-scale, low subsonic Mach number, wind tunnel simulation of a compressor trailing edge flowfield was conducted using a flat plate test model and laser Doppler velocimetry for flowfield definition. One of the important findings of the study is that outer flow velocity profiles in the near wake are nearly identical, with viscous interaction effects confined to a region near wake centerline having a thickness comparable to that of the trailing edge. It is also found that vortex shedding may be a more important mechanism than turbulence for lateral transport of axial momentum in the near-wake region. Qualitative agreement with other plate and circular cylinder near-wake velocity data suggest that the absolute value of boundary layer thickness to plate trailing edge thickness is not a critical parameter in determining the near-wake flow field. V.L.

A84-17892#

REVIEW OF INLET-AIRFRAME INTEGRATION USING NAVIER-STOKES COMPUTATIONAL FLUID DYNAMICS

J. MACE and W. L. HANKEY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs

(AIAA PAPER 84-0119)

Inlet-airframe integration is an aerodynamic discipline dominated by strong viscous-inviscid flow interactions. Although valid approximations can be made which reduce the complexity of the governing equations, these flow interactions are generally described by the Navier-Stokes equations. Computational Fluid Dynamics (CFD) to solve the Navier-Stokes equations for flwos relevant to inlet-airframe integration is emerging as an engineering tool. This paper examines current CFD capabilities to compute aircraft forebody and inlet flows which are described by the Navier-Stokes equations. Author

A84-17894#

APPLICATION OF COMPUTATIONAL METHODS TO THE DESIGN OF LARGE TURBOFAN ENGINE NACELLES

D. J. LAHTI, D. A. DIETRICH, N. O. STOCKMAN, and G. K. FAUST (General Electric Co., Cincinnati, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs

(AIAA PAPER 84-0121)

Computational methods are now widely used in the aerodynamic development of high bypass ratio turbofan engine nacelles. This paper discusses the items of primary importance in the design of the various nacelle components and the role played by computational methods in the design process. The perspective given is that of the nacelle designer and emphasis is placed on practical considerations. Comparisons of predictions and measurements for inlets, external cowls, exhaust nozzles and complete installations are shown to illustrate strengths and weaknesses of the methods used. An assessment of the adequacy of the methods is given and recommendations for future development efforts are suggested. Author

A84-17903#

FREE VORTEX FLOWS - RECENT ENCOUNTERS WITH AN EULER CODE

P. RAJ and J. S. SIKORA (Lockheed-California Co., Computational Aerodynamics Dept., Burbank, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. Research supported by the Lockheed-California Independent Research and Development Program. refs

(AIAA PAPER 84-0135)

A computational algorithm for solving the Euler equations has been used to simulate the free vortices resulting from the separation of flow along the highly swept leading edges of slender wings during low-speed flights and transonic maneuvering. Correlations of computed results with experimental data are presented for three wings at subsonic and transonic Mach numbers. The results to date show that the Euler code can provide a cost-effective and user-oriented approach for the analysis and design of high-speed aircraft. Additional studies are required to assess the capabilities of the present method. Author

A84-17904*# Maryland Univ., College Park.

PREDICTION OF VORTEX LIFT ON INTERACTING DELTA WINGS IN INCOMPRESSIBLE FLOW

S. S. DODBELE and A. PLOTKIN (Maryland, University, College Park, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs

(Contract NCC1-41)

(AIAA PAPER 84-0136)

Vortex flow modeling is used to calculate the steady inviscid incompressible flow past one, two and three delta wing configurations. The wings are modeled with vortex lattices and the leading and trailing-edge sheets are modeled by segmented straight vortex filaments. Aerodynamic characteristics are obtained for a range of geometry and angle of attack. Author

A84-17905#

ON REYNOLDS NUMBER EFFECTS IN VORTEX FLOW OVER AIRCRAFT WINGS

A. WORTMAN (California State University, Fullerton; Istar, Inc., Santa Monica, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs

(AIAA PAPER 84-0137)

An assessment of literature concerning viscous effects in vortex flow over aircraft wings has been conducted in order to establish a firm foundation for theoretical considerations. Comparisons of experimental data with analytical results show that flows over low aspect ratio swept wings with vortices are strongly influenced by viscous effects, and are therefore strong functions of Reynolds number. This is especially true in the Reynolds number range spanned by water tunnel flow visualization studies and low speed wind tunnel tests. It is concluded that the relation between realistic aircraft flows and water tunnel studies is qualitatively tenuous and quantitatively misleading or even nonexistent. O.C.

A84-17906*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THE INFLUENCE OF LEADING-EDGE LOAD ALLEVIATION ON SUPERSONIC WING DESIGN

C. M. DARDEN (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs

(AIAA PAPER 84-0138)

A theoretical and experimental program to assess the effect of leading-edge load constraints on wing design and performance was conducted. For a planform characterized by a highly swept leading edge on the inboard region, linear theory was used to design camber surfaces which produced minimum drag-due-to-lift at the design lift coefficient of 0.08 and a design Mach number of 2.4. In an effort to delay the formation of leading edge vortices which often occur on highly swept wings, two approaches were used in the design criteria to limit the loadings on the leading edge. One wing was constrained to have the normal Mach number less than one everywhere along the leading edge and the second wing was constrained to have a pressure coefficient of zero on the leading edge. Force tests were run on the two constrained wings, on a flat reference wing and on an optimized wing with no leading edge constraints. All wings had identical planforms and thicknesses and were tested over a range of Mach numbers from 1.8 to 2.8 and a range in angles of attack from -5 deg to 8 deg. A comparison of the experimental performance of these four models is shown. Correlations of these results with theoretical predictions and flow visualization photographs are also included. Author

A84-17907*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

APPLICATION OF A FULL POTENTIAL METHOD FOR COMPUTATION OF THREE-DIMENSIONAL SUPERSONIC FLOWS

K. M. JONES, N. A. TALCOTT, JR. (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA), and V. SHANKAR (Rockwell International Science Center, Thousand Oaks, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(AIAA PAPER 84-0139)

A nonlinear aerodynamic analysis technique based on the full potential equation in conservative form has been modified to permit treatment of supersonic flows with embedded subsonic regions (typically near the fuselage-canopy juncture and the wing leading edge). Solution procedures for the equations do not require any specific form of geometry or physical grid system. This results in the capability to analyze easily very complex geometries provided the posed problem lies within the isentropic restrictions of the full potential theory. Characteristic signal propagation theory is used to monitor the type dependent flow and a conservative switching scheme is employed to transition from the supersonic marching algorithm to a subsonic relaxation procedure and vice versa. An implicit approximate factorization scheme is used to solve the finite-difference equations. These modifications now permit analysis of fully three-dimensional flowfields including the interference effects due to lifting surface wakes. Improved grid generation capability allows analysis of complete complex aircraft geometries (fuselage, wing, tail, wing wake, and tail wake). Results are presented showing very good correlations with experimental surface pressure data and aerodynamic force data at both design and off-design operating points. Configurations examined include several waverider concepts, an arrow wing-body with wake, an advanced tactical fighter concept, and a fighter forebody-canard configuration. Author

A84-17921*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

VECTORIZED SCHEMES FOR CONICAL POTENTIAL FLOW USING THE ARTIFICIAL DENSITY METHOD

P. F. BRADLEY, D. L. DWOYER, J. C. SOUTH, JR. (NASA, Langley Research Center, Hampton, VA), and J. M. KEEN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 18 p. refs
(AIAA PAPER 84-0162)

A method is developed to determine solutions to the full-potential equation for steady supersonic conical flow using the artificial density method. Various update schemes used generally for transonic potential solutions are investigated. The schemes are compared for speed and robustness. All versions of the computer code have been vectorized and are currently running on the CYBER-203 computer. The update schemes are vectorized, where possible, either fully (explicit schemes) or partially (implicit schemes). Since each version of the code differs only by the update scheme and elements other than the update scheme are completely vectorizable, comparisons of computational effort and convergence rate among schemes are a measure of the specific scheme's performance. Results are presented for circular and elliptical cones at angle of attack for subcritical and supercritical crossflows. Author

A84-17923*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A CONSERVATIVE TREATMENT OF ZONAL BOUNDARIES FOR EULER EQUATION CALCULATIONS

M. M. RAI (NASA, Ames Research Center, Moffett Field; Informatics General Corp., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 18 p. refs
(AIAA PAPER 84-0164)

Finite-difference calculations require the generation of a grid for the region of interest. A zonal approach, wherein the given region is subdivided into zones and the grid for each zone is generated independently, makes the grid-generation process for complicated topologies and for regions requiring selective grid refinement a fairly simple task. This approach results in new boundaries within the given region, that is, zonal boundaries at the interfaces of the various zones. The zonal-boundary scheme (the integration scheme used to update the points on the zonal boundary) for the Euler equations must be conservative, accurate, stable, and applicable to general curvilinear coordinate systems. A zonal-boundary scheme with these desirable properties is developed in this study. The scheme is designed for explicit, first-order-accurate integration schemes but can be modified to accommodate second-order-accurate explicit and implicit integration schemes. Results for inviscid flow, including supersonic flow over a cylinder, blast-wave diffraction by a ramp, and one-dimensional shock-tube flow are obtained on zonal grids. The conservative nature of the zonal-boundary scheme permits the smooth transition of the discontinuities associated with these flows from one zone to another. The calculations also demonstrate the continuity of contour lines across zonal boundaries that can be achieved with the present zonal scheme. Author

A84-17925*# Cornell Univ., Ithaca, N.Y.

AN IMPLICT LU SCHEME FOR THE EULER EQUATIONS APPLIED TO ARBITRARY CASCADES

E. K. BURATYNSKI and D. A. CAUGHEY (Cornell University, Ithaca, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract NAG3-19)
(AIAA PAPER 84-0167)

An implicit scheme for solving the Euler equations is derived and demonstrated. The alternating-direction implicit (ADI) technique is modified, using two implicit-operator factors corresponding to lower-block-diagonal (L) or upper-block-diagonal (U) algebraic systems which can be easily inverted. The resulting LU scheme is implemented in finite-volume mode and applied to 2D subsonic and transonic cascade flows with differing degrees of geometric complexity. The results are presented graphically and found to be in good agreement with those of other numerical and analytical approaches. The LU method is also 2.0-3.4 times faster than ADI, suggesting its value in calculating 3D problems. T.K.

A84-17927*# Princeton Univ., N. J.

THE EFFECT OF A SHORT REGION OF CONCAVE CURVATURE ON A SUPERSONIC TURBULENT BOUNDARY LAYER

A. J. SMITS (Princeton University, Princeton, NJ) and M. W. TAYLOR American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(Contract NAGW-240)
(AIAA PAPER 84-0169)

Mean flow measurements have been made in a supersonic turbulent boundary layer experiencing a short region of concave curvature and an adverse pressure gradient. The incoming boundary layer had a Mach number of 2.87 and a unit Reynolds number of 6.3 x 10 to the 7th/m. Flow over constant radii curvatures of delta (0)/R = 0.10 and 0.02 with a fixed turning angle of 8 deg were investigated. Results indicate that both flows remain two-dimensional; length scales increase over their equilibrium values; the mean flow behaves similarly to subsonic flows experiencing concave curvature and lateral divergence; and boundary layer behavior is strongly similar to a corresponding 8 deg ramp flow. Author

A84-17929#

A NEW METHOD OF BOUNDARY LAYER CORRECTION IN THE DESIGN OF SUPERSONIC WIND TUNNEL NOZZLE

Y.-S. WANG and G.-L. DU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0171)

A boundary layer correction method is presented in which determination of the displacement thickness is not necessary; the partial differential equations of the turbulent boundary layer are solved directly. The fundamental conservation equations are solved simultaneously by iteration in the region of potential flow and boundary layer. The condition of continuity is then applied to determine the contour of the nozzle. A nozzle of M = 8.5 was designed by this method with about 15 minutes of CPU time. The maximum difference between the calculated results and those obtained by Sivell's method was 1 percent. The present method is applicable to the design of any type of nozzle or any apparatus of confined flow and is free from empirical or semiempirical relations. Details of the flow field may also be predicted. J.N.

A84-17930#

SECOND ORDER COMPOSITE VELOCITY SOLUTION FOR LARGE REYNOLDS NUMBER FLOWS

S. G. RUBIN, M. CELESTINA, and P. K. KHOSLA (Cincinnati, University, Cincinnati, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract AF-AFOSR-80-0047)
(AIAA PAPER 84-0172)

The composite velocity procedure is applied to a reduced form of the Navier-Stokes equations where viscous effects are neglected only in the normal momentum equation. Subsonic and mildly transonic flows are considered for boattail and airfoil geometries. The composite formulation defines viscous and potential-like velocity components. These variables are coupled in a strongly implicit solution procedure (CSIP) and simulate a coupled interacting boundary layer-potential flow solver with a single system of equations. Complete second-order accurate solutions are obtained for laminar and turbulent flows where separation bubbles and weak shocks are present. The effects of inflow and outflow boundary conditions are examined and a procedure for reducing storage of the CSIP is presented. Author

A84-17942*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SUBSONIC/TRANSONIC PREDICTION CAPABILITIES FOR NOZZLE/AFTERBODY CONFIGURATIONS

R. G. WILMOTH and L. E. PUTNAM (NASA, Langley Research Center, Transonic Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 16 p. refs
(AIAA PAPER 84-0192)

Prediction methods for several nozzle/afterbody flow problems at subsonic and transonic speeds are presented. These methods range from viscous-inviscid interaction methods to solutions for the Navier-Stokes equations in two and three dimensions. The problems addressed are the flow around isolated axisymmetric nozzles, isolated nonaxisymmetric nozzles, and axisymmetric nozzles with empennage. An assessment of the state of development of the methods via comparisons with experimental data is presented. Author

A84-17943#

THREE-DIMENSIONAL FLOW ANALYSIS OF TURBOPROP INLET AND NACELLE CONFIGURATIONS

J. S. SOKHEY (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0193)

Among the technologies currently being developed for future commercial aircraft, the advanced turboprop concept has the largest potential with respect to a reduction of fuel consumption. The present investigation is concerned with a survey of turboprop propulsion analyses. The large number of geometrical variables which affect the aerodynamic performance of turboprop installations makes it necessary to reduce the number of variables to a value for which it is possible to evaluate selected configurations either experimentally or theoretically. The computational methodology for propeller flow-fields is presented, taking into account aspects of engine/airframe integration. The computational flow analysis procedure discussed is utilized to analyze the flow-field about a single-scoop turboprop configuration. G.R.

A84-17953#

PAN AIR APPLICATIONS TO MUTUAL INTERFERENCE EFFECTS DUE TO CLOSE PROXIMITY

A. CENKO (Grumman Aerospace Corp., Bethpage, NY), E. N. TINOCO (Boeing Commercial Airplane Co., Seattle, WA), and J. TUSTANIWSKYJ (Burroughs Corp., San Diego, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0217)

The utility of the Pan Air program for analyzing the behavior of complex aircraft configurations at subsonic and supersonic speeds has been previously demonstrated. However, somewhat contradictory results have been obtained in cases in which mutual interference effects due to close proximity predominate. The different results might be attributed to different modeling. The present investigation is concerned with the question of appropriate boundary conditions for a reflection plane simulation, taking into account also test data available for stores traversing vertically and horizontally relative to axisymmetric bodies. It was found that the Pan Air program can accurately predict shock reflection effects for slender bodies, where the nose shock wave does not substantially differ from the linear theory Mach wave. Difficulties arise in the case of blunter nose shapes with a strong bow shock. G.R.

A84-17970*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECT OF SIDEWALL SUCTION ON FLOW IN TWO-DIMENSIONAL WIND TUNNELS

R. W. BARNWELL (NASA, Langley Research Center, NTF Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0242)

A closed-form analysis of flow in a two-dimensional subsonic wind tunnel which uses sidewall suction around the model to reduce sidewall boundary-layer effects is presented. The model problem which is treated involves a flat plate airfoil in a tunnel with a suction window shaped to permit an analytic solution. This solution shows that the lift coefficient depends explicitly on the porosity parameter of the suction window and implicitly on the suction pressure differential. For a given sidewall displacement thickness, the lift coefficient increases as the suction-window porosity decreases. Author

A84-17971#
COMPUTED AND MEASURED WALL INTERFERENCE IN A SLOTTED TRANSONIC TEST SECTION
Y. C.-J. SEDIN (SAAB-Scania AB, Linkoping, Sweden) and H. SORENSEN (Flygtekniska Forsoksanstalten, Bromma, Sweden) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 15 p. Research supported by the Forsvaret Materielverk. refs
(AIAA PAPER 84-0243)

This paper relates some attempts to computationally reconstruct experimentally observed flows about a body in a slotted transonic test section including the main features of the slot flow. The results show that viscous effects are of great importance and must be accounted for in applying the basic inviscid wall theory. Encouraging results have been obtained using a simple viscous flow model to correct for viscous effects. A number of computed cases are shown where pressure distributions and slot flow properties are compared to experimental data for an axisymmetric body in an octagonal shaped test section provided with eight similar slots. Author

A84-17973*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATUS OF ORIFICE INDUCED PRESSURE ERROR STUDIES
E. B. PLENTOVICH (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0245)

The construction of high Reynolds number facilities, such as the National Transonic Facility (NTF) and the 0.3-m Transonic Cryogenic Tunnel (TCT), has stimulated interest again in the study of orifice induced static pressure. In a high Reynolds number facility, the orifice will have a much larger effect on the boundary layer than in a conventional wind tunnel. The present investigation was performed in the 0.3-m TCT at Mach numbers in the range from 0.60 to 0.80 and Reynolds numbers in the range from 6,000,000 to 40,000,000 with the objective to compare the porous plug orifices to conventional 0.025 cm orifices in a high Reynolds number environment. It was found that there was an error at high Reynolds numbers which could not be neglected and that the use of a porous metal disk in a conventional orifice could virtually eliminate the orifice induced pressure error. G.R.

A84-17977*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN INCOMPRESSIBLE NAVIER-STOKES FLOW SOLVER IN THREE-DIMENSIONAL CURVILINEAR COORDINATE SYSTEMS USING PRIMITIVE VARIABLES
D. KWAK (NASA, Ames Research Center, Moffett Field, CA), J. L. C. CHANG, S. P. SHANKS (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA), and S. R. CHAKRAVARTHY (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 14 p. refs
(AIAA PAPER 84-0253)

An implicit, finite-difference computer code has been developed to solve the incompressible Navier-Stokes equations in a three-dimensional, curvilinear coordinate system. The pressure-field solution is based on the pseudo compressibility approach in which the time derivative pressure term is introduced into the mass conservation equation to form a set of hyperbolic equations. The solution procedure employs an implicit, approximate factorization scheme. The Reynolds stresses, that are uncoupled from the implicit scheme, are lagged by one time-step to facilitate implementing various levels of the turbulence model. Test problems for external and internal flows are computed, and the results are compared with existing experimental data. The application of this technique for general three-dimensional problems is then demonstrated. Author

A84-17978#
A NUMERICAL PROCEDURE TO PREDICT THE EFFECTS OF REYNOLDS NUMBER AND TRIP STRIP VARIATION ON THREE-DIMENSIONAL WING LIFT AND PITCHING MOMENT
R. C.-C. LUH and M. D. MACK (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(AIAA PAPER 84-0255)

A cost-effective numerical procedure is used to realistically simulate 3-D viscous effects at subcritical speeds and at angles of attack lower than the onset of separation. The 2-D to 3-D correlations were formulated into a procedure in which the viscous effects calculated for a 'critical' section of a wing are utilized for corrections to the camber and twist of the wing to produce pseudo-viscous 3-D solutions. Prediction of scale effects on pitching moment level and lift from wind tunnel data is made possible with the procedure as well as the inexpensive calculation of aerodynamic center. The effect of different airfoil section characteristics for a given planform, and scale and transition effects on stability characteristics may be evaluated. J.N.

A84-17980*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
THE COMPUTATION OF ROTATIONAL CONICAL FLOWS
B. GROSSMAN (Virginia Polytechnic Institute and State University, Blacksburg, VA) and S. K. CHOI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract NAG1-337)
(AIAA PAPER 84-0258)

A method based on the Clebsch velocity decomposition is presented to solve the steady, inviscid, supersonic flow field about arbitrary conical geometries. The system of equations developed, although formally equivalent to the Euler equations, retains the computational efficiency of type-dependent potential flow solutions. Accurate rotational-flow solutions are developed using shock-fitting procedures at the bow and imbedded waves along with special treatment of the vortical layer. Solutions are presented for several high Mach number conical flows and compared with existing Euler solutions and experimental data. Author

A84-17981#
COMPUTATION OF SUPERSONIC FLOW AROUND BODIES
B. G. ARLINGER (SAAB-Scania AB, Linkoping, Sweden) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0259)

A computational method is presented for space-marching solution of the three-dimensional Euler equations for supersonic flow around bodies of arbitrary shape. A shock capturing finite volume formulation is used for the numerical algorithm which is explicit. The solution is advanced between planes normal to the free stream direction, and a key feature of the method is the type of grid used in these planes. It is body-adapted, tends to a cartesian type far from the body, has a minimum mesh size and is generated by algebraic technique. Due to the independence of body section shape that is characteristic for the grid, the method is very versatile. It is illustrated and verified by computational results for cones, a generalized forebody and a detailed realistic aircraft forebody. Author

A84-17984#
TRANSONIC TURBULENT SEPARATION ON SWEPT WINGS - A RETURN TO THE DIRECT FORMULATION
J. WAI and H. YOSHIHARA (Boeing Military Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 15 p. Research sponsored by the Boeing Commercial Airplane Co. and Boeing Military Airplane Co. refs
(AIAA PAPER 84-0265)

In a finite difference marching procedure it was shown that the direct formulation of the boundary layer problem in the separated case can become improperly posed when the initial data line becomes time-like. The method of characteristics avoids this shortcoming, and its use in the direct formulation is demonstrated for the infinite yawed wing with separation. The integral boundary layer code in the direct mode is then coupled to the exact potential code to calculate the flow over the Boeing 747 wing/fuselage with trailing edge separation. Author

A84-17985#

VISCOUS/INVISCID INTERACTION ANALYSIS OF SEPARATED TRAILING-EDGE FLOWS

V. N. VATSA and J. M. VERDON (United Technologies Research Center, East Hartford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs

(Contract N62271-82-M-2797)

(AIAA PAPER 84-0266)

An analytical procedure based on finite Reynolds number, viscous/inviscid interaction theory is presented for predicting high Reynolds number flows past airfoil trailing edges. This effort stems from the need to provide efficient prediction methods for local strong interaction regions and, in particular, for local flow separations. Attention here is focused on laminar flows past thin-airfoil trailing edges where local separations are induced by airfoil thickness or loading. Solutions are determined using interacting boundary layer theory in which the outer inviscid and inner viscous flows are determined simultaneously and matched through a global semi-inverse iteration procedure until a converged result for the complete flow field is obtained. Detailed results for attached and separated laminar trailing-edge flows are presented including streamline patterns for thick and loaded trailing edges. Author

A84-17987#

NUMERICAL SOLUTIONS OF 2-D UNSTEADY TRANSONIC FLOWS USING COUPLED POTENTIAL-FLOW/BOUNDARY-LAYER METHODS

J. B. MALONE (Lockheed-Georgia Co., Marietta, GA) and N. L. SANKAR (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs

(AIAA PAPER 84-0268)

Analytical procedures for steady and unsteady transonic flows around oscillating two-dimensional airfoil sections are presented and demonstrated. An unsteady potential-flow solver based on the full-potential equation is coupled in each case with both steady and unsteady boundary-layer procedures (either steady-flow or unsteady integral methods). The individual algorithms and the coupling algorithms are developed, and numerical results on RAE2822, NLR 7301, and NACA 64A010 standard airfoils, and on a flat plate in an oscillating free stream are illustrated graphically. Steady and unsteady calculations are found to require 10-20 min and 1-2 hr, respectively, on a VAX 11/780 computer using a 3400-point mesh. A primary advantage of the method described is seen in its applicability to airfoils of supercritical type and to Mach numbers ranging from 0.1 to 1.0. T.K.

A84-17995#

A SIMPLE VISCOUS-INVISCID AERODYNAMIC ANALYSIS OF TWO-DIMENSIONAL EJECTORS

D. TAVELLA and L. ROBERTS (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs

(AIAA PAPER 84-0281)

A theory for the computation of two-dimensional thrust augmentor performance is developed. The flow field is assumed to be incompressible, of uniform density and statistically steady. The flow in and around the augmentor is assumed to consist of an outer, inviscid part and an inner viscous part. The outer field is calculated analytically and then matched with the inner, viscous field, which is computed by means of integral methods. This form of analysis leads to a simple and economical approach, particularly useful for conducting parametric studies. The theoretical results are compared with recently acquired experimental data. Author

A84-17996#

AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF ANNULAR PROPULSIVE NOZZLES

R. R. CONLEY (McDonnell Douglas Astronautics Co., St. Louis, MO), J. D. HOFFMAN, and H. D. THOMPSON (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs

(Contract F33615-80-C-2029)

(AIAA PAPER 84-0282)

This paper discusses an analytical performance prediction methodology for annular propulsive nozzles and the application of that methodology to selected nozzles. Thrust efficiencies and static pressure profiles from cold flow testing of the selected nozzles are summarized and compared to the predictions. These comparisons show that the analytical methods are reasonably accurate if the radial velocity components in the transonic region of annular nozzles are small. The areas of prediction/test disagreement are identified for future improvements. Author

A84-17998#

AERODYNAMICS OF AIRCRAFT AFTER BODY - NUMERICAL SIMULATION

L. ZANNETTI (Torino, Politecnico, Turin, Italy) and M. ONOFRI (Roma, Universita, Rome, Italy) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. Research supported by the Ministero della Pubblica Istruzione. refs

(AIAA PAPER 84-0284)

The aerodynamic field produced by the interaction between aircraft engine jet and external aerodynamics is simulated using a time-dependent computation to describe subsonic, transonic, and supersonic flow fields. Both the jet flow and the external flow are assumed to be inviscid, irrotational, and axisymmetric. The aerodynamic field is described by a numerical integration of the time-dependent Euler equations for the examples of a choked convergent-divergent nozzle and a supersonic external flow. The numerical scheme is a second order finite difference scheme belonging to the 'lambda-family'. J.N.

A84-18006#

FULL-POTENTIAL SOLUTIONS FOR TRANSONIC FLOWS ABOUT AIRFOILS WITH OSCILLATING FLAPS

J. B. MALONE (Lockheed-Georgia Co., Marietta, GA) and N. L. SANKAR (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs

(AIAA PAPER 84-0298)

The two-dimensional unsteady full-potential equation (FPE) for the aerodynamic flow around an airfoil with oscillating trailing edge flaps is solved numerically using a strongly implicit approximate-factorization algorithm. The approach taken solves the FPE in strong conservation form, applying airfoil-boundary conditions by means of a time-conforming body-fitted grid, and permits calculation of both steady-flow problems (as a relaxation procedure) or unsteady-flow problems (as a noniterative procedure providing time accuracy). Sample results from computations on the NACA 64A006 airfoil are presented graphically. Good agreement is found with experimental data (Tijdeman, 1978; Tijdeman and Schippers, 1974). D.G.

A84-18007*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC SOLUTIONS FOR A MULTIELEMENT AIRFOIL USING THE FULL-POTENTIAL EQUATION
J. FLORES, T. L. HOLST, and R. L. SORENSON (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0300)

Transonic flow solutions are obtained over a multielement airfoil (augmentor-wing) using the full-potential equation. Solutions obtained for a subcritical case and a strong shock case show good quantitative agreement with experiment in regions not dominated by viscous effects. In those regions where viscous effects are dominant, the results are still in good qualitative agreement. For the strong shock case, Mach number and angle-of-attack corrections were necessary to match experimental coefficient of lift. Typical results from the transonic augmentor-wing Potential Code on the Cray-1S computer require about 10 sec of CPU time for a three-order-of-magnitude drop in the maximum residual. The speed with which solutions can be generated, and the associated low cost, will make this code a practical tool for the design aerodynamicist. Author

A84-18008*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPARISON OF MEASURED AND CALCULATED AIRLOADS ON AN ENERGY EFFICIENT TRANSPORT WING MODEL EQUIPPED WITH OSCILLATING CONTROL SURFACES
W. E. MCCAIN (NASA, Langley Research Center, Multidisciplinary Analysis and Optimization Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0301)

Wind-tunnel measurements of steady and unsteady pressures for a high-aspect-ratio supercritical wing model are compared with calculations by the linear unsteady aerodynamic lifting-surface theory, known as the Doublet Lattice method, at Mach numbers of 0.650 (subsonic) and 0.78 (transonic). The steady-pressure data comparisons are made for incremental changes in angle of attack and control-surface deflection. The unsteady-pressure data comparisons are made for oscillating control-surface deflections. Some differences between the measured and calculated aerodynamics are attributed to viscous and transonic effects that are not accounted for in the Doublet Lattice analysis. Comparisons of the transonic unsteady-pressure data for the oscillating control surfaces are improved by applying empirical corrections based on the steady-pressure measurements to the unsteady Doublet Lattice calculations. Author

A84-18009*# Grumman Aerospace Corp., Bethpage, N.Y.
TRANSONIC ANALYSIS OF CANTED WINGLETS
B. S. ROSEN (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract NAS1-14732)
(AIAA PAPER 84-0302)

A computational method developed to provide a transonic analysis for upper/lower surface wing-tip mounted winglets is described. Winglets with arbitrary planform, cant and toe angle, and airfoil section can be modeled. The embedded grid approach provides high flow field resolution and the required geometric flexibility. In particular, coupled Cartesian/cylindrical grid systems are used to model the complex geometry presented by canted upper/lower surface winglets. A new rotated difference scheme is introduced in order to maintain the stability of the small-disturbance formulation in the presence of large spanwise velocities. Wing and winglet viscous effects are modeled using a two-dimensional 'strip' boundary layer analysis. Correlations with wind tunnel and flight test data for three transport configurations are included. Author

A84-18012*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN EXPERIMENTAL INVESTIGATION OF SURFACE PRESSURE MEASUREMENTS ON AN ADVANCED WINGED ENTRY VEHICLE AT MACH 10
K. E. WURSTER and E. V. ZOBY (NASA, Langley Research Center, Space Systems Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(AIAA PAPER 84-0308)

Surface pressure measurements have been made at Mach 10 in air on an instrumented 0.006-scale model of an advanced (control configured) winged entry vehicle. The tests were conducted in the Langley Continuous Flow Hypersonic Tunnel. Data were obtained at 83 surface pressure stations, which include locations on the lower and upper surface centerlines, spanwise positions along the lower and upper surfaces of the wing, the lower surface of the body flap, and radial locations on the fuselage. Data were obtained for angles of attack ranging from zero to 40 deg, sideslip angles of -2 deg to +5 deg, Reynolds numbers of 0.5, 1.0, and 2.0 million per foot, and body-flap deflections of zero, 10, and 20 deg. Test conditions and orifice locations were chosen to correspond directly with those for the heat transfer measurements previously reported on the same configuration. Comparison of windward symmetry plane data with predictions based upon an approximate engineering method was found to yield reasonable agreement for angles of attack from 20 to 40 deg. The leeward surface pressure data were observed to be roughly an order of magnitude lower than the corresponding windward data. At low angles of attack, regions of high pressure were noted on the windward wing surface. The result is attributed to vortical action or shock impingement. High pressures were also measured on the deflected body flap, a critical region for this type of vehicle. Reynolds number effects were found to be insignificant. Author

A84-18026#
DESIGN OF A SUPERSONIC COANDA JET NOZZLE
P. M. BEVILAQUA (Rockwell International Corp., Columbus, OH) and J. D. LEE (Ohio State University, Columbus, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 16 p. refs
(Contract F33615-79-C-3026)
(AIAA PAPER 84-0333)

The thrust vectoring of supersonic Coanda jets was improved by designing a nozzle to skew the initial jet velocity profile. A new nozzle design procedure, based on the method of characteristics, was developed to design a nozzle which produces a specified exit velocity profile. The thrust vectoring of a simple convergent nozzle, a convergent-divergent nozzle, and a nozzle which produces a skewed velocity profile matched to the curvature of the Coanda surface were experimentally compared over a range of pressure ratios from 1.5 to 3.5. Elimination of the expansion shocks with the C-D nozzle is shown to greatly improve the thrust vectoring; elimination of turning shocks with the skewed profile nozzle further improves the vectoring. Author

A84-18028#
EQUIVALENT FLAP THEORY - A NEW LOOK AT THE AERODYNAMICS OF JET-FLAPPED AIRCRAFT
A. K. SINHA, R. KIMBERLIN, and J. M. WU (Tennessee, University, Tullahoma, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract N00019-81-C-0506)
(AIAA PAPER 84-0335)

A semi-empirical method for obtaining the lift and pitching moment characteristics of upper surface blown (USB) jet-flapped aircraft has been developed. This is accomplished by using an empirical criterion to replace an airfoil with a mechanical flap and a jet issuing at the trailing edge, by the original airfoil and an equivalent extension of the flap itself. To obtain the load and downwash distribution for a three-dimensional wing, the effect of the induced downwash field was taken into consideration in

obtaining the equivalent wing shape which was treated by the lifting line theory. The jet induced supercirculation lift, due to the presence of the jet on the wing upper surface, has been obtained from momentum considerations. Theoretical results were compared with wind tunnel and flight test data on the Ball-Bartoe experimental USB aircraft with reasonable success. The method developed here has the capability of handling partial span flaps with variable jet momentum distribution and chordwise location of the nozzle.
Author

A84-18029*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A LARGE-SCALE INVESTIGATION OF V/STOL GROUND EFFECTS
R. S. CHRISTIANSEN (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0336)
A large-scale ground-effects test of a single jet in hover was conducted as a first-case study for future tests to provide the V/STOL community with an improved data base. The objectives for this single-jet hover test were to (1) document the jet characteristics and then (2) gather the associated force data. These data are then compared with results obtained from existing prediction methods. A conically convergent nozzle was mounted to a turbojet engine, and an 8-ft-diam suckdown-plate model measured the lift-loss forces in ground effect. Jet-exit characteristics (pressure profile, temperature, turbulence, etc.) are documented for several nozzle pressure ratios. Characteristics that may give rise to scale effects are discussed. Results from this first study indicate that small-scale tests, and current prediction methods, will lead to significant errors in the lift-loss estimation of a single-jet configured aircraft, hovering in ground effect. Author

A84-18039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
OPTIMIZATION AND APPLICATION OF RIBLETS FOR TURBULENT DRAG REDUCTION
M. J. WALSH and A. M. LINDEMANN (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0347)
Riblet surfaces have been tested in boundary layers having different upstream histories and at higher Reynolds numbers than previously reported. The drag reduction for the riblet surfaces was found to be dependent on the height and spacing of the riblets in law-of-the-wall variables regardless of the free-stream Reynolds number or upstream boundary-layer history. Micro-photographs of the actual riblet geometries are examined to determine the effect of rib details on the riblet drag-reduction performances. To further increase drag-reduction performance, riblet surfaces are combined with another drag-reduction concept, the large-eddy breakup device (LEBU). In addition, the yaw sensitivity of riblets is evaluated, as well as the characteristics of riblet surfaces manufactured out of a thin vinyl sheet. Author

A84-18042#
MULTIPLE DUCTED STREAMS WITH A PERIODIC OR A STEADY SUPERSONIC DRIVER FLOW
H. L. PETRIE, A. L. ADDY (Illinois, University, Urbana, IL), and J. C. DUTTON (Texas A & M University, College Station, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract DAAG29-76-G-0200)
(AIAA PAPER 84-0350)
An investigation of multiple ducted streams with a steady and a periodic driver flow has been conducted to determine if the periodic driver is an effective mechanism to improve the momentum and energy exchange and to enhance mixing between compressible high speed ducted streams. The ducted system investigated consisted of a two-dimensional planar, constant area, air-to-air, supersonic-subsonic ejector. An efficient large scale fluidic oscillator was developed to generate the periodic pulses in the primary driver flow. A simplified theoretical analysis based on the assumptions of a one-dimensional, quasi-steady, inviscid flow was developed, and this analysis was compared with the results of an extensive experimental program which examined both steady and periodic driver flows in the ejector. Author

A84-18055#
THE HIAM WING - MILESTONE IN AERONAUTICAL ENGINEERING
B. LOVE (Airlove, Ltd., La Jolla, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(AIAA PAPER 84-0386)
HIAM (High Internal Air Mass) is a promising, but neglected, STOL design concept that utilizes a jet pump for internal suction and blowing to generate maximum lift by integration of the turbine engine compressor with the HIAM wing ducting system. It is applicable to a large range of engine supplied air. HIAM objectives are large reduction of airport size and/or lower fuel costs. HIAM design theory is explained with (1) reference to wing lift potential in the circulation, supercirculation and momentum reaction modes, (2) design of jet pumps to provide high entrainment ratio for maximum blowing and suction flow coefficients, (3) the effect of a HIAM system on airplane performance and (4) preliminary design layouts of prospective high flow ducting systems. System pressure loss is emphasized. Advantages of the HIAM wing over competing systems are pointed out. It is argued that local airlines operating from football field size airports, made possible with HIAM wing airplanes, is the answer to air transportation congestion. Vision of future airplane design requirements suggests that HIAM systems will become standard on all high load transportation aircraft.
Author

A84-18067#
WAVELIKE STRUCTURES IN ELLIPTIC JETS
P. J. MORRIS (Pennsylvania State University, University Park, PA) and D. G. MILLER American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(AIAA PAPER 84-0399)
The stability characteristics of elliptic jets are used to explain some of the observed properties of vortex structures in the initial mixing region of excited and unexcited elliptic jets. The velocity profile in the jet is taken to be both a vortex sheet and a continuous profile. The modes of solution in terms of Mathieu functions are described. The vortex sheet calculations indicate that as the eccentricity of the jet increases the mode which oscillates parallel to the minor axis is the most unstable. Calculations for realistic velocity profiles show that the azimuthal variation of jet momentum thickness at the jet exit is an important parameter in determining the most unstable modes. Author

A84-18068#
SHEAR LAYER DEVELOPMENT IN AN ANNULAR JET
R. W. WLEZIEN and V. KIBENS (McDonnell Douglas Corp., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0400)
The dynamical characteristics of annular jets with and without extended centerbodies have been experimentally investigated at subsonic jet velocities. Jets with small annular heights are most effective in reducing noise at high subsonic velocities. Noise reduction is shown to result from the modification of shear layer dynamics by the presence of the centerbody. Energy is channeled into the shear layer instabilities early in the shear layer development, which effectively suppresses the jet column instability mode. Jets with large annulus heights and centerbody extensions produce little change in the shear layer dynamics in comparison with a round jet. An annular jet without an extended centerbody quickly reverts to a flowfield similar to that resulting from a round

jet with an equivalent area. Detailed spectral contour maps are used to illustrate the evolution of the jet flowfield in frequency and physical location, and the limitations of single-point spectral measurements are discussed. Author

A84-18078#
AERODYNAMIC DESIGN OF HIGH CONTRACTION RATIO, SUBSONIC WIND TUNNEL INLETS
S. M. BATILL and J. J. HOFFMAN (Notre Dame, University, Notre Dame, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract F33615-81-K-3008)
(AIAA PAPER 84-0416)
The inlet or contraction section has significant impact on the performance and operating characteristics of any subsonic wind tunnel. Previous studies demonstrated the possibilities of using numerical aerodynamic prediction methods such as surface paneling or field finite difference solutions to predict the inlet performance. This work builds on this previous experience and develops a set of guidelines for use in preliminary aerodynamic design of three dimensional wind tunnel inlets. A set of preliminary design charts were developed using a finite difference field solution method which can be used for the aerodynamic design of high contraction ratio inlets in the range 10-40. The charts were developed for a family of wall contours defined by matched cubic polynomials. Author

A84-18079*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A METHOD FOR MODELING FINITE-CORE VORTICES IN WAKE-FLOW CALCULATIONS
P. M. STREMEL (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 23 p. refs
(AIAA PAPER 84-0417)
A numerical method for computing nonplanar vortex wakes represented by finite-core vortices is presented. The approach solves for the velocity on an Eulerian grid, using standard finite-difference techniques; the vortex wake is tracked by Lagrangian methods. In this method, the distribution of continuous vorticity in the wake is replaced by a group of discrete vortices. An axially symmetric distribution of vorticity about the center of each discrete vortex is used to represent the finite-core model. Two distributions of vorticity, or core models, are investigated: a finite distribution of vorticity represented by a third-order polynomial, and a continuous distribution of vorticity throughout the wake. The method provides for a vortex-core model that is insensitive to the mesh spacing. Results for a simplified case are presented. Computed results for the roll-up of a vortex wake generated by wings with different spanwise load distributions are presented; contour plots of the flow-field velocities are included; and comparisons are made of the computed flow-field velocities with experimentally measured velocities. Author

A84-18082#
FLOWFIELD AND VORTICITY DISTRIBUTION NEAR WING TRAILING EDGES
E. H. HIRSCHEL and L. FORNASIER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0421)
A compatibility condition is derived from boundary-layer and vorticity considerations which connects properties of the inviscid flowfield at the trailing edge of lifting wings with the derivative of the circulation in spanwise direction. The compatibility condition is applied to some wing flowfields computed with different panel methods, an analytical lifting-surface method, and an Euler method. It is shown that first-order panel methods do not fulfill the compatibility condition because the flowfield is predicted wrongly on large parts of the wing surface. A boundary-layer study reveals the errors which are made by using the inviscid flowfield found with a first-order panel method as outer boundary condition. Author

A84-18085*#
APPLICATION OF THE GREEN'S FUNCTION METHOD FOR 2- AND 3-DIMENSIONAL STEADY TRANSONIC FLOWS
K. TSENG (Icarus, Inc., Boston, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract NGR-22-004-030; NAS1-17317)
(AIAA PAPER 84-0425)
A Time-Domain Green's function method for the nonlinear time-dependent three-dimensional aerodynamic potential equation is presented. The Green's theorem is being used to transform the partial differential equation into an integro-differential-delay equation. Finite-element and finite-difference methods are employed for the spatial and time discretizations to approximate the integral equation by a system of differential-delay equations. Solution may be obtained by solving for this nonlinear simultaneous system of equations in time. This paper discusses the application of the method to the Transonic Small Disturbance Equation and numerical results for lifting and nonlifting airfoils and wings in steady flows are presented. Author

A84-18087#
A METHOD FOR CALCULATING SUBSONIC AND TRANSONIC FLOWS OVER WINGS OR WING-FUSELAGE COMBINATIONS WITH AN ALLOWANCE FOR VISCOUS EFFECTS
M. T. ARTHUR (Royal Aircraft Establishment, Aerodynamics Dept., Farnborough, Hants., England) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0428)
The paper presents a scheme in which a method for solving an equation for the velocity potential is linked in a fully interactive manner with a method for calculating three-dimensional, turbulent, boundary layers and wakes. The boundary layer and wake are computed directly from the velocity distribution in the external, inviscid flow. The method can be used for the calculation of subsonic and transonic flows which are attached but may be close to separation. Preliminary results are presented for a wing-fuselage configuration typical of current designs. Author

A84-18090*# New Mexico Univ., Albuquerque.
BOUNDARY LAYER TRANSITION EFFECTS ON FLOW SEPARATION AROUND V/STOL ENGINE INLETS AT HIGH INCIDENCE
D. C. CHOU (New Mexico, University, Albuquerque, NM), D. P. HWANG (NASA, Lewis Research Center, Wind Tunnel and Flight Div., Cleveland, OH), K. SALARI, and C. P. WONG American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0432)
Numerical methods for calculating laminar and turbulent boundary layer development around vertical-short take off and landing engine inlets at high incidence angles are investigated. Various transition models were compared and evaluated in calculations off flow separation bound inside the inlet. Results of the transition effects on the boundary layer characteristics at onset of separation for two types of engine inlet geometries are presented. Some of the numerical results are compared with existing wind-tunnel test data for scaled inlet models to demonstrate the effects of transition models in the numerical scheme. The effects of transition modeling on the boundary layer development are illustrated for typical engine operating conditions. Author

A84-18094*# Sverdrup Technology, Inc., Arnold Air Force Station, Tenn.
ONE-DIMENSIONAL UNSTEADY MODELING OF SUPERSONIC INLET UNSTART/RESTART
J. C. ADAMS, JR., W. R. MARTINDALE, and M. O. VARNER (Sverdrup Technology Computer Service Center, Tullahoma, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 34 p. refs
(Contract NAS3-23682)
(AIAA PAPER 84-0439)

A quasi-one-dimensional unsteady inviscid analysis of mixed-compression supersonic inlet flow is presented with emphasis on modeling of inlet unstart/restart phenomena. Numerical solution of the governing equations of motion is performed using a computationally efficient shock-capturing split-characteristics algorithm. Inlet unstart is modeled using a mass balance method which relates the expelled normal shock position ahead of the inlet cowl to the amount of spilled mass flow over the inlet housing. Comparison of computed results with experimental data for an axisymmetric inlet at a free-stream Mach number of 2.50 shows quite reasonable agreement over an entire unstart/restart transient which includes centerbody translation and retraction as well as bypass mass flow variations. Author

A84-18095#
CALCULATION OF UNSTEADY THREE-DIMENSIONAL SUBSONIC/TRANSONIC INVISCID FLOWFIELDS BY THE METHOD OF CHARACTERISTICS
D. L. MARCUM and J. D. HOFFMAN (Purdue University, West Lafayette, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 22 p. refs
(AIAA PAPER 84-0440)

An analysis based on the unsteady three-dimensional method of characteristics is presented for calculating unsteady three-dimensional subsonic/transonic inviscid flowfields. The flowfield unit processes are based on a local network consisting of six bicharacteristics and the pathline. The algorithm is an explict second-order accurate predictor-corrector procedure. An inverse marching method is employed, wherein the solution grid in physical space is prespecified. Steady flow solutions are obtained as the asymptotic solution in time. Results are presented for a spherical supersonic source flow, for axisymmetric supersonic flow in a conical nozzle, for three-dimensional supersonic flow in a super-elliptical nozzle, and for three-dimensional subsonic/transonic flow in a super-elliptical nozzle. Author

A84-18149*# Stanford Univ., Calif.
NUMERICAL SIMULATION OF THE TIP VORTEX OFF A LOW-ASPECT-RATIO WING AT TRANSONIC SPEED
N. N. MANSOUR (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 14 p. refs
(Contract NAG2-029)
(AIAA PAPER 84-0522)

The viscous transonic flow around a low-aspect-ratio wing has been computed using an implicit, three-dimensional, 'thin-layer' Navier-Stokes solver. The grid around the geometry of interest is obtained numerically as a solution to a Dirichlet problem for the cube. The geometry chosen for this study is a low-aspect-ratio wing with large sweep, twist, taper, and camber. The topology chosen to wrap the mesh around the wing with good tip resolution is a C-O type mesh. Using this grid, the flow around the wing was computed for a free-stream Mach number of 0.82 at an angle of attack of 5 deg. At this Mach number, an oblique shock forms on the upper surface of the wing, and a tip vortex and three-dimensional flow separation off the wing surface are observed. Particle path lines indicate that the three-dimensional flow separation on the wing surface is part of the roots of the tip-vortex formation. The lifting of the tip vortex before the wing trailing edge is clearly observed by following the trajectory of particles released around the wing tip. Author

A84-18150*# Scientific Research Associates, Inc., Glastonbury, Conn.
CALCULATION OF STEADY AND OSCILLATING AIRFOIL FLOW FIELDS VIA THE NAVIER STOKES EQUATIONS
S. J. SHAMROTH (Scientific Research Associates, Inc., Glastonbury, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. Army-supported research. refs
(Contract NAS1-15214)
(AIAA PAPER 84-0525)

A Navier-Stokes calculation procedure is applied to high Reynolds number flow about steady and unsteady airfoils. The procedure solves the ensemble averaged governing equations via a linearized block implicit (LBI) technique which in general converges to a nominal steady flow within 120 time steps. The grid used in the computation is highly stretched thus resolving the turbulent boundary layers. Calculations have been compared with data for both NACA 4412 airfoil at high incidence and an NACA 0012 airfoil oscillating in dynamic stall. In both cases, good agreement is noted between measured and calculated surface pressure distributions. Author

A84-18151#
NUMERICAL COMPUTATION OF BASE FLOW FOR A MISSILE IN THE PRESENCE OF A CENTERED JET
J. SAHU and C. J. NIETUBICZ (U.S. Army, Ballistics Research Laboratory, Aberdeen Proving Ground, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0527)

A thin-layer Navier-Stokes code, developed for projectile aerodynamics, has been used to compute the missile base flow in the presence of a centered propulsive jet. The thin-layer form of compressible Navier-Stokes equations is solved using a time dependent, implicit numerical algorithm. Numerical computations have been made to predict the missile afterbody flow field for both jet-off and jet-on conditions. Solutions are obtained for an axisymmetric cylindrical afterbody where the free stream Mach number is 1.343 and the jet exit Mach number is 2.7. Exhaust jet static pressure is 2.15 times the free stream static pressure. Computed results show both qualitative and quantitative features of the base region flow field. Author

A84-18152#
INSTABILITY OF TRANSONIC NOZZLE FLOWS
M.-S. LIOU (National Cheng Kung University, Tainan, Republic of China) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0528)

Stability analysis of two-dimensional transonic nozzle flows is presented using the small disturbance procedures. A usual unsteady nonlinear transonic equation results. The paper presents concepts of using acoustic reflection and Fourier components of a disturbance to study the amplification in the flows. Some familiar and interesting physical results are obtained as special limits of the study. The effect of boundary layers on the flow stability is given. Author

A84-18154#
INVESTIGATION OF THE EFFECTS OF A SMALL CENTRALLY LOCATED FENCE ON TWO-JET UPWASH FLOWS
W. G. HILL, JR. (Grumman Aerospace Corp., Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(AIAA PAPER 84-0533)

A determination is sought for the benefits that a small fence between wall jet origins might provide for improving the takeoff performance of a VTOL aircraft by controlling the upwash formation and development. For the small-scale experimental set-up, a single spacing between jet nozzles and a single nozzle height above ground were chosen with values large enough to avoid any jet/plume upwash interference and to provide room for a series of upwash measurements at several heights above the gound. Total and static pressure traverses taken in the plane of the two nozzle centerlines showed that increasing the fence height from zero to approximately the total wall jet thickness increased the total pressure in the upwash by more than a factor of two, and decreased the upwash thickness by the same factor. As a result, the momentum flux in the upwash does not change significantly with fence height. If the aircraft body is narrow relative to the upwash width, the concentration of momentum caused by the fence should be beneficial. The use of a fence for improved in-ground effect V/STOL performance is suggested as a prevention of total disaster in the event of one engine failure. J.N.

A84-18158#
NUMERICAL ANALYSIS OF RAIN EFFECTS ON AN AIRFOIL
W. CALARESE and W. L. HANKEY (USAF, Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0539)

This paper presents a numerical analysis of the effects of rain on the aerodynamic characteristics of a NACA 0012 airfoil at typical take-off/landing angles of attack. The 2-D Navier-Stokes equations are solved using MacCormack's time dependent algorithm. Various water contents are investigated for both fine and coarse size rain. The coarse rain does not alter considerably the lift-drag characteristics of the airfoil. The fine rain, however, increases the lift-drag values by 10 percent for water contents simulating the heaviest rain falls ever recorded. Author

A84-18164*# Gates Learjet Corp., Wichita, Kans.
AERODYNAMIC CANARD/WING PARAMETRIC ANALYSIS FOR GENERAL AVIATION APPLICATIONS
M. W. KEITH (Gates Learjet, Wichita, KS) and B. P. SELBERG (Missouri-Rolla, University, Rolla, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(Contract NAG1-26)
(AIAA PAPER 84-0560)

Vortex panel and vortex lattice methods have been utilized in an analytic study to determine the two- and three-dimensional aerodynamic behavior of canard and wing configurations. The purpose was to generate data useful for the design of general aviation canard aircraft. Essentially no two-dimensional coupling was encountered and the vertical distance between the lifting surfaces was found to be the main contributor to interference effects of the three-dimensional analysis. All canard configurations were less efficient than a forward wing with an aft horizontal tail, but were less sensitive to off-optimum division of total lift between the two surfaces, such that trim drag could be less for canard configurations. For designing a general aviation canard aircraft, results point toward large horizontal and vertical distance between the canard and wing, a large wing-to-canard area ratio, and with the canard at a low incidence angle relative to the wing. Author

A84-18173#
EMPIRICAL CURVES FOR PREDICTING SUPERSONIC AERODYNAMICS OF VERY-LOW-ASPECT-RATIO LIFTING SURFACES
E. F. LUCERO (Johns Hopkins University, Laurel, MD) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(Contract NAVSEA TASK 62R)
(AIAA PAPER 84-0575)

Improved methods for predicting aerodynamics of lifting surfaces are needed at the very-low-aspect ratios found in wing (housing) designs of span-limited missiles and at moderate supersonic to hypersonic Mach numbers. A successful empirical method for estimating the normal force coefficient, C(N), and center of pressure location, X(cp), for this class of surfaces has been developed for unbanked (phi = 0 deg) cruciform wing configurations and for wing configurations banked at phi = 45 deg. The values of C(N) and X(cp) obtained using these empirical curves provide good estimates at Mach numbers greater than about 2.5 and angles of attack to 20 deg for thick and thin surfaces mounted in a cruciform configuration on cylindrical aftbodies. Author

A84-18249#
AN EVALUATION OF FLIGHT TEST MEASUREMENT TECHNIQUES FOR OBTAINING AIRFOIL PRESSURE DISTRIBUTIONS AND BOUNDARY LAYER TRANSITION LOCATIONS
D. T. WARD, S. J. MILEY (Texas A & M University, College Stations, TX), T. L. REININGER, and L. J. STOUT AIAA, AHS, IES, SETP, SFTE, and DGLR, Flight Testing Conference, 2nd, Las Vegas, NV, Nov. 16-18, 1983. 7 p. refs
(AIAA PAPER 83-2689)

Several wind tunnel and flight experiments have been conducted recently at Texas A & M University to evaluate the use of externally attached multitube pressure belts and surfaces to measure pressures, and the use of sublimating chemicals to determine boundary layer transition location. Though results are not complete, the belts provided an excellent means of measuring the coefficient of lift, but, they also interfered with accurate drag measurements. Wake surveys gave a reasonably good definition of the coefficient of drag though measurement of wake static pressures could be better defined with more flow direction sensors. Finally, sublimating chemicals provided useful approximations of the transition location, though considerable care was required in chemical application and in interpretation of results. Further quantification of the effect of the instability region between laminar and turbulent boundary layers is required to determine how sublimation measurements are affected by this region. Author

A84-18349* Princeton Univ., N. J.
TURBULENCE MEASUREMENTS IN TWO SHOCK-WAVE/SHEAR-LAYER INTERACTIONS
K. HAYAKAWA, A. J. SMITS, and S. M. BOGDONOFF (Princeton University, Princeton, NJ) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 279-288. refs
(Contract NAGW-240; F49620-81-K-0018)

Measurements of the longitudinal component of the mass-flow fluctuations have been made in an 8-deg compression corner flow and a reattaching shear layer at a Mach number of approximately 2.9 and unit Reynolds number of about 7 x 10 to the 7th per m. The data include turbulence intensities and probability density distributions. Significant turbulence amplification occurs in both interactions. A qualitative explanation in terms of direct shock effects, extra strain rates, and their relative contribution, is suggested. Author

A84-18350
TWO RAPID DISTORTIONS IN SUPERSONIC FLOWS - TURBULENCE-SHOCK WAVE AND TURBULENCE-EXPANSION
D. BESTION, J. F. DEBIEVE, and J. P. DUSSAUGE (Aix-Marseille II, Universite, Marseille, France) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 289-298. Research supported by the Office National d'Etudes et de Recherches Aerospatiales and Centre National de la Recherche Scientifique. refs

In order to analyze rapid distortions in supersonic flows, a new variable is defined from the Reynolds stress and the mean velocity, taking into account a part of the mean distortion effects. This variable is well adapted to the case of a mean discontinuity and of a bulk dilatation. The results of this analysis are compared to turbulence measurements performed in the case of two interactions: shock wave-turbulence and expansion turbulence. Author

A84-18351
ON THE BREAKDOWN OF THE CROCCO TEMPERATURE-VELOCITY RELATIONSHIP AND THE LAW OF THE WALL IN COMPRESSIBLE TWO-DIMENSIONAL TURBULENT BOUNDARY LAYERS
H. H. FERNHOLZ (Berlin, Technische Universitaet, Berlin, West Germany) and P. J. KLINE (Imperial College of Science and Technology, London, England) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 311-323. refs

Experimental information shows that a breakdown of both the modified Crocco relation and the logarithmic law of the wall is promoted by combinations of strong wall cooling, low Reynolds number, and either streamwise or normal pressure gradients (or both). Whereas the sign of the streamwise pressure gradient as such is not significant, experimental studies of adverse pressure gradient flows have found that these flows possess significant normal pressure gradients owing to wall curvature or changes in the pressure gradient. The evidence does not make it possible to distinguish the influences further; it can only be stated that the relations hold in the absence of heat transfer with smoothly applied combined pressure gradients. The cases of favorable pressure gradient are for the most part at very high Mach number, and this in practice results in low Reynolds numbers. As a consequence, the breakdown in such experiments as those of Beckwith et al. (1971) and Kemp and Owen (1972) can easily be explained without any 'high Mach number' effect as such. C.R.

A84-18352
THE STRUCTURE OF A TWO-DIMENSIONAL, SUPERSONIC, HIGH REYNOLDS NUMBER TURBULENT WAKE
J. P. BONNET and T. ALZIARY DE ROQUEFORT (Poitiers, Universite, Poitiers, France) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 324-333. Sponsorship: Direction des Recherches, Etudes et Techniques. refs
(Contract DRET-80-601)

The two-dimensional wake in a supersonic flow at high Reynolds number is investigated. Mean and fluctuating velocities measurements are discussed following the similarity criterions, and comparisons with incompressible wake behavior are done. The compressibility effects in such a flow are tested. Space and space-time correlations are performed for two downstream stations. Comparisons with the double-roller eddy model established for incompressible wake of cylinder are performed; the classical model does not apply to the wake under study. Isocorrelation curves are plotted and show inclined shapes whose angles of incidence are related to the downstream location. Filtered correlations show the evolution of the life-duration and the phase velocities following the size of the structures. Author

A84-18353
COHERENT STRUCTURES PRODUCING MACHWAVES INSIDE AND OUTSIDE OF THE SUPERSONIC JET
H. OERTEL (Saint-Louis, Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 334-343. refs

Supersonic jets emit Machwaves which are rather regular ones. Previous investigations using visualizations and an optical microphone have revealed that these Machwaves are shock waves which are accompanying mixing layer structures traveling downstream at three preferred speeds. The experimental results could be approximated by very simple relations. Local measurements within the mixing layer are needed in order to find out the reason for these relations. Two particular Doppler velocimeters have been used for doing such measurements. They have shown that a weak regular contribution to the essentially random velocity fluctuations exists. All results obtained so far agree with a hypothesis which is based upon the idea that the regular contribution consists of a vortex pattern, the movement and extent of which are governed by pressure waves. Author

A84-18354
THE STRUCTURE OF TURBULENCE OF A CORNER FLOW
Y. KOBASHI, O. MOCHIZUKI, and K. OGAWARA (Hokkaido University, Sapporo, Japan) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 356-365. refs

The present work was initiated in order to study the mechanism of turbulent contamination or the spread of turbulence into the boundary layer from the corner. Hot-wire measurements together with the flow visualization by smoke show that the turbulence in the corner flow is characterized by the streamwise vortices aligned along the surface and that it squeezes into the boundary layer by inducing the neighboring fluid in the form of vortex filaments. The vortex formation in this case is caused by the interaction between streamwise (two-dimensional) and spanwise (three-dimensional) disturbances just as in the case of boundary layer transition. The effect of the leading edge curvature is strong in the sense that it increases the instability of the corner flow in its laminar phase but not as long as the mechanism of turbulent contamination is concerned. Author

A84-18356
THE INTERACTION OF A WAKE WITH A BOUNDARY LAYER
L. C. SQUIRE (Cambridge University, Cambridge, England) and M. D. ZHOU IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 376-387. refs

Extensive measurements of mean and fluctuating quantities have been made in merging, two-dimensional, viscous layers. These measurements cover the interactions of wakes shed by aerofoils of various shapes with boundary layers growing in zero and adverse pressure gradients. The effects of aerofoil incidence and height about the test surface are included. In all, eleven flows were measured and the basic data were published in a previous report (Zhou and Squire, 1981). This paper presents a description of the general development of a typical merging flow and discusses the influence of individual parameters. The departure from the usual eddy viscosity or mixing length hypothesis is also shown and the possible mechanism for these changes has been studied by flow visualization. It is shown that the main effects are associated with the vortex shedding from the aerofoil and with changes in the hairpin structures. Author

A84-18358
THE TURBULENT WAKE BEHIND AN AXISYMMETRIC BODY AND ITS INTERACTION WITH THE EXTERNAL TURBULENCE
B. A. KOLOVANDIN, N. N. LUCHKO, and IU. M. DMITRENKO (Akademiia Nauk Belorusskoi SSR, Institut Teplo- i Massoobmena, Minsk, Belorussian SSR) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 399-410. refs

Based on the differential second-order model of turbulence unified for arbitrary turbulent Reynolds numbers, an axisymmetric turbulent wake behind a body of revolution in the external turbulence environment is considered. The wind-tunnel experiment which was carried out has provided detailed information on distribution of turbulence characteristics in the near wake. The development of a turbulent wake at arbitrary distances behind a body is modeled numerically. The interaction of the wake turbulence with the external degenerating turbulence has been studied. Author

A84-18359
INTERACTION REGION OF A TWO-DIMENSIONAL TURBULENT PLANE JET IN STILL AIR
L. W. B. BROWNE, R. A. ANTONIA, S. RAJAGOPALAN, and A. J. CHAMBERS (Newcastle, University, Newcastle, Australia) IN: Structure of complex turbulent shear flow; Proceedings of the Symposium, Marseille, France, August 31-September 3, 1982 . Berlin, Springer-Verlag, 1983, p. 411-419. Research supported by the Australian Research Grants Committee. refs

Mean velocity and temperature profiles in the interaction region of a slightly heated turbulent plane jet with initially laminar boundary layers do not deviate perceptibly from the far field self-preserving profiles when the centerline mean velocity/temperature and mean velocity/temperature half-widths are used as the appropriate normalizing scales. On the jet centerline, the maximum value of the ratio of rms to mean temperature is larger by a factor of almost two than the corresponding ratio for any of the three velocity fluctuations. The probability density function of temperature on the centerline and at a distance of twelve slit widths from the nozzle reveals the presence of room temperature fluid and also of fluid which is at the jet exit temperature. Spectral density functions of temperature exhibit a peak up to a distance of about twelve nozzle widths. Space-time correlations of velocity fluctuations indicate that the vortical structures, symmetrical with respect to the centerline, which are observed at the beginning of the interaction are replaced by structures, asymmetrical with respect to the centerline, towards the end of the interaction region. Author

A84-18648#
PERFORMANCE COMPARISON OF STRAIGHT AND CURVED DIFFUSERS
R. K. SULLEREY, B. CHANDRA, and V. MURALIDHAR (Indian Institute of Technology, Kanpur, India) Defence Science Journal (ISSN 0011-748X), vol. 33, July 1983, p. 195-203. refs

Experimental studies have been carried out to compare the performance of two dimensional straight and curved diffusers of same area ratio and effective divergence angle in the Reynolds number range of 7.8 x 10 to the 5th to 1.29 x 10 to the 6th. Free stream turbulence effects have also been studied at the increased turbulence level to 3.4 percent. The results indicate that straight diffuser pressure recovery is slightly higher as compared to the curved diffusers. However, stream turbulence, which improves the pressure recovery in both cases, has been observed to have greater effect in the case of the curved diffuser. Boundary layer velocity profiles on the diffuser surfaces have also been presented at various streamwise stations. It is observed that the growth of inner surface boundary layer has a major effect on losses in the case of a curved diffuser. Author

A84-18749
GAS AND WAVE DYNAMICS [GAZOVAIA I VOLNOVAIA DINAMIKA]
KH. A. RAKHMATULIN Moscow, Izdatel'stvo Moskovskogo Universiteta, 1983, 200 p. In Russian. refs

Problems of the dynamics of supersonic and subsonic gas flows are examined. Topics discussed include one-dimensional plane unsteady gas flows with finite perturbations, two-dimensional steady supersonic gas flows, small-amplitude waves, gas flows of high subsonic velocities, and the theory of axisymmetric supersonic gas flows. The theory of unloading waves is presented based on an analogy with one-dimensional gas flow. A solution is obtained for the problem of the longitudinal impact of an ideal rigid body against an elastoplastic body. The fundamentals of the theory describing the motion of multiphase compressible media are also presented. V.L.

A84-18996
CONDITIONS OF THE MIXING OF TRANSVERSE CO2 JETS WITH A SUPERSONIC NITROGEN FLOW IN A NOZZLE [REZHIMY SMESHENIIA POPERECHNYKH STRUI CO2 SO SVERKHZVUKOVYM POTOKOM AZOTA V SOPLE]
V. A. VOLKOV, N. N. OSTROUKHOV, and B. K. TKACHENKO (Moskovskii Fiziko-Tekhnicheskii Institut, Moscow, USSR) Inzhenerno-Fizicheskii Zhurnal (ISSN 0021-0285), vol. 45, Dec. 1983, p. 954-958. In Russian. refs

Flows of nitrogen in a plane supersonic nozzle with strong transverse injection of a series of CO2 jets are investigated experimentally using shadowgraphy and schlieren photography. For low jet pressure ratios, n, the flow is shown to be similar to that observed in the case of single-jet injection. For high n, interaction between the injected jets is observed. The regions where the interaction of jets with the flow and with each other is most intense are determined. V.L.

A84-19001
THE STRUCTURE OF SEPARATED FLOW IN THE CASE OF SUPERSONIC FLOW PAST BLUNT CONES WITH A REAR STING [STRUKTURA OTRYVNOGO TECHENIIA PRI SVERKHZVUKOVOM OBTEKANII ZATUPLENNYKH KONUSOV S ZADNEI DERZHAVKOI]
N. S. KOKOSHINSKAIA and V. M. PASKONOV Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 4-11. In Russian.

A theoretical study of the effect of base stings of varying thickness on the flow of a viscous gas in the near wake of a spherically blunted axisymmetric cone is presented. A difference scheme was used to solve the complete unsteady Navier-Stokes equations in the case of uniform flow at a freestream Mach number of 20 and a freestream Reynolds number of 66,500. The effect of the base sting and of its thickness on upstream flow from the base, on flow structure in the near wake, and on base pressure is investigated. B.J.

A84-19002
SUPERSONIC VISCOUS COMPRESSIBLE GAS FLOW PAST CONICALLY BLUNTED CYLINDERS AT LOW REYNOLDS NUMBERS [SVERKHZVUKOVOE OBTEKANIE TSILINDROV, ZATUPLENNYKH PO KONUSU, VIAZKIM SZHIMAEMYM GAZOM PRI MALYKH CHISLAKH REINOL'DSA]
N. A. CHERANEVA Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 11-21. In Russian. refs

An analysis is made of supersonic flow (freestream Mach = 4) past conically blunted cylinders for Reynolds numbers of 50, 100, and 200, and cone semiangles of 50-90 deg. The boundary value problem for the unsteady Navier-Stokes equations for a compressible gas is solved by an implicit alternating-direction difference scheme. The numerical experiment investigates the effect of Reynolds number and the inclination angle of the conical surface on flow structure near the body. B.J.

A84-19003
SUPERSONIC FLOW PAST A PLATE AND A CYLINDER IN THE CASE OF INJECTION FROM A LATERAL SURFACE [SVERKHZVUKOVOE OBTEKANIE PLASTINY I TSILINDRA PRI VDUVE S BOKOVOI POVERKHNOSTI]
S. S. KULNEV and V. M. PASKONOV Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 22-38. In Russian. refs

The flow structure resulting from the interaction of a jet injected from a lateral surface with a supersonic gas flow was studied numerically for a freestream Reynolds number of 200, a freestream Mach number of 4, and an injection Mach number of 1.04. An implicit noniterative difference scheme is used to solve the complete Navier-Stokes equations for a compressible gas. The effects of freestream Reynolds number, Mach number, and the velocity profile of the injected jet on the flow characteristics near the body are investigated. An analysis is also made of the effect of the location of the annular nozzle on flow near a cylinder and in its wake, as well as on the total drag of the cylinder. B.J.

A84-19004
NUMERICAL STUDY OF SELF-SIMILAR PROBLEMS CONCERNING VISCOUS COMPRESSIBLE GAS FLOW IN CHANNELS [CHISLENNOE ISSLEDOVANIE AVTOMODEL'NYKH ZADACH O TECHENII VIAZKOGO SZHIMAEMOGO GAZA V KANALAKH]
L. V. KUZNETSOVA, B. M. PAVLOV, and V. V. CHICHAGOV Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 38-56. In Russian. refs

A numerical analysis of self-similar solutions to internal problems of viscous gas flow is carried out using two models: the 'narrow-channel' equations and the complete Navier-Stokes equations. In the first case, the finite-difference method is used to obtain solutions for a cylindrical pipe and a conical nozzle at a specified wall temperature. In the second case, solutions are obtained to the direct and inverse problems for the supersonic section of a conical nozzle in the presence of mass transfer from the wall, with allowance for slip and temperature jump and in the case of an arbitrary power dependence of viscosity on temperature. B.J.

A84-19005
NUMERICAL SIMULATION OF UNSTEADY SUPERSONIC INJECTION INTO AN INCOMING FLOW [CHISLENNOE MODELIROVANIE NESTATSIONARNOGO SVERKHZVUKOVOGO VDUVA V SPUTNYI POTOK]
N. S. KOKOSHINSKAIA, V. M. PASKONOV, and S. V. RUSAKOV Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 56-64. In Russian. refs

The unsteady axisymmetric flow of a viscous gas between two coaxial cylinders in a supersonic stream is analyzed on the basis of a numerical solution to the complete Navier-Stokes equations. The flow is made unsteady by unsteady injection from the rear of the first cylinder, located more upstream. A comparison is made of various methods for specifying boundary conditions on the site where the injection occurs. It is shown that boundary conditions which take flowrate as the main determining characteristic of the nozzle make possible an effective simulation of unsteady jets with subsonic-to-supersonic transition. B.J.

A84-19007
ANALYSIS OF THE STARTING PROCESS IN A SUPERSONIC NOZZLE [RASCHET ZAPUSKA SVERKHZVUKOVOGO SOPLA]
O. V. KULAGINA, U. G. PIRUMOV, and G. S. ROSLIAKOV Vychislitel'nye Metody i Programmirovanie (ISSN 0507-5386), no. 38, 1983, p. 78-92. In Russian. refs

The propagation of disturbances in a supersonic nozzle in which the gas is initially at rest is studied numerically on the assumption that these disturbances are caused by jumpwise variations of parameters in the inlet section of the nozzle. The starting process is investigated in the one-dimensional approximation, which describes sufficiently well the asymptotic behavior of the solution for long time periods. Parametric calculations are made for various pressure and temperature gradients at the nozzle inlet. The effects of geometric parameters and adiabatic exponent on gas flow in a Laval nozzle and the time of transition to a steady-state regime are investigated. B.J.

A84-19227#
LAMINAR BOUNDARY LAYER STABILITY EXPERIMENTS ON A CONE AT MACH 8. II - BLUNT CONE
K. F. STETSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), E. R. THOMPSON (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN), J. C. DONALDSON, and L. G. SILER (Calspan Field Services, Inc., Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 34 p. refs
(AIAA PAPER 84-0006)

The stability of a laminar boundary layer on a slender cone in hypersonic flow is not well understood. The present investigation provides, therefore, stability data for a blunt cone. Stetson et al. (1983) have reported laminar boundary layer stability experiments on a sharp cone at Mach 8. On the basis of the results of the present investigation it is concluded that small nosetip bluntness will lead to significant changes, compared to conditions in the presence of a sharp cone, in the stability characteristics of the cone frustrum boundary layer. Disturbances were found to grow outside the boundary layer, in the entropy layer, indicating the existence of an inviscid instability. G.R.

A84-19228*# Tennessee Univ., Tullahoma.
COMPARISON OF EXPERIMENTAL AND COMPUTATIONAL COMPRESSIBLE FLOW IN A S-DUCT
A. VAKILI, J. M. WU (Tennessee, University, Tullahoma, TN), W. R. HINGST, and C. E. TOWNE (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(Contract NAG3-233)
(AIAA PAPER 84-0033)

This paper describes experimental measurements of secondary flow in a constant area, circular cross-section 30-30 deg S-duct, and compares the results obtained with the computations performed using the PEPSIG code, a parabolized Navier-Stokes code. The flow entering the duct was turbulent, with entrance Mach number of 0.6, and the boundary layer thickness at the duct entrance was 10 percent of the duct diameter. The duct mean radius of curvature to the duct diameter was 5.077. Flow parameters were measured at six stations along the length of the duct. These measurements were made using a five-port cone probe. At least ten radial traverses were made at each station on both sides of the symmetry plane. Wall static pressures along three azimuth angles of zero, 90, and 180 deg along the duct were measured. Plots presenting the secondary velocity field as well as contour plots of the total and static-pressure fields have been obtained. Strong secondary flows were observed in the first bend, and these continued into the second bend with the formation of new vorticity in the opposite sense in the second bend. The flow exiting the duct contained two pairs of counter-rotating vortices. The computational results are in general agreement with the experiments. However, it appears that the computations underestimate the extent of the pressure distortion, due to simplifications made in the pressure field calculations. Author

A84-19230*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SECOND-ORDER-ACCURATE SPATIAL DIFFERENCING FOR THE TRANSONIC SMALL-DISTURBANCE EQUATION
P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA) and R. D. VAN BUSKIRK American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 20 p. refs
(AIAA PAPER 84-0091)

Current methods for calculating transonic flows with the small-disturbance potential equation are typically only first-order accurate in the supersonic regions of the flow. However, calculations using the full-potential equation show significant improvements in accuracy when second-order methods are used instead of first-order methods. In this paper, algorithms for the small-disturbance equations are presented, for both steady and unsteady flows, with spatial differencing that is second-order accurate in both the subsonic and supersonic regions of the flow. These algorithms are stable, simple extensions of implicit monotone algorithms; the former are only first-order accurate spatially in the supersonic regions. Several calculations in one and two dimensions have been made, and the first- and second-order calculations are compared. In one dimension, the calculations include the four types of shock-wave motion. In two dimensions, the comparisons include steady flow over a Korn airfoil and unsteady flow over a pitching airfoil. All the comparisons in two dimensions show that the new methods are just as stable numerically as the old methods, but improve the accuracy of the solutions. The algorithm improvements can be implemented in present computer codes by making minor coding modifications. Author

A84-19231*# Computer Dynamics, Inc., Virginia Beach, Va.
IMPROVED FINITE DIFFERENCE SCHEMES FOR TRANSONIC POTENTIAL CALCULATIONS
M. HAFEZ (Computer Dynamics, Inc., Virginia Beach, VA), S. OSHER (California, University, Los Angeles, CA), and W. WHITLOW, JR. (NASA, Langley Research Center, Unsteady Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 28 p. refs
(AIAA PAPER 84-0092)

Engquist and Osher (1980) have introduced a finite difference scheme for solving the transonic small disturbance equation, taking into account cases in which only compression shocks are admitted. Osher et al. (1983) studied a class of schemes for the full potential equation. It is proved that these schemes satisfy a new discrete 'entropy inequality' which rules out expansion shocks. However, the conducted analysis is restricted to steady two-dimensional flows. The present investigation is concerned with the adoption of a heuristic approach. The full potential equation in conservation form is solved with the aid of a modified artificial density method, based on flux biasing. It is shown that, with the current scheme, expansion shocks are not possible. G.R.

A84-19232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLOWFIELD SCALING OF A SWEPT COMPRESSION CORNER INTERACTION A COMPARISON OF EXPERIMENT AND COMPUTATION
G. S. SETTLES (Pennsylvania State University, University Park, PA), C. C. HORSTMAN, and T. M. MCKENZIE (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract F49620-81-K-0018)
(AIAA PAPER 84-0096)

Over the past decade, there has been some important progress in understanding the problems of three-dimensional (3D) shock wave/turbulent boundary layer interactions. However, the problems are by no means solved. The present investigation has the objective to determine the flowfield structure of a swept compression corner interaction and to perform a test of an equation considered by Settles and Bogdonoff (1982). The experimental data obtained in a 20 x 20 cm high Reynolds number supersonic wind tunnel are compared with the predictions of a state-of-the-art numerical solution of the Navier-Stokes equations. It is found that a 3D scaling law for Reynolds number effects, previously established for interaction 'footprints', is equally valid when applied to the present flowfield. G.R.

A84-19234#
COMPARISON OF FULL-POTENTIAL AND EULER SOLUTION ALGORITHMS FOR TRANSONIC FLOWFIELD COMPUTATIONS
Y. TASSA and J. VADYAK (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. Research supported by the Lockheed Independent Research and Development Program. refs
(AIAA PAPER 84-0118)

A study has been conducted which compares the numerical solutions obtained from full-potential and Euler equation algorithms for transonic flow problems. The computations have been performed for two types of aeropropulsive configurations: two-dimensional or planar nacelle/inlet configurations, and axisymmetric nacelle/inlet configurations. The full-potential equation, written in conservative form, is solved numerically using two different algorithms. The first algorithm is based on a successive-line-over-relaxation scheme (SLOR) with the multigrid technique applied to accelerate convergence. The other algorithm employs the AF2 fully-implicit approximate factorization scheme. The Euler equation algorithm, also writteen in conservative form, is based on the Douglas-Gunn Alternating-Direction-Implicit (ADI) procedure. Detailed comparisons of the computed pressure distributions for aeropropulsive flow-fields at transonic flow conditions and comparison with experimental data are presented to illustrate the accuracy and application of the respective analyses. Discussions on mesh resolution, artificial viscosity, and computer execution time are provided. Author

A84-19242#
AN EVALUATION OF NCOREL, PAN AIR AND W12SC3 FOR THE PREDICTION OF PRESSURE ON A SUPERSONIC MANEUVER WING
M. SICLARI, M. VISICH, A. CENKO, B. ROSEN, and W. MASON (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(AIAA PAPER 84-0218)

The ability of three recently developed computer programs to predict pressures on a supersonic maneuver wing has been evaluated. The supersonic maneuver wing used for the comparison was designed specifically to minimize crossflow shock formation and shock induced boundary layer separation. Hence, retention of attached flow conditions on the upper surface was maximized, making the wing a prime candidate for the evaluation of inviscid methods. Although the NCOREL program was the only code capable of predicting the nonlinear features of the flow, the two linear panel methods, PAN AIR and W12SC3, also did well, particularly at the lower angle of attack. Author

A84-19243*# General Dynamics Corp., Fort Worth, Tex.
PAN AIR PREDICTION OF NASA AMES 12-FOOT PRESSURE WIND-TUNNEL INTERFERENCE ON A FIGHTER CONFIGURATION
L. D. SNYDER (General Dynamics Corp., Fort Worth, TX) and L. L. ERICKSON (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 17 p. refs
(AIAA PAPER 84-0219)

Models tested in the NASA Ames 12-Foot Pressure Wind Tunnel over an angle of attack range from 0 deg to 90 deg are mounted on a floor strut that protrudes from a fairly large support bump. In high-angle-of-attack tests (angle of attack = 40 deg to 90 deg), for which the floor support was originally designed, the effects of the flow angularities produced by the bump are often negligible. This is not so for low-angle-of-attack tests (0 deg to 40 deg). Since there are no standard means for correcting test data for this bump effect, low-angle-of-attack testing with the bump is not recommended by the Ames wind-tunnel staff. This paper presents an exploratory study of a technique for correcting balance forces and experimental pressures for combined wall and bump effects. This is done by modeling the aircraft, wind-tunngl walls, and bump, with PAN AIR. The wall-and-bump-induced increments in the lift coefficient and pitching-moment coefficient predicted by PAN AIR are compared with increments obtained from the Ames 12-foot tunnel with the bump and an 8 x 12 low speed wind tunnel which has no bump. Author

A84-19244*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PAN AIR MODELING STUDIES. II - SIDESLIP OPTION, NETWORK GAPS, THREE-DIMENSIONAL FOREBODY FLOW, AND THICK-TRAILING-EDGE REPRESENTATION
S. STRANDE, L. ERICKSON, R. CARMICHAEL (NASA, Ames Research Center, Moffett Field, CA), and L. SNYDER (NASA, Ames Research Center, Moffett Field, CA; General Dynamics Corp., Fort Worth, Tx) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 21 p. refs
(AIAA PAPER 84-0220)

PAN AIR is a computer program that calculates linear potential flow about arbitrary configurations at both subsonic and supersonic Mach numbers. This paper is a follow-on of another paper entitled 'PAN AIR Modeling Studies', in which several studies were presented that exhibited PAN AIR's versatility for modeling diverse configurations. Results from four modeling studies of interest in modeling realistic aircraft shapes are presented. The topics addressed are (1) half-geometry option in sideslip, (2) network gaps, (3) three-dimensional forebody flows, and (4) trailing-edge representation. Author

A84-19245*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NONLINEAR AERODYNAMIC EFFECTS ON BODIES IN SUPERSONIC FLOW

J. L. PITTMAN (NASA, Langley Research Center, Hampton, VA) and M. J. SICLARI (Grumman Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs

(AIAA PAPER 84-0231)

The supersonic flow about generic bodies was analyzed to identify the elments of the nonlinear flow and to determine the influence of geometry and flow conditions on the magnitude of these nonlinearities. The nonlinear effects were attributed to separated-flow nonlinearities and attached-flow nonlinearities. The nonlinear attached-flow contribution was further broken down into large-disturbance effects and entropy effects. Conical, attached-flow bundaries were developed to illustrate the flow regimes where the nonlinear effects are significant, and the use of these boundaries for angle of attack and three-dimensional geometries was indicated. Normal-force and pressure comparisons showed that the large-disturbance and separated-flow effects were the dominant nonlinear effects at low supersonic Mach numbers and that the entropy effects were dominant for high supersonic Mach number flow. The magnitude of all the nonlinear effects increased with increasing angle of attack. A full-potential method, NCOREL, which includes an approximate entropy correction, was shown to provide accurate attached-flow pressure estimates from Mach 1.6 through 4.6. Author

A84-19247#

SHOCK FITTING IN CONICAL SUPERSONIC FULL POTENTIAL FLOWS WITH ENTROPY EFFECTS

M. J. SICLARI (Grumman Research and Development Center, Bethpage, NY) and M. VISICH American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 15 p. refs

(AIAA PAPER 84-0261)

The full potential equation is solved implicitly for supersonic conical flows with the bow shock fitted as an external boundary. Existing potential flow computational procedures capture the embedded crossflow shock within the context of transonic relaxation schemes. In this study, the crossflow shock is fitted for the first time in potential flow as an internal boundary. Hence, all shocks are implicitly fit making the computation fully conservative. Both isentropic and Rankine-Hugoniot shocks are computed along with pressure entropy corrections for strong shock solutions. The present computations are compared to captured potential as well as Euler shock fit solutions. Remarkably good results are achieved for high Mach number flows using the potential equation with entropy corrections in the absence of vorticity dominated effects such as shock induced separation spirals. Author

A84-19248#

AN INVESTIGATION OF THE EFFECTS OF NON-UNIFORM THROAT FLOW ON BASE PRESSURE AT SUPERSONIC FLIGHT SPEEDS

A. L. ADDY, V. A. AMATUCCI (Illinois, University, Urbana, IL), and J. C. DUTTON (Texas A&M University, College Station, TX) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 47 p. Research supported by the University of Illinois. refs

(Contract DAAG29-79-C-0184)

(AIAA PAPER 84-0314)

The effects on base pressure at supersonic flight speeds of nonuniform propulsive nozzle flow were investigated. The Chapman-Korst component model for base flow during powered supersonic flight served as the basis for the evaluation of these effects. The base pressures were compared for ideal conical nozzles and for conical nozzles with circular arc throats. These comparisons were made for parametric variations in the radius of curvature of the nozzle throat and the specific heat ratio for the propulsive nozzle flow. For the cases presented, the nonuniform nozzle flow resulted in a maximum predicted increase in base pressure of approximately 5-8 percent. On the other hand, an earlier empirical modification to the base flow model, which improves agreement with experiment, decreases the predicted base pressure by approximately 14 percent. Author

A84-19249*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TWO RECENT EXTENSIONS OF THE VORTEX METHOD

P. R. SPALART (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs

(AIAA PAPER 84-0343)

The vortex method, coupled to an integral boundary-layer solver, is applied to the numerical simulation of high-Reynolds-number, separated flows in two new cases: a bluff body in a wind tunnel and flow in a cascade. In the bluff body case, the blockage effect of the tunnel walls is included approximately, assuming an inviscid boundary condition at the walls. The resulting increase in drag is computed, and compares well with a small-disturbance theory and with experiments. The results for flow in a cascade are compared with results from two finite-difference codes for a single-blade case, and good agreement is found. When a staggered cascade is treated with five independent blades, the simulation predicts rotating stall, depending on the angle of attack, and the essential features of the flow are correct. The sensitivity of this phenomenon to various parameters is studied and the stall boundary is found. Author

A84-19257#

A METHOD FOR DESIGNING THREE DIMENSIONAL CONFIGURATIONS WITH PRESCRIBED SKIN FRICTION

S. G. LEKOUDIS, N. L. SANKAR, and S. F. RADWAN (Georgia Institute of Technology, Atlanta, GA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. Research supported by the Lockheed-Georgia Co. refs

(AIAA PAPER 84-0526)

This work addresses the viscous design problem for three dimensional geometries. Close to the body surface the flow is treated as a boundary layer. The design is done as follows. The skin friction distribution is the target. It is used as input in an inverse boundary layer calculation. The resulting pressure distribution is used as input for an inverse potential flow calculation and thus the surface geometry is computed. The procedure is demonstrated by redesigning a swept, tapered wing in subsonic flow. Part of the upper surface of the wing has a prescribed distribution of the skin friction. Author

A84-19258#

THE INFLUENCE OF AIRFOIL ROUGHNESS ON THE PERFORMANCE OF FLIGHT VEHICLES AT LOW REYNOLDS NUMBERS

R. C. NELSON (Notre Dame, University, Notre Dame, IN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. Research supported by the Notre Dame University. refs

(Contract N00014-81-K-2036)

(AIAA PAPER 84-0540)

The flight performance and control characteristics of vehicles operating at low chord Reynolds numbers can be significantly altered by roughness on the airfoil surface. A brief review of airfoil aerodynamic characteristics at low chord Reynolds numbers with and without roughness is presented. These data are used to assess the implication of roughness on the performance, stability and control of flight vehicles designed for operation at low flight Reynolds numbers. Author

A84-19335
A GENERAL ADAPTIVE SCHEME
A. Y. ALLIDINA and F. M. HUGHES (University of Manchester Institute of Science and Technology, Manchester, England) International Journal of Control (ISSN 0020-7179), vol. 38, Dec. 1983, p. 1115-1120. refs

In recent years, many different adaptive schemes have been developed. In addition to the development of specific algorithms, much work has also been done in developing a general complex algorithm for which other algorithms developed by specific approaches are special cases. This paper discusses one such algorithm and shows how it can be further generalized. Author

N84-14118# Poznan Technical Univ. (Poland).
TRANSONIC FLOW OVER AN ISOLATED PROFILE AND THROUGH A CASCADE OF BLADE. PHENOMENOLOGICAL ANALYSIS
R. PIEPRZYK and J. KRAUZE (Polish Inst. for Agriculture) 1983 19 p refs Transl. into ENGLISH from Tech. Lotnicza i Astronautyczna (Poland), v. 37, Oct. 1982 p 8-13
Avail: NTIS HC A02/MF A01

Fundamental changes that have accurred in recent years in the design of turbocompressors are described, and physical processes associated with transonic flow in compressors are discussed. Particular consideration is given to the pattern of flow past an isolated profile, the interaction between shock waves and the surface layer, changes in the drag and lift coefficients of a profile depending on Mach number, and flow through a plane compressor cascade. For cost and performance effectiveness recent trends in the construction of engines has lead to the intensification of power; in other words, to designs leading to a reduction of the size and mass with a simultaneous increase in developed power. Author

N84-14119*# National Aeronautics and Space Administration, Washington, D. C.
LAMINARIZATION OF A BOUNDARY LAYER IN A SUPERSONIC NOZZLE BY COOLING OF THE SURFACE
V. P. MAKSIMOV and A. A. MASLOV Aug. 1983 7 p refs Transl. into ENGLISH from Aerofiz. Issled. (USSR), issue 6, 1976 p 110-112 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77341; NAS 1.15:77341) Avail: NTIS HC A02/MF A01 CSCL 01A

The concept of cooling of the surface of wind tunnel walls in order to laminarize the boundary layer, and thereby eliminate perturbations in the working area, is discussed. Equations are given, which are used to calculate the temperature conditions under which the flow in the boundary layer will be stably laminar. M.G.

N84-14122*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
THE USE OF OIL FOR IN-FLIGHT FLOW VISUALIZATION
R. E. CURRY, R. R. MEYER, JR., and M. OCONNOR Jan. 1984 17 p refs Presented at 14th Ann. Symp. of the Soc. of Flight Test Engr., Newport Beach, Cal., 15-19 Aug. 1983 Prepared in cooperation with NASA, Ames Research Center
(NASA-TM-84915; H-1195; NAS 1.15:84915) Avail: NTIS HC A02/MF A01 CSCL 01A

Oil was used to visualize inflight aerodynamic characteristics such as boundary layer transition, shock wave location, regions of separated flow, and surface flow direction. The technique, which is similar to wind tunnel oil-flow testing, involves an oil mixture to test aircraft before takeoff. After takeoff, the airplane climbs immediately to the test altitude and photographs are taken. The developmental experience is summarized, several examples of inflight oil-flow photographs are presented and discussed, and an approach for potential users of the technique is presented. Author

N84-14124# Dayton Univ., Ohio. School of Engineering.
NONLINEAR OSCILLATIONS OF A FLUTTERING PANEL IN A TRANSONIC AIRSTREAM Final Report, 1 May 1981 - 1 May 1982
F. E. EASTEP Apr. 1983 110 p
(Contract AF-AFOSR-01340-81; AF PROJ. 2307)
(AD-A133918; UDR-TR-83-43; AFOSR-83-0858TR) Avail: NTIS HCA06/MFA01 CSCL 20D

A flutter analysis has been conducted on a simply supported panel to demonstrate the successful combining of the panel (Von Karman) large deflection equations with a linear aerodynamic (Piston) theory for determining the panel response. The panel response was determined by coupling a Galerkin modal representation with a numerical time integration scheme. The time integration scheme was also successfully used to obtain the linear structural (small-deflection) response to a nonlinear aerodynamic pressure. Because the representation of the nonlinear panel response by a linear superposition of linear mode shapes is very questionable, the Von Karman large deflection equations were replaced by a large deflection finite-element representation. The nonlinear panel response of the finite-element model was obtained using Piston theory aerodynamics and it is recommended that the finite-element response be determined for a nonlinear aerodynamic pressure. GRA

N84-14125# Ballistic Research Labs., Aberdeen Proving Ground, Md.
SOME AERODYNAMIC CHARACTERISTICS OF A PROJECTILE SHAPE WITH A NONAXISYMMETRIC BOATTAIL AT MACH NUMBERS OF 0.91 AND 3.02 Final Report
L. D. KAYSER and F. WHITON, JR. Sep. 1983 48 p
(Contract DA PROJ. 1L1-62618-AH-80)
(AD-A133755; AD-F300330; ARBRL-TR-02525) Avail: NTIS HCA03/MFA01 CSCL 19A

Some aerodynamic properties of a projectile shape with a nonaxisymmetric boattail are presented. The boattail is formed by machining three flat surfaces which are equally spaced and inclined seven degrees to the model axis. Aerodynamic forces obtained by strain-gage balance measurements are presented for angles of attack up to 15 degrees and for various roll orientation of the model. Because the effect of roll orientation on coefficient data is quite small, coefficients are presented in incremental form so that the effect of roll can be graphically amplified. A limited quantity of the data is compared to computational results for Mach 3.02. The results of this study support previous studies which show that nonaxisymmetric boattail shapes can improve the static stability of projectiles. GRA

N84-14126# Ballistic Research Labs., Aberdeen Proving Ground, Md.
COMPUTATIONAL MODELING OF AERODYNAMIC HEATING FOR XM797 NOSE CAP CONFIGURATIONS Final Report
W. B. STUREK, L. D. KAYSER, D. C. MYLIN, and H. HUDGINS Sep. 1983 45 p Supersedes ARBRL-IMR-684, ARBRL-IMR-694, ARBRL-IMR-706.e
(Contract DA PROJ. 1L1-62618-AH-80)
(AD-A133684; AD-F300321; ARBRL-TR-02523; ABRL-IMR-684; ARBRL-IMR-694; ARBRL-IMR-706.E) Avail: NTIS HCA03/MFA01 CSCL 19A

The XM797 is a proposed training round for the 105mm M735 high velocity projectile. This projectile is designed to have a trajectory that closely follows that of the M735 yet have a maximum range of 8km. To achieve this performance the XM797 is designed with a nose cap made of zinc alloy which, due to structural weakening caused by aerodynamic heating and centrifugal loads due to spin, is supposed to fail and result in the projectile breaking apart. This paper summarizes the results of a computational study of the effects of aerodynamic heating for several zinc alloy and steel nose cap configurations for flight conditions pertinent to the development testing of the shell. The computational results were obtained using the ABRES Shape Change Code (ASCC) developed by Acurex/Aerotherm for numerically modeling the in-depth unsteady temperature response of an ablating reentry vehicle.

Examples of the in-depth temperature response of XM797 nose cap configurations are shown which demonstrate the capability of the code to predict the effects of ablation, location of boundary layer transition, projectile preconditioning temperature, and atmospheric conditions. Comparisons of the computational results to the results of test firings are shown which have provided assistance in the anlaysis of the projectile performance. GRA

N84-14127# Aeronautical Research Labs., Melbourne (Australia).
AN APPLICATION OF THE FINITE ELEMENT METHOD TO THE SOLUTION OF LOW REYNOLDS NUMBER, INCOMPRESSIBLE FLOW AROUND A JOUKOWSKI AEROFOIL, WITH EMPHASIS ON AUTOMATIC GENERATION OF GRIDS
T. TRAN-CONG Jun. 1983 32 p
(AD-A133008; ARL-AERO-TM-349) Avail: NTIS HCA03/MFA01 CSCL 09B

The problems of external flows around aircraft, internal flows inside propulsions units and also related problems like structural designs all require more and more accurate solutions while incorporating state of the art features involving more and more complex geometries and loadings. This is steadily becoming beyond the reach of analytical solution methods and thus necessitates the use of new computational methods. One of these is the Finite Element Method. The Finite Element Method was initially developed and used by Zienkiewicz for elasticity problems and is at the height of its development at the time of writing. The method is being studied theoretically as well as being applied to a broader and broader range of problems; its applications are found in solid mechanics, fluid mechanics, electromagnetics, etc. Some FORTRAN programs have been written in order to apply the Finite Element Method to the solution for low Reynolds number, incompressible flows around a Joukowski aerofoil, with emphasis on the generation of grids. These programs serve as evaluation tools and as a first step in a planned longer-term study of the Finite Element Method as applied to fluid flow problems. GRA

N84-14128# Georgia Inst. of Tech., Atlanta.
STUDY OF TURBULENT FLOW IN A WING-FUSELAGE TYPE JUNCTURE Ph.D. Thesis
L. R. KUBENDRAN 1983 176 p
Avail: Univ. Microfilms Order No. DA8315357

The turbulent flow field in a wing-fuselage type junction has been investigated. The wing and fuselage are simulated by using a body of constant thickness mounted perpendicular to a large flat plate. The body has an elliptical leading edges, and a two dimensional turbulent boundary layer is developing on the flat plate far upstream of the body nose. The measurements were conducted at three-streamwise stations upstream of the body and at three stations in the juncture downstream of the body leading edge. Two single-sensor hot-wire probes were used in the measurements. The measurements included three mean velocities and six Reynolds stresses in the regions where the flow was not separated. Some exploratory work, using hot wires, was carried out within the separated region to assess the usefulness of hot-wire techniques in reversed flow. The data acquisition technique employed here allows a hot wire to be used in reversed flow to indicate flow direction. All of the collected data have been analyzed to deduce the general flow behavior and to trace the history of the spearation vortex. Dissert. Abstr.

N84-15105 Arizona Univ., Tucson.
EFFECTS OF WALL INTERFERENCE ON UNSTEADY TRANSONIC FLOWS Ph.D. Thesis
S. M. PRZYBYTKOWSKI 1983 59 p
Avail: Univ. Microfilms Order No. DA8319730

Various sources of error can cause discrepancies among flight test results, experimental measurements and numerical predictions in the transonic regime. For unsteady flow, the effects of wind tunnel walls or a finite computational domain are the least understood and perhaps the most important. Although various techniques can be used in steady wind tunnel testing to minimize wall reflections, e.g., using slotted walls with ventilation, wind tunnel wall effects remain in unsteady wind tunnel testing even when they have been essentially eliminated from the steady flow. Even when the walls are ten chord lengths or more from the airfoil being tested, they can have a substantial effect on the unsteady aerodynamic response of the airfoil. Numerical computations of two and three dimensional unsteady transonic flow are compared with one another, and with experimental measurements, to isolate and examine the effects of tunnel walls. An extension of the time-linearized code developed by Fung, Yu and Seebass (1978) is used to obtain numerical results in two dimensions for comparison with one another. Dissert. Abstr.

N84-15106 Princeton Univ., N. J.
A STUDY OF HELICOPTER ROTOR AERODYNAMICS IN GROUND-EFFECT AT LOW SPEEDS Ph.D. Thesis
M. SUN 1983 265 p
Avail: Univ. Microfilms Order No. DA8323886

An experimental and analytical study of helicopter rotor aerodynamics in ground effect at low speeds has been conducted. The experimental studies included flow visualization experiments and measurements of the mean induced velocity distribution near the rotor plane using the hot wire technique using a model rotor. When a lifting rotor operates near the ground at low speeds, its wake will roll up after impinging on the ground because of the effects of the ground and the free stream air flow. The flow field induced by the rolled-up wake influences the rotor aerodynamic properties significantly. When the rolled-up wake moves near to and under the rotor plane, very large and irregular variations of the induce velocity distribution in the forward part of the rotor will occur, as a function of the rotor advance ratio. This causes irregular variations of the rotor forces and moments that have been observed in previous experiments. A simplified free-wake-rolled-up-wake flow model was developed. Dissert. Abstr.

N84-15108 Oklahoma Univ., Norman.
OPTIMIZATION OF WAVERIDER CONFIGURATIONS GENERATED FROM NON-AXISYMMETRIC FLOWS PAST A NEARLY CIRCULAR CONE Ph.D. Thesis
B. S. KIM 1983 124 p
Avail: Univ. Microfilms Order No. DA8324889

The optimum configurations of cone derived waveriders having maximum lift-to-drag ratios subject to a suitable constraint, such as fixed lift, are investigated. Analytic results from inviscid hypersonic small-disturbance theory for non-axisymmetric conical flow past a nearly circular cone are used, and results are valid for all values of K delta - M (infinity) delta, where delta is the semi-vertex angle of the basic circular cone. The special case of the configurations generated from axisymmetric conical flow is compared extensively with other configurations to give insight on the effects of the pertinent parameters. The inviscid analysis accounts for wave drag only, but the effect of viscous drag is discussed. The results are analytic in nature and particularly suitable for studying the various trade-offs that are involved in missile design. Comparison of the results with other types of lifting bodies suggest that properly selected waveriders are among the best producers of large lift-to-drag ratios. Dissert. Abstr.

N84-15113 National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
WIND TUNNEL TESTS ON A MODEL OF A SEMISUBMERSIBLE PLATFORM AND COMPARISON OF THE RESULTS WITH FULL-SCALE DATA
C. LEIJNSE and H. BOONSTRA (Marcon B. V.) 18 Mar. 1982 20 p refs Presented at 14th Ann. Offshore Technol. Conf., Houston, Texas, 3-6 May 1982
(NLR-MP-82014-U) Avail: Issuing Activity

Forces and capsizing moments on the parts of an offshore platform above and below the water were studied using a wind tunnel model. Full scale anchorline force observations were compared with predictions. Theoretically calculated wind forces are 30% and 40% higher than forces obtained from wind tunnel tests. Theoretically calculated wind capsizing moments are not necessarily higher than moments derived from model tests. For the determination of capsizing moments in the free-floating condition, model tests on the underwater part are as important as tests on the part above water. The averages of forces obtained from full scale anchorline tensions are 25% lower than predicted from model test results. In the reduction of platform anemometer readings to undisturbed wind velocities at standard height, effects in the flow field around the structure, and the wind gradient should be taken into account. Maximum moments to be considered for a free floating platform may be reduced by considering the drift velocity of the platform. Author (ESA)

N84-15114*# General Dynamics Corp., Fort Worth, Tex.
TAS: A TRANSONIC AIRCRAFT/STORE FLOW FIELD PREDICTION CODE Final Report, Jul. 1982 - May 1983
D. S. THOMPSON Washington NASA Dec. 1983 59 p refs
(Contract NAS2-11277)
(NASA-CR-3721; NAS 1.26:3721) Avail: NTIS HC A04/MF A01 CSCL 01A

A numerical procedure has been developed that has the capability to predict the transonic flow field around an aircraft with an arbitrarily located, separated store. The TAS code, the product of a joint General Dynamics/NASA ARC/AFWAL research and development program, will serve as the basis for a comprehensive predictive method for aircraft with arbitrary store loadings. This report described the numerical procedures employed to simulate the flow field around a configuration of this type. The validity of TAS code predictions is established by comparison with existing experimental data. In addition, future areas of development of the code are outlined. A brief description of code utilization is also given in the Appendix. The aircraft/store configuration is simulated using a mesh embedding approach. The computational domain is discretized by three meshes: (1) a planform-oriented wing/body fine mesh, (2) a cylindrical store mesh, and (3) a global Cartesian crude mesh. This embedded mesh scheme enables simulation of stores with fins of arbitrary angular orientation. B.W.

N84-15115*# Grumman Aerospace Corp., Bethpage, N.Y.
A WING CONCEPT FOR SUPERSONIC MANEUVERING Final Report
W. H. MASON Washington NASA Dec. 1983 79 p refs
(Contract NAS1-15357)
(NASA-CR-3763; NAS 1.26:3763) Avail: NTIS HC A05/MF A01 CSCL 01A

A theoretical and experimental program in which a wing concept for supersonic maneuvering was developed and then demonstrated experimentally in a series of wind tunnel tests is described. For the typical fighter wing, the problem of obtaining efficient lift at supersonic maneuvering C sub 's occurs due to development of a strong crossflow shock, and boundary layer separation. A natural means of achieving efficient supersonic maneuvering is based on controlling the non-linear inviscid crossflow on the wing in a manner analogous to the supercritical aerodynamic methods developed for transonic speeds. The application of supercritical aerodynamics to supersonic speeds is carried out using Supercritical Conical Camber (SC3). This report provides an aerodynamic analysis of the effort, with emphasis on wing design using non-linear aerodynamics. The substantial experimental data base is described in three separate wind tunnel reports, while two of the computer programs used in the work are also described in a separate report. Based on the development program it appears that a controlled supercritical crossflow can be obtained reliably on fighter-type wing planforms, with an associated drag due to lift reduction of about 20% projected using this concept. Author

N84-15116*# National Aeronautics and Space Administration, Washington, D. C.
WIND TUNNEL INVESTIGATIONS OF GLIDER FUSELAGES WITH DIFFERENT WAISTINGS AND WING ARRANGEMENTS
R. RADESPIEL Feb. 1983 16 p refs Transl. into ENGLISH of "Windkanaltersuchungen an Segelflugzeugruempfen Mit Verschiedener Einschuerung und Fluegelanordung" Akademische Fliegeruppe, (Braunschweig, West Germany), 1983 p 1-13 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Academic Aviation Group
(Contract NASW-3541)
Avail: NTIS HC A02/MF A01 CSCL 01A

The parameters fuselage pinch glider wing arrangement and fuselage leading edge radius of nine glider configurations were investigated in wind tunnel tests. Laminar separation bubbles were found on strongly recessed fuselages. These separations in the juncture between fuselage and wing are essential in the prevention of harmful aerodynamic drag. Drag reduction was measured with increasing pinch and the wing arrangement in the rear. These results are only valid for laminar flow on the fuselage leading edge. E.A.K.

N84-15117*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLOW IMPROVEMENTS IN THE CIRCUIT OF THE LANGLEY 4- BY 7-METER TUNNEL
Z. T. APPLIN Dec. 1983 55 p refs
(NASA-TM-85662; L-15631; NAS 1.15:85662) Avail: NTIS HC A04/MF A01 CSCL 01A

The mean velocity profiles in both the horizontal and vertical planes of symmetry at specific locations throughout the tunnel circuit to identify the most promising means for improving the flow in the 4 by 7 meter wind tunnel were measured. In the base line tunnel flow surveys, the flow patterns near the end of the test section indicate a uniform mean velocity distribution. Downstream of the test section, unsymmetrical flow patterns result in low velocities along the inner walls and in flow separation along the inner wall of the diffuser upstream of the drive fan and along the outer wall of the large diffuser downstream of the drive fan. A set of trailing-edge flaps attached to the five flow-control vanes located just downstream of the first corner were installed. These flaps are successful in making the tunnel flow more symmetrical and in eliminating the regions of separation in the diffusers upstream and downstream of the drive fan. E.A.K.

N84-15118*# National Aeronautics and Space Administration, Washington, D. C.
THREE-DIMENSIONAL EFFECTS ON AIRFOILS
J. P. CHEVALLIER Feb. 1983 45 p refs Transl. into ENGLISH of conf. paper ONERA-TP-1981-117 presented at the 18th Colloq. on Appl. Dyn., Association Aeronautique et Astronomie de France, 1981 p 1-34 Colloq. held in Chatillon, France, 18-20 Nov. 1981 Original language document was announced as A82-19734 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-3542)
(NASA-TM-77025; NAS 1.15:77025; ONERA-TP-1981-117)
Avail: NTIS HC A03/MF A01 CSCL 01A

The effects of boundary layer flows along the walls of wind tunnels were studied to validate the transfer of two dimensional calculations to three dimensional transonic flowfield calculations. Results from trials in various wind tunnels were examind to determine the effects of the wall boundary flow on the control surfaces of an airfoil. Models sliding along a groove in the wall of a channel at sub- and transonic speeds were examined, with the finding that with either nonuniformities in the groove, or even if the channel walls are uniform, the lateral boundary layer can cause variations in the central flow region or alter the onset of shock at the transition point. Models for the effects in both turbulence and in the absence of turbulence are formulated, and it is noted that the characteristics of individual wind tunnels must be studied to quantify any existing three dimensional effects. Author

N84-15119*# National Aeronautics and Space Administration, Washington, D. C.
HELICOPTER BLADE TIPS
R. LYOTHIER Oct. 1983 28 p refs Transl. into ENGLISH of conf. paper NT-81-19 presented at the 18th Colloq. d'Aerodyn. Appl., 1981 23 p Colloq. held in Poitiers, France, 18-20 Nov. 1981 Original language document was announced as A83-11778 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-3542)
(NASA-TM-77370; NAS 1.15:77370; NT-81-19) Avail: NTIS HC A03/MF A01 CSCL 01A

Methods of improving helicopter performance and vibration level by proper shaping of helicopter blade tips are considered. The principle involved consists of reducing the extent of the supersonic zone above the advancing tip and of the turbulent interaction. For stationary and advancing flight, the influence of the rotor and the problems posed by blade tips are reviewed. The theoretical methods of dealing with the two types of flight are briefly stated, and the experimental apparatus is described, including model triple and quadruple rotors. Different blade tip shapes are shown and briefly discussed. The theoretical results include an advancing speed of 309 km/H and a blade tip rotational speed of 215 m/s. The experimental values are advancing speed of 302 km/h and blade tip Mach number 0.86 for both typs of rotors. Author

N84-15120*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOADS AND AEROELASTICITY DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FY 1982 AND PLANS FOR FY 1983
J. E. GARDNER Jan. 1984 167 p
(NASA-TM-84594; NAS 1.15:84594) Avail: NTIS HC A08/MF A01 CSCL 01A

Accomplishments of the past year and plans for the coming year are highlighted as they relate to five year plans and the objectives of the following technical areas: aerothermal loads; multidisciplinary analysis and optimization; unsteady aerodynamics; and configuration aeroelasticity. Areas of interest include thermal protection system concepts, active control, nonlinear aeroelastic analysis, aircraft aeroelasticity, and rotorcraft aeroelasticity and vibrations. A.R.H.

N84-15121# Grumman Aerospace Corp., Bethpage, N.Y.
MACH 0.6 TO 3.0 FLOWS OVER RECTANGULAR CAVITIES Final Report, Jun. 1978 - Jun. 1980
L. G. KAUFMAN, II, A. MACIULAITIS, and R. L. CLARK (AFWAL, Wright-Patterson AFB, Ohio) Wright-Patterson AFB, Ohio AFWAL Mar. 1983 296 p refs Sponsored in part by AFWAL
(AD-A134579; AFWAL-TR-82-312) Avail: NTIS HC A13/MF A01 CSCL 01A

Internal weapons carriage in high performance aircraft is often adversely affected by the severe aeroacoustic environment produced with the weapons bay doors open. To obtain a better understanding of this fluid dynamic problem, basic static and oscillatory pressure data were obtained for Mach 0.6 to 3.0 flows over shallow rectangular cavities in a generic flat plate model. Cavity length to depth ratios were varied from approximately 5 to 10. Static pressure data characteristics of both open and closed cavity flows were obtained. An improved Rossiter method is presented that satisfactorily predicts the possibility frequency modes within the cavity. Highest fluctuating pressure occurs on the aft bulkhead, peaking near Mach 1.5 for the conditions tested. Aeroacoustic levels are substantially reduced by installing suppression fences (spoilers) at subsonic and low supersonic conditions. Acoustic levels generally drop rapidly above Mach 1.5. Author

N84-15122*# National Aeronautics and Space Administration, Washington, D. C.
FLOW MECHANISM AND EXPERIMENTAL INVESTIGATION OF A ROTATING STALL IN TRANSONIC COMPRESSORS
L. YAJUN and Z. SHUNLIN Dec. 1983 21 p refs Transl. into ENGLISH from Acta Aeron. et Astronautical Sinica (China), v. 3, Jun. 1982 p 61-71 Original language document was announced as A82-45193 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77373; NAS 1.15:77373) Avail: NTIS HC A02/MF A01 CSCL 21E

The flow characteristics of the rotating stall in compressors is studied, and a flow model is developed along with a theoretical calculation method based on vortex theory. A detailed theoretical calculation is completed for a two dimensional flow field in a transonic rotor in a rotating stall, and the result is in good agreement with experimental findings. The oscillograms of time-varying stall characteristic parameters recorded for the onset, growth, and cessation processes of rotating stall are analyzed, and some new flow phenomena deserving of further investigation are discovered. These include serious separation of individual blades, often preceding the onset of rotating stall in compressors with very small blade-camber angles, and periodical variation of the circumferential width of the stall cell with time, accompanied by periodical oscillation of the width of the stall cell in the radial direction of the blade. The circumferential and radial oscillation frequencies are the same. C.D.

N84-15123*# Boeing Military Airplane Development, Seattle, Wash.
INLET FLOW FIELD INVESTIGATION. PART 1: TRANSONIC FLOW FIELD SURVEY Final Report
J. A. YETTER, V. SALEMANN, and M. B. SUSSMAN Jan. 1984 122 p refs
(Contract NAS1-16612)
(NASA-CR-172239; NAS 1.26:172239; D180-27738-1) Avail: NTIS HC A06/MF A01 CSCL 01A

A wind tunnel investigation was conducted to determine the local inlet flow field characteristics of an advanced tactical supersonic cruise airplane. A data base for the development and validation of analytical codes directed at the analysis of inlet flow fields for advanced supersonic airplanes was established. Testing was conducted at the NASA-Langley 16-foot Transonic Tunnel at freestream Mach numbers of 0.6 to 1.20 and angles of attack from 0.0 to 10.0 degrees. Inlet flow field surveys were made at locations representative of wing (upper and lower surface) and forebody mounted inlet concepts. Results are presented in the form of local inlet flow field angle of attack, sideflow angle, and Mach number contours. Wing surface pressure distributions supplement the flow field data. Author

N84-15124*# National Aeronautics and Space Administration, Washington, D. C.
NEW INVESTIGATION OF SHORT WINGS WITH LATERAL JETS
E. CARAFOLI and N. CAMARASESCU Oct. 1983 19 p refs Transl. into ENGLISH from Stud. Cercet. Mec. Apl. (Romania), v. 29, no. 4, 1970 p 947-962 Previously announced as A70-42614 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77347; NAS 1.15:77347) Avail: NTIS HC A02/MF A01 CSCL 01A

The lift of short wings by means of lateral fluid jets fired in the plane of the wing in the direction of the span is described. After some theoretical considerations, the experimental results obtained in a wind tunnel on a series of wings of various lengths are presented. Author

N84-15125# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
A MODEL OF THE TRAILING EDGE SEPARATION ON AN AIRFOIL Final Scientific Report, 15 May 1982 - 14 Feb. 1983
G. ZILLIAC Feb. 1983 96 p refs
(Contract AF-AFOSR-0204-82; AF PROJ. 2301)
(AD-A126703; EOARD-TR-83-7) Avail: NTIS HC A05/MF A01 CSCL 01A

A model of the turbulent boundary layer separation of a two dimensional airfoil was investigated. The model consists of distributing sources on the contour in the separated region of sufficient strength to maintain the constant pressure characteristic of trailing edge boundary layer separation. A model for the attached boundary layer is included. An accurate estimation of maximum lift, pitching moment and pressure distribution was obtained. A correct drag prediction was not accomplished. Author

N84-15126# Air Force Academy, Colo.
WAKE CHARACTERISTICS AND INTERACTIONS OF THE CANARD/WING LIFTING SURFACE CONFIGURATION OF THE X-29 FORWARD-SWEPT WING FLIGHT DEMONSTRATOR Final Technical Note
K. E. GRIFFIN, E. C. HAERTER, and B. R. SMITH 15 Aug. 1983 37 p
(AD-A133188; USAFA-TN-83-7) Avail: NTIS HCA03/MFA01 CSCL 20D

This technical note summarizes experimental lifting-surface wake data taken from a 1/10-scale, reflection-plane a model of the X-29 Forward Swept Wing Demonstrator. The model is configured with and without the canard to illustrate the canard/wing wake interactions. The data collected comprises total, dynamic, and static pressures as well as local velocity magnitudes and directions for a series of points around this model. The data point are arrayed to include flow regions near the model as well as the freestream wake regions downstream of its canard and wing. Author (GRA)

N84-15127# Ballistic Research Labs., Aberdeen Proving Ground, Md.
COMPUTATIONS OF PROJECTILE MAGNUS EFFECT AT TRANSONIC VELOCITIES Final Report
C. J. NIETUBICZ, W. B. STUREK, and K. R. HEAVEY. Aug. 1983 32 p
(Contract DA PROJ. 1L1-61102-AH-43)
(AD-A133212; AD-F300314; ARBRL-TR-02515; ARBRL-IMR-74) Avail: NTIS HCA03/MFA01 CSCL 19D

The Magnus effect has long been the nemesis of shell designers. Although very small in magnitude, on the order of 1/10th the normal force, this spin induced side moment has a significant destabilizing effect on projectiles. A combined computational and experimental research program has been ongoing at BRL in recent years to develop a predictive capability for the Magnus effect in particular and for projectile aerodynamics in general. This effort has been very successful in the supersonic regime. The research to be reported in this paper is an extension of this effort into the transonic regime. Utilizing the time marching, thin layer Navier-Stokes computational technique developed at NASA Ames Research Center, solutions have been obtained for a spinning, 6-caliber long, ogive-cylinder-boattail shape at Mach = 0.91 and angle of attack = 2 degrees. The computed results predict the correct development of the Magnus force along the body, and comparisons between the computation and experiment are very favorable. Details of the flow field solution such as turbulent boundary layer velocity profiles and surface pressure distributions are presented. The components which contribute to the Magnus effect are determined and presented as a function of axial position. A complete set of aerodynamic coefficients have been determined from the flow field solutions. Those to be presented here and compared with experimental data include the normal force and Magnus force coefficients. The computations for this research effort were obtained both on a CDC 7600 computer and Cray 1S. (etc.) GRA

N84-15128# Sandia Labs., Albuquerque, N. Mex. Parachute Systems Div.
HIGH-SPEED, LOW-ALTITUDE PAYLOAD DELIVERY USING A SINGLE LARGE RIBBON PARACHUTE
D. W. JOHNSON and C. W. PETERSON 1983 21 p refs
Presented at the 8th AIAA Conf. on Aerodyn. Decelerator and Balloon Technol., Hyannis, Mass., 2 Apr. 1983
(Contract DE-AC04-76DP-00789)
(DE84-002731; SAND-83-2013C; CONF-8304129-1) Avail: NTIS HC A02/MF A01

A 46.3-ft-dia 20-degree conical ribbon parachute was designed to retard a 2200-lb payload delivered at speeds up to 800 KCAS and at altitudes as low as 150 feet above ground level. The parachute uses both Kevlar and nylon materials, some of which were developed specifically for this parachute. The canopy design incorporate a patented construction geometry to minimize stress concentrations. A cluster of three 3.8-ft-dia ribbon parachutes is used to deploy the main parachute in the presence of severe aircraft flow field effects and large payload angles of attack. The results of over 30 full-scale flight tests indicate that fundamental limitations imposed by the dynamics of the air masses inside and behind the canopy determine the ultimate performance of a single large parachute when it is used at a release altitude of 150 ft. DOE

N84-15130# Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Torrejon de Ardoz (Spain). seccion de instrumentos de a Bordo, Proteccion y Salvamento.
ICE FORMATION IN AIRCRAFT [FORMACION DE HIELO EN AVIONES]
E. M. RODRIGUEZ 1983 13 p refs In SPANISH
Avail: NTIS HC A02/MF A01

The wind velocity components around a bidimensional body are established for the case of no-lift and potential flow. An expression giving the drag coefficient of a sphere as a function of Reynolds numbers from 1 to 2000 is derived. Cloud parameters related to ice formation and types of ice are discussed. Mathematical expressions and research programs concerning ice formation are reviewed. Author (ESA)

N84-15131# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
COMPUTATIONAL PROCEDURES IN TRANSONIC AERODYNAMIC DESIGN
J. W. SLOOFF Apr. 1982 27 p refs Presented at Intern. Centre for Transportation Studies (ICTS) Short Course on Computational Meth. in Potential Aerodyn., Amalfi, Italy, 31 May - 5 Jun. 1982
(NLR-MP-82020-U) Avail: NTIS HC A03/MF A01

The hodograph, fictitious gas, inverse and numerical optimization approaches are discussed for transonic wing and airfoil design. It is suggested that if a general design method for complete wings is required neither the fictitious gas method nor the local residual-correction type of inverse approach are adequate. An inverse approach allowing global wing design as well as local design modifications is the best compromise, numerical optmization being too expensive. Author (ESA)

N84-15132# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
CALCULATION OF TRANSONIC FLOW AROUND TWO WING-FUSELAGE COMBINATIONS USING A FULL POTENTIAL EQUATION METHOD
S. G. HEDMAN Jul. 1983 39 p refs
(Contract FMV-F-INK-82223-80-183-21-001)
(FFA-137; ISSN-SW-0081-5640) Avail: NTIS HC A03/MF A01; Aeronautical Research Institute of Sweden, Stockholm KR 70

A full potential finite volume method computed transonic flow around the FFA PT100 and the RAE Wing A Body 2. The solutions are performed in a C-type grid accurately fitting to wing and body. Results agree well with experimental values, but the method is fairly expensive in computer time and storage. Therefore, grids on the order of 80x24x20 meshes were used and only 60 or 90 iterations performed in these final grids. The convergence of higher Mach number cases is slow and may be nonexistent. Considerable patience and practice are required for successful execution of these cases. Author (ESA)

N84-15133 Stanford Univ., Calif.
AN EXPERIMENTAL STUDY OF AIRFOIL-SPOILER AERODYNAMICS Ph.D. Thesis
B. G. MCLACHLAN 1983 104 p
Avail: Univ. Microfilms Order No. DA8320745

Results are presented from an experimental investigation of the steady/unsteady flow field generated by a typical two dimensional airfoil with a statistically deflected flap type spoiler. Subsonic wind tunnel tests were made over a range of parameters: spoiler deflection, angle of attack, and two Reynolds numbers (2.8 and 5.2 million) and involved comprehensive measurements of the mean and fluctuating surface pressures, velocities in the boundary layer, and velocities in the wake. Also, schlieren flow visualization of the near wake structure was performed. The mean lift, moment, and surface pressure characteristics are in agreement with previous investigations of spoiler aerodynamics. At large spoiler deflections, boundary layer character affects the static pressure distribution in the spoiler hingeline region; and, the wake mean velocity field reveals a closed region of reversed flow aft of the spoiler. Dissert. Abstr.

N84-15134 Stanford Univ., Calif.
AERODYNAMICS, AEROELASTICITY, AND STABILITY OF HANG GLIDERS Ph.D. Thesis
I. M. KROO 1983 312 p
Avail: Univ. Microfilms Order No. DA8320735

Fundamental considerations relevant to the design and analysis of tailless gliders, controlled by center of gravity shifting, and simple methods for predicting the stability and performance of rigid hang gliders are presented. Results from a combined aerodynamic/structural analysis reflect the importance of flexibility which leads to several types of aeroelastic instability. Design features which reduce these effects and the potential for constructive aeroelastic design are discussed. Apparent mass and unsteady aerodynamic forces play an important role in the dynamics of very light aircraft as illustrated by an analysis of dynamic stability and control response. A number of problems unique to very low speed flight are identified. A wind tunnel investigation of elastically scaled models provides a means of verifying and extending this theoretical work. Results include the effects of various configuration modifications over a large range of flight conditions. Dissert. Abstr.

03

AIR TRANSPORTATION AND SAFETY

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

A84-15991
BV 234 COMMERCIAL CHINOOK - FIRST YEAR OF OPERATION
T. C. PORTEOUS (British Airways Helicopters, Ltd., Horley, Surrey, England) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 246-256.

The development of the BV 234 from the basic military CH47 is charted, and the results of the first year of commercial use are summarized. Special attention is given to the unexpected problems that arose and the ways they were dealt with. When landing on offshore platforms, it has been found that if the rotors have to be shut down turbulent winds create a cliff-edge effect; during rotor engagement, marked rotor blade sailing is possible. When rotor engagement is required in conditions of high gusty winds, the procedure adopted is to have the aircraft man-handled far enough away from the edge to reduce the adverse effects. With its heavy life potential for aerial work now being realized, the aircraft in gaining acceptance in the offshore support market. C.R.

A84-16162
FL500 - HIGH ALTITUDE SOARING PROJECT: 'SOARING STEPS INTO THE SPACE AGE'
B. L. BROSI IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 73-86.

Record flight attempts and the research capabilities of the FL500 organization are outlined. The program includes rigorous high altitude conditioning sessions in a high altitude chamber, contingency risk training, and free fall egress training in wind tunnels. A G103 Twin II sailplane has been selected to assure a high payload to gross weight ratio, as well as have a design altitude ceiling of 60,000 ft. The sailplane has fiber composite structure and can withstand descent rates of 6000 ft/min, besides featuring a 36:1 glide ratio. ATC interface is accomplished through a 720 channel VHF radio, a 4096 code transponder beacon with altitude encoding, and Loran-C navigation. Life support was accounted for with the A/P226-6A full pressure, high altitude flying outfit, and the 50,000 ft attempt will be made only after denitrification is performed for breathing pure oxygen. A mountain lee wave will serve for the initial boost. M.S.K.

A84-16171* Department of the Air Force, Washington, D.C.
THE NASA F-106B STORM HAZARDS PROGRAM
W. R. NEELY, JR. (USAF, Washington, DC) and B. D. FISHER (NASA, Langley Research Center, Hampton, VA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 242-256. refs

During the NASA LRC Storm Hazards Program, 698 thunderstorm precipitations were made from 1980 to 1983 with an F-106B aircraft in order to record direct lightning strike data and the associated flight conditions. It was found that each of the three composite fin caps tested experienced multiple lightning attachments with only minor cosmetic damage. The maximum current level was only 20 ka, which is well below the design standard of 200 ka; however, indications are that the current rate of rise standard has been approached and may be exceeded in a major strike. The peak lightning strike rate occurred at ambient temperatures between -40 and -45 C, while most previously reported strikes have occurred at or near the freezing level. No significant operational difficulties or major aircraft damage resulting from the thunderstorm penetrations have been found. B.J.

A84-16174* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
NASA B-57B SEVERE STORMS FLIGHT PROGRAM
W. D. PAINTER (NASA, Flight Research Center, Edwards AFB, CA) and D. W. CAMP (NASA, Marshall Space Flight Center, Systems Dynamics Laboratory, Huntsville, AL) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 292-313. refs

Plots of winds encountered in-flight are presented for a severe turbulence case from JAWS flight 7 (near Denver on the afternoon of July 15, 1982). During the flight the B-57B showed a 30-knot increase in airspeed over a distance of about 426 ft and then a more gradual decrease of 40 to 50 knots over a distance of about 3.2 miles. This suspected outflow feature was associated with downdraft in excess of 20 knots. The horizontal wind direction changed almost 180 deg during the pass through the feature, and the intensity of velocity differences decreased for all three components within the downdraft. Calculated probability density functions for u, v, and w showed a jagged character; and distributions for Delta-u, Delta-v, and Delta-w were distinctly non-Gaussian. Based on skewness and kurtosis values, the data could probably best be modeled by a Pearson type VII (Student's t) distribution. B.J.

A84-17886#
THE EFFECT OF THE ATMOSPHERIC DROPLET SIZE DISTRIBUTION ON AIRCRAFT ICE ACCRETION
R. J. HANSMAN, JR. (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. refs
(AIAA PAPER 84-0108)
The impinging mass flux distribution which determines aircraft ice accretion rate is shown to be related to the atmospheric droplet size distribution through the droplet collection efficiency of the body. Collection efficiency is studied by means of a 2-D droplet trajectory code which includes the effect of nonspherical droplet shape due to hydrodynamic deformation. The simulation was found to agree with wind tunnel photographic studies of droplet kinematics. The results of the simulation are used to generate impinging mass flux distributions for typical cloud and precipitation size distributions. Author

A84-17888*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
VISUALIZATION OF GUST GRADIENTS AND AIRCRAFT RESPONSE AS MEASURED BY THE NASA B-57B AIRCRAFT
D. CAMP, W. CAMPBELL, C. DOW (NASA, Marshall Space Flight Center, Huntsville, AL), M. PHILLIPS, R. GREGORY (Boeing Co., Huntsville, AL), and W. FROST (Tennessee, University, Space Institute, Tullahoma, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. refs
(AIAA PAPER 84-0112)
A program to obtain gust gradient measurements over the span of an airfoil is being conducted by NASA. Data have been collected from four areas of the United States (Denver, Colorado; Edwards, California; Huntsville, Alabama; and Norman, Oklahoma). The background program development data collection, and some data analysis efforts of the gust gradient effort have previously been presented (Houbolt, 1979; Camp, et al., 1983; Campbell, 1983; Campbell, et al., 1983; Frost, et al., 1983; and Painter and Camp, 1983). The purpose of this paper is to discuss briefly the animation of a gust gradient data set that was collected during the summer of 1982 at Denver, Colorado. Author

A84-17992*# Tennessee Univ., Tullahoma.
SIMULATED FLIGHT THROUGH JAWS WIND SHEAR - IN-DEPTH ANALYSIS RESULTS
W. FROST (Tennessee, University; FWG Associates, Inc., Tullahoma, TN), H.-P. CHANG (Tennessee, University, Tullahoma, TN), K. L. ELMORE, and J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. Research supported by the National Center for Atmospheric Research, NSF, and NOAA; U.S. Department of Transportation. refs
(Contract DOT-FA01-82-Y-10513; NASA ORDER H-59314-6)
(AIAA PAPER 84-0276)
The Joint Airport Weather Studies (JAWS) field experiment was carried out in 1982 near Denver. An analysis is presented of aircraft performance in the three-dimensional wind fields. The fourth dimension, time, is not considered. The analysis seeks to prepare computer models of microburst wind shear from the JAWS data sets for input to flight simulators and for research and development of aircraft control systems and operational procedures. A description is given of the data set and the method of interpolating velocities and velocity gradients for input to the six-degrees-of-freedom equations governing the motion of the aircraft. The results of the aircraft performance analysis are then presented, and the interpretation classifies the regions of shear as severe, moderate, or weak. Paths through the severe microburst of August 5, 1982, are then recommended for training and operational applications. Selected subregions of the flow field defined in terms of planar sections through the wind field are presented for application to simulators with limited computer storage capacity, that is, for computers incapable of storing the entire array of variables needed if the complete wind field is programmed. C.R.

A84-17993#
SIMULATION OF HAZARDOUS FLIGHT CONDITIONS
J. T. KLEHR (Singer Co., Link Flight Simulation Div., Binghampton, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. refs
(AIAA PAPER 84-0278)
The simulation of hazardous flight conditions originally utilized a sonly procedural trainers, flight simulators today emulate the aerodynamical characteristics so well that the outside flight environment now demands simulation. Over 50 percent of commercial airline accidents are weather-related, and weather remains the greatest unknown factor in flight operations. Well-analyzed storm data has been difficult to obtain for flight simulation purposes. The JAWS project may provide the first data suitable for the simulation of microburst thunderstorm effects. But simple and efficient data utilization techniques must be developed for handling the large quantities of data required for a wide variety of complex meteorological phenomena. As weather simulations become more complex, flight simulation instructors must begin to reply upon internal meteorological simulation of flight effects. Author

A84-18110*# Oklahoma Univ., Norman.
CONDITIONS FOR LIGHTNING STRIKES TO AN AIRPLANE IN A THUNDERSTORM
V. MAZUR (Oklahoma, University, Norman, OK), B. D. FISHER (NASA, Langley Research Center, Hampton, VA), and J. C. GERLACH (NASA, Wallops Flight Center, Wallops Island, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(Contract NCC5-600)
(AIAA PAPER 84-0468)
Conditions conducive to lightning strikes on aircraft were determined through the 1982 Storm Hazards Program. UHF-radar and SPANDAR were used to guide a NASA F-106B research aircraft through the upper regions of active thunderstorms to facilitate direct lightning strikes to the aircraft. Analysis of radar echoes from lightning at the moments of the strikes suggests that the aircraft itself triggers the lightning, in both stormy and nonstormy clouds, and that the induced flashes are not much different from naturally occurring intra-cloud flashes. The highest risk for a direct strike in the upper portions of a thunderstorm occurred where the ambient temperature was -40 C or colder, where turbulence and precipitation were negligible to light, and where the lightning flash rate was no greater than 5 flashes per minute. J.N.

A84-18512#
CHARACTERISTICS OF LIGHTNING STRIKES TO AIRCRAFT
D. W. CLIFFORD (McDonnell Aircraft Co., St. Louis, MO) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. A9-1 to A9-11. refs
Consideration is given to the most probable situations of lightning discharge, and the discharge parameters that might be expected from such events are contrasted with those measured near the ground in thunderstorms. The projected characterization draws upon intracloud discharge parameters, theoretical considerations, the parameters of triggered lightning discharges to wire-trailing rockets, limited in-flight measurements of strikes to aircraft, and examinations of lightning damage markings on aircraft. It is stressed that continuing currents will almost always be experienced in lightning strikes to aircraft and that the continuing currents will precede high energy discrete pulses, right up to the beginning of the pulse. As a consequence, high current damage

may be enhanced through a softening of the metal before the high peak occurs. An important implication of the aircraft/lightning interaction processes discussed here is that the process by which lightning attaches to aircraft may be different from that commonly assumed. C.R.

A84-18518#
LIGHTNING STRIKES TO AIRCRAFT - AN ANALYTICAL STUDY
R. B. ANDERSON (South African Council for Scientific and Industrial Research, Pretoria, Republic of South Africa), H. KROENINGER, and M. SMITH IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. B1-1 to B1-6. refs

Attention is confined to high-flying jet aircraft and to the conditions of South Africa for the period from 1966 to 1981. The analysis presented here quantifies the occurrence in terms that can be universally applied. A table is included giving the mean lightning intensity at South African airports. It is pointed out that when considering aircraft flying in a thunderstorm, the total flash density should be considered; that is, it should include intercloud and intracloud lightning flashes. This is estimated to be from three to five times that of the ground flash density in tropical areas, diminishing with increasing latitude to about 1:1 in temperate areas. Also included is a table giving the distribution of strikes to aircraft. C.R.

A84-18536#
DETECTION OF SPARKS IN FUEL SYSTEM TESTS
K. E. CROUCH (Lightning Technologies, Inc., Pittsfield, MA) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D16-1 to D16-6. refs

Two alternative methods for detecting sparks during lightning tests of fuel system components, i.e., the photographic technique and the fuel-air mixture technique, are examined. In the photographic method, a major problem is the lack of a distance (spark to lens) requirement. If the camera were removed far enough or if many lossy mirrors were used, the light from a small spark would be lost. Although the fuel-air mixture method also has its drawbacks, the technical problems associated with this method are fewer than with the photographic technique. It is pointed out that several recent developments, such as the use of structural adhesive bonding, the use of fuels with lower flash points, and an industry-wide rejection of fuel tank inerting, make it imperative that a new reliable and accurate method of detecting sparks in a fuel system during simulated lightning tests be developed. V.L.

A84-18539#
ELECTROSTATIC HAZARDS IN HELICOPTER SEARCH AND RESCUE OPERATIONS
G. A. M. ODAM, R. H. EVANS (Royal Aircraft Establishment, Farnborough, Hants., England), P. F. LITTLE, and G. J. BUTTERWORTH (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. E5-1 to E5-11. refs

Search-and rescue (SAR) helicopters such as the Sea King often use the lowering of crew member, the 'winchman', on a cable to effect the rescue of accident survivors. The electrostatic charging of the helicopter to energies as high as 2 MV has occasionally resulted in severe shocks to both the winchman and the accident victims. Attention is presently given to the hazardous charging effects reported in the literature and to the feasibility of the methods that may be employed to reduce them. The charging and discharging characteristics of the Sea King SAR helicopter have been investigated to a limited extent, which makes possible the recommendation of near-term methods for the alleviation of this problem. O.C.

A84-18692
THE EFFECTIVENESS OF PASSENGER SECURITY SCREENING - AN OVERVIEW
T. P. TSACOUMIS (FAA, Office of Civil Aviation Security, Washington, DC) Journal of Testing and Evaluation (ISSN 0090-3973), vol. 11, Nov. 1983, p. 366, 367.

A review of the Civil Aviation Security Program is presented. The history of the program is outlined as well as the training of operators, and tests of the effectiveness of the system are discussed. Finally, the magnitude and effectiveness of the program are addressed. Author

A84-18694
COST-EFFECTIVENESS OF THE PASSENGER SECURITY SCREENING SYSTEM
R. A. CHILDS (Frontier Airlines, Inc., Denver, CO) Journal of Testing and Evaluation (ISSN 0090-3973), vol. 11, Nov. 1983, p. 376-378.

The considerations that governed the design of the screening system once it was mandated by the FAA in 1972 are discussed. A means had to be devised to screen millions of travelers, together with their hand-carried items, in a quick, efficient, and pleasant manner while sometimes operating under severe restrictions imposed by the layout of the airport. To illustrate the efficiency of cabinet X rays, the costs that would be incurred in a hand search are calculated. Attention is also given to the improvements that have been made in metal detectors. With regard to safety, it is pointed out that if an X-ray unit detects a weapon, the operator can stop the machine, thereby keeping the weapon away from the passenger until a law-enforcement officer arrives. C.R.

A84-18695
TRAINING THE SECURITY SCREENING STATION OPERATOR
J. M. HUNTER (FAA, Air Operation Security Div., Washington, DC) Journal of Testing and Evaluation (ISSN 0090-3973), vol. 11, Nov. 1983, p. 379, 380.

The Federal Aviation Administration's (FAA) involvement in the subject area is generally limited to establishment of training standards, production, and distribution of training aids, and monitoring ongoing training to assure that regulatory standards are met. The screener/passenger interface is critical not only in assuring the safety of the system, but in projecting the airline image. It is not coincidental that laws and regulations governing the screening process call for courteous and tactful deportment on the part of all screeners. Training requirements include a vigorous testing program conducted by FAA and the airlines. As new threats evolve, such as the use of flammable liquids by Cuban refugees, FAA's training materials are updated and sophisticated. Training records are maintained for every screener and are monitored closely by FAA to assure effectiveness of the system. The cornerstone of the security safeguards in place at U.S. airports is the screening system. Only through continuous training can we collectively have confidence in the safety and security of air transportation in the United States. Author

A84-18696
PASSENGER SCREENING REQUIREMENTS - THE VIEW FROM EUROPE
A. G. KEANE (Aer Rianta, Dublin, Ireland) Journal of Testing and Evaluation (ISSN 0090-3973), vol. 11, Nov. 1983, p. 381-384.

This paper examines the existing passenger screening procedures in use at airports throughout Europe. The question of numerous national boundaries over a relatively small distance and the problems these raise because of differing interpretation of national and international law is discussed. The function of the European Civil Aviation Conference in setting up a working group on security problems is explained and the matters under discussion by the two subgroups which deal with passenger screening. The one subgroup dealing with the study of administrative and operational aspects and the other subgroup focusing upon the study of technical aspects are put into perspective. The methods of financing security measures are explained, and a brief comparison of the systems used follows. The paper concludes with advice to security operatives on methods and practices for good screening. Author

A84-18807
FEAR OF FLYING - IMPACT ON THE U.S. AIR TRAVEL INDUSTRY
R. D. DEAN and K. M. WHITAKER (Boeing Co., Seattle, WA) IN: *Human Factors Society, Annual Meeting, 26th, Seattle, WA, October 25-29, 1982, Proceedings* . Santa Monica, CA, Human Factors Society, 1982, p. 470-473.
A total of 5,860 adult (over 18) Americans were surveyed to measure the prevalence of fear of flying and its impact on airline revenues. It was found that 17 percent of the adult population describe themselves as being afraid of flying and that these people on the average make only one-third as many trips on commercial aircraft as those who have no fear. It was estimated that fear of flying costs the U.S. air travel industry 21 million one-way trips per year, equivalent to an annual revenue loss of $1.6-billion. Author

A84-19255*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LIGHTNING ATTACHMENT PATTERNS AND FLIGHT CONDITIONS EXPERIENCED BY THE NASA F-106B AIRPLANE FROM 1980 TO 1983
B. D. FISHER (NASA, Langley Research Center, Hampton, VA) and J. A. PLUMER (Lightning Technologies, Inc., Pittsfield, MA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 14 p. refs (AIAA PAPER 84-0466)
The direct lightning strike data and associated flight conditions recorded from 1980 to 1983 during 742 thunderstorm penetrations with a NASA F-106B in Oklahoma and Virginia are studied with an emphasis on aircraft protection design. The individual lightning attachment spots were plotted on isometric projections of the aircraft to identify lightning entry and exit points and swept flash patterns. The altitudes, ambient temperatures, turbulence, and precipitation at which the strikes occurred are summarized and discussed. It was noted that peak strike rates (0.81 strikes/min and 3 strikes/penetration) occurred at altitudes between 11 km and 11.6 km corresponding to ambient temperatures between -40 C and -45 C. The data confirmed that initial entry and exit points most frequently occur at aircraft extremities, in this case the nose boom, the wing tips, the vertical fin cap, and the afterburner. The swept-flash attachment paths and burn marks found in this program indicate that the mid-span areas of swept aircraft may be more susceptible to lightning than previously thought. It was also found that lightning strikes may attach to spots within the engine tail pipe. J.N.

A84-19322#
IMPACT OF AIR TRAFFIC CONTROLLERS' STRIKE ON THE SAFETY OF NATIONAL AIRSPACE SYSTEM
M. M. ARJUNAN IN: Human Factors Society, Annual Meeting, 27th, Norfolk, VA, October 10-14, 1983, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1983, p. 848-851. FAA-sponsored research. refs
Daily records of operational errors, defined as an occurrence which results in less than the applicable separation minima between two or more aircraft or between an aircraft and terrain or obstacles, were obtained for a thirteen-day period preceding the air controllers' strike and an approximately eight-month period after it. Operational error rates were determined by finding the ratio of operational errors per million operations. A linear regression analysis and a derivative-free nonlinear least squares estimation method were applied to the data. The post-strike operational error data normalized to the volume of operations were found to be lower than the same rate for the prestrike period. The analysis demonstrates that degradation of safety in the National Airspace System did not occur in the post-strike period. C.D.

N84-14129*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NASA B-57B SEVERE STORMS FLIGHT PROGRAM
W. D. PAINTER and D. W. CAMP Dec. 1983 25 p refs (NASA-TM-84921; NAS 1.15:84921; H-1196) Avail: NTIS HC A02/MF A01 CSCL 01C
The B-57B Severe Storms Flight Program gathers data to characterize atmosphere anomalies such as wind shear, turbulence, and microbursts at altitudes up to 1000 feet (300 meters). These data are used to enhance the knowledge of atmospheric processes, to improve aviation safety, to develop systems technology and piloting technique for avoiding hazards and to increase the understanding of the causes of related aircraft accidents. The NASA Dryden Flight Research Facility B-57B aircraft has participated in several severe storms data collection programs such as the Joint Airport Weather Studies (JAWS) located in Denver, Colorado area, Operation Rough Rider located in the Norman, Oklahoma area with the National Severe Storms Laboratory, and Mountain and desert turbulence in the Edwards Air Force Base, California area. Flight data are presented from flights which encountered the wind shear, turbulence and microburst anomalies. These flight results are discussed and some conclusions are made relating to these atmospheric anomalies. Author

N84-14130# IIT Research Inst., Chicago, Ill.
FIRE MANAGEMENT-SUPPRESSION SYSTEM-CONCEPTS RELATING TO AIRCRAFT CABIN FIRE SAFETY Final Report, 26 Sep. 1980 - 28 Feb. 1982
K. R. MINISZEWSKI, T. E. WATERMAN, J. A. CAMPBELL (Gage-Babcock and Associates, Inc., Elmhurst, Ill.), and F. SALZBERG (Gage-Babcock and Associates, Inc., Elmhurst, Ill.) Jul. 1982 157 p refs
(Contract DTFA30-80-C-00092)
(FAA-CT-82-134; J06532/C06554) Avail: NTIS HC A08/MF A01
A comprehensive review of the applicability of fire protection (management/suppression) system (or concepts) to aircraft cabin fire safety was done. Both inflight fire and post crash fires were considered. Establishment and documentation of the feasibility of each system/concept, determination of costs and benefits for systems judged feasible, and development of test programs to evaluate systems for unknown (undocumented) feasibility were included. A literature search to document the curse and consequences of past accidents, and the degree to which various fire protection concepts were developed was included. Fire scenarios were developed from accident histories and engineering analysis, and used to assist in judging the potential of the various system/concepts examined. Fire prevention, detection, confinement, and suppression; handling of combustion products; and escape aids were studied. Author

N84-14131# Douglas Aircraft Co., Inc., Long Beach, Calif.
DOUGLAS AIRCRAFT COMPANY ADVANCED CONCEPT EJECTION SEAT (ACES 2), REVISION C
1983 26 p
(Contract F33657-81-C-2100)
(AD-A133628; MDC-J4576-REV-C) Avail: NTIS HCA03/MFA01 CSCL 01C
ACES 2 (Advanced Concept Ejection Seat) is a high-performance escape system. The increased performance capability greatly improves the survivability of aircrews during escape from aircraft under adverse conditions throughout the flight envelope. ACES 2 is a rugged, lightweight, easy to maintain ejection seat with advanced-technology subsystems. The subsystems were designed, tested, and qualified in the USAF/Douglas ACES 1 program, and are integral in the all-new seat structure of ACES 2. ACES 2 seat systems are currently being manufactured for installation in F-15A/B, F-16A/B, and A-10 aircraft as the standard USAF Government-furnished ejection seat. It includes the following features: Multiple operating modes to optimize performance over the 0 to 600-KEAS escape envelope; Self-contained sensing of escape conditions for recovery mode selection; Electronics for sequencing and precision timing in each mode; Gyro-controlled

vernier rocket for positive stabilization at low speeds; Hemisflo drogue parachute for stabilization and deceleration at high speeds and high Mach numbers; and Mortar-deployed recovery parachute for consistent, positive operation. GRA

N84-15073# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Aircraft Div.
SOFTWARE TESTING OF SAFETY CRITICAL SYSTEMS
J. STOCKER *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 9 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Safety critical systems must be thoroughly tested. Powerful test facilities and test concepts are very important. The methods used for testing the software of the Tornado Autopilot and flight director system (AFDS) are outlined and existing test systems are reviewed followed by a presentation of a new test facility i.e., the AFDS Cross Software Test System (AFDS-CSTS). E.A.K.

N84-15077# Army Safety Center, Fort Rucker, Ala.
INVESTIGATION, REPORTING AND ANALYSIS OF US ARMY AIRCRAFT ACCIDENT
M. J. REEDER, G. D. LINDSEY, and D. S. RICKETSON, JR. *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 6 p Oct. 1983
Avail: NTIS HC A15/MF A01

Each year aircraft accidents result in large losses of US Army equipment and personnel resources. These losses are described in terms of aircraft and cause factors involved. Also presented is the system-oriented approach used in the investigation, reporting and analysis of these accidents. The results include identification of lessons learned with respect to cost, type aircraft, flight tasks, cause factors and system inadequacies which produced the cause factors. Author

N84-15078# National Aeronautical Establishment, Ottawa (Ontario). Flight Research Lab.
THE USE OF FLIGHT RECORDERS IN THE INVESTIGATION OF AIRCRAFT MISHAPS
B. CAIGER *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 9 p Oct. 1983
Avail: NTIS HC A15/MF A01

Some problems encountered in the recovery of information from flight recorders for the investigation of aircraft mishaps are described. Techniques for rapid dissemination of the information to investigators are illustrated. Future developments in the design of voice and data recorders are discussed. Author

N84-15081*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INCIDENT REPORTING: ITS ROLE IN AVIATION SAFETY AND THE ACQUISITION OF HUMAN ERROR DATA
W. D. REYNARD *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 8 p Oct. 1983
Avail: NTIS HC A15/MF A01

The rationale for aviation incident reporting systems is presented and contrasted to some of the shortcomings of accident investigation procedures. The history of the United State's Aviation Safety Reporting System (ASRS) is outlined and the program's character explained. The planning elements that resulted in the ASRS program's voluntary, confidential, and non-punitive design are discussed. Immunity, from enforcement action and misuse of the volunteered data, is explained and evaluated. Report generation techniques and the ASRS data analysis process are described; in addition, examples of the ASRS program's output and accomplishments are detailed. Finally, the value of incident reporting for the acquisition of safety information, particularly human error data, is explored. M.G.

N84-15082# Air France, Paris. Service Securite et Analyse des Vols.
THE ANALYSIS OF RECORDS OF PARAMETERS: AN INDISPENSABLE TOOL IN OVERSIGHT AND IN OPERATIONS CONTROL [L'ANALYSE DES ENREGISTREMENTS DE PARAMETRES OUTIL INDISPENSABLE A LA SURVEILLANCE ET AU CONTROLE DE L'EXPLOITATION]
J. GAUTHIER *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 7 p Oct. 1983 In FRENCH
Avail: NTIS HC A15/MF A01

The systematic analysis of flight by reading records of flight parameters has been practiced at Air France for nearly 10 years. The fundamental concepts of this policy are discussed as well as the means, methods, and philosophy which led to the establishment of the protocol. The rigorous application of this protocol resulted in the effective adherence and participation of the crew. Operating principles are described for the Commission of Flight Analysis, which is responsible for examining the most significant dossiers as well as for anonymous communication which is designed to gather from the crew any complementary information that is useful to the Commission. Some principle results obtained because of systematic flight analysis are included. Transl. by A.R.H.

N84-15083# Aeritalia S.p.A., Torino (Italy). Gruppo Velivoli da Combattimento.
FLIGHT PARAMETERS RECORDING FOR SAFETY MONITORING AND INVESTIGATIONS
E. BERTOLINA *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 11 p Oct. 1983
Avail: NTIS HC A15/MF A01

A system for monitoring aircraft structural and engine parameters is discussed. The system adopts, as basic philosophy, an on board recording facility on each individual aircraft of all relevant flight and aircraft parameters and ground equipment performing two levels of analysis: (1) trouble shooting for structure, engine and systems limits exceedances or malfunctions after each flight during the normal turn around time giving a GO/NO GO indication for the next flight; and (2) a detailed calculation of fatigue loading experienced during each flight and the consequent residual life evaluation for the critical items, thus allowing the detailed monitoring of the usage of each aircraft. M.G.

N84-15088# Technische Univ., Brunswick (West Germany). Inst. for Flight Mechanics.
INFLUENCE OF WINDSHEAR ON FLIGHT SAFETY
G. SCHAENZER *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 19 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

Physical background characteristics of wind shear phenomena including adequate flight safety procedures to overcome the problems were analyzed. Wind shear during takeoff and landing may restrict flight safety. In some situations hazards may be caused by limited flight performance. In most cases wind shear accidents and incidents result from misunderstanding of the wind shear phenomenon by the pilot. A considerable number of wind shear accidents are interpreted wrongly as pilot error. Numerous investigations were made to solve the wind shear problem, however, failed because of failure to understand the physical phenomena. The problem is shown that some of the correct safety procedures in wind shear contradict the pilot's feeling of how to control an aircraft. E.A.K.

N84-15090# Army Research and Technology Labs., Fort Eustis, Va. Safety and Survivability Technical Area.
ARMY HELICOPTER CRASHWORTHINESS
C. H. CARPER, L. T. BURROWS, and K. F. SMITH *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 17 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

The evolution of crash survival design criteria, its influence on the formulation of a US army military standard for rotary wing aircraft crashworthiness, and its application to current and new generation army helicopters are discussed. The need for a total system's approach in design for crashworthiness and the necessity for considering crashworthiness early in the design phase of a new aviation weapon systems development effort is emphasized. The actual application of crashworthiness to army helicopters with statistics that show dramatic reductions in fatalities and injuries with implementation of a crashworthy fuel system are presented. Crash testing, human tolerance definition, improved energy absorbers, crew restraint systems, and crash impact characteristics of composite helicopter structures are discussed. Applicability of the work within Army helicopter crashworthiness to commercial/civil helicopters and the cost effectiveness of helicopter design to be more crash survivable are discussed. E.A.K.

N84-15135*# Structural Semantics, Palo Alto, Calif.
LINGUISTIC METHODOLOGY FOR THE ANALYSIS OF AVIATION ACCIDENTS
J. A. GOGUEN and C. LINDE Dec. 1983 121 p refs
(Contract NAS2-11052)
(NASA-CR-3741; NAS 1.26:3741) Avail: NTIS HC A06/MF A01 CSCL 01C

A linguistic method for the analysis of small group discourse, was developed and the use of this method on transcripts of commercial air transpot accidents is demonstrated. The method identifies the discourse types that occur and determine their linguistic structure; it identifies significant linguistic variables based upon these structures or other linguistic concepts such as speech act and topic; it tests hypotheses that support significance and reliability of these variables; and it indicates the implications of the validated hypotheses. These implications fall into three categories: (1) to train crews to use more nearly optimal communication patterns; (2) to use linguistic variables as indices for aspects of crew performance such as attention; and (3) to provide guidelines for the design of aviation procedures and equipment, especially those that involve speech. E.A.K.

N84-15136# National Aeronautical Establishment, Ottawa (Ontario).
CAPABILITIES OF THE NRCC/NAE FLIGHT IMPACT SIMULATOR FACILITY
J. B. R. HEATH, R. W. GOULD, and G. R. COWPER May 1983 34 p refs
(AD-A130849; NAE-AN-13; NRC-21379) Avail: NTIS HC A03/MF A01

This report describes the NRCC/NAE Flight Impact Facility in which birdstrike tests on aircraft parts can be carried out. Technical information is given on the capabilities of the pneumatic cannon used to fire real bird carcasses against stationary targets, and on the auxiliary apparatus and instrumentation available at the Facility. Author (GRA)

N84-15137# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
ELECTROFLUIDIC ANGULAR RATE SENSOR FOR EJECTION SEAT THRUST VECTOR CONTROL Final Report
D. R. KEYSER Feb. 1983 70 p
(Contract F41400000)
(AD-A133233; NADC-81189-60) Avail: NTIS HCA04/MFA01 CSCL 13G

Three Hamilton Standard electrofluidic roll rate sensors were tested to measure their dynamic performance and their sensitivity to rotation about an orthogonal axis. An empirical dynamic mathematical model is derived for use in computer simulation of ejection seat dynamics. The test data are reported and evaluated. The data were used in part to develop a specification for a three-axis angular rate sensor intended for thrust vector control of an advanced escape system. The predominant dynamic response of this sensor is a transport delay of approximately 5 msec. Author (GRA)

N84-15138# Coast Guard Research and Development Center, Groton, Conn.
ANALYSIS OF US COAST GUARD HU-25A VISUAL AND RADAR DETECTION PERFORMANCE Interim Report, Feb. - Jun. 1983
H. G. KETCHEN, L. NASH, and G. L. HOVER Jun. 1983 85 p
(AD-A133380; CGR/DC-3/83; USCG-D-29-83) Avail: NTIS HCA05/MFA01 CSCL 06G

During February 1983, the U.S. Coast Guard R/D Center conducted an experiment in Fort Pierce, FL, to evaluate the visual and forward-looking airborne radar (FLAR) detection performance of a new Coast Guard medium-range surveillance aircraft, the HU-25A. Visual searches were conducted for small (13- to 18-foot) boats, orange-canopied life rafts (4- to 6-man), and simulated persons in the water (PIWs). FLAR searches were conducted for small boats with and without radar reflectors and for the canopied life rafts. Target and aircraft positions were monitored with a computer-based microwave tracking system for detection/miss range reconstruction accurate to better than 0.1 nautical mile. The HU-25A was found to perform better as a visual search platform than other Coast Guard fixed-wing aircraft tested previously. Search speeds between 180 and 240 knots resulted in essentially uniform visual detection performance. The AN/APS-127 FLAR achieved cumulative detection probabilities between 11 and 50 percent in 1.5- to 4.5-foot seas and winds of 6 to 19 knots. Under these conditions, the FLAR system achieved initial detection ranges between 1.1 and 3.2 nautical miles. Recommendations are made for HU-25A search operations and future evaluations. Author (GRA)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A84-15987* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PRELIMINARY RESULTS FROM THE NASA GENERAL AVIATION DEMONSTRATION ADVANCED AVIONICS SYSTEM PROGRAM
G. H. HARDY, G. P. CALLAS, and D. G. DENERY (NASA, Ames Research Center, Moffett Field, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 163-190.

NASA's Demonstration Advanced Avionics System (DAAS) is an integrated avionics system employing microprocessor technologies, data busing, and shared electronics displays. A DAAS demonstration system has been assessed through flight testing and demonstration for potential users which includes among its functions autopiloting, navigation/flight planning, a flight warning and advisory system, performance computations, normal and emergency checklists, and a ground simulation function. Exceptional performance has been obtained from the DAAS electronic horizontal situation indicator, the autopilot, the navigator/flight planner, and the discrete address beacon system. O.C.

A84-15989
DIGITAL AVIONICS IN TRANSPORT AIRCRAFT
J. HULT (Saab-Scania AB, Linkoping, Sweden) and J. ERTZGAARD (Scandinavian Airlines System, Bromma, Sweden) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 227-236.

With the SF340 general aviation/executive aircraft's autopilot/flight control system, the pilot is able to independently select two navigation sources for display on the cockpit's horizontal situation indicator, and then to couple the autopilot to either.

Attention is also given to the design and operational features of the system's primary flight display, which incorporates the attitude director indicator. O.C.

A84-16538#
AIRCRAFT EMC PROBLEMS AND THEIR RELATIONSHIP TO SUBSYSTEM EMI REQUIREMENTS
J. C. ZENTNER (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 144-148.

Aircraft electromagnetic compatibility (EMC) problems found during system-level evaluations can usually be related to specific types of MIL-STD-461 (1968), (1980) electromagnetic interference (EMI) requirements. Some subsystem/equipment contractors who must deal with EMI requirements are not aware of the system-level problems encountered. This results in misconceptions of the intent of some of the imposed requirements. This paper presents a summary of EMC problems experienced on Air Force aircraft and discusses which specific MIL-STD-461 requirements are intended to control these problems. Some MIL-STD-462 (1967) EMI testing philosophy is presented which clarifies some of the misconceptions held by subsystem/equipment contractors. Author

A84-16539#
COMPUTER ANALYSIS - AN EMC TOOL
S. DAVIDSON (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 149-157.

There are many possible modes of electromagnetic interference (EMI) coupling between avionics systems. Experience shows that the most significant of these modes is antenna-to-antenna coupling. The Aircraft Inter-Antenna Propagation with Graphics (AAPG) computer program is a new and powerful analysis tool which makes extensive use of computer graphics and is designed for this mode of EMI coupling. This paper discusses why the APG program is a superior analysis program for aircraft EMI. An auxiliary graphics program, FPLOT, which diagrams the entire frequency spectrum used by an aircraft's avionics, is also discussed. Author

A84-16578
CONCEPTS FOR BEYOND-VISUAL-RANGE ENGAGEMENT OF MULTIPLE TARGETS
N. J. TABER, E. H. THOMPSON, R. H. WORSHAM (Westinghouse Defense and Electronic System Center, Baltimore, MD), and M. CLEMENS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 434-440.
(Contract F33615-81-C-1433)

This paper presents three new missile fire control algorithms. They are referred to herein as Autonomous (alone) Prioritization, Cooperative (internetted) Prioritization and Attack Steering. Collectively, they assist a pilot in making and executing counterair engagement decisions. Test results show the benefits of these concepts include multiple kills per pass, and improved survival and missile efficiency. Author

A84-16580
MANEUVERING TARGET TRACKING USING BEARING MEASUREMENTS
J. C. CHUNG and E. Y. SHAPIRO (Lockheed-California Co., Burbank, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 449-451. refs

This pseudolinear filter applied to bearing-only tracking of a constant velocity target had been analyzed in great detail by Lindgren, Gong and Aidala. Their simulation results have demonstrated the effectiveness of the pseudolinear filter when applied to tracking situations characterized by high bearing rates and/or low noise levels. In this paper, the pseudo-linear filter is augmented with a target maneuver detection algorithm for bearing-only tracking application of an infrequent maneuvering target. Author

A84-16582
FUSELAGE POINTING CONTROL LAW USING PRACTICAL SENSORS
K. M. SOBEL and E. Y. SHAPIRO (Lockheed-California Co., Burbank, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 460-465. refs

In this paper, eigenstructure assignment and feedforward command tracking is applied to design a pitch pointing controller for the air-to-air combat and strafing modes. To avoid using pitch attitude and angle of attack sensors, only pitch rate, normal acceleration, altitude rate (which is used to obtain the flight path angle), and control surface deflections are measured. The design is begun by choosing the eigenvectors in an intuitively appealing way to obtain the desired decoupling between pitch attitude and flight path angle. Then the eigenvalues are chosen to trade off the degree of decoupling and the rise time of pitch attitude response. This simple design method yields desired eigenvalues and moderate feedback gains. A pitch pointing controller is designed for the AFTI/F-16 aircraft to illustrate the design method. Author

A84-16586
SINGLE-PASS FINE-RESOLUTION SAR AUTOFOCUS
G. A. BENDOR and T. W. GEDRA (Westinghouse Electric Corp., Baltimore, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 482-488. refs

Fine-resolution (FR) synthetic aperture radar (SAR) is becoming a standard mode in many of today's modern radar systems. Some of its basic limitations are reviewed with specific emphasis on novel schemes for alleviating some of these apparent limitations. The properties of a particular autofocusing technique in the presence of varying scene content and different classes of phase errors are described. Author

A84-16588
AN AUTOMATED TECHNIQUE FOR PREDICTING AND EVALUATING THE PERFORMANCE OF THE IMPROVED AN/APG-66 FIRE CONTROL RADAR
D. F. COHEN (Westinghouse Electric Corp., Baltimore, MD) and W. N. JONES (Wesgin Enterprises, Inc., Severna Park, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 497-502.
(Contract F33657-81-C-0115)

A computer-aided system engineering technique is described. It permits iterative top-down and bottom-up analyses to arrive at a consistent set of requirements and to predict performance of the system, lower level assemblies, and components. Although developed as an error budget analysis for a multimode fire control radar, the method is applicable to any system where total performance depends on interactions among disparate hardware and software operating over a range of external conditions. The technique is used as the basis for customer acceptance tests, and to provide operational and field evaluation criteria of the Improved AN/APG-66 Fire Control Radar for later versions of the F-16 aircraft. Author

A84-16591#
NEW TECHNOLOGIES AND THEIR LOGISTICS EFFECTS ON INTEGRATED CNI AVIONICS
R. L. HARRIS (USAF, Avionics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 520-526. refs

Several disciplines have been developed during the past decade that will affect integrated communication navigation identification avionic (ICNIA) systems of the future. Among them are VLSI and VHSIC technologies, testing technologies, maintainability engineering, and system fault tolerance implementations. VLSI and VHSIC will affect the functional partitioning, reliability, testability, and maintainability of system application design. Testing technologies will govern the amount, types, and applications of built-in-test (BIT), the amount and levels of automatic test equipment and their requirements, and the manner in which the total system can be supported. Maintainability engineering will contribute to and be a part of ICNIA's system design in order that ICNIA's operational readiness objectives are attained economically. This paper recognizes the early tradeoff possibilities among parameters within these disciplines and their logistics effects on the ICNIA system. Author

A84-16605
IMPLEMENTATION OF BROADCAST MESSAGES AND ACYCLIC DATA TRANSFER TECHNIQUES IN A MULTIBUS BASED AVIONIC SYSTEM
P. R. BARNETT (British Aerospace, PLC, Brough, Humberside, England) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 625-632. Research supported by the Ministry of Defence /Procurement Executive/.

The configuration of avionic systems has moved in recent years towards a more federated architecture, with digital processing embedded in various subsystems and the majority of system data communicated by means of a multiplex data bus network. The high update rates required by most of the Mission systems forces the use of Broadcast transfers to reduce bus loading. Acyclic transactions allow infrequent data transfers to occur without compromising bus loading and creating excessive subaddress utilisation. MIL-STD-1553B does not specify any explicit techniques for the handling of acyclic message transfers either on the same bus or between buses nor does it define Broadcast checking schemes. This paper describes the implementation of these transfer mechanisms in considerable detail and demonstrates how they can be used to extend the MIL-STD-1553B message transfer protocols to work in a practical environment. Author

A84-16626
SIMULATION OF FUTURE EW SYSTEMS IN A COMPLEX ENVIRONMENT
R. B. JOHNSON, JR. (AAI Corp., Baltimore, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 790-796.

It is pointed out that the next generation of Electronic Warfare (EW) avionics suites will provide new challenges to the manufacturers of EW training systems. A projection of the trends of future EW systems is provided, and various approaches to simulating these systems are discussed. The decision process for selecting a simulation approach will be affected by three characteristics of the next generation of EW suites. These characteristics are related to the system's capacity, complexity, and fidelity. A stimulation approach to EW simulation is considered along with an emulation approach, and an imitation approach. Attention is given to trade considerations of simulation approaches, aspects of fidelity, data availability, questions of concurrency, the availability of EW equipment, the stability of EW system's design, the complexity of the threat updata process, the EW system mission, and areas for improvement. G.R.

A84-16629
SYNTHETIC APERTURE RADAR SIMULATION IN AIRCRAFT SIMULATOR DESIGN
E. R. KEYDEL (Analytic Sciences Corp., Reading, MA) and J. D. STENGEL, JR. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 812-820.

During the last ten years, great advances have been made with respect to Digital Radar LandMass Simulator (DRLMS) technology. Current DRLMS systems provide for Weapon System Trainers (WSTs) a high fidelity radar simulation capability. In most cases, DRLMS design and analysis has been based upon conventional, noncoherent Real-Beam Radar (RBR) systems. However, currently advanced aircraft radar systems for providing high resolution imagery in the Synthetic Aperture Radar (SAR) mode are being developed for the Air Force. In parallel with the development of such systems arises the need to simulate them for future flight simulators. The aspects involved in such a simulation are discussed, taking into account the perceptible characteristics of radar imagery, a comparison of RBR and SAR imaging, and a SAR effects analysis methodology. Attention is given to range/Doppler feature distortion, scene decorrelation due to wind, and motion compensation errors. G.R.

A84-16689
A REVIEW OF UNITED KINGDOM AIRBORNE RADAR
J. CLARKE (Royal Signals and Radar Establishment, Malvern, Worcs., England) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1391-1398.

As a successor to airborne early warning, a medium-PRF pulse-Doppler radar has been developed. The radar design is unique in that two scanners, each having an angular coverage of 180 deg, are used. The most recent airborne radar is the Foxhunter radar, used in the Tornado ADV aircraft. Radars used in maritime reconnaissance are also discussed, as are helicopter radars. It is noted that much work has been done on active air-to-air seekers using both solid-state and tube devices and that the development of digital detection, acquisition, and response to ECM threats all under the microprocessor control is at an advanced stage. Radar proximity fuzes are also surveyed. C.R.

A84-17651
OPTIMIZATION OF SOUNDING SIGNALS FOR THE MEASUREMENT OF DISTANCE TO THE EARTH'S SURFACE [OPTIMIZATSIIA ZONDIRUIUSHCHIKH SIGNALOV PRI IZMERENII DAL'NOSTI DO POVERKHNOSTI]
V. I. CHIZHOV Radioelektronika (ISSN 0021-3470), vol. 26, Nov. 1983, p. 8-12. In Russian. refs

Mutual ambiguity functions of reflected and radiated signals are analyzed for different orientations of the antenna radiation pattern and the velocity vector of the flight vehicle. A relationship is established between the bias estimate and discrimination curve determining fluctuation errors and the ambiguity functions of sounding signals for two range-estimation techniques: according to the location of the maximum and according to the location of the leading front of the mutual ambiguity function. Optimal parameters minimizing the total error of range measurement are chosen. B.J.

A84-18031#

PRECISION LANDING GUIDANCE FOR ADVANCED V/STOL

R. L. BERGER, R. V. SODERHOLM, and V. L. HIGBEE (McDonnell Aircraft Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs

(AIAA PAPER 84-0338)

The theory of operation of the state-of-the-art NAVTOLAND Landing Guidance System is discussed and the total system functional architecture is defined. A design for integrating the NAVTOLAND Landing Guidance System Advanced Development Model airborne system into an AV-8B is presented. The implementation, operation and flight test evaluation of the present AV-8B All Weather Landing System is also discussed. A possible alternate approach for enhancing the performance of the present AV-8B All Weather Landing System when operating in conjunction with the NAVTOLAND shipboard system is presented. Author

A84-18240

MULTIPATH INTERFERENCE FOR IN-FLIGHT ANTENNAS MEASUREMENTS

C. A. BALANIS (Arizona State University, Tempe, AZ), R. HARTENSTEIN, and D. DECARLO (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-32, Jan. 1984, p. 100-104. refs

Formulations are presented to predict the pattern of interference (multipath) between direct rays and those reflected from the surface of the earth. These formulations can be used to assess the performance of ground-to-air, air-to-ground, ground-to-ground, and air-to-air communication and antenna measuring systems. Methods are also introduced to determine accurately the point of reflection and the path phase difference between the direct and reflected waves. Various divergence factors, used to account for energy spreading from a curved surface, are presented and compared. The formulations introduced can account for any polarization state (linear, circular, elliptical), sense of rotation (right hand, left hand), and tilt angle of the transmitting and receiving elements, and for polarization changes due to reflection. Author

A84-18317#

MODELS FOR COMBINING SINGLE CHANNEL NAVSTAR/GPS WITH DEAD RECKONING FOR MARINE POSITIONING

D. E. WELLS and D. DELIKARAOGLOU (New Brunswick, University, Fredericton, Canada) IN: International Geodetic Symposium on Satellite Doppler Positioning, 3rd, Las Cruces, NM, February 8-12, 1982, Proceedings. Volume 2 . Las Cruces, NM, New Mexico State University, 1983, p. 1259-1274. Research supported by the Bedford Institute of Oceanography and Natural Sciences and Engineering Research Council of Canada. refs

The usefulness of present generation GPS receivers and the present constellation of prototype satellites are considered using two navigation models. The first model is analogous to the 2-D single pass TRANSIT marine positioning combination of satellite Doppler range differences and dead reckoning, the only difference being the substitution of GPS pseudoranges for TRANSIT range differences based on integrated Doppler shift measurements, and the substitution of the GPS time offset parameter for the TRANSIT frequency offset parameter. The second model is a dead reckoning model in which NAVSTAR/GPS pseudoranges serve to calibrate the dead reckoning. It was found that with the use of log/gyro and a GPS receiver with reacquisition times of 60 s, the TRANSIT model is preferable to the dead reckoning model. The utility of the TRANSIT model is dependent on the available GPS satellite geometry. J.N.

A84-18318#

OFFSHORE POSITIONING WITH AN INTEGRATED GPS/INERTIAL NAVIGATION SYSTEM

R. V. C. WONG and K. P. SCHWARZ (Calgary, University, Calgary, Alberta, Canada) IN: International Geodetic Symposium on Satellite Doppler Positioning, 3rd, Las Cruces, NM, February 8-12, 1982, Proceedings. Volume 2 . Las Cruces, NM, New Mexico State University, 1983, p. 1275-1288. Research supported by Sheltech Canada. refs

The paper investigates the accuracy of offshore positioning by combining the current generation of GPS receivers with a state of the art inertial system. The integration of the two systems for offshore surveying combines the advantages of both: the capability of the GPS for near-instantaneous position fixes and the excellent interpolation accuracy of the inertial system between fixes. Such a system can be used with the present configuration of GPS-satellites and provides an economical solution to the offshore positioning problem in areas where conventional methods are not available or not accurate enough. The simulation study concentrates on two questions: the position accuracy achievable with different satellite configurations and the determination of optimal update intervals. Author

A84-18627

VLF DATA FOR AIRCRAFT NAVIGATION BASED ON AN EXTENDED KALMAN FILTER DESIGN

B. W. LEACH (National Aeronautical Establishment, Flight Research Laboratory, Ottawa, Canada) and C. A. MASKELL (Carleton University, Ottawa, Canada) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1353-1358. refs

VLF communications station phase difference measurements are optimally combined with Doppler radar and magnetic compass data to form an integrated aircraft navigation scheme based on an extended Kalman filter design. The resulting ten-state discrete Doppler/VLF Kalman filter algorithm is being used for real-time navigation onboard the NAE Convair 580 research aircraft. Particular emphasis is placed on methods of handling the types of error known to occur in the VLF phase measurement data due to propagation anomalies. A very simple adaptive filter approach is used for automatically detecting these VLF contingencies in-flight and modifying certain matrix elements of the Kalman filter in order to maintain navigation accuracy. Author

A84-19124

MICROCOMPUTER CONTROL APPLICATIONS IN INTEGRATED FLIGHT/WEAPON CONTROL SYSTEM

C.-F. LIN (Wisconsin, University, Madison, WI) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 827-832. refs

This paper discusses the integrated flight/weapon control system (IFWCS) of a fighter aircraft. The IFWCS enhances flight performance and accurate weapon delivery through an onboard microcomputer control system. With the IFWCS, the pilot is able to perform the flight and attack roles with the aid of multifunction cockpit displays of numerous flight and tracking commands. In the IFWCS, the mission computer serves as the center of interaction between the flight control system and the weapon control system. It prescribes optimal trajectories to be followed automatically by the flight control computer. In designing the IFWCS, attention must be given to the limited cockpit space. Therefore, the use of microprocessors is essential in the building of the IFWCS. A pipelined multimicroprocessor computer system will enable the onboard computer to function much faster than real-time, thus increasing the effectiveness of the IFWCS. This microcomputer control appliction in the IFWCS will contribute to significant mission improvement. The specifications and review of the IFWCS software/hardware are also discussed, including the implementation of the MIL-STD-1750A chip set. Also to be considered in the design of the IFWCS is the pilot's physiological capability. Author

A84-19345
A NAVIGATION ALGORITHM USING MEASUREMENT-BASED EXTRAPOLATION
A. R. STUBBERUD Optimal Control Applications and Methods (ISSN 0143-2087), vol. 4, Oct.-Dec. 1983, p. 343-356.
An element in the guidance loop of any aircraft is the navigation system. This system derives position (and sometimes velocity) information by combining data from various on-board and external measurement devices and transmits it to guidance algorithm. In this paper a navigation algorithm is designed for an aircraft which has on-board inertial measurements, range measurements from a TACAN station, and range, elevation and azimuth measurements from a ground-based radar. The basic design philosophy is the predictor-corrector form for a recursive estimator. State prediction is accomplished by extrapolation of the inertial measurements rather than from Newton's second law. This eliminates major modelling problems caused by the aircraft's aerodynamics. State correction is accomplished using optimal linear stochastic estimation methods. The resulting estimator (navigation algorithm) is essentially an 'extended Kalman filter' which processes the above-mentioned inputs and generates optimal (in a linearized sense) estimates of the aircraft's latitude, longitude and altitude.
Author

N84-15068# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
METHODS FOR DEVELOPING THE NAVIGATION AND WEAPON SYSTEMS OF THE MIRAGE 2000 [METHODES DE DEVELOPPEMENT DU SYSTEME DE NAVIGATION ET D'ARMEMENT DU MIRAGE 2000]
D. BONCORPS *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 In FRENCH
Avail: NTIS HC A21/MF A01
The definition, completion, and mass production of a weapon system as complex as that of the Mirage 2000 aircraft poses numerous problems that are solved by direct collaboration among the French Official Service, the industry, and the user (French Air Force). This collaboration was concretized by the establishment of an industrial coordination body that is charged by Technical Services with establishing work dossiers which are then examined at different levels by all the interested parties. The association of recent work methods with sophisticated methods of development permits the definition of a complex system that conforms with the demands of users, with the least delay and at minimum cost.
A.R.H.

N84-15141# Federal Aviation Administration, Washington, D.C. Office of Aviation Policy and Plans.
ESTABLISHMENT AND DISCONTINUANCE CRITERIA FOR AIRPORT TRAFFIC CONTROL TOWERS Final Report
S. G. HELZER Aug. 1983 145 p
(AD-A133461; FAA-APO-83-2) Avail: NTIS HCA07/MFA01 CSCL 17G
This report presents an economic analysis of VFR Airport Traffic Control Towers and criteria for tower establishment and discontinuance based on this analysis. Site-specific activity forecasts are used to develop tower benefits from prevented collisions between aircraft, other prevented accidents, and reduced flying time. Establishment costs include annual costs for staffing, maintenance, equipment, supplies and leased services and investment costs for facilities, equipment, and operational start up. The present value of tower benefits are compared with the present value of tower costs over a fifteen-year time frame. A location meets tower establishment criteria when the benefits which derive from operating the tower exceed the costs; a tower meets discontinuance criteria, when the costs of continued operation exceed the benefits. Applying the criteria to more than four-thousand airports, seventeen sites satisfy the benefit/cost criteria for tower establishment and fifty-five towers satisfy the benefit/cost criteria for discontinuance. These figures compare with twenty-five tower establishment candidates and forty-two tower discontinuance candidates under previous tower criteria. The sensitivity of the criteria results to several key assumptions is also examined.
Author (GRA)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A84-15935
IN-FLIGHT ACOUSTIC EMISSION MONITORING OF A WING ATTACHMENT COMPONENT
S. L. MCBRIDE and J. W. MACLACHLAN (Royal Military College of Canada, Kingston, Ontario, Canada) Journal of Acoustic Emission (ISSN 0730-0050), vol. 1, Oct. 1982, p. 223-228. refs
A single channel acoustic emission data recording system was flown for a period of 15 months in an operational Avro CT-100 jet fighter. The instrumentation, transducer and acoustic bond functioned successfully throughout the entire monitoring period. In-flight acoustic emission measurements on the upper forward wing trunnion showed a wide variation in the number of events per flying hour although the signal parameters (amplitude distribution and frequency spectra) did not change significantly during the monitoring period. It is shown that the amplitude of the trunnion noises are typically an order of magnitude greater than those expected from slow stable crack advance in common airframe materials as measured in constant amplitude fatigue tests. Near component failure, however, signals due to crack advance could be higher in amplitude than the largest trunnion noises.
Author

A84-15936
EFFECT OF CRACK PRESENCE ON IN-FLIGHT AIRFRAME NOISES IN A WING ATTACHMENT COMPONENT
S. L. MCBRIDE and J. W. MACLACHLAN (Royal Military College of Canada, Kingston, Ontario, Canada) Journal of Acoustic Emission (ISSN 0730-0050), vol. 1, Oct. 1982, p. 229-235. refs
The relation of the occurrence of airframe acoustic emissions to aircraft maneuver is reported for Avro CF-100 upper forward wing trunnions. Periods of excessive noise are found when the airframe load is changing during entry to and exit from sustained-G maneuvers. During constant-G periods, the airframe noise level is reduced by a factor of more than one hundred. These quiet periods provide a suitably low airframe noise level for the in-flight detection and monitoring of slow, stable crack growth in common airframe materials, even in a noisy load transfer component such as the wing trunnion studied here. Simultaneous in-flight acoustic emission measurements in symmetrically-located aiframe components are also reported. The ratio of the number of recorded event counts in a cracked component to that in an uncracked component during the same flight is found to increase linearly with the measured crack face area for through crack lengths in the range 0-5 mm.
Author

A84-15976
1982 REPORT TO THE AEROSPACE PROFESSION; PROCEEDINGS OF THE TWENTY-SIXTH SYMPOSIUM, BEVERLY HILLS, CA, SEPTEMBER 22-25, 1982
Symposium sponsored by the Society of Experimental Test Pilots. Lancaster, CA, Society of Experimental Test Pilots, 1982, 382 p.
Among the topics discussed are the F101-engine conversion of the F-14, the flight testing of the A-10 night attack variant, the development of F/A-18 digital flight control technology, AV-8B system testing, 757/767 flight testing, the DC-8/CFM56 reengining program, the development status of the Lear Fan 2100, and preliminary results from the NASA general aviation program for the demonstration of advanced avionics systems. Also considered are the Tornado fighter terrain-following system's development, Tornado flight testing at high angles of attack, digital avionics in

transport aircraft, F-20 development and flight testing, advanced systems testing for the Space Shuttle, the F-16 Advanced Fighter Technology Integration program's initial test results, the performance of a circulation control helicopter tail boom, U.S. Air Force test pilot training methods, and the Rotor Systems Research Aircraft. O.C.

A84-15977
THE F-14/F101 DFE FLIGHT TEST PROGRAM
C. SEWELL (Grumman Aerospace Corp., Bethpage, NY) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 4-23.

The F101 Derivative Fighter Engine (DFE) military turbofan currently under consideration for F-14 fighter reengining is a merging of the core components of the B-1B bomber and CFM56 transport engines with scaled-up versions of the F404 engine's fan, augmentor, and exhaust nozzle. The F101 DFE flight test program set out to test F-14 inlet/engine compatibility, afterburner operation, engine airstarts and performance, flying qualities, powerplant and systems installation details, and structural dynamics. Over 1000 throttle transients have been made in order to evaluate engine operability and inlet/engine compatibility. There have been no engine stalls due to inlet distortion, and no engine stagnation. Afterburner operation has been tested throughout the flight envelope without lighting or operation failures. Attention is given to range, thrust and specific fuel consumption comparisons between the F101 DFE and TF30 engines of the F-14. O.C.

A84-15978
A-10 SINGLE SEAT NIGHT ATTACK
G. P. LYNCH, JR. (Fairchild Republic Co., Farmingdale, NY) and D. F. NIMS (USAF, Washington, DC) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 24-40.

Attention is given to the results of a program undertaken to assess pilot performance and workload for the case of air-to-ground night attack missions aboard the Single Seat Night Attack (SSNA) version of the A-10. The cockpit systems employed include forward-looking IR sensor target search and identification, an HUD, terrain following/terrain avoidance radar, inertial navigation, and radar altimeter; all of which have been carefully arranged into control and display groups to require a minimum of pilot attention and effort. Attention is given to the novel workload measurement methods devised for the SSNA. O.C.

A84-15980
NAVY EVALUATION OF C-2A AERIAL REFUELING
C. R. HENRY and K. ZIMMERMAN (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 68-79.

An air refueling (AR) capability study for the U.S. Navy's C-2A twin-turboprop logistics support aircraft notes that the C-2A's AR system is incompatible with the KC-135 refueling boom during night conditions. During daytime operations, although the risks present appear manageable, indications are found of unacceptably high fuel pressure surges. Attention is given to the problem posed by the C-2A's constrained cockpit field-of-view during approaches to the tanker aircraft. The pilots experienced significant difficulty in conducting AR during light turbulence, and the aircraft was incapable of the flight corrections necessary to engage the refueling drogue in moderate turbulence conditions. O.C.

A84-15981
TESTING THE AV-8B AS A SYSTEM
R. A. BOROWSKI (USAF, Flight Test Center, Patuxent River, MD) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 80-89.

The AV-8B is typical of recent fighter and attack aircraft in that it incorporates distributed flight data processing, a multiplex bus, highly integrated avionics systems, HUD, etc. Attention is given to the innovative strategies for manual pilot back-up that have been devised in anticipation of avionics failures. These reversion modes are controlled by the mission computer, as it continuously monitors the status of systems on the multiplex bus and bypasses them in the event that the data they present is suspect. Attention is given to the functions and capabilities of the AV-8B's man-machine interface features, cockpit displays, weapons accuracy, and computer performance. O.C.

A84-15982
F-16 POWER APPROACH HANDLING QUALITIES IMPROVEMENTS
D. W. MILAM and E. A. THOMAS (USAF, Flight Test Center, Edwards AFB, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 90-105.

Attention is given to the assessment of F-16 power approach handling qualities by the test pilots that participated in the development of its flying characteristics. Questions arose concerning power approach handling from the outset of the development program, especially when the F-16 was loaded with external stores and when flying in turbulence or crosswinds. While most pilots were able to adapt to the problems they perceived, they did so in various ways, and disagreed as to both their severity and cause. The control laws, speed stability concept, and approach and landing piloting techniques which are the basis for pilot judgments are discussed. O.C.

A84-15983
767/757 FLIGHT TESTING
S. L. WALLICK, JR. and R. L. MCPHERSON (Boeing Commercial Airplane Co., Seattle, WA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 108-122.

The initial certification of the 767 airliner has been accomplished in 1794 flight hours, under the command of 152 pilots. A leading edge slat failure due to airloads differing from those predicted occurred during the third 767 flight, and three months of redesign and development were required to arrive at a satisfactory solution. A total of 264 flight hours were devoted to the development of novel flight deck displays and digital avionics. The 757 airliner flight test program is projected to require 1480 flight hours, including 87 hours for British certification. O.C.

A84-15985
THE DC-8/CFM56 RE-ENGINE PROGRAM
P. J. BATTAGLIA (McDonnell Douglas Corp., St. Louis, MO) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 131-141.

The rationale and the methodology of the DC-8 airliner's reengining with large diameter CFM56 turbofans are discussed. The major purposes of this development program were reductions in fuel consumption and noise levels. Fuel consumption has been reduced by an average of 20-22 percent for the DC-8-71 variant. It is found that the reengined DC-8 has retained its predevelopment handling qualities, obviating additional training for crew members. O.C.

A84-15986
LEAR FAN 2100 PROGRESS REPORT
D. E. MADONNA and D. M. NEWTON (Lear Fan, Ltd., Belfast, Northern Ireland) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 142-162.

A detailed account is presented of the design features, construction methodology, and flight test results of the Lear Fan 2100 all-composite turboprop aircraft. The results of airframe component testing are noted for such conditions as heating, salt water immersion, lightning strikes, etc., which illustrate the durability of the graphite-epoxy laminate composite system employed in the aircraft primary structure. Attention is given to the novel technique by which the aircraft may recover from spins, by jettisoning the propeller assembly and deploying a small parachute from the propeller hub which will stabilize the aircraft in a direct vertical descent. The pilot then ejects the parachute and glides to an emergency landing. O.C.

A84-15988
TERRAIN FOLLOWING DEVELOPMENT TESTING ON THE TORNADO AIRCRAFT
P. WEGER (Messerschmitt-Boelkow-Blohm GmbH, Manching, West Germany) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 194-226.

The Tornado fighter's automatic, low altitude Terrain-Following (TF) system has been under development over the last 5 1/2 years and incorporates, in addition to a TF radar that measures range to ground return and scan angle, an inertial navigation unit, a secondary attitude and heading reference system, Doppler radar, an air data computer, and a radio altimeter. These provide data on ground speed, elevation incidence, drift rate, and height, for processing by the TF computer. Attention is given to system flight test results for such natural terrains as mountain ranges and such urban terrains as are found in industrial areas. O.C.

A84-15990
TORNADO FLIGHT TESTING AT HIGH ANGLES OF ATTACK
P. MILLETT (British Aerospace PLC, Warton Div., Preston, Lancs., England) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 237-245.

Attention is given to the high angle-of-attack (AOA) handling and spinning flight test program phase for the Tornado fighter, which sought to determine the limits of acceptable operational handling, examine stall warning, determine stall boundaries, and establish recovery action from incipient and developed spins. In parallel with the low speed trials conducted, a spin prevention system under development derived encouraging results from these high AOA handling tests. Aircraft handling at up to AOA limits was found to be excellent in the wing configurations at either forward and mid-sweep positions or with the wings fully swept. O.C.

A84-15992
TIGERSHARK DEVELOPMENT AND FLIGHT TEST
R. J. SCOTT (Northrop Corp., Los Angeles, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 257-263.

Flight tests have expanded the flight envelope to 1.05 Mach number and 39,000 feet altitude. It is expected that future flight tests will expand the envelope to a Mach number of 2.0 and an altitude of 50,000 feet. The flight control system incorporates a high-authority digital electronic pitch and yaw control augmentation system that operates in parallel with the conventional F-5 flight control system. The F404-100 engine provides 17,000 lb of afterburning thrust. A panoramic canopy improves the pilot's over-the-shoulder view by 15 deg. The avionics will combine navigation, air-to-air, and air-to-ground modes operating through a digital mission computer to perform weapon delivery computations and to control the dual avionics multiplexed data bus. In all, 17 flights (15.3 hours) have been made. The aircraft has met or exceeded all performance expectations for all conditions tested. C.R.

A84-15994
AFTI/F-16 PROGRAM REVIEW AND INITIAL TEST RESULTS
H. H. HEIMPLE (USAF, Edwards AFB, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 286-307.

A development status assessment is presented for the Advanced Fighter Technology Integration (AFTI) F-16 program, for which NASA maintains the modified F-16A aircraft and provides two test pilots. Attention is given to the design rationale and performance advantages obtained to date for such features as the AFTI/F-16's dorsal fairing, canards, test instrumentation, head-up displays and multipurpose displays, and the fly-by-wire digital flight control system which manages the six-degrees-of-freedom, uninterruptable control needed for relaxed static stability vehicles. Flight tests have uncovered unexpectedly good power approach handling qualities for the AFTI/F-16. O.C.

A84-15995
NOTAR - NO TAIL ROTOR (CIRCULATION CONTROL TAIL BOOM)
S. A. HANVEY (Hughes Helicopters, Inc., Culver City, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 308-332.

The circulation control tail boom 'NO TAil Rotor'(NOTAR) concept employed by the modified OH-6A helicopter, whose design features and flight test program results are presently discussed, is based on the control of the main rotor wake as it impinges on the helicopter tailboom at low speeds or in hover. The deflection of the rotor wake by Coanda effect circulation control provides an antitorque force whose effectiveness invites comparison with that of conventional tail rotors. A direct jet thruster and fixed control surfaces are added to the tailboom in order to augment the circulation control effect in sideward, rearward, and forward flight. It is found that the NOTAR tailboom configuration yields lower noise and vibration levels, increases hover stability out of ground effect, and increases safety in confined areas. O.C.

A84-16157
1983 REPORT TO THE AEROSPACE PROFESSION; PROCEEDINGS OF THE TWENTY-SEVENTH SYMPOSIUM, BEVERLY HILLS, CA, SEPTEMBER 28-OCTOBER 1, 1983
Symposium sponsored by the Society of Experimental Test Pilots. Lancaster, CA, Society of Experimental Test Pilots, 1983, 343 p.

Papers are presented on such topics as XC-142A flight testing, XV-15 e xperience, maneuvering flight performance testing in modern rotary wing aircraft, KC-135R DT&E, the X-29A forward swept wing aircraft, AFTI/F-16 flight test results and lessons, L-1011 relaxed longitudinal stability, the NASA F-106B Storm Hazards Program, and CTOL aircraft ski jump evaluation. Consideration is also given to voice interactive systems technology assessment, the comparative evaluation of predicted flying qualities boundaries using ground and airborne simulators, and a real-time pilot guidance system for improved flight-test maneuvers. B.J.

A84-16158
XV-15 EXPERIENCE - JOINT SERVICE OPERATIONAL TESTING OF AN EXPERIMENTAL AIRCRAFT
R. B. CARPENTER (U.S. Army, Aviation Engineering Flight Activity, Edwards AFB, CA), J. C. BALL (U.S. Navy, Naval Plant Representative Office, Stratford, CT), and C. BECKER (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 4-20. refs

Flight test performance characteristics of the XV-15 Tilt Rotor Research Aircraft being considered by the armed services are described. The two flight models were delivered and began testing in 1977 and 1979, respectively. It is noted that one of the aircraft was lost during testing when put through operational modes for which it was not designed, and for which the JVX tilt rotor concept is intended. The two 25-ft diam rotors are mounted on tilting nacelles, which contain a transmission and a T-53 turboshaft engine. The aircraft can operate with the nacelles in either vertical, horizontal, or any intermediate positions, including hover. The XV-15 performed well in contour and nap of the earth flight tests, with accelerations from 60-180 kn achieved within 10 sec. Pilot workload was low, as were vibrations, while cockpit field of view was high. Landing accuracy to within two feet of target was accomplished on board ship, as were short-run take offs. M.S.K.

A84-16159
THE CHALLENGES OF MANEUVERING FLIGHT PERFORMANCE TESTING IN MODERN ROTARY WING AIRCRAFT
C. A. PARLIER (Hughes Helicopters, Inc., Culver City, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 21-41.

The increasing demand for greater maneuvering flight performance in rotary wing aircraft has illuminated a weakness which faces each segment of the rotary wing aviation community. Helicopter specifications are inadequate in their definition of maneuvering performance. The actual maneuvering performance of modern rotary wing aircraft can be greater than the demonstrated maneuvering performance required by the specification. Pilots are given a flight envelope which they can not identify due to insufficient presentation of maneuvering flight information. The paper presents several broad areas where this weakness is manifested. Specific improvements incorporated in the U.S. Army/Hughes Helicopters, Inc., AH-64A Apache are discussed. Author

A84-16163
KC-135R DT&E
C. L. GEBHARDT, III (Boeing Military Airplane Co., Wichita, KS) and W. H. JONES (USAF, Flight Test Center, Edwards AFB, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 90-107.

The present report covers the developmental test and evaluation period which began with the first flight on August 4, 1982 and ended with the ferry flight from Edwards AFB to Boeing's facilities at Wichita, Kansas on April 5, 1983. It is concluded that the flight test engineers demonstrated a great degree of flexibility in meeting the test schedule; part of this flexibility was due to the use of computer programs to keep track of the instrumentation parameters required for each test condition, to track the accomplishment of test conditions, to aid in planning each flight, and to print out test plans and knee cards for use during the flights. It is noted that the KC-135 met or exceeded its performance requirements. The improved handling qualities in the approach and landing configurations make the aircraft safer and easier to fly, and the modified systems reduce the crew work load. B.J.

A84-16164
OVER SIMPLIFICATION CAN SOMETIMES BE HAZARDOUS TO YOUR HEALTH - THE XA4D SKYHAWK STORY
R. RAHN (Rockwell International Corp., Pittsburgh, PA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 114-129.

The history of the XA4D Skyhawk design concept is reviewed and attention is given to rudder flutter, the maximum safe Mach number (1.2) at 30,000 feet, spins, lateral stability, transonic wind drop, aileron flutter, and crosswind landing. Conclusions are drawn as to the need for redundant, irreversible hydraulic controls for supersonic flight; the need for a variable rate input device for flutter testing; and inverted spins. It is noted that the XA4D was originally a simple lightweight aircraft that eventually grew into a complex 4 A4M. B.J.

A84-16165
X-29A FORWARD SWEPT WING AIRPLANE
C. A. SEWELL (Grumman Aerospace Corp., Bethpage, NY) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 130-142.

The X-29A advanced technology demonstrator is a forward swept wing aircraft featuring an aeroelastically tailored wing, a close coupled variable incidence canard, relaxed static stability, a fly-by-wire flight control system, and variable wing camber along with a thin supercritical airfoil in the forward swept configuration. The forward swept wing concept offers a large potential improvement in aerodynamic efficiency for high-performance aircraft; there is 10-20 percent less drag for a given mission; the aircraft requires a smaller engine, which means lower fuel consumption; this design is 5-25 percent lighter than an aft swept design. X-29A integrated technologies are described, and attention is given to future technology options, which could include a two-dimensional nozzle and a stores carriage. B.J.

A84-16166
FEASIBILITY OF USING LONGITUDINAL ACCELERATION (NX) FOR MONITORING TAKEOFF AND STOPPING PERFORMANCE FROM THE COCKPIT
J. T. SMALL, JR. (USAF, Washington, DC) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 143-154.

The feasibility of using Nx for monitoring takeoff and stopping performance from the cockpit was evaluated for the HU-25A aircraft. It is shown that the HU-25A Nx curves are extremely 'well behaved' and therefore appear to serve as a useful tool for acceleration monitoring on takeoff. The cockpit task of reading the Nx gauge was reasonable even under the high workload of takeoff and stopping. The Nx data plots showed excellent repeatability for a given thrust-to-weight ratio under the conditions tested. It is concluded that the use of Nx as an additional cross-check item during takeoff or landing could prove to be a very feasible concept based on what has been observed for the HU-25A. B.J.

A84-16167* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
AFTI/F-16 FLIGHT TEST RESULTS AND LESSONS
S. D. ISHMAEL (NASA, Flight Research Center, Edwards, CA) and D. R. MCMONAGLE (USAF, Flight Test Center, Edwards AFB, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 158-184.

The AFTI/F-16 flight test program is summarized, and several design issues of general interest are addressed. A brief description is given of the test vehicle, its flight control modes, and the flight envelopes in which testing was performed. Flight test results are summarized by addressing benefits experienced in flight control task-tailoring, handling qualities in mission tasks, aircraft structure considerations, digital flight control system performance, and human factors. Finally, several design issues relevant to future fighter aircraft are examined, including degraded flight control, system complexity, simplex information in redundant systems, and single failure propagation in redundant systems. B.J.

A84-16169
THE FLY-BY-WIRE JAGUAR
C. J. YEO (British Aerospace PLC, Aircraft Group, Preston, Lancs., England) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 193-214. Research supported by the Ministry of Defence and Royal Aircraft Establishment.

A description is given of a UK research program undertaken with the aim of the design, development, and demonstration of a *safe, practical fly-by-wire (FBW) flight control system for a combat* aircraft. A standard production Jaguar was converted to be the FBW test vehicle. The flight trials included flight assessment of integral spin prevention control laws and aircraft configurations that were unstable in pitch. It is concluded that the first major objectives of the program have been achieved by the generation of confidence in the airworthiness of such an FBW system, by the successful completion of the design, development, and ground testing, and by the initial flight assessment of a full-authority digital FBW system. B.J.

A84-16173
CONVENTIONAL TAKEOFF AND LANDING (CTOL) AIRPLANE SKI JUMP EVALUATION
C. P. SENN and J. A. EASTMAN (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 269-288.

In an effort to evaluate ski jump launches as an alternative to shipboard catapult launch for CTOL aircraft, the Naval Air Test Center conducted a ski jump launch test program using T-2C and F-14A aircraft operating from a variable exit angle ski jump. Tests were performed to evaluate the feasibility of the concept, to define the operating limitations, to document performance gains, and to verify aerodynamic and structural ski jump simulations. Reduction in takeoff ground roll in excess of 50 percent was obtained with the T-2C, while maximum capability with the F-14A was not achieved due to single engine considerations. It is noted that, with the longitudinal trim set properly, stick free ski jump takeoff is possible, the stick free ski jump launch being an easier maneuver than a normal field takeoff. It is found that simulation provided the pilot with the ability to qualitatively access ski jump launch characteristics, with motion-based simulations providing the best cues. B.J.

A84-16529
FEASIBILITY STUDY OF AN ALL ELECTRIC FIGHTER AIRPLANE
G. J. CECERE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), I. S. MEHDI, and R. F. YURCZYK (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 62-71.

The development of two parallel aircraft actuation and secondary power systems designs for a two-engine fighter is described: (1) the baseline aircraft, which would use hydraulic actuators for the actuation functions and have hydraulic as well as electric power extraction from the engine; and (2) the all electric aircraft (AEA), which would utilize electromechanical actuators and have only electric power extraction from the engine. The two designs are compared with respect to weight, reliability, maintainability, and life cycle costs; and a qualitative assessment of the two designs is made with respect to structural integration, growth capability, survivability/vulnerability, EMC/lightning, environmental constraints, and technology risks. Results indicate that the AEA offers a potential for reducing the LCCs of the actuation and secondary power systems by about 12 percent compared with the baseline configuration. The probabilities of mission success and aircraft safety are found to be comparable for the two aircraft. B.J.

A84-16530
PUTTING NEW ALL ELECTRIC TECHNOLOGY DEVELOPMENT TO THE TEST
M. HOLMDAHL (Boeing Commercial Airplane Co., Seattle, WA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 74-79.

Two programs devoted to the development of electromechanical actuators (EMAs) are described. A description is first given of problems, solutions, and test results of the EMA and electronic controller design installed on the spoilers of the Quiet Short-Haul Research Aircraft. A description is then given of the design and hardware development status of a program leading to the flight certification of EMA, 270 VDC, and a digital autonomous terminal access communication data bus system on a Boeing 727 upper rudder. It is concluded that, although problems developed, these programs are successful and on track. B.J.

A84-16531
A SYSTEM LOOK AT ELECTROMECHANICAL ACTUATION FOR PRIMARY FLIGHT CONTROL
J. B. LEONARD (Grumman Aerospace Corp., Bethpage, NY) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 80-86. refs

While the benefits of electromechanical actuator systems (EMAS) have been well-publicized and several study and hardware development programs have been documented, little has been reported on the integration of the EMAS into the craft. This paper presents the integration issues with particular emphasis on reliability, redundancy, electrical power supplies, velocity versus torque or force summing techniques, fault tolerance, fault isolation, performance after failures, and the overall implications of aerodynamic summing or control surface redundancy. In the case of transports, the incentive for control-surface redundancy is safety and the protection of passengers against failures and unexpected events that would cause severe structural and/or systems damage. In the case of military fighters, control-surface redundancy has been used to provide precise control and new control modes such as direct lift and direct side force. Author

A84-16532
DEMONSTRATION OF ELECTROMECHANICAL ACTUATION TECHNOLOGY FOR MILITARY AIR CARGO TRANSPORT
K. THOMPSON (Lockheed-Georgia Co., Marietta, GA), K. EITENMILLER (Sundstrand Corp., Rockford, IL), and L. HUNTER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 87-93. refs

Development of the electromechanical actuation system (EMAS) for use in primary flight controls is one of the key technologies in the path to an All-Electric Airplane. Electromechanical actuators have been the subject of many studies extolling their potential virtues, and a number of successful laboratory demonstrations have been performed. However, before electromechanical actuation will be considered as a viable alternative to hydraulically powered controls, actual flight test demonstrations are needed. This paper describes a development program that is currently underway to flight-test demonstrate an electromechanically actuated primary flight control surface for the C-141 aircraft. Author

A84-16534
THE ALL-ELECTRIC HELICOPTER
D. WARD (Kollmorgen Corp., Inland Motor Specialty Products Div., Radford, VA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 104-113. refs

The concept of the all-electric helicopter, using Electromechanical Actuators (EMA's) in place of the present Electrohydraulic Actuators for primary flight control, is introduced. Technology advances that have made the all-electric helicopter possible will be described, as will unresolved problem areas relating to the helicopter environment that have not been covered by previous fixed wing EMA studies. The concept of the EMA 'weight equation' is introduced, and new concepts that will interface with the all-electric helicopter, such as Higher Harmonic Control, Fly-by-Wire, Fly-by-Light and Multiplexed avionics will be discussed. Author

A84-16541
757 LIGHTNING PROTECTION
C. H. KING, D. A. EAST, and J. W. MAKSIM (Boeing Commercial Airplane Co., Seattle, WA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 162-165.

The Boeing 757 is an advanced technology aircraft which incorporates multiple digital systems and makes extensive use of composite materials for secondary structure. Fiberglass, Kevlar, graphite, and graphite/Kevlar composites are used in the wing leading and trailing edges, engine nacelle and strut fairing, horizontal and vertical stabilizer tip fairings, rudder, and elevators. Aircraft power, signal, and control wiring run through structure covered by these composite materials. Author

A84-16685
AIRPLANE ACTUATION TRADE STUDY
C. W. HELSLEY, JR. (Rockwell International Corp., El Segundo, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1360-1372. refs

In an 'all electric' aircraft, hydraulics would be eliminated as a secondary power medium and its place would be taken by electromechanical devices designed for specific applications. Attention is presently given to the design features and technological feasibility of an all electric Air-to-Surface (ATS) tactical aircraft employing electromechanical flight control and utility actuators for its flaps, ailerons, rudder, canards, thrust vector vanes, thrust reverser, landing gear, and environmental control systems. The ATS assumes 1995 technological readiness for all its electromechanical systems. It is concluded that this all electric aircraft will not be viable for the time period in question, and can become so only if the power inverter's specific weight can be cut in half, even as its reliability is increased. O.C.

A84-16690* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
INSTRUMENTATION AND DATA PROCESSING FOR AFTI/F-16 FLIGHT TESTING
P. HARNEY, W. CLIFTON (NASA, Flight Research Center, Edwards AFB, CA), and D. A. JOHNSON (General Dynamics Corp., Fort Worth, TX) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1404-1409.

The primary objective of the advanced fighter technology integration/F-16 (AFTI/F-16) development program is to demonstrate advanced fighter technologies to improve weapon delivery and aircraft survivability. Instrumentation and data processing for monitoring aircraft operation during flight testing is necessary not only for safety-of-flight considerations but also for rapid evaluation of flight test results. The complexity of the AFTI/F-16 aircraft necessitates an extensive capability to accomplish data goals; this paper describes that capability and the resultant product. Author

A84-16700
THE SHAPING OF THE SST - PAST, PRESENT, AND FUTURE
F. A. BRUCKMAN (Lockheed-California Co., Operations Analysis Div., Burbank, CA) Lockheed Horizons, no. 14, 1983, p. 30-40.

An overview of Lockheed's approach to SST design is presented, encompassing the early SST configuration, basic design philosophy for the 1960s, the emergence of the double-delta wing concept and the evolution of design requirements through the 1980s. Influences on the shape of the SST in the past and the present, what technology changes have shaped the current design, and what economically viable configuration might emerge in the future are examined. The application of liquid hydrogen technology is identified as a probable requirement for an environmentally acceptable SST concept, though one predicated on the discovery of a cost-effective LH2 production method. It was concluded that selection of a basic SST wing configuration, i.e., delta, arrow, or the variable sweep wing, is solely dependent on the requirements, design philosophy, and technology imposed on SST design in general. J.N.

A84-17014
A REVOLUTIONARY AIRCRAFT - THE GRUMMAN X-29A [UN AVION REVOLUTIONNAIRE - LE X-29A DE GRUMMAN]
J. MORISSET Air et Cosmos (ISSN 0044-6971), vol. 21, Nov. 19, 1983, p. 21, 22. In French.

The development and characteristics of the X29-A FSW aircraft are summarized. The history of FSW designs is traced from the German JU-287 of the 1940's to the present, and the primary advantages are listed: better performance at high angles of attack, better transfer of force at the wing-fuselage junction, and generaly better maneuverability over most of the flight envelope. The essential role of composite technology and progress in calculating and optimizing aeroelastic structures in overcoming the unfavorable divergence arising in FSW under aerodynamic loading is indicated. The developmental stages of the X-29A are reviewed, and its most important features (including variable-camber wing, vector nozzle, electric flight control, and 35-percent negative static margin) are discussed. It is estimated that this technology wil permit a 30 percent weight savigs and a 6-year development-time gain for the Advanced Technology Fighter program. T.K.

A84-17016
THE FOKKER 50, SUCCESSOR TO THE F-27 FRIENDSHIP [LE FOKKER 50, SUCCESSEUR DU F-27 'FRIENDSHIP']
J. MORISSET Air et Cosmos (ISSN 0044-6971), vol. 21, Dec. 10, 1983, p. 14-16. In French.

The Fokker 50 twin-engine turboprop aircraft being developed for first flight in 1985 and certification in 1986 is characterized, with consideration of its competitive position in the world and European markets. Aircraft parameters using a six-blade 'slow' propeller (with the type-124/2 engine being developed by Pratt and Whitney of Canada) include seating capacity 50-66, fuel capacity 5034 liters, maximum takeoff weight 19,000 kg, cruising power (at 20,000 ft) 1172 kW, cruising fuel consumption (at 20,000 ft and 500 km/h) 264 g/kW h, internal noise less than a twinjet aircraft, and external noise 81 and 96 EPNdB at overflight and appraoch, respectively. The main competition for the Fokker 50 in the 1000-aircraft market predicted for this class up to the year 2000 is seen as the ATR-42. Drawings and graphs are provided. T.K.

A84-17170
INHIBITION OF STRESS CORROSION CRACKING IN THE DESIGN OF AIRCRAFT STRUCTURES
P. M. TOOR (Lockheed-Georgia Co., Marietta, GA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 973-981. refs

Stress corrosion cracking (SCC) mechanisms are examined, taking into account anodic dissolution and hydrogen embrittlement. Aspects of designing to inhibit SCC are discussed. It is pointed out that presently there exists no design methodology for stress corrosion cracking. Guidelines are usually provided to select materials and postdesign analysis. These guidelines are either based on crack initiation (safe-life) or on crack growth (fail-safe). An attempt is made to emphasize the various parameters affecting the SCC of aircraft structures. The opinion is expressed that insufficient attention to the detailed aspects of design from a material viewpoint, coupled with a lack of appreciation of the production processes, has led to many aircraft structural failures. G.R.

A84-17205
ACAP - A GIANT STEP TOWARDS LOW COST COMPOSITE AIRCRAFT
V. A. CHASE (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) and D. E. GOOD (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1464-1470.

Preliminary design studies for an Advanced Composite Airframe Program (ACAP) have indicated that weight and cost savings of 22 percent and 17 percent, respectively, could be achieved on a medium-sized utility helicopter fabricated with composites instead of metals. The present investigation is concerned with developments and conclusions related to an American aerospace company which was selected as one of two contractors to design, fabricate, and flight test an ACAP helicopter. The ACAP helicopter, in the case considered, was designed for a basic 2.3 hour flying mission at 2000 ft/95 F at a mission gross weight of 8470 lb. An ACAP objective was to achieve a minimum 17 percent cost reduction and a 22 percent weight reduction as compared to an all metal baseline while demonstrating improvements in crashworthiness and maintainability. It is concluded that 23 percent cost reduction is achievable with present day technologies. G.R.

A84-17207
DEVELOPMENT OF AN ADVANCED COMPOSITES FORWARD FUSELAGE FOR A FIGHTER AIRCRAFT
P. SHYPRYKEVICH, S. J. DASTIN (Grumman Aerospace Corp., Bethpage, NY), and L. LEMMER (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1515-1528.

This program was an advanced development study of the suitability of graphite/epoxy for the forward fuselage of current fighter aircraft. The program consisted of three phases: preliminary design; design verification by element testing; and design demonstration by design, fabrication, test, and assessment of a large component. The selected design consisted of single-cure integrally stiffened side skins, honeycomb sandwich floors and bulkheads, and plain panel frames and longerons using mechanical fasteners to create the assembly. The component was successfully tested for critical ultimate fuselage pressure and bending, with final failure occurring at 130 percent of design ultimate loading. Comparison of the graphite/epoxy fuselage to an equivalent aluminum structure indicated a 17 percent weight savings along with an assessment of a high potential for series production to stringent durability and damage tolerance requirements. Author

A84-17406*# Texas A&M Univ., College Station.
PERFORMANCE DEGRADATION OF PROPELLER SYSTEMS DUE TO RIME ICE ACCRETION
K. D. KORKAN (Texas A & M University, College Station, TX), L. DADONE (Boeing Vertol Co., Philadelphia, PA), and R. J. SHAW (NASA, Lewis Research Center, Icing Research Section, Cleveland, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 44-49. refs
(Contract NAG3-109; NAG3-242)
(AIAA PAPER 82-0286)

A theoretical ice accretion model has been established applicable to both aircraft propellers and helicopter rotors to determine the effect of rime ice on the thrust, power, and efficiency as a function of exposure time in a natural icing condition. Comparisons have been made of theoretical performance levels with previously published experimentally determined propeller thrust and efficiency for five natural icing conditions. Agreement between test and theory was acceptable. Author

A84-17412*# Texas A&M Univ., College Station.
HELICOPTER ROTOR PERFORMANCE DEGRADATION IN NATURAL ICING ENCOUNTER
K. D. KORKAN (Texas A & M University, College Station, TX), L. DADONE (Boeing Vertol Co., Philadelphia, PA), and R. J. SHAW (NASA, Lewis Research Center, Cleveland, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 84, 85.
(Contract NAG3-109; NAG3-242)

The analytical model described by Korkan et al. (1982) for predicting the performance degradation of propellers in a natural icing encounter is used to determine the feasibility of predicting helicopter performance degradation in hover during natural icing. The flight condition selected for analysis involves an altitude of 3000 ft and a free-air temperature of 1 F. The values of degradation yielded by the model for rime ice accretion are representative of those experienced in actual flight. C.R.

A84-17413#
A METHOD FOR PREDICTING WING RESPONSE TO BUFFET LOADS
B. H. K. LEE (National Aeronautical Establishment, High Speed Aerodynamics Laboratory, Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 85-87. refs

A method is described for predicting the response of a wing to buffet loads. The method proposed by Lee (1980) is extended to include the coupling between the structural vibration and the aerodynamics of the oscillating wing under random loading. The analysis takes into consideration the unsteady aerodynamic forces generated by the vibrating wing. Unsteady aerodynamic forces are shown to have a significant effect on the response predictions at low frequencies; at higher frequencies, however, they become less important. In modeling the input load, the constant correlation assumption yields reasonable results at low frequencies, whereas at higher frequencies the exponential, spatially decaying form of the cross-power spectrum for the fluctuating pressures gives results that are in much better agreement with flight test data. C.R.

A84-17862#
SYNTHESIS AND PERFORMANCE OF AN AIR-TURBORAMJET-PROPELLED SUPERSONIC TARGET VEHICLE
M. M. BRIGGS (Integrated Systems, Inc., Missile, Div., Palo Alto, CA), J. V. CAMPBELL, S. R. ANDRUS (Aerojet TechSystems Co., Sacramento, CA), and G. R. BURGNER (U.S. Naval Weapons Center, China Lake, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p.
(Contract N60530-82-C-0315)
(AIAA PAPER 84-0075)

A modified version of the AQM-37 target vehicle was used in this study in expectation that integrating an Air-TurboRamjet (ATR) propulsion subsystem would provide safety and performance benefits relative to the existing AQM-37A target. The ATR propulsion subsystem allows utilization of relatively benign fuel (OTTO II) in place of the inhibited red fuming nitric acid/mixed amine fuel NO. 4 (IRFNA/MAF no. 4) bipropellant combination used in the current version of the AQM-37. Otto II provides more than twice the currently delivered specific impulse. Performance evaluations of the ATR-propelled target vehicle designs show capability for sustained low-altitude flight at Mach 1.5 and a powered flight range of more than 200 NM cruising at Mach 3.0, 80,000 ft. altitude when launched at Mach 1.5, 50,000 ft. altitude. Author

A84-17891*# Grumman Aerospace Corp., Bethpage, N.Y.
ELEMENTS OF COMPUTATIONAL ENGINE-AIRFRAME INTEGRATION
C. W. BOPPE (Grumman Aerospace Corp., Bethpage, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 24 p. Research supported by the Grumman Aerospace Corp. refs
(Contract NAS1-11525; NAS1-14732)
(AIAA PAPER 84-0117)

Computerized flow simulation methods are being developed to refine the traditional engine-airframe integration process. These analyses reduce design risk, minimize wind tunnel and flight test requirements, and provide detailed design information not available by any other means. This paper describes computational tools which have matured sufficiently to permit project applications. Several applications are combined with research studies to illustrate the prediction of high-speed nonlinear phenomena associated with engine inlet flow rate, nacelle shape and position, afterbody shape and integration, propeller slipstream interactions, airframe-induced inlet flow, and pylon integration. Both fighter and transport configurations are used to highlight current capabilities and future requirements. Author

A84-17893#
COMPUTATIONAL REQUIREMENTS FOR EFFICIENT ENGINE INSTALLATION
T. J. BARBER (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) and W. M. PRESZ, JR. American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0120)

The current trend towards larger, faster, and more fuel efficient aircraft has emphasized the importance of proper engine installation on aircraft design. Analytical design and design analysis procedures are required by the engine manufacturer to aid in the design of low drag engine installations. This paper reviews the unique computational requirements for engine/aircraft flowfield analyses, presents the current state of the art of such analyses, and presents a logical approach to needed improvements to allow powered aircraft design optimization. Author

A84-17895*# Analytical Methods, Inc., Redmond, Wash.
THE APPLICATION OF A SECOND GENERATION LOW-ORDER PANEL METHOD - PROGRAM 'VSAERO' - TO POWERPLANT INSTALLATION STUDIES
D. R. CLARK, B. MASKEW, and F. A. DVORAK (Analytical Methods, Inc., Redmond, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. Research supported by the General Electric Co. refs
(Contract NAS2-8788; NAS2-11169)
(AIAA PAPER 84-0122)

Results from the application of a second generation low-order panel method to a number of powerplant installations are presented. The method, which retains the advantages of ease of use and low operating cost of earlier panel methods while retaining the aerodynamic modelling rigor of higher-order methods was used to predict the flow in and around typical nacelles and aircraft for a wide range of conditions. The ability of the second generation low-order analysis to calculate internal flows without the leakage problems associated with earlier programs is demonstrated and correlation between calculated and measured surface pressures and flow behavior, including predicting streamlines and locating regions of separated flow, is presented. Author

A84-17936#
EXPERIMENTAL INVESTIGATION OF ICE ACCRETION ON ROTORCRAFT AIRFOILS AT HIGH SPEEDS
R. J. FLEMMING and D. A. LEDNICER (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0183)

Ice was accreted on airfoils, including the NACA 0012, SC 1095, VR-7, SC 1094 R8, and SC1012 R8, in the Canadian NRC High Speed Icing Wind Tunnel for a range of liquid water content, temperature, and Mach number at several steady and unsteady angles of attack. Ice boundaries and force and moment increments were then determined and ice shapes were documented. Castings of the ice bonded to the airfoils' leading edges were similarly tested in the Transonic Airfoil Facility of Ohio State University to complement the more limited range of the NRC tunnel. These tests showed a reduction in the lift curve slope of 8 percent, an increase in the zero lift angle of 0.2 deg, a decrease in maximum lift coefficient of about 30 percent, and an increase in drag in the range of 50 to 150 percent. It was found that ice boundaries are nearly independent of airfoil configuration, but lift and drag changes are airfoil dependent. J.N.

A84-17937*# Texas A&M Univ., College Station.
EXPERIMENTAL STUDY OF PERFORMANCE DEGRADATION OF A MODEL HELICOPTER MAIN ROTOR WITH SIMULATED ICE SHAPES
K. D. KORKAN, E. J. CROSS, JR. (Texas A & M University, College Station, TX), and C. C. CORNELL American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 14 p. refs
(Contract NAG3-242)
(AIAA PAPER 84-0184)

An experimental study utilizing a remote controlled model helicopter has been conducted to measure the performance degradation due to simulated ice accretion on the leading edge of the main rotor for hover and forward flight. The 53.375 inch diameter main rotor incorporates a NACA 0012 airfoil with a generic ice shape corresponding to a specified natural ice condition. Thrust coefficients and torque coefficients about the main rotor were measured as a function of velocity, main rotor RPM, angle-of-incidence of the fuselage, collective pitch angle, and extent of spanwise ice accretion. An experimental airfoil data bank has been determined using a two-dimensional twenty-one inch NACA 0012 airfoil with scaled ice accretion shapes identical to that used on the model helicopter main rotor. The corresponding experimental data are discussed with emphasis on Reynolds number effects and ice accretion scale model testing. Author

A84-17954#
A METHOD FOR PREDICTION OF JET-INDUCED LOADS ON THRUST-REVERSING AIRCRAFT
P. B. JOSHI (Northrop Corp., Aircraft Div., Hawthorne, CA) and M. COMPTON (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 16 p. Research supported by the Northrop Corp. refs
(Contract F33615-81-C-3025)
(AIAA PAPER 84-0222)

A method currently being developed for the prediction of the forces and moments induced by thrust reverser jets on the airframe is described and experimental results are presented. A computer code which couples a panel method to a jet-in-cross-flow model was applied to two different wind tunnel model configurations, referred to as Versatile Twin Engine and Versatile Single Engine models. Extensive comparisons of the predictions of the code with test data in zero sideslip including the effects of reverser efflux angle and position relative to the vertical and horizontal tails have led to the identification of certain areas of improvement in the predictive methodology. The predicted trends of jet-induced effects are in reasonably good agreement with test data, suggesting that the prediction method can serve as a helpful, diagnostic analytical tool. J.N.

A84-17966#
TOWARD A UNIFYING THEORY FOR AIRCRAFT HANDLING QUALITIES
R. A. HESS (California, University, Davis, CA) and I. SUNYOTO American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0236)

A structural model of the human pilot which has been used to study a variety of problems in manual control tasks is applied to the study of aircraft handling qualities. A physical theory for handling qualities is reviewed and interpreted in terms of the model. The theory postulates that, in manual control tasks, rate-control activity on the part of the human is the sole determining factor in the generation of pilot opinion ratings. Using the structural model, rate-control activity is related to the power in a proprioceptive feedback signal proportional to vehicle output-rate due to control input. By appealing to simple single-axis tracking tasks, the model and theory are shown capable of demonstrating the manner in which three major determinants of aircraft handling qualities can effect pilot opinion ratings. Author

A84-18027*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPROACH AND LANDING AERODYNAMIC TECHNOLOGIES FOR ADVANCED STOL FIGHTER CONFIGURATIONS
D. W. BANKS and J. W. PAULSON, JR. (NASA, Langley Research Center, Subsonic Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0334)

Providing next-generation fighter aircraft with STOL capability will require effective high-lift systems, methods of providing adequate longitudinal trim and control, and thrust reversers compatible with advanced configurations. Recent wind-tunnel tests in the NASA Langley 4 x 7-m tunnel have provided the opportunity to investigate some promising technologies for providing this STOL capability. These tests include investigations of the high-lift contribution of spanwise blowing on a trailing-edge flap system, the trim capability of a blown high-lift canard, and the deceleration contribution of a thrust reverser for ground-roll reduction. This paper reviews the results of each investigation and examines the integration of these technologies on a common advanced-fighter configuration to determine their compatibility and the resulting overall performance of the configurations. Author

A84-18030*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NOISE AND PERFORMANCE CHARACTERISTICS OF A MODEL SCALE X-WING ROTOR SYSTEM IN HOVER
W. L. WILLSHIRE, JR. and R. M. MARTIN (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0337)

Noise data for the hover condition were measured for a 8 m diameter X-wing model rotor mounted on an outdoor whirl tower. The noise was found to be a function of operating condition, in general increasing with performance. The X-wing spectra obtained from narrowband and 1/3-octave band analyses were dominated by the blade passage frequency harmonics. The circulation control slot blowing produced 1 to 10 kHz broadband noise which exhibited a jet velocity to the 5.4 dependency. Under the rotor plane loading noise was dominant, except at low values of blade pressure ratio where a sharp decrease in the blade passage frequency harmonic levels was observed. In the rotor plane, the contribution of the broadband noise sources was greater than under the rotor plane. The X-wing rotor system in hover exhibited flexibility in operating conditions to achieve a specific level of performance. The high collective, low blade passage ratio combinations which meet a given level of performance were associated with low overall sound pressure levels. Author

A84-18052#
TRANSONIC CFD APPLICATIONS TO ENGINE/AIRFRAME INTEGRATION
E. N. TINOCO and A. W. CHEN (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0381)

The application of transonic computational methods to the analysis of pylon wing-mounted engine/airframe configurations typical of subsonic transports is presented. The computational methods used include a three-dimensional isolated nacelle code based on a time-dependent Euler formulation; an axisymmetric explicit Navier-Stokes code for exhaust system analysis and plume modeling calibration; and a three-dimensional full-potential finite volume wing-body-strut-nacelle code. Comparisons of experimental and calculated pressure distributions on isolated nacelles and on wing-body-strut-nacelle configurations are presented. The agreement between computed results and test data is shown to be very good both in terms of trends and absolute levels. Author

A84-18054#
A NEW BI-ROTOR HELICOPTER CONFIGURATION - MODEL DEVELOPMENT AND PERFORMANCE PREDICTIONS
B. P. SELBERG (Missouri-Rolla, University, Rolla, MO) and K. ROKHSAZ American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0385)

A bi-rotor concept, in which the helicopter blades are closely coupled, is introduced which offers the potential of providing the same thrust at less required torque than a single rotor helicopter system of equal radius and area. An analytical hover model is developed both for the single and bi-rotor systems. The aerodynamic input for the model, two dimensional lift coefficient at zero angle of attack, two dimensional lift curve slope, and local two dimensional drag coefficient, are analytically predicted for both dual and single rotor systems using multi-element vortex panel programs in conjunction with boundary layer programs. Comparisons are made with experimental results for the single rotor systems to validate the model. Torque and thrust coefficients comparisons between the bi-rotor and single rotor are made for two airfoil shapes, the NACA 23012 and the NASA MS(1)-0313. Figure of merit results are also presented. All results show the bi-rotor to have superior performance if the dual blades have approximately the proper geometric placement, i.e., S approximately 1.0, G approximately 0.26, and D approximately -6 degrees. Author

A84-18108#
LIGHTNING EFFECT ON AIRCRAFT ELECTRONICS
R. V. ANDERSON (U.S. Navy, Naval Research Laboratory, Washington, DC) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. refs
(AIAA PAPER 84-0465)

Three trends in aircraft practice are shown to affect the possible importance of lightning activity on the safety and effectiveness of aircraft operations. It is shown that current directions in electronics utilization, electronics technology, and aircraft structural design all tend to exacerbate the lightning problem. Three mechanisms are described through which lightning strike energy is coupled to electronic systems; and the third, the (relatively) low frequency magnetic field produced by the passage of a discharge current, is described as relatively underappreciated. There is a brief discussion of lightning hazard definitions with suggestions for further study, and the paper concludes with an overview of strategies with which to address the perceived threat. Author

A84-18166#

IN-FLIGHT MEASUREMENT OF ENGINE POWER EFFECTS ON THE LIFT AND DRAG CHARACTERISTICS OF A HIGH PERFORMANCE BUSINESS JET

T. R. YECHOUT, W. G. SCHWEIKHARD (Kansas, University, Lawrence, KS), and K. BRAMAN American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs

(AIAA PAPER 84-0563)

An in-flight technique has been developed by the University of Kansas under NASA Dryden and Kohlman Systems Research sponsorship to define the aerodynamic effect of thrust level on aircraft lift and drag characteristics. Conventional stabilized 'speed power' tests require the thrust to be adjusted for each test condition and, as a result, the effect of thrust on aerodynamic characteristics cannot be identified. The technique utilizes quasi steady-state maneuvers at selected power settings throughout the Mach range of the aircraft to define lift and drag coefficient variation as a function of angle of attack, Mach number and power setting. A twenty hour flight test program was accomplished using a Learjet Model 35 aircraft. Significant power effects were identified which should be anticipated on any aircraft with jet engines mounted on the aft fuselage above the inboard wing section. Author

A84-18519*# Texas Technological Univ., Lubbock.

ANALYSIS OF ELECTROMAGNETIC FIELDS ON AN F-106B AIRCRAFT DURING LIGHTNING STRIKES

T. F. TROST (Texas Tech University, Lubbock, TX) and F. L. PITTS (NASA, Langley Research Center, Hampton, VA) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. B3-1 to B3-11. refs

Information on the exterior electromagnetic environment of an aircraft when it is struck by lightning has been obtained during thunderstorm penetrations with an F-106B aircraft. Electric and magnetic fields were observed, using mainly time-derivative type sensors, with bandwidths to 50 MHz. Lightning pulse lengths ranging from 25 ns to 7 microsec have been recorded. Sufficient high-frequency content was present to excite electromagnetic resonances of the aircraft, and peaks in the frequency spectra of the waveforms in the range 7 to 23 MHz are in agreement with the resonant frequencies determined in laboratory scale-model tests. Both positively and negatively charged strikes were experienced, and most of the data suggest low values of peak current. Author

A84-18522#

THE INTERACTION OF ELECTROMAGNETIC FIELDS WITH AIRCRAFT DURING A LIGHTNING EVENT

R. A. PERALA and T. H. RUDOLPH (Electro Magnetic Applications, Inc., Denver, CO) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abington, Oxon, England, Culham Laboratory, 1982, p. C3-1 to C3-13. refs

(Contract F33615-79-C-3412)

This paper is a brief review of interaction analysis techniques which can be used to predict the electromagnetic coupling to an aircraft during a lightning event. Techniques for external and internal interaction and cable propagation are presented. Nonlinear effects are also discussed. Some example interaction computations are also given. Author

A84-18528#

TRANSIENT ELECTROMAGNETIC FIELDS ON A DELTA-WING AIRCRAFT MODEL WITH INJECTED CURRENTS

T. F. TROST and C. D. TURNER (Texas Tech University, Lubbock, TX) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D5-1 to D5-7. refs

An account is given of modeling studies carried out on the interaction of a delta-wing aircraft with direct lightning strikes. The modeling encompasses both laboratory experiments and computer analysis. Here, an approximate scale model of an F-106B aircraft is subjected to direct injection of fast current pulses. The pulses are provided by wires that simulate the lightning channel and are attached at various locations on the model. Small B-dot and D-dot sensors on the surface of the model are used to measure the resulting transient electromagnetic fields. Fourier transformation and the computation of transfer functions for the model are used in the computer analysis of the measured fields. The transfer functions reveal several resonances of the moderate Q. The fields on the model are compared with those obtained in flight during actual lightning strikes with the NASA F-106B aircraft. C.R.

A84-18529#

NORTHROP'S LIGHTNING LABORATORY AND TEST TECHNIQUES ON COMPOSITES AND RADOMES FOR AN ADVANCED FIGHTER AIRCRAFT

G. W. SCOTT (Northrop Corp., Aircraft Div., Hawthorne, CA) and W. F. J. CREWSON (Physics International Co., San Leandro, CA) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D7-1 to D7-8.

A84-18530#

DESIGN TESTING OF COMPOSITE MAIN ROTOR BLADES FOR LIGHTNING PROTECTION

H. R. ELLIS, M. J. HESELTINE (Westland Helicopters, Ltd., Yeovil, Somerset, England), and C. JONES (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D8-1 to D8-8.

The considerations that govern the selection of composites for helicopter main rotor blades are set forth, with attention given to some of the problems encountered in their design and manufacture. Protection against lightning and erosion is also discussed, with the note that interim testing of the initial design schemes is necessary because of the time lag between the design and manufacture of a representative composite blade. A description is given of the design of flat test specimens, which are representative of the blade construction but are inexpensive and easy to manufacture, and can be used to test various lightning protection schemes well in advance of blade manufacture. The results obtained from the flat coupon test for the final chosen scheme are compared with those obtained from tests on a prototype blade section. Good agreement is obtained. C.R.

A84-18532#

STUDIES OF LIGHTNING-ATTACHMENT TESTING USING AIRCRAFT MODELS

J. GALCZAK (Lodz, Politechnica, Lodz, Poland) and A. AKED (Strathclyde, University, Glasgow, Scotland) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D10-1 to D10-8. Research supported by the Ministry of Defence (Procurement Executive) of England. refs

The results of three studies of lightning-attachment-point testing are reported: (1) comparative tests using two metal-surfaced Boeing 747 models having a scale ratio of 2.8/1 and discussion of proposed test conditions; (2) discharge observations and attachment-point tests on a Lynx helicopter model; and (3) discharge growth and electric-field measurements in a 3-electrode, nonuniform-field gap. The effects of model size and test voltage level on strike point distribution are considered, as well as Aleksandrov's (1973) recommendations for the conditions of model testing. Corona discharge tests on the Lynx model implied that the most likely strike point would be on the main rotor and that the most likely exit point would be from either rotor or from a landing wheel. In the 3-electrode gap, it is found that, under apparently identical conditions, the corona could develop in such a way that no discharges are detected at the isolated electrode or it could develop a leader channel which approaches the isolated electrode and causes extensive discharges from both posts on this electrode. J.N.

A84-18533#
ASSESSMENT OF LIGHTNING SIMULATION TEST TECHNIQUES
W. G. BUTTERS, D. W. CLIFFORD, K. P. MURPHY, K. S. ZEISEL (McDonnell Aircraft Co., St. Louis, MO), and B. P. KUHLMAN (USAF, Atmospheric Electricity Hazards Group, Wright-Patterson AFB, OH) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D13-1 to D13-10. refs
(Contract F33615-80-C-3406)

The induced transient responses on interior wiring caused by the current pulse and shock-excitation lightning simulation test techniques were compared. The test technique evaluation was then extended to full-scale tests on the flight control circuits of a YF-16 fighter aircraft. Both techniques were applied to a long aluminum cylinder with simple interior circuits for three output configurations; (1) the open cylinder output with large gap spacing, (2) the hard-wired output in which the gap electrodes are connected together to ground the cylinder, and (3) intermediate gap spacings. Computer modeling and the experimental results for the cylinder agreed well and demonstrated that capacitive coupling was dominant for the high impedance circuits tested. The presence of a spark gap between the test article and the return conductors enabled the charge transients as well as the discharge transients to be studied. The shock-excitation test was capable of producing the high dI/dt and dV/dt levels of a lightning strike for short durations. J.N.

A84-18534#
LIGHTNING TESTING OF THE VIGGEN AIRCRAFT
B. I. WAHLGREN, B. A. OLSSON (Saab-Scania AB, Linkoping, Sweden), and C. A. LUTHER (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D14-1 to D14-11. Research supported by the FORSVARET Materielverk.

The results of full-scale lightning tests of a prototype Swedish Viggen aircraft are reported. The test rig comprised the aircraft with diagnostic cables installed, a low-inductance return-conductor system constructed around the aircraft, a 6.25-microfarad 100-kV single-stage capacitor bank with remote control and effective output inductance of 100 nH, and a pulse-recording system housed in a shielded room. Surface current density, magnetic-flux density, and voltages induced in wires and cables were measured at various points under conditions simulating the restrike phase of a lightning stroke. Drawings of the test setup are provided, and the results are presented in tables and graphs. The various factors which make the test less than realistic are discussed, and a method for computing realistic worst-case values from the results is developed. Absolute dominant voltages were measured in cables crossing wing or drop-tank joints, but only small voltages were found within the cockpit or in an equipment bay with a CFRP door. T.K.

A84-18535#
LIGHTNING TESTS OF AIRCRAFT FUEL TANK DETAILS
B. OLSSON (Saab-Scania AB, Linkoping, Sweden) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D15-1 to D15-8.

The results of a series of lightning tests conducted on certain fuel tank details of the Saab-Scandia Viggen aircraft are reported. The program included direct hit tests on three different types of fuel tank access door joints, one permanent tank panel, and a standard fuel measurement probe and also an induced-voltage test on the fuel probe. In no case did sparks or flash over phenomena occur between the probe and the box simulating a partially filled tank or between the probe and the horizontal fuel tube. Sparks were, however, generated inside the probe for voltages down to 4.4 kV between the probe and the box. Sparks under the plastic connector of the measuring system cable were generated at voltages down to 6kV between the connectors and the probe cylinders. The sparking voltage tended to be somewhat higher for the shorter pulse. V.L.

A84-18543#
APPLICATION OF CHARGING EFFECTS - RANGING OF AIRCRAFT
H. TRINKS and J. L. TER HASEBORG (Hamburg, Hochschule der Bundeswehr, Hamburg, West Germany) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. E9-1 to E9-8. refs

Missiles and especially aircraft are electrically charged during free flight in the range of 10 to the -7th to 10 to the -3rd C. The electric charging of aircraft and helicopters is not only a reason for undesirable disturbances but also a basis for obtaining information about the flight path. The electric field, transported by the aircraft during free flight, can be observed quantitatively in distances of up to some hundred meters. A system of three plane sensors, arranged in the corners of a triangle on the earth surface is described by which the flight path of aircraft in the range of 40 to 500 m, with velocities of 50 m/s, is detected. The theory and typical experimental results are discussed. Author

A84-18545#
PROBABILISTIC APPROACH TO AIRCRAFT LIGHTNING PROTECTION
G. L. WEINSTOCK (McDonnell Aircraft Co., St. Louis, MO) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G1-1 to G-4.

Attention is given to a novel approach to lightning protection for tactical military aircraft which is based on a realistic assessment of probabilities for strike parameters and damage. Unnecessarily stringent lightning protection requirements can add weight to such aircraft which is out of proportion to the lightning strike risks incurred by their mission profiles. The built-in tolerance of tactical aircraft for battle damage must also be included in considerations of the lightning damage measures to be incorporated. It is noted that lightning strike data gathered from mountain tops located in midcontinent regions may be substantially invalid for naval aircraft flying over water or coastal regions. O.C.

A84-18549#
DEVELOPMENT AND TEST OF THE LIGHTNING PROTECTION SYSTEM FOR THE CFRP RUDDER ON A310 AIRCRAFT
H.-W. KRUEGER (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G5-1 to G5-8.

Attention is given to the structural design features of the Airbus A310 airliner rudder's carbon reinforced plastic composite structure, and the lightning protection system developed and tested for it.

Lightning protection system design criteria encompassed airworthiness, weight, durability, maintainability, and production costs. An initial design, approach employing an aluminum foil covering for the rudder surface was not successful in testing. A novel design was then developed which uses diverter straps, and which performed well in simulated lightning strike tests. O.C.

A84-18552#
LIGHTNING PROTECTION OF EXPOSED PARTS OF THE VIGGEN AIRCRAFT
L. ANDERSSON and B. OLSSON (SAAB-Scania AB, Linkoping, Sweden) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G8-1 to G8-7.

The SAAB-SCANIA VIGGEN military fighter aircraft has been provided with lightning protection of parts for which there is a high probability of a strike. This report explains the function and the design of the protection system for the tail fin antenna and the radome. It discusses the protection devices in detail and it also discusses how the laboratory testing was performed to verify their capability to withstand a severe lightning strike. Author

A84-18610
IMPLEMENTATION OF AIRCRAFT PARAMETER IDENTIFICATION
P. MEREAU (Adersa-Gerbios, Palaiseau, Essonne, France) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1133-1138. Sponsorship: Centre d'Essais en Vol. refs
(Contract CEV-75,20012; CEV-81,20013)

The implementation of aircraft parameter identification at the French Flight Test Center is described. The main parts of the identification procedure have been analyzed, including model characterization, data collection, data processing, estimation of parameter values, estimation of uncertainty intervals, validation of results, and calculation of desired quantities (e.g., aerodynamic coefficients, and mode frequency and damping). Methods have been defined in the frame of a general identification program to be used extensively by aeronautical engineers. The purpose of this package is two-fold: the systematic and extensive exploitation of flight test data to obtain aircraft parameters in the flight domain, and the development of appropriate models for a flight simulator. Special emphasis is placed on information display, operator/computer interaction, and identification viewed from the standpoint of the flight test engineer. B.J.

A84-18613
FLIGHT TEST RESULT OF FIVE INPUT SIGNALS FOR AIRCRAFT PARAMETER IDENTIFICATION
E. PLAETSCHKE (Deutsche Forschungs- und Versuchsanstalt fuer Luft und Raumfahrt, Institut fuer Flugmechanik, Brunswick, West Germany), J. A. MULDER (Delft, Technische Hogeschool, Delft, Netherlands), and J. H. BREEMAN (Nationaal Lucht en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1149-1154. refs

A joint Dutch/German aircraft parameter identification program has been conducted to investigate various factors affecting identification results. Different design methods led to five test signals which were implemented via a hydraulic control system in a flight test program with a De Havilland DHC-2 Beaver experimental aircraft. Aircraft parameters were calculated using two different parameter identification algorithms, classical Maximum Likelihood method and flight path reconstruction followed by linear regression analysis. Each test signal was repeated nine resp. ten times allowing a statistical evaluation based on Cramer-Rao lower bounds and sample variances. Author

A84-18615* Joint Inst. for Advancement of Flight Sciences, Hampton, Va.
ON THE DETERMINATION OF AIRPLANE MODEL STRUCTURE FORM FLIGHT DATA
V. KLEIN (Joint Institute for Advancement of Flight Sciences, Hampton, VA), J. G. BATTERSON (NASA, Langley Research Center, Hampton, VA), and P. L. SMITH (Old Dominion University, Norfolk, VA) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New york, Pergamon Press, 1983, p. 1163-1168. refs

A procedure based on a modified stepwise regression and several selection criteria is presented for the determination of airplane model structure from flight data. The aerodynamic force and moment coefficients in an airplane model are expresed either as polynomials in output and input variables or as a combination of splines. The procedure is demonstrated in three examples by attempting to determine a local, extended and global model. Some of the resulting models are verified by using the maximum likelihood estimation or by examining model prediction capabilities. Author

A84-19177* Connecticut Univ., Storrs.
ON-LINE METHODS FOR ROTORCRAFT AEROELASTIC MODE IDENTIFICATION
J. A. MOLUSIS and D. L. KLEINMAN (Connecticut, University, Storrs, CT) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1363-1368. Army-supported research. refs
(Contract NASA ORDER L-26971-B)

The requirements for the on-line identification of rotorcraft aeroelastic blade modes from random response test data are presented. A recursive maximum likelihood (RML) technique is used in conjunction with a bandpass filter to identify isolated blade mode damping and frequency. The RML technique is demonstrated to have excellent convergence characteristics in random measurement noise and random process noise excitation. The RML identification technique uses an ARMA representation for the aeroelastic stochastic system and requires virtually no user interaction while providing accurate confidence bands on the parameter estimates. Comparisons are made with an off-line Newton type maximum likelihood algorithm which uses a state variable model representation. Results are presented from simulation random response data which quantify the identifed parameter convergence behavior for various levels of random excitation which is typical of wind tunnel turbulence levels. The RML technique is applied to hingless rotor test data from the NASA Langley Research Center Helicopter Hover Facility. Author

A84-19262*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOME AERODYNAMIC CONSIDERATIONS FOR ADVANCED AIRCRAFT CONFIGURATIONS
L. J. WILLIAMS, J. L. JOHNSON, JR., and L. P. YIP (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0562)

Recent NASA wind-tunnel investigations of advanced unconventional configurations are surveyed, with an emphasis on those applicable to general-aviation aircraft. Photographs of typical models and graphs of aerodynamic parameters are provided. The designs discussed include aft installation of tractor or pusher-propellor engines; forward-swept wings; canards; combinations of canard, wing, and horizontal tail; and propeller-over-the-wing configurations. Consideration is given to canard-wing flow-field interactions, natural laminar flow, the choice of canard airfoil, directional stability and control, and propulsion-system location. T.K.

A84-19343
AN EXPLICIT FEEDBACK APPROXIMATION FOR MEDIUM-RANGE INTERCEPTIONS IN A VERTICAL PLANE
J. SHINAR and M. NEGRIN (Technion-Israel Institute of Technology, Haifa, Israel) Optimal Control Applications and Methods (ISSN 0143-2087), vol. 4, Oct.-Dec. 1983, p. 303-323. refs

Minimum-time interception of a target flying at a constant speed and altitude by a missile-carrying fighter aeroplane is analysed using the method of forced singular perturbations (FSP). The engagement starts beyond visual range and terminates when the firing envelope of the missile is reached. Since in a medium-range scenario the interceptor does not reach its maximum specific energy, the solution consists of matched initial and terminal boundary layers. The paper concentrates on interception of high flying targets for which the terminal phase is also a climbing subarc. The solution of this problem is approximated in a uniformly valid explicit feedback form using a range-dependent weighting parameter. Application to an interceptor with realistic aerodynamic and propulsion models serves as an illustrative example. Author

N84-14134 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Betriebsbereich.
CONNECTION OF LARGE AIRBUS COMPONENTS TAKING EXAMPLE OF CONTROL SURFACES JUNCTIONS [ANSCHLUESSE VON GROSSBAUTEILEN DES AIRBUS AN BEISPIELEN VON LEITWERKSVER-BINDUNGEN]
H. BRENNEIS 7 Dec. 1982 115 p In GERMAN Presented at Technische Univ. Munich and Hochschule der Bundeswehr, Munich Sem. fuer Leichtbau WS 82/83, Munich
(MBB-UT-07-82-OE) Avail: Issuing Activity

The construction of control surfaces junction of the Airbus family (A300, A310, A310-600, and A320) is commented on. Industrial aspects (worksharing, production method, mounting costs), airliner requirements (repair, handling, inspectability, inspection frequency), and legal requirements (construction regulations) are considered. These aspects are also considered for the Boeing 737, 757, and 767; Mercure, Douglas DC10, and Transall C160. Author (ESA)

N84-14135# National Aeronautical Establishment, Ottawa (Ontario).
EVALUATION OF THE EFFECTS OF LATERAL AND LONGITUDINAL APERIODIC MODES ON HELICOPTER INSTRUMENT FLIGHT HANDLING QUALITIES
S. R. M. SINCLAIR and S. KERELIUK Jul. 1983 34 p
(AD-A134116; NAE-AN-15; NRC-22576) Avail: NTIS HCA03/MFA01 CSCL 01B

This report describes a part of a larger program funded by the US Federal Aviation Administration and the National Aeronautical Establishment to provide background information on instrument flight handling qualities of helicopters. This latest series of tests was aimed at addressing the acceptability of pitch and roll aperiodic characteristics when performing general handling and mission oriented tasks in the NAE Airborne simulator. In general, the results of these tests are consistent with proposed requirements for helicopter IFR handling qualities. Two significant factors were highlighted in these tests: aircraft characteristics which were not specifically under study may have affected pilot opinions; and changes in pilot opinion occurred depending on whether the task was one of general handling or was specifically mission oriented. Author (GRA)

N84-14137# Air Force Flight Test Center, Edwards AFB, Calif. Flight Test Technology Branch.
HYDRAULIC SUBSYSTEMS FLIGHT TEST HANDBOOK Final Report
K. J. LUSH Aug. 1983 132 p
(AD-A132633; AFFTC-TIH-83-2) Avail: NTIS HCA07/MFA01 CSCL 01C

This Handbook provides AFFTC (Air Force Flight Test Center) engineers with guidelines for the testing of aircraft hydraulic subsystems. Future technological advances, characteristics of individual aircraft and test programs and cost constraints may necessitate other methods being used in some cases. A background is provided on aircraft hydraulic subsystems and the requirements to which they are designed. Details are provided of individual tests, test support requirements and evaluation criteria and suggestions made for presentation of results. Author (GRA)

N84-14138# Systems Technology, Inc., Hawthorne, Calif.
TENTATIVE STOL (SHORT-TAKEOFF-AND-LANDING) FLYING QUALITIES CRITERIA FOR MIL STANDARD AND HANDBOOK Final Report, Jun. 1982 - Jun. 1983
R. H. HOH and D. G. MITCHELL Wright-Patterson AFB, Ohio AFWAL Jun. 1983 159 p
(Contract F33615-80-C-3604; AF PROJ. 2403)
(AD-A132857; STI-TR-1163-3; AFWAL-TR-83-3059) Avail: NTIS HCA08/MFA01 CSCL 01C

A move is underway in the military services to expand the scope of the military flying qualities specification, MIL-F-8785C to include STOL flying qualities. This report is the result of review, analysis and unification of existing STOL flying qualities data in a form facilitating inclusion into the new MIL Standard and Handbook, particularly in the area where STOL aircraft differ from CTOL aircraft. The report recommends proposed requirements where sufficient data exist; the report presents discussion where data are sparse or non-existant. Author (GRA)

N84-14139# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
PRELIMINARY AIRWORTHINESS EVALUATION OF THE UH-60A CONFIGURED WITH THE EXTERNAL STORES SUPPORT SYSTEM (ESSS) Final Report, 4 Dec. 1982 - 26 Jan. 1983
A. R. MARSHALL, R. G. OLIVER, R. M. BUCKANIN, and R. S. ADLER Mar. 1983 88 p
(AD-A132964; AD-F300304; USAAEFA-82-14) Avail: NTIS HCA05/MFA01 CSCL 01C

The Preliminary Airworthiness Evaluation of the UH-60A helicopter configured with the External Stores Support System was conducted. A total of 26 test flights were conducted. Limited level flight performance tests were conducted to determine the change in drag of the UH-60A helicopter caused by three External Stores Support System configurations with various stores installed. An unexplained increase in power required was found between the Preliminary Airworthiness Evaluation test aircraft and the aircraft used during a previous Airworthiness and Flight Characteristics evaluation. GRA

N84-15040# Electronique Serge Dassault, St. Cloud (France).
TOWARDS A MODULARITY OF SOFTWARE CONCEIVED FOR THE REQUIREMENT OF THE USER [VERS UNE MODULARITE DU LOGICIEL CONCUE POUR LES BESOINS DE L'UTILISATEUR]
P. CATEL *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 14 p Oct. 1983 In FRENCH
Avail: NTIS HC A21/MF A01

Background data on software for the main computer of an avionics system is reviewed and the step taken at Dassault in the search for modularity of software that is adapted to user needs is examined. This step evolved in two phases. The first phase concerned the median size (up to 64 K words) and permitted definition of a software structure and rules for cutting. The second phase appeared on the occasion of starting a new application, of more important volume, before becoming the base for an important family of applications. A study, led conjointly with the program specifier (the master work of the system), permitted different improvements, both on the plan of the structure as well as the methods for cutting, so as to obtain a perfect recovery of the entities of the software. This was concretized by the use of new tools and by extensions of the virtual machine of the computer used. A.R.H.

N84-15041# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Military Aircraft Div.
INCREASING SIGNIFICANCE OF ELECTROMAGNETIC EFFECTS IN MODERN AIRCRAFT DEVELOPMENT
D. JSEGER *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 18 p Oct. 1983
Avail: NTIS HC A21/MF A01

Due to the use of new materials, the enlargement of the electromagnetic environment, the increasing susceptibility of electronic components and the rising dependence on satisfactorily functioning electronics, greater attention must be paid to electromagnetic effects in modern aircraft development. The increase in the scope of problems in comparison with the past and the possibilities which can be recommended for their solution are presented. Author

N84-15045# Naval Weapons Center, China Lake, Calif.
NAVY'S ADVANCED AIRCRAFT ARMAMENT SYSTEM PROGRAM CONCEPT OBJECTIVES
T. M. LEESE and J. F. HANEY *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 17 p Oct. 1983
Avail: NTIS HC A21/MF A01

The Advanced Aircraft Armament System (AAAS) was originally chartered to improve armament equipment performance, support, and interoperability. Because of funding constraints the AAAS Program was increasingly directed to development of air armament interface standards and technology, while advanced concept development of suspension release and stores management equipment was de-emphasized. The current program concentrates on supporting the Joint Navy/Air Force Aircraft Armament Interface Program whose task is development of MIL-STD-1760 (Aircraft Electrical Interconnection System) and associated guidelines for successful application. Since the advanced concepts which were to be originally developed are a more appropriate subject, the context of the discussion is the program prior to the redirection. The Fleet needs and deficiencies which provided the requirements for the concept effort are briefly outlined, the objectives and goals are detailed, and the approach to achieve mission flexibility and performance improvements at reduced ownership costs is discussed. A key aspect of the approach is development of generic designs which capitalize on cost and growth advantages of standards while allowing incorporation of advancing technology. Author

N84-15046# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
CONNECTING AIRCRAFT AND EXTERNAL LOADS [LIASONS AVION-CHARGES EXTREMES]
C. CONNAN and M. SALUAN *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 13 p Oct. 1983 In FRENCH
Avail: NTIS HC A21/MF A01

The evolution and complexity of so-called simple external loads (bombs) and the more important number of parameters demanded by complex loads (missiles, especially nacelles) makes the digitization of most material indispensable. The only other information left to connect is that pertaining to safety and large bandpass information. This information can be communicated as a function of the aircraft loads. For safety purposes, information authorizing the firing of weapons is not entirely digitized and is electrically segregated from other signals. The stanag 3837 project proposes a standardization of the electrical connections of external loads; however, it imposes the type of digital connection of the aircraft which is not necessary for interoperability: all securities are processed by doubling the numerical connection without any special connection. Architecture in existing aircraft or aircraft being developed or to be developed is discussed. Transl. by A.R.H.

N84-15049# Royal Aircraft Establishment, Farnborough (England).
DEF STAN 00-18: A FAMILY OF COMPATIBLE DIGITAL INTERFACE STANDARDS
D. R. BRACKNELL and A. A. CALLAWAY *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 5 p Oct. 1983
Avail: NTIS HC A21/MF A01

Four data transmission standards published as parts of DEF STAN 00-18 are described. They constitute a compatible family of standards for avionic data transmission to meet the majority of current system requirements, and serve to focus both component and system development resources within the UK, to the benefit of both MOD and Industry. The guide to the use of the standards, future plans, and new options for standarization are discussed. M.G.

N84-15051# General Dynamics Corp., Fort Worth, Tex.
A VIDEO BUS FOR WEAPON SYSTEM INTEGRATION
P. L. CURRIER and W. E. MILES *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 9 p Oct. 1983
Avail: NTIS HC A21/MF A01

Military standard 1760, which defines the mechanical and electrical characteristics of the connector interface for new weapons, is described. As a joint Air Force/Navy standard, all new weapons will be required to be designed such that all command, control, and communication with those stores will occur through these pre-defined connector pins. Once an aircraft is built to meet the connector requirements, then any new weapon can be added by only changing the weapon delivery software. The problems an airframe manufacturer faces in adopting the standard are highlighted and the solution of one of these problems, viz, the video requirements of the standard, is examined. M.G.

N84-15054# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
FIRST LEVEL INTEGRATED MAINTENANCE IN WEAPONS SYSTEMS [MAINTENANCE PREMIER ECHELON INTEGREE DANS LES SYSTEMES D'ARMES]
M. E. L. COURTOIS *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 In FRENCH
Avail: NTIS HC A21/MF A01

The localization of replaceable entities in breakdown and the validation of functional chains are the two objectives of first level integrated maintenance that must be performed using only devices onboard modern combat aircraft. Integrated maintenance in a weapon system meets these imperatives by profiting from the technical evaluation of the equipment, the architecture of the weapon system, and the digital bus for the exchange of multiplexed information such as that used on the mirage 2000 aircraft. The principles of integrated maintenance, both on the ground and in-flight, are discussed. Transl. by A.R.H.

N84-15060# Operational Research and Analysis Establishment, Ottawa (Ontario). Directorate of Air Operational Research.
COMPUTER AIDED CONSTRUCTION OF GROUND ATTACK MISSION PROFILES OVER EUROPEAN TERRAIN
D. W. MASON *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 13 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

The optimization of an air-to-ground weapon inventory must investigate the trade-off between the effectiveness of the weapons and the vulnerability of the delivery aircraft to opposing ground defences while flying the mission profile required by the weapon. A computerized technique for constructing air-to-ground mission profiles in relation to actual terrain is described. The aim was to develop a profile construction system that permits the user to accurately but concisely direct the construction process. The technique relies on computer graphics to assist the user in creating realistic attack profiles. The system employs a data base of digitized central European terrain to produce perspective terrain image snapshots at key positions in the profile. Post analysis of the exposure history of a given profile will allow a reasonable assessment of the comparative survivability of an aircraft having to deliver weapon type A versus its survivability when delivering weapon type B. Although designed for use in weapon mix determinations for the Canadian Forces, this analysis tool may have useful applications in both aircraft design and air-to-ground weapon design for low level ground attack missions. M.G.

N84-15063# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AFTI/F-16: AN INTEGRATED SYSTEM APPROACH TO COMBAT AUTOMATION
F. R. SWORTZEL and W. S. BENNETT, II (General Dynamics) *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 15 p Oct. 1983
Avail: NTIS HC A21/MF A01

The Advanced Fighter Technology Integration, AFTI/F-16 Program which was developed and flight validating advanced technologies which improve fighter lethality and survivability is discussed. The capability is achieved by the integration of mission task tailored, digital flight controls with a director type fire control system and advanced target sensor/trackers into an automated maneuvering attack system. The core technology in the AFTI/F-16 approach to this integrated system capability is the digital flight control system (DFCS). Integrated with the onboard avionics system, the DFCS provides capabilities for maximum exploitation of flight/fire/weapon control and other subsystem integration. Task automation as applied to the fighter mission is evaluated with AFTI/F-16's automated maneuvering attack system (AMAS). Radar and FLIR/Laser sensor/trackers provide precise targeting information in AMAS for both air to air and air to surface attack. The pilot/vehicle interface through multifunction displays, wide field of view HUD, predictive HUD symbology and hands on controllers are considered. Voice command is anticipated to be a key interface feature. The AMAS is expected to allow accurate weapon delivery from low altitudes (below 100m) while achieving increased survivability through maneuverability, the low altitude environment and standoff delivery. E.A.K.

N84-15064# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
CONCEPT OF A FIGHTER AIRCRAFT WEAPON DELIVERY SYSTEM
R. L. RODE *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 7 p Oct. 1983
Avail: NTIS HC A21/MF A01

Modern fighter aircraft which carry besides various types of bombs more and more intelligent weapons, are discussed. The development of a stores and missile management system must consider the requirement from the operational/tactical considerations and the optimal usage of advanced electronic equipment together with a growth and adaption capability in both areas. On the basis of existing weapon delivery systems some possible trends in weapon development and weapon control systems development are discussed. The integration problems of a complete aircraft weapon delivery system from the planning stage via equipment and subsystem development to rig and on aircraft testing up to first flight test experiences are also outlined. E.A.K.

N84-15080# Flight Safety Foundation, Inc., Arlington, Va.
TWO DECADES OF AIR CARRIER JET OPERATION
E. C. WOOD and G. P. BATES *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 7 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

The accident record of the world fleet of air carrier jet aircraft from 1960 to 1981 is examined. Comparisons of total accidents, fatal accidents, and hull losses for this time period are reviewed against numbers of departures and hours flown. It is shown that there is a close correlation between fatal accidents and hull losses and that there has been a general stabilizing of the accident rate in the past decade of two to four accidents (hull losses) per million departures with the probability that, if no changes are introduced, this rate will remain essentially unchanged. Phases of operations where accidents have occurred are also examined, showing that over 50 percent of the fatal accidents have occurred during 14 percent of the operational exposure time spent in initial approach, final approach, and landing. Of this 50 percent, nearly 40 percent have occurred in the initial and final approach phases. The data indicate that airframe systems and powerplants, as well as maintenance air traffic control and weather factors have reached a high level of reliability and that the human factor is still the prevalent factor in the existing accident rates. Operator error has remained at over 70 percent. Since it is reasonably predictable that future accidents will occur in or near a major airport and will probably involve post crash fire, safety measures in this area are also discussed. M.G.

N84-15084# Army Aviation Engineering Flight Activity, Edwards AFB, Calif. Flight Test Directorate.
ROTORCRAFT ICING TECHNOLOGY: AN UPDATE
R. WARD and H. W. CHAMBERS (Army Aviation Research and Development Command, St. Louis, Mo.) *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 15 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

Inflight icing tests for rotary wing aircraft are discussed. Topics specifically addressed include: (1) flight testing of pneumatic deice boots installed on a UH-1H helicopter in artificial icing conditions behind the Canadian NRC Ottawa Spray Rig; (2) artificial and natural icing tests of the unprotected CH-47C and UH-60A helicopter rotor systems; (3) evaluation of ice shapes on a UH-1H rotor system and hover performance degradation caused by rotor icing; and (4) current and planned improvements to the US Army JCH-47C Helicopter Icing Spray System (HISS). M.G.

N84-15085# Centre d'Essais en Vol, Istres (France). Service Essais.
AIRCRAFT OPERATIONS FROM AIRFIELDS WITH SPECIAL UNCONVENTIONAL CHARACTERISTICS
G. ROBERT *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 17 p Oct. 1983 refs In FRENCH
Avail: NTIS HC A15/MF A01

Studies conducted by the General Directorate of Civil Aviation, assisted by the De Havilland Aircraft Company and users, resulted in the definition of procedures which assure a significant level of safety with regards to engine trouble at takeoff on the short runways used by TPP2 multimotor aircraft. Since authorization of use of these runways according to these procedures is very recent, it is premature to draw definitive conclusions on operational results. At present, the waiver granted concerns only the DHC6-300 aircraft; however, the recommendations formulated would be applicable to other types of aircraft providing complementary data is used concerning the minimal control of ground speed and performance of rolling at takeoff with engine trouble. Transl. by A.R.H.

N84-15093# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France). Dept. Equipements Dassault.
THE MIRAGE 2000: FLY BY WIRE CONTROL AND SAFETY [MIRAGE 2000: CDVE ET SECURITE]
J. LADEL and J. BASTIDON *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 9 p Oct. 1983 In FRENCH
Avail: NTIS HC A15/MF A01

The Mirage 2000 aircraft was built to provide the best efficiency in combat. To this end it uses electric flight control which permits a reasonable application of the generalized automatic control of the aircraft. Research on the safe operation of the piloting system led to a level of safety that is clearly superior to that observed on any previous aircraft. These performance and safety objectives were the subjects of theoretical and practical validations both in the laboratory and in flight in order to justify an a operational use of electric flight control. Transl. by A.R.H.

N84-15097# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Military Aircraft Div.

NEW FLIGHT DECK DESIGN IN THE LIGHT OF THE OPERATIONAL CAPABILITIES

R. SEIFERT and K. BRAUSER *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 13 p Oct. 1983 refs

Avail: NTIS HC A15/MF A01

The classification of human errors (H.E.) by category and conditions of occurence is presented. According to the conditions and causes of H.E. occurence different means of preventing H.E.'s by ergonomic design, by manning, selection and training are considered. In flight deck design, besides conventional ergonomic design, two strategies are proposed: (1) provision of sufficient feedback to allow the pilot to detect and correct unintentional performance errors before they affect system performance, and (2) Introduction of "fail safe and fail ops. ergonomic design" by means of H.E. detection and correction functions designed into the man-machine interface intelligence. The last generations of aircraft are compared regarding their task and system complexity. The increased complexity formed the need, and the advances in electronics provided the means for the new integrated flight deck, based on a cockpit data management system that includes "error monitoring capabilities". Finally the pilot's cockpit requirements of fire/flight control and post-stall-manoeuvring modes are discussed, requiring increased automation, information feedback loops and a "reconfiguration" of the pilot's task load. Author

N84-15100# Royal Aircraft Establishment, Farnborough (England).

INCREASED AIRCRAFT SURVIVABILITY USING DIRECT VOICE INPUT

R. G. WHITE and P. BECKETT (British Aerospace PLC) *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 13 p Oct. 1983 refs

Avail: NTIS HC A15/MF A01

Direct Voice Input, a conventional keyboard and a touch-sensing display were compared as methods of en-route data entry during a simulated ground attack sortie. It was shown that when using Direct Voice Input the pilot looked inside the cockpit less frequently and for shorter periods and, when flying at very low level, was able to control height more accurately then when using either of the tactile systems. Contrary to expectation, the total entry times for a sequence of data and the times between entry of individual instructions and digits were long using Direct Voice Input than with either the keyboard or the touch-sensing display. This was attributed to the characteristics and performance of the isolated word recognizer used in the DVI system. A further simulator trial is planned, which will use a connected speech recognizer with a higher recognition performance. Author

N84-15101# Airbus Industrie, Blagnac (France). Flight Div.

CERTIFICATION EXPERIENCE WITH METHODS FOR MINIMUM CREW DEMONSTRATION

J. J. SPEYER and A. FORT *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 31 p Oct. 1983 refs

Avail: NTIS HC A15/MF A01

AIRBUS INDUSTRIE's human factors involvement in flight test and certification with the double objective of checking functional effectiveness of the man-machine system and human welfare in its utilization process is discussed. The crew complement question prompted the consideration of workload for which Airworthiness Regulations provide a set of design-related, operational and human factors parameters. The rule on Minimum Flight Crew, FAA's FAR 25. 1523 and its Appendix D became effective in 1965 after an industry-wide consultation that included flight deck unions. This effectively coincided with the advent of the first two man crew commercial jet aircraft. The regulation called for an analysis and evaluation of the workload imposed upon the crewmembers of a particular type of aircraft by its cockpit environment. This concern for workload stems from theory and experience that beyond some unacceptable threshold of workload a pilot's or a crew's performance will be degraded to unsafe levels and that the ability to cope with unexpected emergencies may be seriously impaired without the assistance of an extra crewmember. With the advent of today's new technology aircraft the crew complement question stirred such a controversy among US and European pilot unions tha the President of the United States himself set up a Task Force on aircraft crew complement. Author

N84-15142 Kansas Univ., Lawrence.

ANALYSIS OF NONPLANAR WING-TIP MOUNTED LIFTING SURFACES ON LOW-SPEED AIRPLANES Ph.D. Thesis

C. P. G. D. VANDAM 1983 187 p

Avail: Univ. Microfilms Order No. DA8317975

Nonplanar wing-tip-mounted lifting surfaces have shown to reduce lift-induced drag substantially. Winglets, which are small, nearly vertical, winglike surfaces, are an example of these devices. To achieve reduction in lift-induced drag, winglets produce significant side forces. Consequently, these surfaces can also seriously affect airplane lateral-directional aerodynamic characteristics. In this study, the effects of winglets on the lateral-directional stability and control of low-speed general aviation and agricultural airplanes are researched. In addition, winglet aerodynamic loading is investigated. A lifting surface method is used to conduct a parametric study of the effects of various winglet parameters on lateral-directional stability derivatives of general aviation type wings. The results indicates that sideslip stability derivatives, in particular, are affected by the installation of winglets. Winglet chordwise location, sweep angle, and cant angle appear to provide design freedom to trade small reductions in induced drag for larger reductions in the stability of side force and rolling moment due to sideslip. Dissert. Abstr.

N84-15143*# National Aeronautics and Space Administration, Washington, D. C.

RECOGNIZING DEFECTS IN CARBON-FIBER REINFORCED PLASTICS

R. SCHUETZE and W. HILLGER Sep. 1982 24 p refs Transl. into ENGLISH conf. paper DGLR-81-057 presented at the Deutsche Gesellschaft fuer Luft- und Raumfahrt Jahrestagung, 1981 p 1-20 Meeting held in Aachen, 11-14 May 1981 Original language document was announced as A81-47565 Transl. by Scientific Translation Service, Santa Barbara, Calif.

(Contract NASW-3542)

(NASA-TM-76947; NAS 1.15:76947; DGLR-81-057) Avail: NTIS HC A02/MF A01 CSCL 01C

The damage tolerance of structures made of carbon-fiber-reinforced plastic is tested under various loads. Test laminate (73/1/1, 24/9/1, 1465 A) specimens of thickness 1.5-3.2 mm with various defects were subjected to static and dynamic loads. Special attention was given to delamination, and ultrasonic C-scans were made on the specimens. It was shown that cracks from even small defects are detected with great accuracy. The same probes were also X rayed; defects that could not be detected under ordinary X rays were bored and studied under vacuum by a contrast technique. The nondestructive ultrasonic and X ray tests were controlled by partially destructive tests, and good agreement was observed. Author

N84-15144*# National Aeronautics and Space Administration, Washington, D. C.

FUEL ECONOMY IN AVIATION

J. L. ETHELL 1983 117 p Original contains color illustrations

(NASA-SP-462; NAS 1.21:462) Avail: NTIS MF A01; SOD HC $15.00 as 033-000-00899-6 CSCL 01C

Engine component improvement, an energy efficient engine, advanced turboprops, composite structures, energy efficient transport, and laminar flow control are discussed. N.W.

N84-15146# Dayton Univ., Ohio.
FOD (FOREIGN OBJECT DAMAGE) GENERATION BY AIRCRAFT TIRES Final Report, Nov. 1981 - Oct. 1982
S. J. BLESS, L. CROSS, A. J. PIEKUTOWSKI, and H. F. SWIFT Tyndall AFB, Fla. AFESC Aug. 1983 247 p
(Contract F08635-82-K-0102; AF PROJ. 2104)
(AD-A133319; UDR-TR-82-136; AFESC/ESL-TR-82-47) Avail: NTIS HCA11/MFA01 CSCL 01C

Lofting of loose debris by overrolling tires was investigated by experiments and analysis. Trajectories of lofted particles were determined with a stereoscopic camera system. Tire speeds ranged up to 40 mph; single-and dual-wheel carriages were used. Debris was mostly stones, 1 inch and smaller. Concrete and packed dirt surfaces, both wet and dry, were included. The probability of lofting a stone, given an encounter, was typically 15 percent, until the stone density exceeded one stone per footprint area; then the lofting probability was much less. Launch directions were mainly within 20 degrees of the direction defined by the wheel axle. Launch velocities were mainly less than 2.5 m/s. The probability of launching debris to above 4 was about 0.03. Angularity and size both increase lofting probability. Water did not greatly affect stone lofting, except for very small stones (6 mm). Extrapolations of these results to airfield scenarios predict that the danger of engine ingestion of nosewheel generated debris is minimal. The worst case considered was the F-4, which was less than 0.17 stones/km ingestion. These conclusions are based on extrapolations and need to be checked with experiments at higher tire speeds and loads. Author (GRA)

N84-15147# Aeronautical Research Labs., Melbourne (Australia).
REPORT ON VISIT TO THE US AND EUROPE IN MAY 1983, COVERING THE 1983 ICAF (INTERNATIONAL COMMITTEE ON AERONAUTICAL FATIGUE) MEETINGS AND RELATED VISITS Structures Technical Memo.
G. S. JOST Jul. 1983 110 p Meetings held in Toulouse, May 1983
(AD-A133415; ARL/STRUC-TM-362) Avail: NTIS HCA06/MFA01 CSCL 01C

In May, 1983, the author made a number of fatigue-related technical visits in the US, and attended the 1983 meetings of the International Committee on Aeronautical Fatigue (ICAF) held in Toulouse, France. This report summarizes the matters considered during these visits. Author (GRA)

N84-15148# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
THE EFFECT OF SUPERPOSING RIPPLE LOADING OF MANEUVER LOAD CYCLES Final Report
M. S. ROSENFELD and P. KOZEL Feb. 1983 47 p
(Contract F41000)
(AD-A132653; NADC-81190-60) Avail: NTIS HCA03/MFA01 CSCL 14B

An experimental investigation of the effect of superposing ripple loads on large amplitude cycles typical of aircraft maneuver loads is discussed. A range of valves intended to represent a severe case was selected. It was concluded that ripple load superposition reduces the constant amplitude fatigue life of 7075-T6 aluminum, but consistent, large life reductions were not apparent until ripple load amplitude exceeded 15% of the amplitude of the primary load cycles. Current methods of fatigue analysis which employ a local strain approach had a tendency to underpredict the magnitude of the ripple effect. R.J.F.

N84-15149# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
HELIX AND FELIX: LOADING STANDARDS FOR USE IN THE FATIGUE EVALUATION OF HELICOPTER ROTOR COMPONENTS
A. A. TENHAVE Aug. 1982 24 p refs Submitted for publication
(NLR-MP-82041-U) Avail: NTIS HC A02/MF A01

Standardized fatigue test load histories for helicopter rotors are presented. Loading standards for fixed wing aircraft are described. Author (ESA)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A84-15984
DEVELOPMENT AND CERTIFICATION OF A COMMERCIAL HEAD UP DISPLAY
F. W. HAMILTON (Douglas Aircraft Co., Long Beach, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 123-130.

The DC-9 airliner's head-up display (HUD) system incorporates, in addition to the display optics, a console control panel and a computer. Attention is given to the role assumed by the test pilots during the development of this HUD's symbology during a two-year evaluation period. Also important in HUD development were analyses of simulator time histories, in light of which control law gains were adjusted to provide the most accurate approach (with a relaxed pilot in the control loop), taking into account weather effects, ceiling, visibility, winds, and wind shear. O.C.

A84-16120
AN OPTIMALLY INTEGRATED TRACK RECOVERY SYSTEM FOR AERIAL BATHYMETRY
D. B. REID, B. N. MCWILLIAM (Huntec, Ltd., Scarborough, Ontario, Canada), W. S. GESING (Toronto, University, Toronto, Canada), and J. R. GIBSON (Canada Center for Remote Sensing, Ottawa, Canada) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-19, Sept. 1983, p. 751-760. refs

In coastal mapping applications, or photobathymetry, where aerial photography is employed to measure shallow water depths, photo orientation problems can arise. The present investigation is concerned with a new approach for overcoming orientation difficulties. This approach is based on the employment of an accurate track recovery system (TRS) to measure the orientation parameters of the survey camera directly. A profiling laser radar (lidar) is used to provide auxiliary depth data as an aid in the analytical leveling of stereomodels. The described coastal mapping system was developed during the Canadian Aerial Hydrography Pilot Project reported by Reid et al. (1980). Attention is given to the principles of operation of the mapping system and the structure and operation of the multisensor track recovery system. G.R.

A84-16161* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
REAL-TIME PILOT GUIDANCE SYSTEM FOR IMPROVED FLIGHT-TEST MANEUVERS
E. T. SCHNEIDER and R. R. MEYER, JR. (NASA, Flight Research Center, Edwards AFB, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 57-72.

The real-time pilot display uplink development at the Dryden Flight Research Facility is described, with a focus on recent F-104 studies. A nose boom gathers data on the Mach number, pressure altitude, and angle of attack. The system provides the pilot with guidance to improve maneuver accuracy and fly more complex trajectories. The uplink presents the pilot with computed differences between a reference flight path and actual flight state conditions, using a downlink to the ground where engineering computations are performed, feedback is transmitted, and corrections are applied. Details of the flight test trajectories and data from test results are provided for level turns, constant thrust turns, dynamic pressure trajectories, constant radar altitude accelerations and decelerations, and a Reynolds number trajectory. The system has proved capable of reducing pilot workload and saving fuel by decreasing the flight time necessary to obtain specific data. M.S.K.

A84-16168
VOICE INTERACTIVE SYSTEMS TECHNOLOGY ASSESSMENT
J. D. WETHERBEE (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 185-191.

The Voice Interactive System Technology Assessment (VISTA) program is designed to evaluate the technical feasibility and functional utility of a voice interactive system in the Navy F/A-18 aircraft. Ground and flight tests are scheduled to be performed in 1984 to evaluate the system incorporated in the mission computer software programs. This paper examines the characteristics of voice interactive systems and considers the VISTA test program and the question of error rates. B.J.

A84-16540
EME SUSCEPTIBILITY TESTING OF AIRCRAFT
D. E. CLARK (Georgia Institute of Technology, Atlanta, GA) and F. W. HEATHER (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 158-161.

The Naval Air Test Center, Patuxent River, Maryland, has the task of conducting tests and evaluations on naval aircraft to assure compliance with EME (electromagnetic environment) susceptibility specifications. The NATC is developing a facility called the Electromagnetic Environmental Generation System (EMEGS) to perform the system-level susceptibility tests. This paper describes the EMEGS facility and its supporting instrumentation and examines the engineering aspects of upgrading the EMEGS. B.J.

A84-16549
STANDARD CENTRAL AIR DATA COMPUTER (SCADC) INTO PRODUCTION
D. E. MORRIS (Marconi Avionics, Ltd., Rochester, Kent, England) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 234-239.

This combined USAF and USN standardization program is now nearing the production phase. Air Data Computers from the SCADC core hardware set have already been configured, developed and tested for over thirty aircraft variants. Development, qualification, operational approval, and production of the SCADC hardware are being completed. The paper outlines the progress of the hardware program, and emphasizes the production readiness of the SCADC. Author

A84-16550
OMNIDIRECTIONAL AIR DATA SYSTEM FOR HELICOPTERS IN THE 80'S AND 90'S
P. J. ONKSEN (Pacer Systems, Inc., Burlington, MA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 240-246.

Omnidirectional Air Data Systems for the Apache Advanced Attack Helicopter and the Dolphin Short Range Recovery helicopter are currently being produced. Both systems are based on technology invented to satisfy a requirement for omnidirectional low range airspeed data on the X-22 V/STOL research aircraft. Each system consists of nearly identical Omnidirectional Airspeed Sensors and electrically similar, but physically different Air Data Computers. The resolving circuits in the computers are the same, but the signal outputs and electrical scaling is matched to the requirements of the two different helicopters and missions. Author

A84-16551
OMNI-DIRECTIONAL AIR DATA SYSTEMS FOR HELICOPTERS
R. A. DE VERTEUIL (Marconi Avionics, Ltd., Rochester, Kent, England) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 247-253.

It is evident that an Omni-Direction Air Data System is required for the modern and future helicopters. The standardisation of avionics equipment reduces Life Cycle and Logistics costs. The time is right for a centrally funded and managed program to develop a flexible system, of proven, reliable performance, suitable for retrofit or complete integration into helicopter avionics and flight systems. The AH-1S Enhanced Cobra Air Data System Sensor with a new flexible SCADC based computer as the low cost, low risk solution. Author

A84-16552
AIRSPEED MEASUREMENTS
M. GOLBERSTEIN and G. M. DELUCA (Rosemount, Inc., Eden Prairie, MN) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 254-259.

Reliable, accurate and cost effective pressure sensing instrumentation that provides airspeed measurements for operating ranges of 0 - 40 KTS is essential for air data and fire control systems of vertical flight aircraft. Rosemount's capacitive pressure sensing transducers provide air data system measurements of free and local stream airspeed up to three axes from a single sensor. The airspeed transducer senses differential pressures proportional to relative airflow in each of the longitudinal, lateral and vertical directions. The differential pressures are transmitted to air data modules containing pressure sensors and electronics, producing bidirectional outputs proportional to airspeed. For the sake of simplicity an orthogonal airspeed system is described. Author

A84-16556
A MULTIPURPOSE INTEGRATED INERTIAL REFERENCE ASSEMBLY (IIRA)
J. L. MOHR (McDonnell Aircraft Co., Avionics Engineering Div., St. Louis, MO) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 279-285. refs

Current military aircraft use multiple inertial sensors to perform navigation, flight control compensation, weapon delivery, and mission avionics functions. The feasibility of using common sensors for all these purposes was established previously. This IIRA Phase I program defined a system which would demonstrate this capability in Phase II. Using the same sensors has many advantages. However, the different requirements of these users create design conflicts. This paper describes these conflicts and shows how the proposed design resolves them. Author

A84-16557
APPLICATION OF VLSI TO STRAPDOWN
J. L. FARRELL and O. M. CROMER (Westinghouse Electric Corp., Systems Development Div., Baltimore, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 286-290. refs

Emerging strapdown technology is evaluated for future applications, with special attention given to data rates. Rather than long-term pay accuracy, emphasis is placed upon (1) precise short-term translational information and (2) submilliradian pointing. Examples of pertinent applications include synthetic aperture radar (SAR) motion compensation, air-to-air tracking, and adaptive null steering with an electronically agile beam. High data rate computation is especially needed for conformal active aperture arrays, wherein a rapidly darting radar beam is controlled by phase switching of multiple elements distributed on a nonrigid airframe. Author

A84-16558* Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
THE RELIABILITY ANALYSIS OF A SEPARATED, DUAL FAIL OPERATIONAL REDUNDANT STRAPDOWN IMU
P. MOTYKA (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 291-296.
(Contract NAS1-16887)

A methodology for quantitatively analyzing the reliability of redundant avionics systems, in general, and the dual, separated Redundant Strapdown Inertial Measurement Unit (RSDIMU), in particular, is presented. The RSDIMU is described and a candidate failure detection and isolation system presented. A Markov reliability model is employed. The operational states of the system are defined and the single-step state transition diagrams discussed. Graphical results, showing the impact of major system parameters on the reliability of the RSDIMU system, are presented and discussed. Author

A84-16559
COCKPIT INTEGRATION IN THE HH-60D NIGHT HAWK HELICOPTER
C. RICHARDSON (IBM, Federal Systems Div., Owego, NY) and R. LAMBDIN (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 298-305.

The HH-60D Night Hawk is discussed with respect to mission, aircraft design, cockpit integration, controls and displays, and display formats and utilization. It is noted that the cockpit represents the latest in practical man-machine interfaces coupled with significant workload reduction features. This design is implemented with a dual redundant core avionics system architecture to prevent simplex failures from affecting pilot functions. B.J.

A84-16560
A DIGITAL DISPLAY AND CONTROL SYSTEM FOR MODERN FIGHTER AIRCRAFT
A. S. SILVER and J. C. STROLE (Bendix Corp., Southfield, MI) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 306-313.

The CRT based integrated display subsystem has become the critical interface between the pilot and aircraft on modern fighter aircraft. As this subsystem assumes more navigation, weapons control and combat information duties its reliability, performance and survivability become very critical issues. The display system described herein has addressed these new system requirements. The system includes two display indicators, a data entry panel, and a display processor unit that is capable of providing simultaneous independent stroke over raster formats to each display unit, as well as a unique stroke format to the head-up-display. The display system is fully redundant and self monitored and insures mission success by providing that no single point failure can cause the loss of Head-Up or Head-Down display capability. Reliability and performance have been achieved through the use of a new 3 chipset LSI based programmable symbol generator. This very flexible and powerful single card symbol generation subsystem permits the mechanization of a fully redundant processor in a very compact low power and reliable unit. Author

A84-16561
DISPLAY MANAGEMENT IN FUTURE MILITARY AIRCRAFT
R. S. KALAWSKY (British Aerospace PLC, Aircraft Group, Brough, Humberside, England) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 314-321. Research supported by the Ministry of Defence /Procurement Executive/.

The 'All electronic military cockpit' has been realized due to advances in digital computers and computer graphics. This has led to the introduction of multiple cathode ray tube (CRT) displays that replace conventional electromechanical displays. Human factors research suggests rules in the way that information is presented to the pilot on appropriate display formats. In order not to saturate the pilot's limited mental processing resources it is essential to partition the information in a manner which minimizes mental processing. Therefore it is necessary to employ a repertoire of display formats so that basic data for a given flight phase is available without being cluttered with redundant information. Display format management is essential. Author

A84-16562
NEW VIDEO STANDARDS
J. C. BYRD (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 322-326.

The USAF assisted in developing two new video standards, one for monochrome and one for color, both based on existing commercial standards. The monochrome standard is STANAG 3350 AVS, 'Monochrome Video Standard for Aircraft System Application', generated by a NATO committee. The color standard drafted by ENASI requires color to be a 3-channel (RGB) version of the monochrome signals described in the STANAG. Use of these standards throughout the defense community will result in major cost savings to the government. The STANAG describes three classes of video (525 line, 625 line and 875 line). The standard does not yet address a very high resolution format. It is recognized that higher line rate formats for large computer graphics or EW displays are proliferating and should be standarized. Ideally, the standard adopted should be compatible with the current commercial standard (EIA-RS-343, 1023 line) or a proposed high definition TV standard in the 110-1300 line range. Digital video and a video data bus are also discussed and considered. Author

A84-16563
CHARACTERIZATION OF CRT RESOLUTION
J. BARBARASCH (Kaiser Aerospace and Electronics Corp., Kaiser Electronics Div., San Jose, CA) and F. T. BUHLER IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 327-334.

Resolution is a key parameter for airborne display systems. The resolution of a display system affects the pilot's ability to see fine detail in an image. In air to air combat a pilot views targets at long range to determine presence (detection), position (orientation) and type (identification). THe airborne weapons system designer must assure that the resolving capability of the specified system enables the pilot to perform his mission. This paper identifies typical airborne display resolution requirements, methods for analyzing display system resolution performance and effects of resolution requirements on display system hardware. Author

A84-16564
A KALMAN FILTER APPLICATION FOR POSITION ESTIMATION OF AN AIRBORNE RELAY VEHICLE IN THE PRECISION LOCATION STRIKE SYSTEM
H. T. ANDERLE, R. J. SCHLABIG, and J. S. KULCZYCKI (Softech, Inc., Dayton, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 336-343. USAF-sponsored research. refs
A Kalman filter application of tracking and position estimation of an Airborne Relay Vehicle (ARV) in the Precision Location Strike System (PLSS) is discussed. The eight components of a discrete filter are identified. These components are defined in a general sense. The five basic equations of the discrete Kalman filter algorithm are presented in terms of the eight components. The eight components of the filter are then particularized to fit the application. This filter is aided by external measurements of range from the aircraft to known fixed points on the earth's surface. This type of measurement suggests a form for the observation matrix and leads to a differential form for the elements of the system state vector. Author

A84-16569
MULTICOLOR ELECTROCHROMIC DISPLAY TECHNOLOGY
M. M. NICHOLSON and T. P. WEISMULLER (Rockwell International Corp., Defense Electronics Operations, Anaheim, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 368-374. USAF-Navy-supported research. refs
Multicolor flat-panel displays that are easily read in bright ambient light are essential to most advanced cockpit designs. The electrochromic technology described uses a film of a rare-earth diphthalocyanine dye material which changes to various colors in response to small applied dc voltages. Fundamentally, the writing and erasure processes resemble the charging and discharging of a battery, and, like a battery, the device retains its state of charge, or memory, on open circuit. The image can be viewed with front or back lighting or projected on a screen. The cell structure, performance, chemical switching mechanism, and drive requirements are discussed, and some results of a recent color-enhancement study are presented. Author

A84-16570
FLIGHT SIMULATOR EVALUATION OF A HIGH SPEED GRAPHICS DOT-MATRIX DISPLAY WHILE PORTRAYING PRIMARY FLIGHT CONTROL INFORMATION
K. T. BURNETTE (Burnette Engineering, Fairborn, OH), J. A. UPHAUS (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and T. P. BARRY (Systems Control Technology, Inc., Dayton, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 375-388. refs
This article describes what is believed to be the first investigation of the suitability of a dot-matrix media for use in the display of vector-graphic image depictions of time-variant information. A 64 dot/in. green LED display depicting an integrated flight control format at frame rates of 25-125 Hz and input data rates of 25 and 50 Hz was evaluated after flying 10 missions (each consisting of 6 Proficiency and Confidence maneuvers) in a fighter aircraft simulator. Performance, usefulness, and appearance compared to conventional instruments were rated for the display's: readouts, moving scales, and rotating/translating lines and symbols. Stair-stepping of rotating lines was rated as annoying, but could be accepted. Deficiencies cited were all format design related and correctable. All 28 pilots rated the display suitable to fly high performance maneuvers in actual aircraft (subject to the correction of the cited format design deficiencies). Author

A84-16571
THE MULTI-MODE MATRIX (MMM) MULTI-COLOR LED FLAT PANEL DISPLAY
R. H. STOPFORD (Litton Systems Canada, Ltd., Rexdale, Ontario, Canada) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 389-393.
LED flat panel display systems for aircraft cockpits have been under development at Litton Systems Canada since 1975 and from 1980 onward a number of Advanced Development Models (ADMs) have been constructed and delivered to various airframe manufacturers and Government research establishments for assessment. The first successful outcome of this effort was the award of a production contract for a monochrome (green) display for the F-16 aircraft. This paper reviews the ADM 6, a version of the basic MMM display which is functionally designated the Time Critical Display (TCD). The ADM 6, which features a 3 in. by 2 in. multi-color display surface of 32 pixels per inch, was developed in co-operation with Boeing Research. The displayed imagery is clearly legible in bright sunlight, having a contrast ratio of at least 3:1 in an ambient illumination of 10,000 foot-candles. Author

A84-16572#
TRI-SERVICE FLAT-PANEL DEVELOPMENT
W. G. MULLEY (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 394-401.
The objective, approach, and results of the Tri-Service Working Group of Aircraft Displays in the area of flat-panel displays are described. Six candidate technologies are being investigated for use in flat-panel development: thin-film electroluminescent technology, LED, liquid crystal, integral silicon drive, crossed electrode matrix, and varistor. Also considered is the development plan which calls for the following procurements: head-up display, helmet-mounted display, multipurpose/mission management display, mission management display/multifunction keyboard, and multifunction keyboard/discretes. B.J.

A84-16573
SPEECH TECHNOLOGY FOR AVIONIC COMPUTERS
G. MELLEN (Sperry Corp., St. Paul, MN) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 404-408.
Speech technology in the aviation environment is considered with attention given to the current state of the art, and previous and proposed applications. It is noted that Sperry Defense Systems Division is taking an integrated systems approach to provide speech capability in its avionic computers, entailing no size and minimum weight penalties. A 6 by 9 inch audio module has been developed which interfaces with the avionic computers over the Sperry Defense Systems standard bus. B.J.

A84-16574
THE COCKPIT VOICE ENTRY TRAIL - WHERE IS IT GOING?
R. H. POOL and H. G. KELLETT (Rockwell International Corp., Collins Avionics Div., Cedar Rapids, IA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 409-412.
The Collins Avionics Divisions of Rockwell International have been involved since 1979 in developing the technology for an acceptable Cockpit Voice Entry (CVE) system. What has been accomplished from 1979 to the present is described. A description of our CVE simulator is given, and the approach taken toward development of a speaker-independent, continuous speech recognition unit is discussed. The latter discussion includes a

description of a speaker normalizer concept along with normalizer test results, a description of the selected acoustic-phonetic recognition technique, and a description of the word recognition process employed. In addition, some of our concerns and some of our thoughts about the future are indicated. Author

A84-16576#
AUTOMATIC TARGET RECOGNIZER EVALUATION METHOD
R. JENNEWINE and S. SAWTELLE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 418-424.

This paper describes a first attempt to develop a method to evaluate Target Recognizer and algorithm performance. Target Recognizer efforts have been under development for several years and are currently being conducted in all three branches of the military as well as within industry. It is envisioned that the algorithm suites and hardware being developed will provide reasonable automatic target recognition performance levels, but, a baseline, universal method to evaluate the performance of current and future, more sophisticated, recognizers must be developed. It is anticipated that the method presented here will be built upon as more definitive methods are devised. Thus, an optimized universal procedure for testing Automatic Target Recognizers to determine their performance levels will evolve over a period of time. Author

A84-16608
B-1B CENTRAL INTEGRATED TEST SYSTEM OPTIMIZATION
D. E. PIERATT (USAF, Dayton, OH) and K. DERBYSHIRE (Rockwell International Corp., Los Angeles, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 646-650.

The B-1B Central Integrated Test System (CITS) is the on-board test system for the B-1B air vehicle and the avionics subsystems. The CITS operates continuously and automatically in flight and on the ground to display performance and faults to the aircrew. When a fault is detected, it is displayed on the CITS Control and Display Panel, printed on the CITS printer, and three snapshots of all CITS data parameters is recorded on magnetic tape for maintenance troubleshooting. The CITS performs preflight and postflight test automatically. Ground Readiness tests are conducted on individually selected subsystems at the request of the operator. This paper presents results of the optimization of the CITS developed for the B-1A aircraft for application to the B-1B, the implementation of the test system, and the planned use of CITS in an operational environment. Author

A84-16609
ADVANCED SYSTEM INTEGRATION DEMONSTRATIONS (ASID) FOR THE 1990S
E. A. ROSENKOETTER and R. C. BURNS (McDonnell Aircraft Co., Avionics Engineering Div., St. Louis, MO) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 651-658.
(Contract F33615-82-C-1904)

This paper discusses the avionics role and identifies the key issues associated with the Pave Pillar Advanced System Integration Demonstrations (ASID) System Definition Program. The objective of the ASID System Definition is to define the requirements and architecture for an avionic system and crew station which satisfy the severe mission requirements for the Air Force fighter/attack aircraft of the 1990s. The evolution of technologies over the past two decades is reviewed and the impact of microprocessors, VHSIC, artificial intelligence and standardization are related to the objectives of improving the lethality, survivability, availability and affordability. A hierarchical avionic system concept is presented which satisfies the objectives and takes full advantage of the emerging technologies. Author

A84-16612
RELIABILITY/LOGISTICS ANALYSIS TECHNIQUES FOR FAULT-TOLERANT ARCHITECTURES
M. H. VEATCH and A. B. CALVO (Analytic Sciences Corp., Reading, MA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 675-681. refs
(Contract F33615-82-C-0002)

This paper discusses Reliability and Logistics Support Analysis techniques and issues for Fault-tolerant avionic systems. These techniques are applicable to Integrated Communications, Navigation and Identification Avionics (ICNIA) architectures which are entering into the Advanced Development phase. They contain redundancy and dynamic reconfiguration elements as part of their fault-tolerant design. These system elements, combined with the reliability and logistics analysis needs during the early stages of development, pose unique modeling requirements. The techniques being developed by TASC are aimed at generating design criteria reflective of reliability and logistics support needs for systems during the early stages of design. Author

A84-16613
AN APPLICATION OF SIMULATION TO THE DESIGN FORMULATION OF A HELICOPTER INTEGRATED MULTIPLEX SYSTEM
W. A. WINDHAM (Harris Corp., Melbourne, FL) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 682-687.

Multi-tasking multi-processing systems design can be an extremely complex endeavor, particularly when the amply loaded system is being used for real-time execution of a large number of helicopter electronic subsystems including flight controls. Such a system is used in the Helicopter Integrated Multiplex System (IMS) under development by Harris for the Agusta A-129. A brassboard system has successfully completed flight tests on an Agusta A-109. Detailed knowledge of the intimate operations of such systems is needed early in their development to avoid potential major redesigns. A SLAM-based software simulation package which is sufficiently general and flexible to accommodate the various candidate system configurations was developed under IR&D to provide such information. It can model each system in sufficient detail to permit investigation of redundancy management, data staleness, shared memory contention and task timing. This simulation is described herein. Author

A84-16682#
FLIGHT MANAGEMENT FOR AIR-TO-SURFACE WEAPON DELIVERY
N. HUDSON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1340-1343.

Results obtained as of the end of 1982 in determining the cockpit configuration best suited to air-to-surface missions in the years 1990-1995 are reported. A total of 16 pilots evaluated the two basic designs. The goals of the evaluation were to determine pilot acceptability of reach and vision parameters and of the number, size and arrangement of displays and to evaluate the global display concept, multifunction keyboard concepts, and display content and formats. The pilots were talked through the mission scenario in a full scale wood and cardboard mock-up as they envisioned themselves executing the tasks called for in that particular stage of the mission. Data were collected from questions and answers during the time in the mock-up, from comments made by the pilots, and from written questionnaires. The data are now being used to validate the design approach, to identify areas that can be improved, and to produce the recommended configuration. C.R.

A84-16686

PERFORMANCE OF A FIVE-INCH BY FIVE-INCH VERY HIGH-RESOLUTION, FULL-COLOR AVIONIC CRT DISPLAY

J. ARMSTRONG and R. SPENCER (Sperry Corp., Sperry Flight Systems Div., Phoenix, AZ) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1373-1378.

A state-of-the-art, very high-resolution shadow-mask color display, designed expressly for military avionics, is described. The display accommodates either a newly designed very high-resolution CRT developed for this application in conjunction with Tektronix, Inc., or a Japanese CRT that incorporates conventional shadow-mask technology. The technology described is being applied in the F-15 aircraft under contract with MCAIR. An overview of the system is described, including modes and capabilities. Examples of presentations are given, including color stroke-generated maps. A comparison of color shadow-mask CRTs is made between the very high-resolution domestically manufactured Tektronix CRT and the conventional high-resolution color CRTs available from Japan for avionic applications. Discussion will cover resolution, brightness, color and filtering, Moirepatterns, and vibration hardening. Author

A84-16687#

FUTURE DEVELOPMENT TRENDS FOR HEAD-UP DISPLAYS

J. F. COONROD (USAF, Systems Avionics Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1379-1384. refs

The most important area of HUD design will continue to be the development of diffraction optics to provide the largest possible field of view (FOV). With larger FOVs, there will be greater demands on display resolution. Greater demands will also be placed on display brightness with the display of gray scale video. Significant improvements in reliability will also need to be made. The state of the art is surveyed, and improvements deemed possible in these areas are outlined. The two primary design approaches for attaining wide FOV diffraction optics HUD performance - the three element combiner and the single element combiner - are described. C.R.

A84-16698

LOCKHEED AIRBORNE DATA SYSTEM ADVANCES TEST TECHNOLOGY

J. A. TABB (Lockheed-Georgia Co., Engineering Test and Evaluation Div., Marietta, GA) Lockheed Horizons, no. 14, 1983, p. 12-18.

The Lockheed Airborne Data System (LADS) uses multiple microcomputers in a highly distributed configuration to control, verify, process, analyze, and display data in real time, on board the test aircraft. A data-collection technique called 'burst scan' makes on-board derivations of data from multiple-channels possible by virtually eliminating time skew and phase delays. All input modules are read simultaneously with an effective data rate greater than 2.7 million channels a second. The cost-effectiveness of LADS is supported by citing such under budget and under schedule programs as C-141B, C-5 Wing Mod, and numerous C-130 test programs. J.N.

A84-17414#

AIRFOIL PROBE FOR ANGLE-OF-ATTACK MEASUREMENT

P. J. HERMANN (Iowa State University of Science and Technology, Ames, IA), D. B. FINLEY (General Dynamics Corp., Fort Worth, TX), S. C. REHFELDT (McDonnell Douglas Astronautics Co., St. Louis, MO), and L. C. BENISHEK (McDonnell Douglas Technical Services Co., Houston, TX) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 87-89.

The design features and test results of the use of a small airfoil as an angle of attack sensing probe in low-speed low-dynamic pressure environments are presented. The probe consists of a small canard wing on the side of the fuselage with pressure sensing taps on the upper and lower surfaces in the forward 10 percent of the airfoil chord. Pressure differential transducers are connected to an on-board computer for digitized angle-of-attack data input to the flight computer and/or the cockpit display. Three pressure taps are included to permit the dynamic pressure analysis of sufficient sets of differential pressure signals. The device was tested in a wind tunnel on a NACA 0012 airfoil in four flows 93-130 ft/sec. Computed values were within 0.1 deg of set angles from -14.0 to 6.0 deg, and within 0.5 deg from -16.0 to 16.0 deg. Error sources were analyzed, and the probe was concluded to offer order of magnitude improvements for differential pressure coefficients available with hemispherical probes. M.S.K.

A84-17991*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

CLEAR AIR TURBULENCE AVOIDANCE USING AN AIRBORNE MICROWAVE RADIOMETER

B. L. GARY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p.
(AIAA PAPER 84-0273)

The avoidance of Clear Air Turbulence (CAT) is theoretically possible by selecting flight levels that are a safe distance from the tropopause and inversion layers. These favored sites for CAT generation can be located by an 'airborne microwave radiometer' (AMR) passive sensor system that measures altitude temperature profiles. A flight evaluation of the AMR sensor shows that most CAT could be avoided by following sensor-based advisories. Some limitations still exist for any hypothetical use of the sensor. The principal need is to augment the sensor's 'where' advisories to include useful 'when' forecasts. Author

A84-18043*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AIRBORNE INFRARED LOW LEVEL WIND SHEAR PREDICTOR

P. M. KUHN (NASA, Ames Research Center; Northrop Services, Inc., Moffett Field, CA) and R. L. KURKOWSKI (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(Contract NAS2-10592)
(AIAA PAPER 84-0356)

The operating principles and test performance of an airborne IR (13-16 micron) temperature-sensing detection and warning system for low-level wind shear (LLWS) are presented. The physics of LLWS phenomena and of the IR radiometer are introduced. The cold density-current outflow or gust front related to LLWS is observed in the IR spectrum of CO_2 by a radiometer with + or - 0.5-C accuracy at 0.5-Hz sampling rate; LLWS alerts are given on the basis of specific criteria. Test results from the JAWS experiments conducted at Denver in July 1982, are presented graphically and discussed. The feasibility of the passive IR system is demonstrated, with an average warning time of 51 sec, corresponding to a distance from touchdown of about 2 miles. D.G.

A84-18375#

VISUAL AIDS FOR FUTURE HELICOPTERS

H.-D. V. BOEHM and R.-D. V. RETH (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Associazione Industrie Aerospaziali and Associazione Italiana di Aeronautica e Astronautica, European Rotorcraft Forum, 9th, Stresa, Italy, Sept. 13-15, 1983, Paper. 20 p. refs

The Pilot Visionics System (PVS) recently tested aboard an MBB-Bo 105 helicopter comprises a Helmet Mounted Sight/Display (HMS/D), a stabilized, steerable platform with a wide field-of-view Forward Looking IR (FLIR) sensor, and a Low Light Level TV (LLLTV) camera. These were compared with a Head-down Display system. The FLIR and LLLTV images could be alternately displayed to allow direct comparison during flight tests. More recently, the steerable platform FLIR system whose German designation is 'Piloten Infrarot Sicht-Anlage' (PISA) was tested. Attention is presently given to major results of the PVS and PISA flight trials. The FLIR is found to generally give a better image when directly compared with the LLLTV camera. The effectiveness of night vision goggles is confirmed, even by comparison with complex systems using FLIR, HMS/D, and separate display equipment. O.C.

A84-18515#
INSTRUMENTATION DESIGN TRADE-OFFS FOR THE AIRBORNE CHARACTERIZATION OF LIGHTNING
J. E. NANEVICZ and E. F. VANCE (SRI International, Menlo Park, CA) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. A12-1 to A12-8. refs

This paper discusses the various considerations associated with the design of sensors and instrumentation suitable for the airborne measurement of the broadband electromagnetic characteristics of lightning. Where appropriate, the approaches followed in various airborne experiments are indicated. Author

N84-14140# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
FIXED-BASE SIMULATOR INVESTIGATION OF DISPLAY/SCAS REQUIREMENTS FOR ARMY HELICOPTER LOW-SPEED TASKS
D. CARICO, C. L. BLANKEN, C. C. BIVENS, and P. M. MORRIS 1983 21 p Presented at the 39th Ann. Forum of the Am. Helicopter Soc., St. Louis, 9-11 May 1983
(AD-A134123) Avail: NTIS HCA02/MFA01 CSCL 01D

A piloted simulation was conducted to investigate the effect of presenting flight symbology on a panel mounted display (PMD) versus a head up display (HUD) for different levels of augmentation and turbulence while performing low speed tasks representative of the scout helicopter mission. A secondary objective was to investigate the advantages of using a collective kinesthetic tactual display (KTD) for altitude control during a precision hover task. The results show that the display symbology from either the HUD or PMD improved the pilot ratings for low levels of augmentation. The KTD helped the pilot reduce altitude drift during the precision hover task for the low to mid augmentation levels, but it had little effect on pilot ratings. GRA

N84-14141# Rockwell International Corp., Columbus, Ohio. Applied Research Dept.
FLIGHT EVALUATION OF A LINEAR OPTICAL DISPLACEMENT TRANSDUCER Final Report, Jun. 1982 - May 1983
E. J. SOLOMON Indianapolis, Ind. Naval Avionics Center May 1983 127 p
(Contract N00163-82-C-0232)
(AD-A132638; NR83H-20; NAC-TR-2329) Avail: NTIS HCA07/MFA01 CSCL 01D

The flight demonstration and evaluation of the operation of the MIL-T-85289 Linear Optical Displacement Transducer (LODT) as an active sensing unit of the Advanced Flight Control Actuation System in a T-2C aircraft were successfully accomplished. The test installation contained a LODT as the rudder position feedback device, fiber optic link, computer interface unit, microcomputer, direct-drive rudder actuator, electronic drive unit, force transducers, and a localized 8000 PSI (55 MPa) hydraulic supply. The system met all laboratory and flight test objectives and demonstrated that the LODT represents a viable approach to EMI immunity in advanced aircraft control systems. Author (GRA)

N84-15035# General Dynamics Corp., Fort Worth, Tex. Avionic Systems Dept.
SYSTEM ARCHITECTURE: KEY TO FUTURE AVIONICS CAPABILITIES
G. R. ENGLAND *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 6 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Modern aircraft still rely, as old World War II aircraft, upon the pilot or crew for integration of information from diverse discrete subsystems, sensors and weapons. During this long period of technology time, each generation of systems has generally become more complex and increased the quantity and rate of information to the crew. In many weapon system implementations these two factors have resulted in increased problems in the areas of system availability, affordability, supportability and operability. Although the F-16 has broken this trend it is still evident that new system architectures will be needed as mission requirements in the future create added system demands. Traditional avionic design, support and operability approaches will be unable to cope. The size reduction and performance improvements resulting from large scale and high speed integrated circuits will make it possible to restructure the way avionics systems are designed. For example, standard modules for multiuse applications are possible. These modules become the building blocks for a new type of system architecture. Advanced data switching communication techniques provides the necessary data transfer rates to support sensor fusion, cockpit automation, and fault tolerant processing. Generic signal processors make shared functions realizable. Author

N84-15036# Westinghouse Electric Corp., Baltimore, Md. Defense and Electronics Center.
TACTICAL REQUIREMENTS IMPACT ON AVIONICS/WEAPON SYSTEM DESIGN
T. E. SPINK and J. F. PATTON *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 15 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

The complexity of tactical weapon delivery was greatly increased by the advent of new weapons, the enormity of enemy defenses and the awesome capability of new digital technology. However, careful assessment of the tactical requirements becomes even more important if a truly effective marriage of airframe, avionics and weapons is to be achieved. A review of a typical tactical mission requirement, battlefield interdiction, establishes a base for derivation of functional requirements on which an integrated attack system architecture is designed. The result is a need for a multisensor, multimode capability functionally integrated to achieve the flexibility required by the mission. Author

N84-15037# Northrop Corp., Hawthorne, Calif. Aircraft Div.
OPERATIONAL READINESS AND ITS IMPACT ON FIGHTER AVIONICS SYSTEM DESIGN
J. F. IRWIN *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 11 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Operational Readiness (OR) is a widely used term that covers various aspects of availability, maintainability, reliability and testability. Just as the development of avionic systems require the establishment of system engineering, software design and interface management guidelines, the same requirement exists for the world of operational readiness. These OR guidelines include the following controllable elements: design for testability (DFT), operational fault tolerance, system diagnostic reconfiguration, post flight data extraction/analysis, and integrated test and maintenance. Design and Acquisition of systems and prime electronic equipment must account for early consideration of testability and automatic test design requirements. Testability factors influence all phases of design, integration, deployment and support of electronic equipment and will adversely impact weapon system availability and ultimate return on investment if improperly specified and implemented. The major goals of fault tolerant systems are increased weapon systems availability, mission survivability, and an affordable life cycle cost. Widespread acceptance of operational readiness objectives will probably be predicated on the demonstrated life cycle cost of those initial aircraft containing fault tolerant systems. A managerial and technical roadmap for accomplishing the desired operational readiness goals in the next generation fighter is provided. The contribution of the various attributes (including testability, avionic architecture, fault tolerant designs, BIT, standardization and operational readiness control) is provided. Author

N84-15038# Naval Weapons Center, China Lake, Calif. Weapons and Tactics Analysis Center.
AVIONICS CONCEPT EVALUATION AT THE FORCE LEVEL
M. CARTWRIGHT and T. HAVEN *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 7 p Oct. 1983
Avail: NTIS HC A21/MF A01

The development of new avionics systems should be guided and supported by force level analysis. Evaluation at the force level is necessary in order to assure that a concept, as it is conceived and developed, will indeed provide a significant increase in capability when the resulting weapon system is used in an operational environment. The Weapons and Tactics Analysis Center (WEPTAC) at the Naval Weapons Center is a war gaming facility for doing force level analysis. It is used to evaluate weapon systems and tactics as they would be employed in realistic scenarios involving opposing forces. It provides a valuable tool, therefore, for the evaluation of avionics concepts. The importance of force level analysis in avionics system development, describes the WEPTAC facility, and gives an example of the use of WEPTAC to evaluate an avionics concept is discussed. Author

N84-15042# Naval Air Development Center, Warminster, Pa.
AVIONICS/CREW STATION INTEGRATION
W. G. MULLEY *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 9 p Oct. 1983
Avail: NTIS HC A21/MF A01

Advanced development concepts aimed at increasing the aircraft instrumentation performance for multiplatform applications of 1990's weapons systems are discussed. The objectives of these three areas are as follows: the system integration objectives are to produce a system architecture easily adaptable to many platforms; technology objectives are to determine the state of the art for displays, electronics, and controls; and the human factors objectives are to determine the proper human machine interfaces so that the ultimate crew station will be capable of providing the pilot with the proper display and controls performance to satisfy the diverse requirements of a fighter, attack, ASW, fixed wing, rotary wing, and V/STOL platforms in both a one man crew or two man crew matrix. All data/control interface among units of this crew station system and other platform subsystems are via digital data buses and video multiplex buses. No individual discrete signal, data, or control lines are needed. The six interfaces necessary to ensure the optimum development of this crew station, the predicted platform mission improvements, and the requisite life cycle cost considerations are discussed. This concept serves as a basis for planning the integration of the necessary hardware and software features in current and future weapons systems.
Author

N84-15043# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
COMBINED VISUALIZATION [LE COMBINE DE VISUALISATION]
B. SIMON *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 In FRENCH
Avail: NTIS HC A21/MF A01

Combined visualization corresponds to a mechanical ensemble uniquely regrouping a head up display and a head down display. The head up imagery is collimated and the head down imagery is either collimated or focalized on a fixed plane. Such a system permits a diversity of uses: (1) extending the visual field downward when the head down visualization is collimated; (2) reducing the head up symbology by a better division on the entire screen when the head down visualization is collimated; and (3) when the head down visualization is focalized at a fixed distance, it can be associated with another head down screen. A.R.H.

N84-15044# Bundesamt fuer Wehrtechnik und Beschaffung, Koblenz (West Germany).
GUIDELINES AND CRITERIA FOR THE FUNCTIONAL INTEGRATION OF AVIONIC SYSTEMS WITH CREW MEMBERS IN COMMAND
F. W. BROECKER *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 12 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Significant technical hardware advances were made during the past few years in digital-micro-technology that have caused problems of how to handle and how to use their great potential for the best benefit of designing a distinctly better system and working environment for the crew member in order to make him a real functional member of the system. Such a good approximation to a real functional integration of technical means and human beings seems to be the only promising way for a distinct improvement of weapon system effectiveness. Although the human member of the airborne system has not made at all comparable performance advances, he is increasingly used in a Superman role, required to integrate and monitor most of the subsystem, and thereby to compensate for the shortcomings and discrepancies of the total weapon system. Last but not least the primary job is to perform a mission in hostile environment. Author

N84-15047# Northrop Corp., Hawthorne, Calif. Aircraft Div.
TOWARDS THE FUNCTIONAL PARTITIONING OF HIGHLY INTEGRATED, FAULT TOLERANT AVIONICS SIGNAL PROCESSORS
J. A. REY *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 12 p Oct. 1983
Avail: NTIS HC A21/MF A01

Avionics systems for new interdiction fighter aircraft require a high degree of integration, translated into automation for crew operations, of such formerly diverse subsystems of penetration, target acquisition, weapon delivery, threat detection and suppression and flight/propulsion control. Also coupled into this is the infusion of VHSIC/VSLIC. All this implies the need for a fault tolerant system to ensure flight safety and high operational ability. Some of the partitioning (configuration) issues involved in the integration process are discussed. Specifically, the issues involved with the functional partitioning into "generic" high speed signal processors and how this partitioning will cross some of the traditional interfaces between such things as flight control systems and avionics systems and subsystems within the avionic suite are addressed. Of special interest is the partitioning for sensor blending/data fusion/hi-speed data buses as pertains to terrain following/terrain avoidance function and how the critical path computations are made fault tolerant and/or allow for graceful degradation so that flight/mission safety is assured. Also discussed are the methods for computing reliability values based on these new configurations so that fault tolerant evaluations methods, such as the Markov process, may more realistically be computed.
Author

N84-15048# McDonnell Aircraft Co., St. Louis, Mo.
ADVANCED F/A-18 AVIONICS
R. C. DRUMMOND and J. L. LOOPER *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 13 p Oct. 1983
Avail: NTIS HC A21/MF A01

The F/A-18 Hornet is a single seat, twin engine aircraft designed to fulfill fighter and light attack roles for the United States Navy and Marine Corps, and is being purchased by Canada, Australia and Spain. It has a very capable multimission weapon system, integrated so a single pilot can perform both fighter and attack missions. The challenge of multimission capability is to provide the necessary weapon system elements for effective air-to-air and air-to-surface weapons delivery without requiring a major flight line change each time the aircraft is reconfigured with armament. The answers for the multimission Hornet are digital technology and extensive system integration. High reliability, large scale integrated circuits and microprocessors are employed throughout the digital avionics suite. Integration among avionic subsystems is accomplished over the MIL-STD-1553A dual digital multiplex bus under control of two mission computers. The Hornet has significant growth potential in addition to its present capabilities. Growth capacity includes spare computer memory, electrical power, cooling air and physical space. Author

N84-15050# British Aerospace Aircraft Group, Brough (England). Avionics Development Engineering Dept.
TECHNIQUES FOR INTERBUS COMMUNICATION IN A MULTIBUS AVIONIC SYSTEM
W. H. HALL *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

While studying the design of total aircraft systems using MIL-STD-1533 Data Buses the need for interbus communication protocols in multibus architectures was established. Two types of interbus communication were identified as necessary; cyclic message transfer and acryclic message transfers. Cyclic messages are handled by assigning specific subaddresses in the bus controller remote terminals which receive and pass on these messages to the appropriate destination on a cyclic basis as preprogrammed in the relevant bus controllers. Acyclic messages are handled by a special protocol based on the use of the service request bit in the status word, the transmit vector word mode code, a specially formulated vector word, special data words which are used as interbus transmit and interbus receive command words, together with the use of reserved subaddresses, one for each bus on the network. This protocol is explained in detail together with the measures taken in the subsystem to remote terminal interface to ensure orderly transmission of data and effective error recovery with lost or corrupt messages. Author

N84-15052# Air Force Avionics Lab., Wright-Patterson AFB, Ohio.
NETWORK COMMUNICATIONS FOR A DISTRIBUTED AVIONICS SYSTEM
J. C. OSTGAARD and D. A. ZANN *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Due to the postulated 1990's threat environment advanced avionics architectures are experiencing demands for increased performance which have led, in part, to increased processing requirements and system complexity. As more processors are added to the control environment of sophisticated military aircraft, the choice of processor interconnection topology and methodology assumes greater importance. This choice profoundly influences information throughput, reliability, survivability and integrity throughout the weapon system. The ability to rapidly exchange/transfer information among processors and devices is critical if one is to develop a reliable, effective, communication system. Basic communication techniques which could serve as candidates in satisfying the network communication requirements of an advanced avionics architecture are addressed. Features of each technique are examined to ascertain the performance of these multi-access protocols in terms of developed system-driven criteria. Author

N84-15053# McDonnell Aircraft Co., St. Louis, Mo.
AVIONICS FAULT TREE ANALYZER
M. E. HARRIS *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 15 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

McDonnell Douglas' F/A-18 aircraft allows use of a man-portable, microprocessor controlled, ground based test set to isolate avionic failures to the electronic card or shop replaceable assembly (SRA). Through a single existing connector on the aircraft, this Avionics Fault Tree Analyzer (AFTA) communicates, exercises, interrogates, and diagnoses the avionic subsystems. There are many instances when the AFTA not only isolates faults in the electronics but also in the aircraft wiring. Largely due to the truly distributive processing architecture of the aircraft and the modular design of the avionics, fault detection and isolation well beyond the weapon replaceable assembly (WRA) is achieved within milliseconds. Avionics as sophisticated as the flight control system, RADAR, and the stores management system are supported quickly and efficiently with electronics card replacement without intermediate level ground support facilities. The AFTA is currently a ground based device; however, the AFTA function will be incorporated in future aircraft. M.G.

N84-15057# British Aerospace Public Ltd. Co., Preston (England).
CASCADE: A DESIGN ENVIRONMENT FOR FUTURE AVIONIC SYSTEMS
A. O. WARD *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 18 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

The design and development environment for software has grown from the basic needs of assembler to the wider requirements of higher order languages. The use of the latter has also witnessed a growing, but disparate, use of tools associated with the design process. Language standardization has presented the opportunity to produce powerful software development environments. Integrity and cost requirements will dictate the introduction of formal verification techniques to all levels of design and implementation. The use of VLSI/VHSIC technology and beyond will allow the designer to specify components and hence the design environment should be integrated with relevant CAD tools. These prospects are discussed and illustrated using a model of a Comprehensive Avionic System Computing Analysis and Design Environment, (CASCADE). Those features of CASCADE which exist today are described and its progress is charted in the medium and long term. Author

N84-15058# British Aerospace Public Ltd. Co., Preston (England). Aircraft Group.
A PRACTICAL APPROACH TO THE DESIGN OF A NEW AVIONIC SYSTEM
P. A. DUKE *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 11 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

A program to design, construct and demonstrate an advanced avionic system for the next generation of tactical combat aircraft is described. The program has the prime objective of reducing the development risks associated with the rapid advance of technology. A number of factors contribute to this risk, notably the dramatic increase in system capability made possible by the general availability of LSI and VLSI circuitry. Traditionally independent systems can be linked using a data bus to provide a fully integrated system with the pilots needs foremost in mind. The system is based on a multi bus architecture recognizing the differing integrity requirements of different parts of the system. The avionic systems are linked to an advanced cockpit, with the objective of reducing pilot workload. The cockpit makes use of multi-purpose displays and an integrated approach to system control. A display of the out of cockpit scene is provided to allow the 'pilot' to operate the controls in a realistic manner and so provide representative input to the avionic system. The development is based on an evolutionary approach through a series of readily identifiable intermediate stages. Configuration control, procurement and management techniques are being developed in parallel with the avionic system itself. M.G.

N84-15059# General Dynamics Corp., Fort Worth, Tex.
INTEGRATION OF ICNIA INTO ADVANCED HIGH PERFORMANCE FIGHTER AIRCRAFT
E. R. CONRAD *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 8 p Oct. 1983
Avail: NTIS HC A21/MF A01

The incorporation of an integrated communications, navigation and identification avionics (ICNIA) system into modern high performance fighter aircraft is examined. To illustrate ICNIA interface with aircraft two types of avionics suites are considered. The first is an aircraft without an avionics multiplex interface, representing the older aircraft in service today. The second is an aircraft avionics suite with a dual multiplex bus interface such as is being designed today. M.G.

N84-15061# General Dynamics Corp., Fort Worth, Tex.
COLOR DISPLAY TECHNOLOGY IN ADVANCED FIGHTER COCKPITS
K. E. GROSGEBAUER, W. J. WILDMAN, and J. A. DAVIS *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 8 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

Over the past four years, the use of color-display technology in military aircraft has received a significant amount of attention; to date, the question of how to use color effectively has not been answered. With high-quality color cathode ray tubes (CRTs) now being manufactured in the United States, Japan, France, and England, additional questions concerning the display performance requirements need to be answered prior to their introduction into the fighter cockpit. Weapon systems of today and those planned for the near term demand more effort from the pilot. A judicious application of color displays is considered to be one of the perequisites to overcome this additional workload. The selection process being applied to available color display technology, the flight simulator evaluations and some of the uses of color displays are discussed. As a result of simulator evaluations, future work will be directed toward optimizing color CRT technology and the use of color displays in the cockpit of advanced fighter/attack aircraft. Author

N84-15062# Aeritalia S.p.A., Caselle Torinese (Italy). Gruppo Sistemi Avionici ed Equipaggiamenti.
CRITICAL FACTORS AND OPERATIONAL RESEARCH IN TACTICAL FIGHTER AVIONIC SYSTEM DEVELOPMENT
L. BERADI *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 13 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

The problem to design and to develop a complex system as a multiobjective optimization problem is considered. The avionic system of a tactical fighter is illustrated; assumptions and objectives of the project are listed. An approach to the problem that uses operations research tool and techniques, multiobjectives and marginal substitution rate functions is described. The method applied to the design and development of a tactical fighter avionic system is outlined. The expected characteristics, and the impact of implanned events on the system development are pointed out. Possible critical factors in the development process are emphasized by computation of the Marginal Substitution Rates. The operational mission software development for the avionic system is shown with attention to critical factors individuation. E.A.K.

N84-15065# Elektronik-System G.m.b.H., Munich (West Germany).
CADAS: A COMPUTER AIDED DESIGN TOOL FOR AVIONIC SYSTEMS
M. BURFORD, R. COPE, and H. SCHNEEWEISS *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

The development of CADAS - a computer aided design tool for avionic systems is outlined. Prior to outlining the basic concepts behind CADAS, an overview of present methods for validating software is presented. These concepts illustrate how certain key elements, such as the events language, the automatic generation and inclusion of models etc. were implemented. The objectives still to be achieved are presented. The need of such a general tool as a basic component of the programming support environment for embedded software is presented. E.A.K.

N84-15067*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DESIGN, DEVELOPMENT AND FLIGHT TEST OF A DEMONSTRATION ADVANCED AVIONICS SYSTEM
D. G. DENERY, G. P. CALLAS, G. H. HARDY, and W. NEDELL *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01 CSCL 01D

The design of integrated avionics suitable for general aviation was examined. The program emphasizes the use of data busing, distributed microprocessors, shared electronic displays and data entry devices, and improved functional capability. Design considerations includes cost, reliability, maintainability, and modularity. A demonstration advanced avionics system (DAAS) was designed, built, and flight tested in a Cessna 402, twin engine, general aviation aircraft. The DAAS, and the system architecture are described. E.A.K.

N84-15071# British Aerospace Public Ltd. Co., Preston (England).
HARDWARE-IN-THE-LOOP SIMULATION TECHNIQUES USED IN THE DEVELOPMENT OF THE SEA HARRIER AVIONIC SYSTEM
M. MANSELL, W. J. QUINN, and C. J. SMITH *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 17 p Oct. 1983
Avail: NTIS HC A21/MF A01

The use of simulation utilizing airborne hardware in the loop during the development of avionic systems is described. Each new weapon system, however, produces a different set of problems that usually requires a change of technique to satisfy the test requirements for the system. The Sea Harrier avionic system and the techniques used by British Aerospace in the development of this system are described. The special to type interfaces required to drive the forward looking radar, navigation system automatic flight control and HUD/weapon aiming computer are described. E.A.K.

N84-15072# Northrop Corp., Hawthorne, Calif. Aircraft Div.
SIMULATION REQUIREMENTS TO SUPPORT THE DEVELOPMENT OF A FAULT TOLERANT AVIONIC SYSTEM
J. SHAW *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 11 p Oct. 1983
Avail: NTIS HC A21/MF A01

The simulation package which was designed to support the development of fault tolerant avionic systems is presented. The Executive Support System, ESS, package which is presently used as a development, test and verification tool for F-5G and F-18L avionics models is described. The ESS provides an avionics system designer with a mechanism for developing and testing several avionic core configurations and develop avionic simulation and application modules. E.A.K.

N84-15075# British Aerospace Public Ltd. Co., Preston (England). Aircraft Group.
A DYNAMIC APPROACH TO MILITARY AVIONICS SYSTEMS TESTING
R. A. C. SMITH *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 9 p Oct. 1983
Avail: NTIS HC A21/MF A01

Avionic systems development testing is outlined. The preflight ground test philosophy is based on the construction of an avionics systems development rig. The rig testing techniques were changed as the avionics systems increased in complexity and influence throughout the aircraft. The techniques presently employed are made possible due to two main factors: (1) the adoption of an integrated approach towards the use of and interaction between the avionics rig and other development facilities; (2) an increase in the use of computing for the data acquisition and simulation tasks. This has resulted in a shift in emphasis from static to dynamic system testing and the avionics development rig for the Tornado F Mk 2 is capable of simulating flight. It is possible to exercise the avionics systems throughout the aircraft mission envelope on the rig before flight testing begins. The dynamic testing technique and its advantages form the basis for the Torndao F Mk 2 avionics rig facility and its operation. E.A.K.

N84-15098# British Aerospace Public Ltd. Co., Godalming (England).
MODERN FLIGHT INSTRUMENT DISPLAYS AS A MAJOR MILITARY AVIATION FLIGHT SAFETY WEAKNESS
J. F. FARLEY *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 3 p Oct. 1983
Avail: NTIS HC A15/MF A01

Consideration of the major causes of flying accidents over which the airframe and engine manufacturers can exert a powerful influence shows the following list: structural failure, engine failure, flying control failure, instrument failure, and pilot error. With the first three of these causes, Structural, Engine and Flying Control failures, while mistakes do occur, the manufacturers have a reasonable record, there is no evidence of complacency, and in addition there is a large well established, government controlled, national bureaucracy offering valuable checks and advice on testing and airworthiness certification. Pilot error in different, but appropriate ways, also attracts much effort aimed at its reduction. Most importantly, so far as the purposes of this paper are concerned, the accident trends related to the first three causes, as well as those due to pilot error, do not appear to have changed fundamentally during the last decade. The same cannot be said of instrument display related accidents. Since the advent of Head Up and computed displays in general, and the operator's real need to expand the non-visual maneuver envelope, there has been a marked increase in display related accidents/incidents in both operational and development flying. This note suggests that attempts at curing the problem have been based on a false assumption that has ignored the reality of the piloting task in modern high performance jet aircraft. Proposals are offered to improve the situation by both engineering and organizational changes. Author

N84-15150# Battelle Columbus Labs., Ohio.
VALIDATION OF DIGITAL SYSTEMS IN AVIONICS AND FLIGHT CONTROL APPLICATIONS HANDBOOK, VOLUME 1 Draft Report, Jun. 1981 - Jul. 1982
E. F. HITT, J. WEBB, C. LUCIUS, M. S. BRIDGMAN, and D. ELDREDGE Jul. 1983 356 p
(Contract DTFA03-81-C-00059)
(AD-A133222; FAA-CT-82-115-VOL-1) Avail: NTIS HCA16/MFA01 CSCL 01C

The purpose of this handbook is to identify techniques, methodologies, tools, and procedures in a systems context that may be applicable to aspects of the validation and certification of digital systems at specific times in the development and certification portion of the system life cycle. The application of these techniques in the development of discrete units and/or systems will result in a completion of a product or system which is verifiable and can be validated in the context of the existing regulations/orders for the government regulatory agencies. The handbook uses a systems engineering approach to the integration and testing of software and hardware during the design, development, and implementation phases. The handbook also recognizes and provides for the evaluation of the pilot's workload and utilization of the new control/display technologies, especially when crew recognition and intervention may be necessary to cope with/recover from the effects of faults or failures in the digital systems. In summary, the handbook: (1) Identifies and presents the issues related to design, development, and implementation of software based digital systems; (2) identifies specific approaches applicable to all aspects of the verification and validation procedures, at specific times in the development and certification portion of the system life cycle, (3) provides the government regulatory agencies (especially the Federal Aviation Administration (FAA) as well as the industry with a set of tools/procedures, in a systems engineering context which may be of value in the validation/certification process. GRA

07

AIRCRAFT PROPULSION AND POWER

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

A84-16527
ADVANCED ELECTRIC POWER SYSTEMS FOR ALL ELECTRIC AIRCRAFT
M. J. CRONIN (Lockheed-California Co., Burbank, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 42-52. refs

The paper examines the changes associated with the replacement of multiple power systems now in conventional aircraft and considers the loads for the impact on the performance, weight, and development/supporting costs of the all electric aircraft (AEA). It is emphasized that the AEA entails electric power generation systems and electric load utilization systems that are markedly different from present aircraft systems which utilize engine bleed air, hydraulics, pneumatics, and conventional electrics. It has been suggested that it is possible to capture some 60 to 70 percent of the benefits of the AEA by the adoption of electric (engine) start and electric air conditioning/thrust reversing systems. The movement toward digital management/processing, and the development of digital electric/avionic equipment (e.g., VHSIC) are considered significant trends. B.J.

A84-16528* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ADVANCED ELECTRICAL POWER SYSTEM TECHNOLOGY FOR THE ALL ELECTRIC AIRCRAFT
R. C. FINKE and G. R. SUNDBERG (NASA, Lewis Research Center, Cleveland, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 53-55.

The application of advanced electric power system technology to an all electric airplane results in an estimated reduction of the total takeoff gross weight of over 23,000 pounds for a large airplane. This will result in a 5 to 10 percent reduction in direct operating costs (DOC). Critical to this savings is the basic electrical power system component technology. These advanced electrical power components will provide a solid foundation for the materials, devices, circuits, and subsystems needed to satisfy the unique requirements of advanced all electric aircraft power systems. The program for the development of advanced electrical power component technology is described. The program is divided into five generic areas: semiconductor devices (transistors, thyristors, and diodes); conductors (materials and transmission lines); dielectrics; magnetic devices; and load management devices. Examples of progress in each of the five areas are discussed. Bipolar power transistors up to 1000 V at 100 A with a gain of 10 and a 0.5 microsec rise and fall time are presented. A class of semiconductor devices with a possibility of switching up to 100 kV is described. Solid state power controllers for load management at 120 to 1000 V and power levels to 25 kW were developed along with a 25 kW, 20 kHz transformer weighing only 3.2 kg. Previously announced in STAR as N83-24764 Author

A84-16535#
ELECTRICALLY COMPENSATED AIRCRAFT ALTERNATOR DRIVE
J. J. CATHEY (Kentucky, University, Lexington, KY) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 116-122. refs
(Contract F49620-82-C-0035)

Feasibility and concept of designing a suitable constant speed aircraft alternator drive utilizing a mechanical differential in conjunction with an electric drive speed compensation link is examined. Constant speed is maintained through proper clockwise or counter-clockwise rotation of the differential carrier housing by the electric drive. Full speed range bidirectional power flow in this compensation link is accomplished by use of permanent-magnet machines interconnected by a cycloconverter. One machine is controlled as a brushless dc machine while the other functions as a variable-speed, variable-voltage synchronous machine. This paper presents for the first time analysis of bidirectional power flow through a cycloconverter supplied by a variable-voltage, variable-frequency source. A block diagram is developed for a microprocessor-based control of the electrical compensating drive system. Author

A84-16536
IMPLEMENTING MICROPROCESSOR TECHNOLOGY IN AIRCRAFT ELECTRICAL POWER GENERATING SYSTEM CONTROL
S. LORENZ, B. MEHL, and G. RUFFNER (Sundstrand Corp., Advanced Technology Group, Rockford, IL) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 123-134. refs

Today's advanced aircraft electrical power generating systems rely on microprocessor technology for the implementation of most control, protection, and built-in test functions. Microprocessors offer distinct advantages over discrete logic devices in system design and performance. The first half of this paper highlights these advantages by illustrating the design implementation process used in current systems. The second half of the paper expands on these advantages. By adapting more advanced microprocessor systems in the next generation of aircraft electric systems, additional functions can be implemented. Microprocessor control of generator paralleling and voltage regulation coupled with more effective built-in test capabilities will result in significant improvements in system performance. Author

A84-16537
HV POWER SUPPLY MANUFACTURING IMPROVEMENT
W. G. DUNBAR (Boeing Aerospace Co., Seattle, WA) and H. STEARNS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 135-141. refs
(Contract F33615-80-C-5171)

Modifications to high-voltage power supplies are made continually to increase MTBF and decrease maintenance and life cycle cost. A program devoted to HV power supply manufacturing improvement is described, the power supplies selected for modifications being those with known marginal MTBF in service. Improvement was achieved through packaging to relieve electrical stresses, selecting long-life parts, and selecting a void-free insulation to eliminate corona effects and eventual voltage breakdown. Electrical stresses were reduced by solder-balling terminations and connections and by properly spacing HV and LV parts. B.J.

A84-16684
A NOVEL FUEL CONSERVATION SYSTEM APPROACH FOR TODAY'S TRANSPORT AIRCRAFT
J. E. MINNEAR (AiResearch Manufacturing Company of California, Torrance, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1352-1357.

The AiResearch engine power trim system (EPTS) uses a new approach to fuel conservation in which a power trimming mechanism was designed specifically for implementing the fuel saving function. The airborne system hardware, software, and interfaces are minimized by partitioning fuel saving functions between airborne and ground-based computers, thereby reducing acquisition, installation, and maintenance costs. The system was certified on a Boeing 727-200 aircraft. A 1.5 to 2 percent reduction in total fuel consumption is anticipated using this system. Power trimming is achieved by the use of a throttle control gearbox (TCGB) mounted in close proximity to the engine, thereby providing extremely precise engine power control. This approach eliminates both the hysteresis effects of the airplane throttle cable/pulley system and the need for additional hardware such as clutch packs or redundancy to achieve fail-safe operation. Author

A84-16964
A PROBABILITY STUDY OF THE FATIGUE LIFE OF THE COMPRESSOR BLADES OF GAS-TURBINE ENGINES [OTSENKA USTALOSTNOI ZHIVUCHESTI KOMPRESSORNYKH LOPATOK GTD V VEROIATNOSTNOM ASPEKTE]
A. V. PROKOPENKO and M. V. BAUMSHTEIN (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Nov. 1983, p. 74-76. In Russian. refs

A method based on statistical procedures has been developed for determining the acceptable limits of the fatigue life of structures. The method is demonstrated for standard prismatic specimens with a crack and compressor blades of 14Kh17N2 steel tested under conditions of vibrational bending. The experimentally determined fatigue lives are found to lie within the tolerance limits calculated from test results. V.L.

A84-16971*# Curtiss-Wright Corp., Wood-Ridge, N.J.
MULTI-FUEL ROTARY ENGINE FOR GENERAL AVIATION AIRCRAFT
C. JONES (Curtiss-Wright Corp., Woodbridge, NJ), D. R. ELLIS (Cessna Aircraft Co., Wichita, KS), and P. R. MENG (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 19th, Seattle, WA, June 27-29, 1983
(AIAA PAPER 83-1340)

Design studies of advanced multifuel general aviation and commuter aircraft rotary stratified charge engines are summarized. Conceptual design studies were performed at two levels of technology, an advanced general aviation engines sized to provide 186/250 shaft kW/hp under cruise conditions at 7620 (25,000 m/ft) altitude. A follow on study extended the results to larger (2500 hp max.) engine sizes suitable for applications such as commuter transports and helicopters. The study engine designs were derived from relevant engine development background including both prior and recent engine test results using direct injected unthrottled rotary engine technology. Aircraft studies, using these resultant growth engines, define anticipated system effects of the performance and power density improvements for both single engine and twin engine airplanes. The calculated results indicate superior system performance and 27 to 33 percent fuel economy improvement for the rotary engine airplanes as compared to equivalent airframe concept designs with current baseline engines. The research and technology activities required to attain the projected engine performance levels are also discussed. Previously announced in STAR as N83-18910 S.L.

A84-17015
CIVILIAN-AIRCRAFT ENGINES - BATTLE AT TEN TONS [MOTEURS CIVILS - BATAILLE AUTOUR DU 'DIX TONNES']
J. MORISSET Air et Cosmos (ISSN 0044-6971), vol. 21, Dec. 3, 1983, p. 23, 24, 25, 29, 30. In French.

The characteristics and development status of CFM International's CFM-56-4-A1, and the new IAE consortium's V-2500 jet engines are compared in the light of the upcoming announcement of the development schedule for the planned A-320 150-passenger aircraft to which they will be applicable. Both engines are designed to deliver 10,430 kg of thrust and employ snubberless fan blades. It is pointed out that the V-2500 represents a new design and is to be built by five main contractors, wile the CFM-56-4-A1 is essentially an improved version of the CFM-56-2 now in service. The implications of the projected performance parameters and deliver dates (spring 1988), and of the potential development risks, for the competitiveness of the two engines are considered. T.K.

A84-17110
AUTOMATED JET ENGINE TURBINE BLADE REPAIR
T. E. DOYLE, D. F. BUSCH, T. J. JOHNSON (Battelle Columbus Laboratories, Columbus, OH), and F. R. MILLER (USAF, Materials Laboratory, Wright-Patterson AFB, OH) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 123-132.

An automated welding machine for turbine blade repair has been designed, and is presently under construction. This machine will be used to restore worn shroud surfaces and airseals on gas engine turbine blades. The design, construction, and implementation of this machine has been governed by the systems engineering methodology of Integrated Computer Aided Manufacturing. This machine, in conjunction with other automated equipment and control computers, will be configured to realize a true stand-alone welding repair operation. Author

A84-17362*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REAL-TIME PEGASUS PROPULSION SYSTEM MODEL V/STOL-PILOTED SIMULATION EVALUATION
J. R. MIHALOEW (NASA, Lewis Research Center, Cleveland, OH), S. P. ROTH, and R. CREEKMORE (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, FL) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 77-84. refs

Previously cited in issue 07, p. 982, Accession no. A82-19221

A84-17675
FAULT-INSPECTION OF AIRCRAFT GAS TURBINE ENGINES ACCORDING TO THERMOGASDYNAMIC PARAMETERS [DIAGNOSTIROVANIE AVIATSIONNYKH GAZOTURBINNYKH DVIGATELEI PO TERMOGAZODINAMICHESKIM PARAMETRAM]
M. F. MOKROUS IN: Fault diagnostics of machine automata and industrial robots (Diagnostirovanie mashin-avtomatov i promyshlennykh roboto). Moscow, Izdatel'stvo Nauka, 1983, p. 138-142. In Russian. refs

The paper examines the development and operational application of a technique for the inspection of gas turbine engines on the basis of smooth deviations of thermogasdynamic parameters recorded in a steady-state flight mode. A block diagram of an algorithm for the processing of the tthermogasdynamic parameters of a gas turbine engine recorded in flight is presented, and variations of deviations of the thermogasdynamic parameters of well-functioning and malfunctioning engines are examined. B.J.

A84-17997*# General Electric Co., Cincinnati, Ohio.
COMPARISON OF FULL-SCALE ENGINE AND SUBSCALE MODEL PERFORMANCE OF A MIXED FLOW EXHAUST SYSTEM FOR AN ENERGY EFFICIENT ENGINE (E3) PROPULSION SYSTEM
A. P. KUCHAR (General Electric Co., Cincinnati, OH) and R. CHAMBERLIN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0283)

A full scale engine test of the NASA/General Electric Company (GE) Energy Efficient Engine (E3) was conducted to demonstrate the E3 engine concept and evaluate its performance. The test program, performed at the GE outdoor engine test facilities in Peebles, OH, included a detailed evaluation of the total pressure and temperature profiles at the exit of the mixed flow exhaust system to determine its mixing effectiveness. Subscale model tests of the same mixed flow exhaust system had been previously conducted at FluiDyne Engineering Corporation in Minneapolis, Minnesota as part of the GE E3 mixer aerodynamic technology development program. The scale model and full scale engine nozzle exit survey data and the calculated mixing effectiveness are compared and discussed. Results indicate the full scale engine mixing effectiveness to be five percent higher than the scale model as a result of a geometric difference and higher turbulence levels in the engne exhaust flowfield. Author

A84-17999#
COMPUTATIONAL ANALYSIS OF THE FLOW FIELD IN AN ENGINE TEST CELL
S. L. KROMER-OEHLER (General Electric Co., Cincinnati, OH) and D. A. DIETRICH American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0285)

An analytic technique, which is a derivative of a panel method analysis, has been developed for analyzing the flow field in an engine test cell. The technique, referred to as the combination technique, yields a solution of interest by combining four fundamental solutions. It is shown that this method can be effectively used to analyze the complex three-dimensional flow field of a test cell facility. Results of the analysis for two engines are presented and compared with experimental data and other analytic results. Various applications of the method are examined, including the design of new test cells, redesign of existing facilities, and calculation of the cell factor correction accounting for three-dimensional effects. V.L.

A84-18093#
THIN TURBOMACHINERY BLADE DESIGN USING A FINITE-VOLUME METHOD
J. V. SOULIS (Thrace, University, Xanthe, Greece) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0438)

A numerical method is presented for the design of thin turbomachinery blades with specified whirl velocities across the blade span. The numerical scheme involves iteration between the direct solution of a finite-volume method, which solves the 3D transonic, potential flow and a design solution. The numerical method has been used to design free-vortex thin turbomachinery blades. Results show that the new numerical procedure is a comparatively economic and reliable method for designing thin turbomachinery blades. It may form the baseline for complete three-dimensional turbomachinery blade designs. Author

A84-18582* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IDENTIFICATION OF MULTIVARIABLE HIGH PERFORMANCE TURBOFAN ENGINE DYNAMICS FROM CLOSED LOOP DATA
W. MERRILL (NASA, Lewis Research Center, Cleveland, OH) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 1 . Oxford and New York, Pergamon Press, 1983, p. 427-434. refs

The multivariable instrumental variable/approximate maximum likelihood (IV/AML) method of recursive time-series analysis is used to identify the multivariable (four inputs-three outputs) dynamics of the Pratt and Whitney F100 engine. A detailed nonlinear engine simulation is used to determine linear engine model structures and parameters at an operating point using open loop data. Also, the IV/AML method is used in a direct identification made to identify models from actual closed loop engine test data. Models identified from simulated and test data are compared to determine a final model structure and parameterization that can predict engine response for a wide class of inputs. The ability of the IV/AML algorithm to identify useful dynamic models from engine test data is assessed. Previously announced in STAR as N82-20339 Author

A84-18748
AIRCRAFT ELECTRICAL MACHINES: A HARMONIC ANALYSIS OF ACTIVE ZONES [ELEKTRICHESKIE MASHINY LETATEL'NYKH APPARATOV: GARMONICHESKII ANALIZ AKTIVNYKH ZON]
B. S. ZECHIKHIN Moscow, Izdatel'stvo Mashinostroenie, 1983, 152 p. In Russian. refs

Principles from the classical theory of electrical machines are used in developing a theory and calculation methods for noncontact electrical machines. The lumped parameters from design models for electrical machines are determined through an investigation of electrodynamic processes on distributed models; these models, which are described by equations from mathematical physics, approximate actual physical objects. Distributed models make it possible to increase the precision of the calculation methods, to save on experimental work, and to extend the possibilities of automated design. A classification is presented of the problems encountered in the electrodynamics of active zones. Systems of design parameters are determined, and calculation models with lumped parameters of noncontact synchronous aircraft generators are validated. C.R.

A84-19179
THE USE OF TESTS OF GOODNESS OF FIT DURING AN ANALYSIS OF FATIGUE DATA [PRIMENENIE KRITERIEV SOGLASIIA PRI ANALIZE REZUL'TATOV ISPYTANII NA USTALOST']
B. F. BALASHOV, V. P. KHARKOV, and Z. KH. IUROVSKII (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) Problemy Prochnosti (ISSN 0556-171X), Dec. 1983, p. 18-21. In Russian. refs

The probabilistic approach to the determination of the fatigue life of gas-turbine engine components requires that the type and parameters of the statistical distributions of fatigue strength and stress characteristics be known. The type of sample distributions of experimental data is determined through the use of tests of goodness of fit. The validity of the omega-squared and chi-squared tests of goodness of fit is investigated here for the case of the lognormal distribution of the fatigue life of gas-turbine blades. It is recommended that a significance level of 0.01 be adopted when using the chi-squared test. In the case of the omega-squared test, significance levels of 20-40 percent should be used for samples less than 100. V.L.

N84-14143*# Solar Turbines International, San Diego, Calif.
EXPERIMENTAL STUDY OF THE OPERATING CHARACTERISTICS OF PREMIXING-PREVAPORIZING FUEL/AIR MIXING PASSAGES Final Report
D. A. ROHY and J. G. MEIER Nov. 1983 60 p
(Contract NAS3-20662)
(NASA-CR-168279; NAS 1.26:168279; SR83-R-4663-30) Avail: NTIS HC A04/MF A01 CSCL 21E

Fuel spray and air flow characteristics were determined using nonintrusive (optical) measurement techniques in a fuel preparation duct. A very detailed data set was obtained at high pressures (to 10 atm) and temperatures (to 750 K). The data will be used to calibrate an analytical model which will facilitate the design of a lean premixed prevaporized combustor. This combustor has potential for achieving low pollutant emissions and low levels of flame radiation and pattern factors conductive to improved durability and performance for a variety of fuels. Author

N84-14144*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPARISON OF FLIGHT RESULTS WITH DIGITAL SIMULATION FOR A DIGITAL ELECTRONIC ENGINE CONTROL IN AN F-15 AIRPLANE
L. P. MYERS and F. W. BURCHAM, JR. Oct. 1983 19 p refs
(NASA-TM-84903; NAS 1.15:84903) Avail: NTIS HC A02/MF A01 CSCL 21E

Substantial benefits of a full authority digital electronic engine control on an air breathing engine were demonstrated repeatedly in simulation studies, ground engine tests, and engine altitude test facilities. A digital engine electronic control system showed improvements in efficiency, performance, and operation. An additional benefit of full authority digital controls is the capability of detecting and correcting failures and providing engine health diagnostics. Author

N84-14146*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A REVIEW OF NASA COMBUSTOR AND TURBINE HEAT TRANSFER RESEARCH
R. A. RUDEY and R. W. GRAHAM 1984 26 p refs Proposed for presentation at the 29th Ann. Intern. Gas Turbine Conf., Amsterdam, 3-7 Jun. 1984; sponsored by ASME
(NASA-TM-83541; E-1912; NAS 1.15:83541) Avail: NTIS HC A03/MF A01 CSCL 21E

The thermal design of the combustor and turbine of a gas turbine engine poses a number of difficult heat transfer problems. The importance of improved prediction techniques becomes more critical in anticipation of future generations of gas turbine engines which will operate at higher cycle pressure and temperatures. Research which addresses many of the complex heat transfer processes holds promise for yielding significant improvements in prediction of metal temperatures. Such research involves several kinds of program including: (1) basic experiments which delineate the fundamental flow and heat transfer phenomena that occur in the hot sections of the gas turbine but at low enthalpy conditions; (2) analytical modeling of these flow and heat transfer phenomena which results from the physical insights gained in experimental research; and (3) verification of advanced prediction techniques in facilities which operate near the real engine thermodynamic conditions. In this paper, key elements of the NASA program which involves turbine and combustor heat transfer research will be described and discussed. B.W.

N84-14147*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLOW VISUALIZATION AND INTERPRETATION OF VISUALIZATION DATA FOR DEFLECTED THRUST V/STOL NOZZLES
H. C. KAO, P. L. BURSTADT, and A. L. JOHNS 1984 51 p refs Presented at the 22nd Aerospace Sci. Meeting, Reno, Nev., 9-12 Jan. 1984; sponsored by AIAA
(NASA-TM-83554; E-1933; NAS 1.15:83554) Avail: NTIS HC A04/MF A01 CSCL 21E

Flow visualization studies were made for four deflected thrust nozzle models at subsonic speeds. Based on topological rules and the assumption that observed streaks constitute continuous vector fields, available visualization pictures are interpreted and flow patterns on interior surfaces of the nozzles are synthesized. In particular, three dimensional flow structure and separations are discussed. From the synthesized patterns, the overall features of the flow field in a given nozzle can be approximately perceived. Author

N84-14148*# Textron Bell Aerospace Co., Buffalo, N. Y.
NASTRAN FLUTTER ANALYSIS OF ADVANCED TURBOPROPELLERS Final Report
V. ELCHURI and G. C. C. SMITH Apr. 1982 121 p refs
(Contract NAS3-22533)
(NASA-CR-167926; NAS 1.26:167926; D2536-941009) Avail: NTIS HC A06/MF A01 CSCL 02A

An existing capability developed to conduct modal flutter analysis of tuned bladed-shrouded discs in NASTRAN was modified and applied to investigate the subsonic unstalled flutter characteristics of advanced turbopropellers. The modifications pertain to the inclusion of oscillatory modal aerodynamic loads of blades with large (backward and forward) variable sweep. The two dimensional subsonic cascade unsteady aerodynamic theory was applied in a strip theory manner with appropriate modifications for the sweep effects. Each strip is associated with a chord selected normal to any spanwise reference curve such as the blade leading edge. The stability of three operating conditions of a 10-bladed propeller is analyzed. Each of these operating conditions is iterated once to determine the flutter boundary. A 5-bladed propeller is also analyzed at one operating condition to investigate stability. Analytical results obtained are in very good agreement with those from wind tunnel tests. Author

N84-14149# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
THE VTX DUTY CYCLE DEVELOPED FROM T-2C AND TA-4J ENGINE USAGE DATA Final Report
S. M. COTE 22 Jun. 1983 15 p
(AD-A133992; NADC-83048-60) Avail: NTIS HCA02/MFA01 CSCL 21E

A T-2C and a Ta-4J aircraft were suitably instrumented for recording engine usage data. These aircraft flew typical training profiles which were obtained via pilot interviews. Based on flight data, the duty cycles were calculated for each trainer to establish design requirements which apply to the VTX system. A VTX duty cycle was developed from this study. Author (GRA)

N84-14150# California Inst. of Tech., Pasadena.
MECHANISMS OF EXCITING PRESSURE OSCILLATIONS IN RAMJET ENGINES Interim Report, 20 Aug. 1980 - 19 Aug. 1981
F. E. C. CULICK, F. E. MARBLE, and E. E. ZUKOSKI 1 Oct. 1982 10 p
(Contract AF-AFOSR-0265-80; AF PROJ. 2308)
(AD-A133977; AFOSR-83-0875TR) Avail: NTIS HCA02/MFA01 CSCL 21E

This report covers the first year of an experimental and analytical program concerned with problems of pressure oscillations in ramjet engines. Initial tests have been performed showing that the blowdown facility operates as planned; modifications for operation at higher pressure have been started. An analysis of the response of a normal shock wave to pressure oscillations has been completed and will be used as the upstream boundary condition in calculations of the acoustical field. Construction of a general framework for analyzing the instabilities in engines has been started, including modeling of the steady flow field. Special attention is being directed to unsteady shear layers and combustion in a vortex as a mechanism for exciting pressure oscillations. Utilizing the physical model derived from the transient burning of a flame in a vortex field, it has been possible to correlate screech data for a wide variety of fuels. Author (GRA)

N84-14151# Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.
RESEARCH ON AERO-THERMODYNAMIC DISTORTION INDUCED STRUCTURAL DYNAMIC RESPONSE OF MULTI-STAGE COMPRESSOR BLADING Annual Summary Report, 15 Apr. 1982 - 14 Apr. 1983
S. FLEETER Jun. 1983 56 p
(Contract AF-AFOSR-0188-82; AF PROJ. 2307)
(AD-A133853; ME-TSPC-TR-83-04; AFOSR-83-0737TR) Avail: NTIS HCA04/MFA01 CSCL 21E

The overall objective of this research is to quantitatively investigate the fundamental phenomena relevant to aerothermodynamic distortion-induced structural dynamic blade response in multi-stage gas turbine fans and compressors. Unique unsteady aerodynamic data will be obtained to validate and indicate necessary refinements to state-of-the-art analyses and to direct the modeling of new analyses. Also, for the first time, a first principles capability to predict the vibrational response amplitude of blading due to aerodynamic excitations will be developed. Progress and results obtained during the first year of this program. Include: the dynamic instrumentation of the first-stage vane row of a three-stage research compressor; the design, specification, and initiation of the development of the dynamic data acquisition and analysis system; the initiation of the development of the necessary data analysis and calibration techniques; and the theoretical development of a unique coupled mode structural dynamic blade response analysis based on an energy balance technique. GRA

N84-14152# Naval Weapons Center, China Lake, Calif.
TURBULENT MIXING AND COMBUSTION OF MULTI-PHASE REACTING FLOWS IN RAMJET AND DUCTED ROCKET ENVIRONMENT Final Progress Report, 1 Apr. 1981 - 30 Sep. 1982
M. J. LEE and K. C. SCHADOW Oct. 1982 6 p
(Contract AFOSR-MIPR-82-00010; AF PROJ. 2308)
(AD-A133802; AFOSR-83-0872TR) Avail: NTIS HCA02/MFA01 CSCL 21E

Experiments with gaseous fuels to establish the base for the multiphase fuel tests were completed for the axisymmetric-coaxial flow fields. Radial and axial profiles of pressure, velocity, species concentration and temperature were determined. Agreement between measured values (velocity and temperature) and computer predictions was, in general, reasonably good. Experiments to determine axial and radial temperature profiles with boron particle-laden fuels were started. Author (GRA)

N84-14153# Naval Postgraduate School, Monterey, Calif.
POWERPLANT SELECTION FOR CONCEPTUAL HELICOPTER DESIGN M.S. Thesis
T. J. CASEY Jun. 1983 127 p
(AD-A132982) Avail: NTIS HCA07/MFA01 CSCL 21E

A method of optimizing the selection of a power plant based upon engine and fuel weight is developed for use in a conceptual helicopter design course. Historical data is analyzed to verify and modify existing formulae used to estimate engine performance and engine installation weight. Computational programs for use on a hand-held computer and the IBM 3033 are developed to predict analytically engine fuel flow characteristics and to optimize engine selection. Author (GRA)

N84-15151*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
CLEAN CATALYTIC COMBUSTOR PROGRAM Final Report, Oct. 1979 - Jul. 1982
E. E. EKSTEDT, T. F. LYON, P. E. SABLA, and W. J. DODDS Nov. 1983 152 p refs
(Contract NAS3-22003)
(NASA-CR-168323; NAS 1.26:168323) Avail: NTIS HC A08/MF A01 CSCL 21E

A combustor program was conducted to evolve and to identify the technology needed for, and to establish the credibility of, using combustors with catalytic reactors in modern high-pressure-ratio aircraft turbine engines. Two selected catalytic combustor concepts were designed, fabricated, and evaluated. The combustors were sized for use in the NASA/General Electric Energy Efficient Engine (E3). One of the combustor designs was a basic parallel-staged double-annular combustor. The second design was also a parallel-staged combustor but employed reverse flow cannular catalytic reactors. Subcomponent tests of fuel injection systems and of catalytic reactors for use in the combustion system were also conducted. Very low-level pollutant emissions and excellent combustor performance were achieved. However, it was obvious from these tests that extensive development of fuel/air preparation systems and considerable advancement in the steady-state operating temperature capability of catalytic reactor materials will be required prior to the consideration of catalytic combustion systems for use in high-pressure-ratio aircraft turbine engines.
Author

N84-15152*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
AEROTHERMAL MODELING. EXECUTIVE SUMMARY Final Report
M. K. KENWORTHY, S. M. CORREA, and D. L. BURRUS Dec. 1983 55 p refs
(Contract NAS3-23525)
(NASA-CR-168330; NAS 1.26:168330) Avail: NTIS HC A04/MF A01 CSCL 21E

One of the significant ways in which the performance level of aircraft turbine engines has been improved is by the use of advanced materials and cooling concepts that allow a significant increase in turbine inlet temperature level, with attendant thermodynamic cycle benefits. Further cycle improvements have been achieved with higher pressure ratio compressors. The higher turbine inlet temperatures and compressor pressure ratios with corresponding higher temperature cooling air has created a very hostile environment for the hot section components. To provide the technology needed to reduce the hot section maintenance costs, NASA has initiated the Hot Section Technology (HOST) program. One key element of this overall program is the Aerothermal Modeling Program. The overall objective of his program is to evolve and validate improved analysis methods for use in the design of aircraft turbine engine combustors. The use of such combustor analysis capabilities can be expected to provide significant improvement in the life and durability characteristics of both combustor and turbine components.
B.W.

N84-15153*# Textron Bell Aerospace Co., Buffalo, N. Y.
NASTRAN DOCUMENTATION FOR FLUTTER ANALYSIS OF ADVANCED TURBOPROPELLERS Final Report
V. ELCHURI, A. M. GALLO, and S. C. SKALSKI Apr. 1982 216 p refs
(Contract NAS3-22533)
(NASA-CR-167927; NAS 1.26:167927; D2536-941010) Avail: NTIS HC A10/MF A01 CSCL 20K

An existing capability developed to conduct modal flutter analysis of tuned bladed-shrouded discs was modified to facilitate investigation of the subsonic unstalled flutter characteristics of advanced turbopropellers. The modifications pertain to the inclusion of oscillatory modal aerodynamic loads of blades with large (backward and forward) varying sweep.
Author

N84-15154*# Textron Bell Aerospace Co., Buffalo, N. Y.
BLADED-SHROUDED-DISC AEROELASTIC ANALYSES: COMPUTER PROGRAM UPDATES IN NASTRAN LEVEL 17.7 Final Report
A. M. GALLO, V. ELCHURI, and S. C. SKALSKI Dec. 1981 348 p
(Contract NAS3-22533)
(NASA-CR-165428; NAS 1.26:165428; D2536-941006) Avail: NTIS HC A15/MF A01 CSCL 21E

In October 1979, a computer program based on the state-of-the-art compressor and structural technologies applied to bladed-shrouded-disc was developed. The program was more operational in NASTRAN Level 16. The bladed disc computer program was updated for operation in NASTRAN Level 17.7. The supersonic cascade unsteady aerodynamics routine UCAS, delivered as part of the NASTRAN Level 16 program was recorded to improve its execution time. These improvements are presented.
Author

N84-15155*# General Electric Co., Cincinnati, Ohio. Advanced Technology Operation.
AEROTHERMAL MODELING, PHASE 1. VOLUME 1: MODEL ASSESSMENT Final Report
M. J. KENWORTHY, S. M. CORREA, and D. L. BURRUS Nov. 1983 386 p refs 2 Vol.
(Contract NAS3-23525)
(NASA-CR-168296-VOL-1; NAS 1.26:168296-VOL-1) Avail: NTIS HC A17/MF A01 CSCL 21E

Phase 1 was conducted as part of the overall NASA Hot Section Technology (HOST) Program. The purpose of this effort was to determine the predictive accuracy of and the deficiencies within the various analytical modules comprising the overall combustor aerothermal model used at General Electric, as well as to formulate recommendations for improvement where needed. This effort involved the assembly of a benchmark quality data base from selected available literature, and from General Electric engine and combustor component test data. This data base was supplemented with additional definitive data obtained from an experimental test program conducted as part of the Phase 1 effort. Using selections from this data base, assessment studies were conducted to evaluate the various modules. Assessment of the internal flow module was conducted using 2-D parabolic and ellipitic, as well as 3-D elliptic internal flow calculations of definitive test data selected from the assembled data base. The 2-D assessment provided methodical examination of the mathematical techniques and the physical submodules, while the 3-D assessment focused on usefulness as a design tool. Calculations of combustor linear metal temperatures, pressure loss performance, and airflow distribution were performed using aerothermal modules which were in general use for many years at General Electric. The results of these assessment provided for the identification of deficiencies within the modules. The deficiencies were addressed in some detail providing a foundation on which to formulate a prioritized list of recommendations for improvement.
Author

N84-15156*# General Electric Co., Cincinnati, Ohio. Advanced Technology Operation.
AEROTHERMAL MODELING, PHASE 1. VOLUME 2: EXPERIMENTAL DATA Final Report
M. J. KENWORTHY, S. M. CORREA, and D. L. BURRUS Nov. 1983 161 p 2 Vol.
(Contract NAS3-23525)
(NASA-CR-168296-VOL-2; NAS 1.26:168296-VOL-2) Avail: NTIS HC A08/MF A01 CSCL 21E

The experimental test effort is discussed. The test data are presented. The compilation is divided into sets representing each of the 18 experimental configurations tested. A detailed description of each configuration, and plots of the temperature difference ratio parameter or pattern factor parameter calculated from the test data are also provided.
Author

N84-15157# DyTec Engineering, Inc., Long Beach, Calif.
STUDY OF NOISE-CERTIFICATION STANDARDS FOR AIRCRAFT ENGINES. VOLUME 1: NOISE-CONTROL TECHNOLOGY FOR TURBOFAN ENGINES Final Report
A. H. MARSH Jun. 1983 51 p 3 Vol.
(Contract DOT-FA78WA-4096)
(AD-A133386; FAA/EE-82-11-VOL-1) Avail: NTIS HCA04/MFA01 CSCL 21E

This study, reported in three volumes, had the purpose of considering the feasibility of establishing an FAA requirement for a manufacturer of aircraft engines to demonstrate compliance with an engine noise-level standard in order to obtain an engine noise type certificate. The objective of engine-noise type certification (if feasible on the basis of economic reasonableness, technological practicality, and appropriateness to the type design) would be to supplement the aircraft-noise type certification requirements in Part 36 of the Federal Aviation Regulations. The scope of the study was limited to aircraft turbofan engines. Volume 1 identifies sources of noise produced by aircraft turbofan engines, proposes a working definition of an engine's envelope within which an engine manufacturer may incorporate noise control design features, and evaluates applications of noise-control designs to 22 experimental and production versions of turbofan engines developed over a period from late 1950s to the mid 1970s and ranging in nominal take-off-rated thrust from 7.2 to 236 kN (1600 to 53 000 lb). A description is included of the general procedure for selecting appropriate noise-control designs applicable within the engine envelope for various sources of engine noise. GRA

N84-15158# DyTec Engineering, Inc., Long Beach, Calif.
STUDY OF NOISE-CERTIFICATION STANDARDS FOR AIRCRAFT ENGINES. VOLUME 2: PROCEDURES FOR MEASURING FAR FIELD SOUND PRESSURE LEVELS AROUND AN OUTDOOR JET-ENGINE TEST STAND Final Report
A. H. MARSH Jun. 1983 88 p 3 Vol.
(Contract DOT-FA78WA-4096)
(AD-A133408; DYTEC-8204-VOL-2; FAA/EE-82-11-VOL-2) Avail: NTIS HCA05/MFA01 CSCL 21E

This study, reported in three volumes, had the purpose of considering the feasibility of establishing an FAA requirement for a manufacturer of aircraft engines to demonstrate compliance with an engine noise-level standard in order to obtain an engine-noise type certificate. The objective of engine-noise type certification would be to supplement the aircraft-noise type certification requirements in Part 36 of the Federal Aviation Regulations. The scope of the study was limited to aircraft turbofan engines. Volume 2 describes the general characteristics of 16 outdoor engine test stands used by 11 organizations for measurements of engine noise levels. Instruments and microphone installations are also described. Recommendations are presented for test procedures to measure farfield sound pressure levels around a turbofan engine mounted on an outdoor test stand. After adjusting the measured data to common reference conditions, the test results should be suitable for demonstrating compliance with the requirements for a static-engine noise type certificate. GRA

08

AIRCRAFT STABILITY AND CONTROL

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

A84-15918#
DESIGN OF THE AIRCRAFT LATERAL-DIRECTION MODEL-FOLLOWING SYSTEM
L. LEI Northwestern Polytechnical University, Journal, vol. 1, July 1983, p. 137-148. In Chinese, with abstract in English.

The quadratic performance index of linear optimal control theory is applied to the design of an explicit aircraft lateral direction model-following system in the discrete time case. Control effects on the model are accounted for by imposing the desired control characteristics on the uncontrolled model dynamics. Integral control is adopted for the aircraft control surfaces. The digital computer simulation uses linearized lateral direction data for a typical fighter aircraft. A set of suitable weighting matrices for the transient characteristics are found by trial and error. The simulation results show that the roll rate and bank angle are very close to the model values, that the maximum side-slip angle is very small, and that the maximum control surface deflections and deflection rates are much below permissible limits. The magnitude of control gains is apt. The method is suitable for designing an actual flight control system. C.D.

A84-15919#
ANALYSIS AND TESTING OF A NONLINEAR LATERAL FIN SERVO
Z. QUE Northwestern Polytechnical University, Journal, vol. 1, July 1983, p. 149-159. In Chinese, with abstract in English.

A practicable nonlinear fin servo is analyzed and its mathematical model is constructed experimentally. The fin servo has on-off nonlinear characteristics for the servo-amplifier and the clutch with dead-band and hysteresis. The second on-off nonlinear element may be combined with the linear element to form a pure time delay, transforming the fin servo system into a nonlinear system with only one on-off characteristic of pure time delay. The pure time delay is calculated using the existence condition of self-excited oscillations. This delay can also be determined by testing. The critical self-excited oscillation condition is used to calculate limiting values of the fin servo parameters. The nonlinear system is analyzed with an analog computer. The results for the time response, the frequency and amplitude of the self-excited oscillations are almost identical to those for the physical system. C.D.

A84-15979
DEVELOPMENT OF THE F/A-18 HANDLING QUALITIES USING DIGITAL FLIGHT CONTROL TECHNOLOGY
L. A. WALKER and W. J. LAMANNA (McDonnell-Douglas Corp., St. Louis, MO) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 41-67.

The F/A-18 fighter's primary flight control system is an electrical, fly-by-wire system comprised of four redundant channels. At the heart of each channel is a digital computer with a PROM memory containing the appropriate control laws. These control laws contain numerous feedback loops which achieve the desired aircraft response as a function of pilot inputs, rather than simply commanding control surface positions. Attention is given to the computer-assisted system's alleviation of the effects of pilot-induced oscillations, and to its role in improving aircraft performance in such respects as landing approach speed stability, high angles of attack, roll coupling, loads alleviation, and stores-oscillation active suppression. O.C.

A84-15996
ADVANCED FLIGHT CONTROL INSTRUCTION AT THE AIR FORCE TEST PILOT SCHOOL
R. L. ENGEL, J. W. SMOLKA (USAF, Test Pilot School, Edwards AFB, CA), and L. H. KNOTTS (Calspan Corp., Edwards AFB, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 333-362.

The U.S. Air Force Test Pilot School has restructured its curriculum to furnish improved instruction in flight control technology. Academic instruction in the new program covers aircraft equations of motion and dynamics, linear control theory, simulation, flight control systems analysis and handling qualities flight test techniques. The inflight simulation capability of a modified, variable stability Learjet aircraft is used for instruction in aircraft stability derivatives. O.C.

A84-15997* Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

FLIGHT TESTING THE ROTOR SYSTEMS RESEARCH AIRCRAFT (RSRA)

R. K. MERRILL (U.S. Army, Aviation Engineering Flight Activity, Edwards AFB, CA) and G. W. HALL (NASA, Ames Research Center, Moffett Field, CA) IN: 1982 report to the aerospace profession; Proceedings of the Twenty-sixth Symposium, Beverly Hills, CA, September 22-25, 1982 . Lancaster, CA, Society of Experimental Test Pilots, 1982, p. 363-373.

The Rotor Systems Research Aircraft (RSRA) is a dedicated rotor test vehicle whose function is to fill the gap between theory, wind tunnel tests and flight verification data. Its flight test envelope has been designed to encompass the expected envelopes of future rotor systems under all flight conditions. The test configurations of the RSRA include pure helicopter and compound (winged helicopter) modes. In addition, should it become necessary to jettison an unstable rotor system in flight, the RSRA may be flown as a fixed wing aircraft. The heart of the RSRA's electronic flight control system is the TDY-43 computer, which can be programmed in numerous ways to change stability and control or force feel system gains. Computer programming changes allow the RSRA to be used as a five-degree-of-freedom inflight simulator for studying the handling qualities of research rotors. O.C.

A84-16170

COMPARATIVE EVALUATION OF PREDICTED FLYING QUALITIES BOUNDARIES USING GROUND AND AIRBORNE SIMULATORS

T. J. MELODY, K. M. MCNELLIS, and J. M. PAYNE (USAF, Test Pilot School, Edwards AFB, CA) IN: 1983 report to the aerospace profession; Proceedings of the Twenty-seventh Symposium, Beverly Hills, CA, September 28-October 1, 1983 . Lancaster, CA, Society of Experimental Test Pilots, 1983, p. 215-241. refs

In a recent student project by class 82B of the Air Force Test Pilot School, results of a pitch tracking task performed in the Simulator for Aircraft Flight Test and Development and the NT-33A in-flight simulator were compared. The main objective of the evaluation was to determine and compare Level 1 and Level 2 short period natural frequency boundaries for Class IV aircraft in Flight Phase Category A as predicted by both types of simulation. Secondary objectives included the study of the same boundaries at higher load factors and the effects of visual and motion cues on pilot ratings. It is shown that ground-simulator results correlated well with the NT-33A results for low and medium short period frequencies (2, 4, and 6 radians per second). At higher frequencies (8 and 10 radians per second) the ground-simulator ratings continued to improve; however, in-flight ratings differed from those of the ground simulator as the pilots rated the increasing frequencies successively worse. B.J.

A84-16523#

THE SYNTHESIS OF AN ACTIVE FLUTTER SUPPRESSION LAW BASED ON AN ENERGY CRITERION

A. F. KLEIN (Bristol, University, Bristol, England) Aeronautical Quarterly (ISSN 0001-9259), vol. 34, Nov. 1983, p. 260-281.

Theory and results are presented which show that it is questionable to base a flutter suppression law, synthesized in terms of an energy dissipation criterion, entirely on aerodynamic data. It is shown that aileron mass balance and aileron/jack impedance can adversely affect regions of stability which have been predicted using aerodynamic terms alone. Comments are also made which attempt to unify various cost functions which are used when either an energy dissipation or an energy dissipation and storage criterion is used in the formulation of flutter suppression laws. Author

A84-16665* General Dynamics Corp., Fort Worth, Tex.

AFTI/F-16 DFCS DEVELOPMENT SUMMARY - A REPORT TO INDUSTRY MULTIMODE CONTROL LAW DESIGN

R. D. TOLES and D. C. ANDERSON (General Dynamics Corp., Fort Worth, TX) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1212-1219. USAF-Navy-NASA-sponsored research.

The primary goal of the AFTI/F-16 program is to develop a reliable triplex digital multimode flight control system; this system is to be tailored to optimize fighter performance and capable of six-degree-of-freedom decoupled aircraft control. The multiple digital control law configurations arrived at through flight testing are presented. The changes in these designs from the results of flight tests establish that flight testing is an integral part of the development process. The flight test results are analyzed here from the standpoint of pilot comments and resulting control law design modifications. C.R.

A84-16666

AFTI/F-16 DFCS DEVELOPMENT SUMMARY - A REPORT TO INDUSTRY REDUNDANCY MANAGEMENT SYSTEM DESIGN

W. J. YOUSEY, A. M. ARABIAN, T. M. SCHINDLER (General Dynamics Corp., Fort Worth, TX), and R. A. WHITMOYER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1220-1226.

Achieving the same probability of loss of control and essentially two fail operative performance with a triplex computer architecture without reliance on an independent backup requires that many of the conventional redundancy management design techniques, previously employed in quadruplex digital flight control systems, be examined and modified. These include the practice of taking an entire branch off line every time a failure is detected, continuously running processor self test and memory sum checks in the background and using memory parity as a prime method of failure detection. The primary shortcoming of these tests is that they lack the ability to discriminate between serious failures and those of little or no consequence to the safe operation of the aircraft. However, when these tests are triggered by other failure detecting methods which have discrimination, then it is possible to leave a partially failed branch on line. The net effect is a reduction in the probability of loss of control and a reduced self test coverage requirement. Author

A84-16667

AFTI/F-16 DFCS DEVELOPMENT SUMMARY - A REPORT TO INDUSTRY SOFTWARE DESIGN/MECHANIZATION

T. M. SCHINDLER, A. M. JOHNSTON, and G. W. KEITH (General Dynamics Corp., Fort Worth, TX) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1227-1234.

Several emerging flight control technologies are under evaluation by the F-16 Advanced Fighter Technologies Integration (AFTI) program. These technologies include multimode task-tailored control laws and asynchronous triplex redundant digital flight control system architecture. This paper describes system mechanization and software design considerations for three areas which are greatly influenced by the emerging technologies. These discussions center on mechanization approaches for multimode control law design, software implementation of complex gain scheduling functions, and executive design for triplex asynchronous operation. Author

A84-16668
AFTI/F-16 DFCS DEVELOPMENT SUMMARY - A REPORT TO INDUSTRY VERIFICATION AND VALIDATION TESTING
M. R. GRISWOLD, M. GORDOA, and R. D. TOLES (General Dynamics Corp., Fort Worth, TX) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1236-1240.

The actual testing effort was divided into main parts related to preliminary stand-alone test procedures and to integrated procedures. This approach was to provide an orderly operational transition of the Operational Flight Program (OFFP) from a stand-alone test of a triplex breadboard target computer complex to a test of the OFP in the actual flight control computers (FLCC) integrated with the Avionic OFPs and flight hardware in a hot-bench AFATI/F-16 Air Vehicle Simulator. It is pointed out that each type of test, stand-alone and integrated, has limitations and strengths. Taken together they provided an overall high level of test coverage. Attention is given to Verification and Validation (V and V) test procedures, the stand-alone test facility, the Int Sys Test facility, aspects of V and V documentation, and software audit results. G.R.

A84-16670* Auburn Univ., Ala.
INTEGRATED PILOT - OPTIMAL AUGMENTATION SYNTHESIS FOR COMPLEX FLIGHT VEHICLES: EXPERIMENTAL VALIDATION
M. INNOCENTI (Auburn University, Auburn, AL) and D. K. SCHMIDT (Purdue University, West Lafayette, IN) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1252-1258. refs
(Contract NAG4-1)

The purpose of this work is to present an experimental validation via fixed-base simulation of analytical methods for predicting handling qualities of flight vehicles. Different augmented dynamics are considered and analytical predictions of performance and pilot rating obtained. A flight simulation is then performed and comparison between experiment and theoretical data is shown. Author

A84-16671#
SYNTHESIS AND PERFORMANCE EVALUATION TOOLS FOR CGT/PI ADVANCED DIGITAL FLIGHT CONTROL SYSTEMS
P. S. MAYBECK, R. M. FLOYD, and A. MOSELEY (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1259-1266. refs

This paper develops both the concept of, and efficient interactive computer software for the design of, digital Command Generator Tracker control systems employing Proportional-plus-Integral inner loop controllers, or CGT/PI control systems. Kalman filters are also embedded in the controller structure to provide estimates of states (needed for control generation) from incomplete noise-corrupted data available from sampled data sensors. Such a controller is particularly well suited to the typical aircraft control design problem. The developed software allows the designer to specify system parameters and objectives (including 'handling qualities' specifications) in the continuous-time domain, and it then obtains the corresponding discrete-time representations, generates a direct digital design for sampled-data implementation, and evaluates its performance characteristics in a realistic environment. Author

A84-16674#
SELF-REPAIRING FLIGHT CONTROL SYSTEMS - OVERVIEW
D. P. RUBERTUS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1280-1286.

It is pointed out that imposed safety-of-flight requirements and flight control system designs are not always compatible with their combat role. High levels of redundancy, usually quadruplex replication of essential flight control elements, have been brought to bear in a brute force approach to preserve the flight control function for single and double failures within the flight control system. The need for new flight control system design concepts to sustain acceptable air craft sortie rates for an expanded array of combat-induced traumatic conditions is emphasized. It is expected that self-repairing flight control system concepts will significantly increase combat aircraft availability while also reducing the cost of acquiring and owning the aircraft. Self-repairing flight control concepts are discussed. C.R.

A84-16675
THE USE OF FAULT-TOLERANT SOFTWARE FOR FLIGHT CONTROL SYSTEMS
L. H. RANEY (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1287-1291. refs

Fault-tolerant software is developed to provide for continued operation of a system in the presence of faults. A critical issue of software fault-tolerance is the requirement for fault detection. The criteria and techniques for fault detection applied to flight control systems are investigated to provide a framework for the design of appropriate fault detection algorithms. A strategy known as the hardened kernel is aimed at minimizing the complexity of system software by limiting its operational requirements to flight-essential functions. This software kernel subset provides ultra-reliable performance and represents an effective basis for implementing software fault-tolerance. Several software fault-tolerance strategies utilizing the kernel structure are presented. Author

A84-16676
RECENT DIGITAL TECHNOLOGY ADVANCEMENTS AND THEIR IMPACT ON DIGITAL FLIGHT CONTROL DESIGN
T. F. WESTERMEIER and H. E. HANSEN IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1292-1299. refs

A microprocessor-based flight control system has been built around the F-15 Eagle dual control Augmentation System. This parallel-processing system is flight-worthy, and has supported the research and development of various software mechanizations, including floating point and the Pascal high order language. The advantages and limitations of parallel processing systems are discussed. The features of microprocessors that portend their increased use in flight control applications are assessed. The advantages of floating point arithmetic are described, along with a software algorithm that makes floating point practical. Pascal is discussed from two standpoints: software productivity and compiler efficiency. Author

A84-16678
NONLINEAR SELF-TUNING ADAPTIVE CONTROL OF THE T38 AIRCRAFT
G. G. LEININGER, D.-L. TANG, and D. K. SCHMIDT (Purdue University, West Lafayette, IN) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1306-1313. refs

A new nonlinear decoupling self-tuning adaptive digital control method is applied to the control of an aircraft simulation model.

This application uses the complete set of nonlinear continuous time differential equations with three controllable inputs. The self-tuning algorithm utilizes the nonlinear form of the equations to provide model information to the nonlinear pole placing control algorithm. An example demonstrates the effectiveness of the new method. Author

A84-16679
STATUS OF THE FLYING QUALITIES MIL STANDARD
R. H. HOH and D. G. MITCHELL (Systems Technology, Inc., Hawthorne, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1316-1323. USAF-supported research. refs

Work is currently in progress to upgrade the Military Flying Quality specification for conventional and short takeoff and landing aircraft (CTOL and STOL). This status report presents the basic rationale behind the revised format of the proposed organization termed the MIL Standard and Handbook. A discussion of the proposed organization of the MIL Handbook criteria is included as well as the rationale used to upgrade the way in which atmospheric disturbances are handled. A review of current progress on the STOL amendment to the MIL Standard and Handbook is also included. Author

A84-16680
LARGE AIRCRAFT FLYING QUALITIES
R. T. MEYER (Lockheed-Georgia Co., Marietta, GA) and T. A. GENTRY (USAF, Flight Dynamics Laboratory, Dayton, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1324-1330. refs

An assessment is made of large aircraft flying quality criteria with a view to the identification of areas in which recent aircraft design developments have rendered criteria inadequate. Attention is given to permissible time delays in aircraft response and to lateral control/damping requirements. The design requirements which follow from these considerations have a great influence on the control electronics employed. It is established that an 0.1-sec criterion is too stringent for total large aircraft response time, while a maximum roll mode time constant of 1.4 sec is too low, and a 2.5-sec time to bank to 30 deg is too restrictive. O.C.

A84-16681
AUTOMATION OF FIGHTER AIRCRAFT TRAJECTORY CONTROL
S. J. ASSEO and P. D. SHAW (Northrop Copr., Aircraft Div., Hawthorne, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1332-1339. Research supported by the Northrop Independent Research and Development Program. refs

Attention is given to a Trajectory Control System (TCS) that combines Terrain Following/Terrain Avoidance (TF/TA), Integrated Fire and Flight Control (IFFC), and Integrated Flight Trajectory Control (IFTC) functions in an integrated flight control system. The incorporation of a vertical and horizontal path decoupler and thrust control in the TCS achieves compatiblity between IFTC and TF/TA. The isolation between vertical and horizontal path control channels furnished by the decoupler enhances trajectory control. TCS performance has been evaluated by flying a simulated six-degree-of-freedom nonlinear aircraft model along a three-dimensional flight trajectory. O.C.

A84-16683
THE TRAJECTORY GENERATOR FOR TACTICAL FLIGHT MANAGEMENT
M. W. BIRD, M. D. OLINGER (Lear Siegler, Inc., Grand Rapids, MI), R. V. DENTON, and J. E. JONES (Theory and Applications Unlimited Corp., Los Gatos, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1344-1351. refs
(Contract F33615-81-C-3601)

Trajectory Generation - the computation of the desired aircraft trajectory - and Tracking - the control of the aircraft to this trajectory - are major elements of the Tactical Flight Management System, an on-board system for tactical aircraft. The system objective is to increase survivability and mission effectiveness through the integration of sensors, weapons, displays, and data links. Trajectory Generation and Tracking are the core elements of this integration. An Air Force study program is underway to define the Tactical Flight Management system with an emphasis on developing the Trajectory Generation and Tracking algorithms. This paper reports on the trajectory generator which blends together maximum survivable threat penetration, terrain following/terrain avoidance, maneuvering weapon delivery, position/time control, and energy management techniques to provide a total mission capability. The trajectory generator features and architecture are discussed, the energy management and position/time control algorithms are developed, and the approach to computing the maximum survivable threat penetration path is described. Author

A84-16691#
STOL FLYING QUALITIES AND THE IMPACT OF CONTROL INTEGRATION
D. J. MOORHOUSE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1410-1419. refs

The history of V/STOL flight experience is reviewed showing a trend of flight control problems. The conclusion is that STOL vehicles are highly coupled and require a major effort in controls and integration in order to extract the full potential of these configurations. Current design problems of highly augmented systems are illustrated to contrast with historical design problems. It shows a greater interaction of aerodynamics, flying qualities and control design disciplines. This design problem is of greater significance for STOL vehicles. STOL flying qualities requirements are discussed in the form of the latest proposed criteria. It is concluded, however, that the available data base requires careful interpretation for application to a modern, highly augmented control system. Finally, the design issues of controls integration are discussed relative to the requirements for the Air Force STOL Fighter Technology Demonstration Program. Author

A84-16693
AFTI/F-16 DIGITAL FLIGHT CONTROL COMPUTER DESIGN
A. M. ARABIAN (General Dynamics Corp., Fort Worth, TX), E. A. NAUMANN (Bendix Corp., Flight Systems Div., Teterboro, NJ), and D. E. SWIHART (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1426-1432.

The heart of the AFTI/F-16 Digital Flight Control System is the triplex redundant Flight Control Computers (FLCC's). A two fail-operate capability is provided by employing self-test for failure isolation after a second similar FLCC failure. Communication between the redundant FLCC's is provided via serial intercomputer data links. Communication with the aircraft avionics suite is provided by a dual 1553 mux bus interface capability. Flight critical sensors (e.g. rate gyros) are hardwired into one channel of computation, and sensor data is exchanged via the intercomputer data links. All monitoring, voting and redundancy management functions are implemented in software, with the intercomputer data links being utilized to exchange the necessary data. Discrete failure logic is included to preclude a 'beserk' computer from circumventing the system redundancy management design. The system began a 275 sortie flight test program on 10 July 1982. Author

A84-16694
VALIDATION-ORIENTED DEVELOPMENT OF A QUADRUPLEX DIGITAL FLIGHT CONTROL SYSTEM
R. M. DAVIS, D. B. MULCARE, and W. G. NESS (Lockheed-Georgia Co., Marietta, GA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1433-1440. refs
As a first step in establishing the superiority of a new development methodology, a quadruplex digital flight control system (DFCS) has been implemented and evaluated in a real-time system simulator. The methodology, which centers on the analytical design of system/software structure to control complexity and foster verification, is specifically tailored to the characteristics of DFCSs. The design focuses on the explicit definition of control states and variables, and in turn on the corresponding activation of structure. In application, this methodology has successfully demonstrated that the details of digital mechanization can be made accessible and that accountability of the associated multi-level requirements can be enforced. Of note is the direct and precise link between the early-on design and validation testing. Author

A84-17363#
CALCULATION OF TRIM SETTINGS FOR A HELICOPTER ROTOR BY AN OPTIMIZED AUTOMATIC CONTROLLER
D. A. PETERS, B. S. KIM, and H.-S. CHEN (Washington University, St. Louis, MO) (Structures, Structural Dynamics and Materials Conference, 22nd, Atlanta, GA, April 6-8, 1981, and AIAA Dynamics Specialists Conference, Atlanta, GA, April 9, 10, 1981, Technical Papers, Part 2, p. 463-470) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 85-91. refs
(Contract DAAG29-80-C-0092)
Previously cited in issue 12, p. 1950, Accession no. A81-29478

A84-17364*# Calspan Advanced Technology Center, Buffalo, N.Y.
IN-FLIGHT INVESTIGATION OF LARGE AIRPLANE FLYING QUALITIES FOR APPROACH AND LANDING
N. C. WEINGARTEN and C. R. CHALK (Calspan Advanced Technology Center, Buffalo, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 92-98. NASA-supported research. refs
(Contract F33615-79-C-3618)
Previously cited in issue 19, p. 2982, Accession no. A82-39083

A84-17365#
INFLUENCE OF ROLL COMMAND AUGMENTATION SYSTEMS ON FLYING QUALITIES OF FIGHTER AIRCRAFT
D. G. MITCHELL and R. H. HOH (Systems Technology, Inc., Hawthorne, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 99-105. refs
(Contract F33615-80-C-3604)
Previously cited in issue 20, p. 3154, Accession no. A82-40287

A84-17366#
ANALYSIS OF AIRCRAFT ATTITUDE CONTROL SYSTEMS PRONE TO PILOT-INDUCED OSCILLATIONS
R. A. HESS (California, University, Davis, CA) (Guidance and Control Conference, Albuquerque, NM, August 19-21, 1981, Collection of Technical Papers, p. 138-145) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 106-112. refs
Previously cited in issue 21, p. 3624, Accession no. A81-44092

A84-17367*# Waterloo Univ. (Ontario).
BIFURCATION ANALYSIS OF AIRCRAFT PITCHING MOTIONS ABOUT LARGE MEAN ANGLES OF ATTACK
W. H. HUI (Waterloo, University, Waterloo, Ontario, Canada) and M. TOBAK (NASA, Ames Research Center, Moffett Field, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 113-122. refs
(Contract NAGW-130)
Previously cited in issue 06, p. 814, Accession no. A82-17862

A84-17368*# Drexel Univ., Philadelphia, Pa.
OPTIMIZATION OF AIRCRAFT ALTITUDE AND FLIGHT-PATH ANGLE DYNAMICS
A. J. CALISE (Drexel University, Philadelphia, PA) (Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 7, Jan.-Feb. 1984, p. 123-125. refs
(Contract NSG-1496)
Previously cited in issue 03, p. 331, Accession no. A82-13107

A84-17402*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT DYNAMICS OF ROTORCRAFT IN STEEP HIGH-G TURNS
R. T. N. CHEN (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 14-22. refs
Previously cited in issue 19, p. 2983, Accession no. A82-39117

A84-17404*# Technion - Israel Inst. of Tech., Haifa.
DYNAMIC LOAD MEASUREMENTS WITH DELTA WINGS UNDERGOING SELF-INDUCED ROLL OSCILLATIONS
D. LEVIN and J. KATZ (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 30-36. refs
(Contract NAGW-00218)
Previously cited in issue 19, p. 2982, Accession no. A82-39098

A84-17409#
A DYNAMIC MODEL FOR AIRCRAFT POSTSTALL DEPARTURE
M. A. HREHA and F. H. LUTZE (Virginia Polytechnic Institute and State University, Blacksburg, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 62-68. refs
Previously cited in issue 05, p. 595, Accession no. A83-16674

A84-17426*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A VORTEX-LATTICE METHOD FOR CALCULATING LONGITUDINAL DYNAMIC STABILITY DERIVATIVES OF OSCILLATING DELTA WINGS
D. LEVIN (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 6-12. refs
Previously cited in issue 21, p. 3626, Accession no. A81-44570

A84-17920#
NEW CONCEPTS IN CONTROL THEORY 1959-1984 - DRYDEN LECTURE FOR 1984
A. E. BRYSON, JR. (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(AIAA PAPER 84-0161)
Attention is given to some of the developments in control theory that have accompanied the improvements in digital computers and inertial sensors. The discussion covers optimal flight planning, optimal feedback control, modal methods, random processes, optimal estimation, identification, adaptive control, model-following, disturbance rejection, some new algorithms, and digital control. The way in which the calculus of variations has been incorporated into flight planning is traced. The discussion of feedback includes

a description of a temperature regulator designed in the 17th century. An account is given of the emergence of a new group of applied mathematicians who specialize in algorithm development. C.R.

A84-17965*# Boeing Vertol Co., Philadelphia, Pa.

AN INVESTIGATION OF SIDE-STICK-CONTROLLER/STABILITY AND CONTROL-AUGMENTATION SYSTEM REQUIREMENTS FOR HELICOPTER TERRAIN FLIGHT UNDER REDUCED VISIBILITY CONDITIONS

K. H. LANDIS, S. I. GLUSMAN (Boeing Vertol Co., Philadelphia, PA), E. W. AIKEN, and K. B. HILBERT (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 22 p. refs
(Contract NAS2-10880)
(AIAA PAPER 84-0235)

Simulation of the reduced visibility tasks is effected by providing the pilot with a visually coupled, helmet-mounted display of flight-control symbols superimposed upon terrain-board imagery. Forward-flight, low-speed, and precision-hover control modes are implemented, and a method is developed for the blending of control laws between each control mode. An investigation is made of the variations in the level of integration of primary control functions on a single side-stick controller. For most of the flight tasks investigated, separated controller configurations are preferred to a single, fully integrated side-stick device. Satisfactory handling qualities over all controller configurations are attained only for a precision-hover task conducted with a high level of stability and control augmentation. For most tasks flown with the helmet-mounted display significant degradation in handling qualities occurs relative to the identical tasks flown under visual flight conditions. C.R.

A84-17967*# Princeton Univ., N. J.

ANALYSIS OF AIRCRAFT CONTROL STRATEGIES FOR MICROBURST ENCOUNTER

R. F. STENGEL (Princeton University, Princeton, NJ) and M. L. PSIAKI American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract NGL-31-001-252)
(AIAA PAPER 84-0238)

Analyses have indicated that improved control strategies could reduce the threat posed by the presence of microburst-type wind shear during aircraft takeoffs and landings. The attenuation of flight path response to microburst inputs by feedback control to elevators and throttle was studied for the cases of a jet transport and a general aviation aircraft, using longitudinal equations of motion, root locus analysis, Bode plots of altitude response to wind inputs, and nonlinear numerical simulation. Energy management relative to the airmass, a pitch-up response to the decreasing airspeed, increased phugoid mode damping, and decreased phugoid natural frequency, are found to improve microburst penetration aircraft behavior. Aircraft stall, and throttle saturation, are limiting factors in an aircraft's ability to maintain a given flight path during a microburst encounter. O.C.

A84-17968#

AN ACTIVE CONTROL SYSTEM FOR AIRCRAFT DURING LANDING APPROACH IN WIND SHEAR

M. N. WAGDI (Suez Canal University, Port Said, Egypt) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(AIAA PAPER 84-0239)

A proportional-integral control system with a simplified reduced order observer is described for counteracting the wind shear effects encountered by aircraft during landing approaches. It is found that for low level wind shear the proportional controller is adequate. For high level wind shear, however, the proportional-integral controller should be used. Simulations are made of two velocity representations. The velocity state in one is described by the aircraft inertial velocity; in the other representation, the velocity state is described by the aircraft airspeed. C.R.

A84-18163*# Pennsylvania State Univ., University Park.

WIND TUNNELING TESTING AND ANALYSIS RELATING TO THE SPINNING OF LIGHT AIRCRAFT

B. W. MCCORMICK (Pennsylvania State University, University Park, PA), G. G. ZILLIAC (NASA, Ames Research Center, Moffett Field, CA), and M. G. BALLIN (Rockwell International Corp., Downey, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(AIAA PAPER 84-0558)

Included is a summary of two studies related to the spinning of light aircraft. The first study was conducted to demonstrate that the aerodynamic forces and moments acting on a tail of a spinning aircraft can be obtained from static wind-tunnel tests. The second study analytically investigated spinning using a high angle-of-attack aerodynamic model derived from a static wind-tunnel data base. The validity of the aerodynamic model is shown by comparisons with rotary-balance data and forced-oscillation tests. The results of a six-degree-of-freedom analysis show that the dynamics and aerodynamics of the steep- and flat-spin modes of a modified Yankee have been properly modeled. Author

A84-18165#

STABILITY, CONTROL, AND HANDLING QUALITIES CHARACTERISTICS OF THE LEAR FAN MODEL 2100

R. A. MACDONALD (Lear Fan, Ltd., Reno, NV) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p.
(AIAA PAPER 84-0561)

This paper describes the Lear Fan Model 2100's flying qualities as they have been established by flight test and related analysis. The aircraft's unusual features - its composite construction, pusher propeller, and extended operating envelope - are evaluated from a stability and control standpoint. Several problems that have been encountered and solved during the program are documented. The paper concludes that the Lear Fan, for all its unconventional features, possesses essentially conventional handling qualities and stability and control characteristics. Author

A84-18614* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A MATHEMATICAL MODEL FOR EFFICIENT ESTIMATION OF AIRCRAFT MOTIONS

R. E. BACH, JR. (NASA, Ames Research Center, Moffett Field, CA) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1155-1161. refs

In the usual formulation of the aircraft state-estimation problem, motions along a flight trajectory are represented by a plant consisting of nonlinear state and measurement models. Problem solution using this formulation requires that both state- and measurement-dependent Jacobian matrices be evaluated along any trajectory. In this paper it is shown that a set of state variables can be chosen to realize a linear state model of very simple form, such that all nonlinearities appear in the measurement model. The potential advantage of the new formulation is computational: the Jacobian matrix corresponding to a linear state model is constant, a feature that should outweigh the fact that the measurement model is more complicated than in the conventinal formulation. To compare the modeling methods, aircraft motions from typical flight-test and accident data were estimated, using each formulation with the same off-line (smoothing) algorithm. The results of these experiments, reported in the paper, demonstrate clearly the computational superiority of the linear state-variable formulation. The procedure advocated here may be extended to other nonlinear estimation problems, including on-line (filtering) applications. Author

A84-18628
ADAPTIVE FLUTTER SUPPRESSION AS A COMPLEMENT TO LQG BASED AIRCRAFT CONTROL
J. B. MOORE (Newcastle, University, Newcastle, Australia), A. F. HOTZ (McDonnell Douglas Corp., Houston, TX), and D. GANGSAAS (Boeing Commercial Airplane Co., Seattle, WA) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1359-1364. refs

Flutter mode control is critical for flexible wing aircraft designed for fuel efficiency. However, parameters associated with the unstable flutter may only be imprecisely calculated from sensor data, and classical or modern controllers which of necessity have significant open-loop gain at the flutter frequency may well have inadequate phase margins at this frequency. Adaptive flutter mode suppression schemes offer the possibility of 180 deg effective phase margins at the flutter frequency. This paper presents an adaptive approach to flutter mode suppression which is integrated with the control laws of the aircraft. The design approach is of interest in its own right since it blends the classical, linear quadratic gaussian, and adaptive techniques so that each contributes at its point of strength to achieve a robust design with good performance characteristics. Author

A84-18629
AIRCRAFT PARAMETER ESTIMATION WITH NON-RATIONAL TURBULENCE MODEL
F. C. TUNG (TRW, Defense and Space Systems Group, Redondo Beach, CA) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1371-1375. refs

The maximum likelihood technique is applied to estimate aircraft stability and control parameters from flight data allowing for gust (turbulence) disturbance to be modeled by the von Karman spectrum rather than the more commonly used Dryden spectrum. The von Karman spectrum is a more accurate model of atmospheric turbulence, but unfortunately it is a non-rational function. This leads to complications in the theory because the finite dimensional state space representations can no longer be used. The identification and the associated filtering problems are solved by posing them in an artificially defined infinite dimensional state space. Numerical method of computing the optimal filter weighting function is presented. This algorithm is demonstrated by using actual flight test data. Author

A84-19154
DIGITAL FLIGHT CONTROL SYSTEM DESIGN USING SINGULAR PERTURBATION METHODS
J. S. SMYTH (USAF, Armament Div., Eglin AFB, FL) and J. J. DAZZO (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1158-1166. refs

In this paper a longitudinal output feedback tracker is developed for an aircraft and is shown to produce excellent performance for three different flight conditions without change of the control law matrices. The aircraft utilizes flight propulsion control coupling to provide greater control and responsivenes to command inputs. The singular perturbation method is applied to obtain an output-feedback digital multivariable control. Each flight condition has three command modes: positive pitch pointing, vertical translation, and straight climb. Decoupling of the outputs is demonstrated. A sensitivity study is performed to validate the robustness of the design and to illustrate design parameter influences on system response. The paper contains a summary of the control law design method. Since the CB matrix of the aircraft model does not have full rank, the use of a modified output feedback is used to obtain the required tracking performance. Author

A84-19178
MODEL REFERENCE ADAPTIVE CONTROL FOR A RELAXED STATIC STABILITY AIRCRAFT
K. M. SOBEL (Lockheed-California Co., Burbank, CA) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1369-1373.

A direct model reference adaptive control algorithm is utilized for the design of a stability augmentation system for the longitudinal axis of a transport aircraft. Control system performance is evaluated for a scenario which includes takeoff, climb and cruise conditions. The adaptive law is compared with a fixed gain controller designed via pole placement. The adaptive controller is shown to be superior for controlling the short period mode. Author

A84-19246#
MULTIVARIABLE CONTROL LAWS FOR THE AFTI/F-16
A. F. BARFIELD (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and J. J. DAZZO (USAF, Institute of Technology, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 16 p. refs
(AIAA PAPER 84-0237)

In the development of a digital task-tailored control system for the Advanced Fighter Technology Integration (AFTI)/F-16 use is made of recently evolved multivariable design techniques. The design considered in the present investigation is a full authority digital fly-by-wire system. The system is intended for air-to-air combat missions. Attention is given to the selected flight envelope, design requirements, an aircraft description, an aerodynamic model, aspects of multivariable control theory, output feedback and the M matrix, asymptotic characteristics, transmission zeros, measurement matrix elements, closed-loop roots, real-time computer-aided designs, design requirements, maximum maneuver elements, robustness, and suggestions for simplifying and improving the design process. G.R.

A84-19261*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
USE OF A DISCONTINUOUS WING LEADING-EDGE MODIFICATION TO ENHANCE SPIN RESISTANCE FOR GENERAL AVIATION AIRPLANES
D. J. DICARLO, K. E. GLOVER, E. C. STEWART, and H. P. STOUGH (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0559)

Spin resistance of two typical general aviation airplanes has been studied. Improvement in spin resistance due to an outboard wing leading-edge modification was evaluated through wind-tunnel and flight tests. The basic airplanes would readily enter a spin; however, with the wing modification the airplanes were highly spin resistant. Spin resistance has been related to the angle of attack of the outer wing panel and the yaw rate as a step toward development of guidelines for design of more spin resistant airplanes. Author

N84-14154 Washington Univ., Seattle.
FREQUENCY-SHAPED ESTIMATION AND ROBUST CONTROLLER DESIGN FOR AIRCRAFT FLIGHT CONTROL IN WIND DISTURBANCES Ph.D. Thesis
B. K. KIM 1983 131 p
Avail: Univ. Microfilms Order No. DA8319422

Autoland flight control systems designed to maintain airspeed in the presence of wind shear tend to have large bandwidth which admits significant amounts of noise from wind turbulence through the airspeed measurement. This noise can produce unacceptable levels of control activity, particularly in thrust control. To improve this situation, a frequency-shaped optimal estimator algorithm by Gupta has been reformulated to provide smooth wind state information to the flight control system. It is shown that the measurement noise shaping function generates transmission zeros which can be used to introduce lag compensators in the estimators.

This property of the frequency shaped estimator is useful in attenuating high frequency wind disturbance effects on the flight control system while maintaining transient response. A simple method has been developed for selection of shaping functions which both improve disturbance attenuation and also improve other system robustness measures such as stability margins and parameter insensitivity. Dissert. Abstr.

N84-14155 Texas Univ., Austin.
SUPPRESSION OF INTERFERENCE FLUTTER BY COMPOSITE TAILORING Ph.D. Thesis
T. N. BAKHTHAVATHSALAM 1983 120 p
Avail: Univ. Microfilms Order No. DA8319557

The composite tailoring aspect of design and analysis for suppression of interference flutter is considered. The tail spar is designed to have a washout deflection shape under loads while matching the stiffness of the composite spar with that of the original aluminum spar. To get the maximum washout effect and also to have the matched stiffness, optimization techniques are employed. This washout design increases the flutter margin by about 6%. The tail is inherently very rigid and the bending deflections are small as is the controlled rotation (washout) which is coupled to this deflection. The bending stiffness of the tail spar is reduced by about 33% and an analysis is attempted. For this tail spar with washout design, the flutter margin improved to about 12%. In yet another study, the tail spar is made of aluminum and the wing spar is of composite construction with matched stiffness and with washin design features. This combination yields an appreciable increase of 37% in flutter margin. Tailoring the wing proved to be the most ideal way to control the downwash field that causes the interference flutter. Dissert. Abstr.

N84-14156 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Betriebsbereich.
REDUCED STABILITY IN A MODERN COMMERCIAL AIRCRAFT AND CENTER OF GRAVITY CONTROL [VERWIRKLICHUNG REDUZIERTER STABILITAET IN EINEM MODERNEN VERKEHRSFLUGZEUG DURCH SCHWERPUNKTSREGELUNG]
A. KROEGER 1982 33 p refs In GERMAN Presented at DGLR Symp. Leistungssteigerungen bei Flaechenflugzeugen, Frankfurt am Main, 11-12 Nov. 1982
(MBB-UT-22-82-OE; DGLR-82-092) Avail: Issuing Activity

The reduction of commercial aircraft stability was investigated. The reduction of the total drag by redistribution of the buoyancy on elevator units and wings leads to reduced static stability. Ways in which a given commercial aircraft can make use of the advantage of drag saving by applying a trim tank system, and improving stability by slight modifications to the automatic flight control system are described. Author (ESA)

N84-14157*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DESIGN IMPLICATIONS FROM AFTI/F-16 FLIGHT TEST Final Report
S. D. ISHMAEL, V. A. REGENIE, and D. A. MACKALL Jan. 1984 13 p refs Presented at IEE/AIAA 5th Digital Avionics Systems Conf., Seattle, 31 Oct. - 3 Nov. 1983
(NASA-TM-86026; H-1213; NAS 1.15:86026) Avail: NTIS HC A02/MF A01 CSCL 01C

Advanced fighter technologies are evolving into highly complex systems. Flight controls are being integrated with advanced avionics to achieve a total system. The advanced fighter technology integration (AFTI) F-16 aircraft is an example of a highly complex digital flight control system integrated with advanced avionics and cockpit. The architecture of these new systems involves several general issues. The use of dissimilar backup modes if the primary system fails requires the designer to trade off system simplicity and capability. This tradeoff is evident in the AFTI/F-16 aircraft with its limited stability and fly-by-wire digital flight control systems. In case of a generic software failure, the backup or normal mode must provide equivalent envelope protection during the transition to degraded flight control. The complexity of systems like the AFTI/F-16 system defines a second design issue, which can be divided into two segments: the effect on testing, and the pilot's ability to act correctly in the limited time available for cockpit decisions. The large matrix of states possible with the AFTI/F-16 flight control system illustrates the difficulty of both testing the system and choosing real-time pilot actions. B.W.

N84-15086# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Dept. de Physique Generale.
A SYSTEMATIC CHARACTERIZATION OF THE EFFECTS OF ATMOSPHERIC ELECTRICITY ON THE OPERATIONAL CONDITIONS OF AIRCRAFT
J. TAILLET *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 14 p Oct. 1983 In FRENCH; ENGLISH summary Original language document was announced as A83-48180
Avail: NTIS HC A15/MF A01

The effects of lightning and atmospheric static electricity on composite structures and digital controls is discussed. Flight trials were performed with instrumented aircraft to characterize and quantify the aircraft atmospheric electricity interactions, and to develop a data base that could eventually be used to ameliorate the effects of electromagnetic pulses. Static electricity can be coupled with the airframe by solid precipitation or by passage of the aircraft near an electrically charged cloud. Parasitic radioelectric signals gather on communications and navigation antennas, and are manifested in sparks, surface streamers, and coronal discharges. Coating with antistatic compounds and metallization can prevent the buildup of static charges. Lightning, however, can set off aircraft fuel, burst the radome, or kill the engines. Protective measures which include isolating and/or hardening the circuitry, reducing the collector loops surface for magnetic flux with twisted wires, and by replacing conductor data wiring by optoelectronic devices such as optic fibers, are outlined. E.A.K.

N84-15089# Ministry of Defence, London (England). Defence Science.
SOME COMMENTS ON THE HAZARDS ASSOCIATED WITH MANOEUVRING FLIGHT IN SEVERE TURBULENCE AT HIGH SPEED AND LOW ALTITUDE
J. BURNHAM *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 12 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

The results of calculations made following several accidents and incidents during service training are described to show risks associated with severe turbulence during high speed maneuvering flight at low altitude. It does not imply that the phenomena are necessarily the cause of any particular accident or incident. Two dangers are considered: a combination of gust and maneuver loads may be sufficiently high to cause structural failure, or that this combination may result in a stall or other departure from controlled flight from which recovery is impossible due to the proximity of the ground. High speed low level flight by military combat aircraft are examined. Such aircraft are capable of achieving and sustaining high maneuvering accelerations. This capability is used in terrain following, in maneuvering to take advantage of terrain screening. The existence of a possible problem area which appears to have received little attention in the past is indicated. E.A.K.

N84-15091# Naval Air Test Center, Patuxent River, Md. Strike Aircraft Test Directorate.
THE IMPACT OF THE F/A-18 AIRCRAFT DIGITAL FLIGHT CONTROL SYSTEM AND DISPLAYS ON FLIGHT TESTING AND SAFETY
B. T. KNEELAND, W. G. MCNAMARA, and C. L. WHITE *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 14 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

The development of the digital fly by wire flight control system (FCS) in the F/A-18 aircraft is reviewed. A general description of the FCS and an overview of the significant changes that were incorporated to improve handling qualities and to correct anomalies that were discovered during the full scale development (FSD) program are presented. The interface of the FCS with the total avionics package of the F/A-18 via the 1553 multiplex bus and the impact of this interface on specific flight testing and FCS development is also highlighted. The impact of the flight control laws on high Angle of Attack (AOA) handling qualities, and the changes made is presented. The specialized displays and controls that are implemented in the F/A-18 to assist the pilot and enhance flight testing and safety are discussed. E.A.K.

N84-15092# General Dynamics Corp., Fort Worth, Tex. Flight Control Systems.

LESSONS LEARNED IN THE DEVELOPMENT OF THE F-16 FLIGHT CONTROL SYSTEM

C. S. DROSTE *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 9 p Oct. 1983

Avail: NTIS HC A15/MF A01

Examples of several external factors which manifested themselves in the development of the F-16 and how the F-16 flight control system evolved to minimize their effect are discussed. External factors are pilot interface, ground maintenance, structural resonance, environmental conditions, indirect electrical hazards and other system failures. One of the most significant evolutions to aid in the isolation and resolution of problems is the time sequenced data provided by the F-16 maintenance memory. E.A.K.

N84-15094# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Aircraft Div.

TORNADO AUTOPILOT MEASURES TO ENSURE SURVIVABILITY AFTER FAILURES

W. SCHMIDT and U. BUTTER *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 8 p Oct. 1983

Avail: NTIS HC A15/MF A01

Measures applied to the autopilot of the TORNADO to ensure survivability of the aircraft after failures during automatic low level flying are presented. Apart from redundant equipment, these measures include hardware and software limiters to minimize the effect of failures upon the aircraft, hardware and software monitors to detect and isolate failures, emergency procedures to initiate recovery maneuvers, as well as efficient testing of software. Author

N84-15095# Marconi Avionics Ltd., Rochester (England). Combat Aircraft Controls Div.

CERTIFICATION EXPERIENCE OF THE JAGUAR FLY-BY-WIRE DEMONSTRATOR AIRCRAFT INTEGRATED FLIGHT CONTROL SYSTEM

K. S. SNELLING *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 19 p Oct. 1983 refs

Avail: NTIS HC A15/MF A01

The digital Integrated Flight Control System (IFCS) is developed for the Jaguar Fly-By-Wire (FBW) demonstrator program, identifying the specification requirements, resultant architecture, implementation and the incorporated self test capability. The redundancy management aspect of the IFCS are described together with the techniques for providing the pilot with relevant information to determine the IFCS redundancy status. Particular emphasis is given to the software definition and preparation procedures, and the comprehensive integrity appraisal leading to flight clearance of the system. Following the extensive rig proving of the system, the early phases of flight test were very successfully carried out using the fixed gain control laws. During this period a major software update was commenced to incorporate the scheduled gain control laws and to enhance the self test capability. The software segregation introduced at this stage is described, together with the experience obtained in rectifying the system. Flight testing of the scheduled control laws is continuing, and the minor problems encountered are mentioned. A further software revision to include the control laws for the statically unstable aircraft is well advanced, and the benefits of software segregation identified during this revision are described. Author

N84-15159*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AFTI/F-16 FLIGHT TEST RESULTS AND LESSONS

S. D. ISHMAEL and D. R. MCMONAGLE Oct. 1983 30 p Presented at the 27th Symp. of the Soc. of Exptl. Test Pilots, Beverly Hills, Calif., 28 Sep. - 1 Oct. 1983

(NASA-TM-84920; NAS 1.15:84920; H1206) Avail: NTIS HC A03/MF A01 CSCL 01C

The advanced fighter technology integration (AFTI) F-16 aircraft is a highly complex digital flight control system integrated with advanced avionics and cockpit. The use of dissimilar backup modes if the primary system fails requires the designer to trade off system simplicity and capability. The tradeoff is evident in the AFTI/F-16 aircraft with its limited stability and fly by wire digital flight control systems when a generic software failure occurs the backup or normal mode must provide equivalent envelop protection during the transition to degraded flight control. The complexity of systems like the AFTI/F-16 system defines a second design issue, which is divided into two segments: (1) the effect on testing, (2) and the pilot's ability to act correctly in the limited time available for cockpit decisions. The large matrix of states possible with the AFTI/F-16 flight control system illustrates the difficulty of both testing the system and choosing real time pilot actions. The third generic issue is the possible reductions in the user's reliability expectations where false single channel information can be displayed at the pilot vehicle interface while the redundant set remains functional. E.A.K.

N84-15160# Hydraulic Research Textron, Valencia, Calif.

A STUDY OF DIGITALLY CONTROLLED FLIGHT CONTROL ACTUATION Final Technical Report, Aug. 1980 - Jun. 1983

H. H. BELMONT Wright-Patterson AFB, Ohio AFWAL Jul. 1983 152 p

(Contract F33615-80-C-3623; AF PROJ. 2403)

(AD-A133274; AFWAL-TR-83-3041) Avail: NTIS HCA08/MFA01 CSCL 01B

This report describes a study of flight control actuation system with an objective to determine the degree of digitalization possible between the digital flight control processor and the control surface. A typical analog actuation system is defined as a reference for comparison with five alternates, each mechanized with increasing amounts of digital equipment. The report provides a basis for determining the direction of digital actuation systems. It verifies that distributed actuation systems are now feasible and promise enhanced performance, reliability, and cost reductions. GRA

09

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A84-16619

F/A-18 SIMULATED AIRCRAFT MAINTENANCE TRAINERS (SAMT)

D. FARQUHARSON, J. ASLETT, and M. NAROTAM (Burtek, Inc., Tulsa, OK) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 729-737.

The continuously increasing complexity of military aircraft and onboard systems in conjunction with cost considerations has led to designs with improved 'maintainability'. Ease of maintenance is largely based on the use of Built-In Test (BIT) and onboard computer memory inspect facilities. The present investigation is concerned with a set of devices developed for line maintenance technician training to support the avionics and flight control systems of the F/A-18 Hornet aircraft. Attention is given to the U.S. Navy line maintenance, the technical manual structure, troubleshooting examples, the Canadian Armed Forces line maintenance, the simulated cockpit, graphics displays, the instructor station, the computer system, hardware and software characteristics, and the instructor/student interface. G.R.

A84-16624#
GENERAL PURPOSE AVIONICS SIMULATOR
D. A. WILLIAMS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 778-781.

Traditionally, avionics testing has meant the creation of a new support facility for each new avionics system. Under these conditions, the cost of a new avionics system also includes the cost of a new support system. In connection with economic considerations, attention has been given to the development of a general purpose support system capable of responding to new avionic designs and not built for a specific system. The design approach for building a general purpose avionics simulator is considered along with design details. It is shown that any aircraft system can be simulated with the appropriate software coupled to five basic pilot interface functions. A description is given of a process for evolving a simulation system as a tool by reducing system needs to basic functional areas and designing with reusability as a prime system requirement. G.R.

A84-16625#
NAVIGATION AND DEFENSIVE SYSTEMS SIMULATION IN THE U-2 COCKPIT PROCEDURES TRAINER
T. STANZIONE (USAF, Human Resources Laboratory, Williams AFB, AZ) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 782-789.

A U-2 Cockpit Procedures Trainer for the Strategic Air Command (SAC) was recently designed and built by the Operating Training Division of the Air Force Human Resources Laboratory. A trainer was needed for emergency procedures, inflight engine restarts, and the operation of specialized navigation and defensive systems. The trainer consists of one standard seven foot electronics cabinet, a U-2 cockpit, and an off-line maintenance station. The flight model for the trainer was derived from empirical data supplied by SAC. Attention is given to a system description, system capabilities, LN-33 inertial navigation set simulation, defensive systems panel simulation, and the instructor/operator station. G.R.

A84-16627
LAMPS AN/APS-124 RADAR SIMULATOR
J. W. DEMPEWOLF (IBM Corp., Federal Systems Div., Manassas, VA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 797-803. refs

The Light Airborne Multipurpose System (LAMPS) MK III SH-60B tactical radar function is concerned with search and detection of surface and air contacts within a 160 nmi range. The LAMPS MK III SH-60B Weapons Tactics Trainer Radar Simulator has the objective to enhance the realism of the simulated radar/IFF display. The simulator consists of the radar software model, the trainer unique radar target generator, and the retained tactical signal data converter. Attention is given to the radar software model, target detection criteria, target power return, target cross section fluctuation, helicopter tail attenuation, the elelvation beam pattern reduction factor, sea clutter, volumetric clutter, and attenuation due to atmospheric gases, clouds, and rain. G.R.

A84-16628
F-16 DRLMS - AN APPROACH FOR CURRENT AND FUTURE RADAR SIMULATION
F. DELISLE, K. DONOVAN, and A. HEIDRICH (General Electric Co., Simulation and Control Systems Dept., Fairfield, CT) IN: NAECON 1983; *Proceedings of the National Aerospace and* Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 804-811.

As the number of actual aircraft functions depending on the radar system increases, radar simulation becomes more and more important. Simulation of the air to ground radar modes is particularly important since onboard signal processing has provided an aid to automatic navigation, low level flying, target tracking, and weapon delivery. It is pointed out that digital radar landmass simulators (DRLMS) must support these operations in a flight simulator training mission by providing realistic radar returns which correlate with other sensors. The present investigation is concerned with the challenges of simulating more advanced radars, taking into account as a baseline the F-16 DRLMS design developed by an American aerospace company. Attention is given to a current F-16 DRLMS overview, DRLMS requirements, the current F-16 simulator, and future radar simulators. G.R.

A84-16638
DESIGN AND OPERATION OF A COORDINATED MULTISITE TEST ENVIRONMENT
R. E. KAHN (Westinghouse Defense and Electronic System Center, Baltimore, MD) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 918-925. refs

Six important features of the environment are distinguished. The first is a heavy commitment to host computers dedicated to supporting the integration of one or more operational modes simultaneously. The second is the use of modern simulation techniques, and the third is the use of common test tools, devices, hardware, support software, and testing framework. The fourth is the use of pivotal personnel with well-defined roles and functions, and the fifth is the use of a configuration management system to control development and correction activities. Finally, the sixth is a disciplined attempt at configuration control of both software and hardware undergoing test and integration at each test site. It is stressed that what is most essential is the need for staged, incremental testing, first at the software and then at the system level, combined with a high degree of communication and coordination among all active participants. C.R.

A84-16640
A NEW APPROACH TO AUTOMATED FLIGHT TEST DATA REDUCTION
S. A. WALTERS (Aerospatiale Helicopter Corp., Grand Prairie, TX) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 932-939.

In support of flight test activities of the Coast Guard Short Range Recovery (SRR) helicopter, the HH-65A, Aerospatiale Helicopter Corporation (AHC) is utilizing a low-cost, high performance minicomputer based system for flight test data reduction and analysis. A number of advantages have evolved with this system over the more expensive traditional large system approach. This paper provides an introduction to Aerospatiale's approach to automated data reduction and to the capabilities of this system. Author

A84-17408*# Massachusetts Inst. of Tech., Cambridge.
WIND TUNNEL WALL INTERFERENCE CORRECTIONS FOR AIRCRAFT MODELS IN THE TRANSONIC REGIME
M. H. RIZK (FLow Industries, Inc., Kent, WA) and E. M. MURMAN (Flow Industries, Inc., Kent, WA; MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 54-61. refs
(Contract NAS1-16262)

A procedure for the evaluation of wall interference corrections for three-dimensional models is presented. In addition to Mach number and angle-of-attack corrections, the procedure provides an estimate of the accuracy of the corrections. Lift, pitching moment, and pressure measurements near the tunnel walls are required by the correction method. The method is demonstrated by application to an isolated wing model and to a wing-body-tail configuration. Author

A84-17962#
THE WIND TUNNEL SIMULATION OF PROPULSION JETS AND THEIR MODELING BY CONGRUENT PLUMES INCLUDING LIMITS OF APPLICABILITY
R. A. WHITE (Illinois, University, Urbana, IL), J. AGRELL, and S.-E. NYBERG (Flygtekniska Forsoksanstalten, Bromma, Sweden) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 15 p. Research supported by the Flygtekniska Forsoksanstalten. refs
(Contract DAJA37-81-C-1213; DAAG29-79-C-0184)
(AIAA PAPER 84-0232)

Reference is made to the installaton constructed at the Aeronautical Research Institute of Sweden for jet plume simulation with a variety of gases. Improvements in modeling methods are described which allow for congruent plumes produced from nonideal nozzle flows. The test conditions are thus extended to complex afterbody and wake flows caused by angle of attack and afterbody mounted control fins at incidence. Results are presented which show that the modeling methods give good agreement for the base pressure and separation location for stagnation pressure ratios of + or 25 deg from the design condition, for angles of attack as high as + or - 20 deg, and with the effects of control fins deflected + or - 10 deg in conjunction with angle of attack of + or - 6 deg. Explanations are offered for the small but systematic difference between the Freon and air results. C.R.

A84-17972*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PRE-EXISTING SEED PARTICLES AND THE ONSET OF CONDENSATION IN CRYOGENIC WIND TUNNELS
R. M. HALL (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0244)

The condensation research at NASA Langley Research Center has used a variety of experimental approaches to gather information on seed particles that can act as sites for condensation growth. Total pressure measurements have suggested that condensation growth is caused by impurities in the flow and not by unevaporated liquid nitrogen (LN2) droplets resulting from the LN2 injected to cool the 0.3-Meter Transonic Cryogenic Tunnel. A separate test with an optical droplet sizing probe, which was designed to detect droplets in the 2- to 300-micron range, confirmed the conclusions from the total pressure measurements and also discovered what appears to be solidified oil droplets having diameters of about 3 microns. These oil droplets appear to be the dominant source of seed particles above 2 microns. However, computer simulations of static pressure test data suggest that the measured condensation effects are the result of more numerous, smaller seeds with number densities on the order of 10 to the 12th per kilogram of the gas and diameters on the order of 0.5 microns. Author

A84-18075*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PROGRESS TOWARDS LARGE WIND TUNNEL MAGNETIC SUSPENSION AND BALANCE SYSTEMS
C. P. BRITCHER (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. Research supported by the University of Southampton; Science and Engineering Research Council of England. refs
(Contract SERC-RS-78305574; SERC-GR/B/3691.5; NSG-7523)
(AIAA PAPER 84-0413)

Recent developments and current research efforts leading towards realization of a large scale production wind tunnel Magnetic Suspension and Balance facility are reviewed. Progress has been made in the areas of model roll control, high angle-of-attack testing, digital system control, high magnetic moment superconducting solenoid model cores, and system failure tolerance. Formal design studies of large scale facilities have commenced and are continuing. Author

A84-18147#
MILITARY AIRCREW TRAINING SIMULATION - THE NEXT DECADE
R. J. HEINTZMAN (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p.
(AIAA PAPER 84-0519)

There are four general areas of military flight simulation: undergraduate pilot training, wide-body cargo aircraft, strategic aircraft, and tactical aircraft. It is believed that the advances expected in microelectronics should be used to reduce cost and improve reliability and performance and not to increase the complexity. The new DOD standard computer language Ada is seen as a possible answer to simulator software problems. It should aid in reducing documentation and software management problems because by its very structure it enforces documentation and record keeping. With regard to motion systems, it is believed that a properly designed (high bandwidth) and implemented 'g' seat that principally provides haptic cues to the pilot may be the best substitute for platform motion in future tactical simulators. New approaches to the wide-field-of-view display for tactical simulation are discussed, and attention is also given to the importance of modularity. C.R.

A84-18531#
RECENT EXPERIMENTAL WORK ON LIGHTNING ATTACHMENT-POINT-LOCATION TESTS
A. W. HANSON IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D9-1 to D9-9. Research supported by the Ministry of Defence and Dowty Rotol, Ltd.

Experimental techniques for lightning-simulation tests on aircraft are discussed, and the results of tests on a full-scale propeller blade and a model helicopter are reported. Attempts at international standardization of test parameters are considered worthwhile but unrelated to the realism of the simulation. The choice of electrode shape and waveform is considered. The tests reported used a combination of a 1-MV dc generator and an impulse generator capable of up to 1.6 MV feeding a stress-relieving-torus lower electrode and a flat upper electrode which were at distances of 1.7 to 2.5 m. The scale model was suspended between the electrodes, while the propeller blade (of metal and composite construction) was mounted on the lower electrode. Both polarities of the dc voltage were used, and corona photographs were obtained in total darkness. Sample photographs are provided. The main and tail rotors of the helicopter were struck most often, and coronas were also observed when the strike missed the model. The propeller-blade attachments occurred at the stress points of the carbon-fiber substructure near the blade tip. T.K.

A84-19138* General Electric Co., Schenectady, N. Y.
MULTIVARIABLE FREQUENCY DOMAIN CONTROLLER FOR MAGNETIC SUSPENSION AND BALANCE SYSTEMS
R. S. BAHETI (General Electric Co., Schenectady, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1020-1025. NASA-supported research.

The magnetic suspension and balance system for an airplane model in a large wind tunnel is considered. In this system, superconducting coils generate magnetic forces and torques on the magnetized soft iron core of the airplane model. The control system is a position servo where the airplane model, with six degrees of feedom, follows the reference static or dynamic input commands. The controller design, based on the characteristic loci method, minimizes the effects of aerodynamic and inertial cross-couplings, and provides the specified dynamic response. Author

A84-19256#
VISTA - A MODEST PROPOSAL FOR A NEW FIGHTER IN-FLIGHT SIMULATOR
J. BARRY, JR. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) and A. E. SCHELHORN (Calspan Corp., Advanced Technology Center, Buffalo, NY) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0520)

Design requirements and development plans for the variable-stability inflight simulator test aircraft (VISTA) being developed for the US Air Force are discussed. The performance characteristics of the current NT-33A simulator are reviewed, and the need for a VISTA which can reproduce the parameters of modern fighter aircraft is indicated. A low-risk development strategy based on modification of an existing advanced aircraft such as the F5-F, F-20, F-16B, TF/A-18, or T-45 has been adopted, and operational status by 1989 is planned. Consideration is given to the mission requirements in research, simulation, and training; the host-aircraft requirements of performance, physical configuration, availability, and variable stability; and the preliminary design concepts, including both 6-degree-of-freedom and limited-degree-of-freedom control, heads-up displays, signal conditioning, safety-pilot control, and computer-system design. T.K.

N84-15069# Naval Air Development Center, Warminster, Pa.
CREW STATION EVALUATION IN A DYNAMIC FLIGHT SIMULATION FACILITY
J. EYTH, JR. *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 10 p Oct. 1983
Avail: NTIS HC A21/MF A01

The unique capabilities and design of the dynamic flight simulator and crew station evaluation facility as they pertain to avionics systems development and validation are described. This capability for preflight man-in-the-loop evaluation of aircraft systems/subsystems during early phases of development diminishes the problems surfacing during flight tests and will ultimately reduce the cost and time required for operational deployment. E.A.K.

N84-15070# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Military Aircraft Div.
CONCEPTS FOR AVIONIC AND WEAPON INTEGRATION FACILITIES
F. KAESTNER *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 8 p Oct. 1983
Avail: NTIS HC A21/MF A01

The Tornado avionic and weapon integration facility is presented. The increased test capabilities are pointed out. Requirements for future integration concepts and the according ground test facilities are given. E.A.K.

N84-15161# Aktiebolaget Rollab, Stockholm (Sweden).
A QUASI-CONTINUOUS TRANSONIC WIND TUNNEL FOR CRYOGENIC OPERATION
C. NELANDER Nov. 1983 13 p
(ROLLAB-MEMO-RM-096) Avail: NTIS HC A02/MF A01

An alternative for driving a transonic or subsonic facility of medium to large size is described. The principle is to drive the fan in a closed circuit tunnel by using an air turbine fed by a high pressure air storage. The temperature rise imposed by the fan will be taken care of by introducing the cold outlet air from the turbine into the tunnel circuit. The same amount of air will be dumped to the atmosphere via a heat exchanger or matrix and thus cooling down the high pressure air. The stagnation enthalpy in the tunnel will be the same as the enthalpy of the driving gas in front of the turbine and the regeneration of the matrix accomplished by the temperature difference due to the Joule-Thomson effect. M.G.

N84-15163# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Flaechenflugzeuge.
FLYING QUALITIES EXPERIMENTS OF RATE COMMAND/ATTITUDE HOLD SYSTEMS IN THE HFB 320 IN-FLIGHT SIMULATOR
D. HANKE Jul. 1983 109 p
(DFVLR-FB-83-25) Avail: NTIS HC A06/MF A01; DFVLR, Cologne DM 17

The technical implementation and flight experiments for handling qualities evaluation of a rate-command/attitude-hold system for pitch and roll axes using a sidegrip as pilot's control are described. The influence of maneuver enhancement by DLC, the influence of heading hold, and wing levelling functions were investigated. The HFB 320 in-flight simulator was used as the flight test vehicle. Overall system behavior was evaluated by two pilots in 85 instrument landing approaches. Pilot-vehicle performance was determined by measured aircraft state and performance parameters. Author (ESA)

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CHEMISTRY AND MATERIALS

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

A84-16337
FLIGHT SIMULATION BEHAVIOUR OF ARAMID REINFORCED ALUMINIUM LAMINATES (ARALL)
R. MARISSEN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Werkstoff-Forschung, Cologne, West Germany) Engineering Fracture Mechanics (ISSN 0013-7944), vol. 19, no. 2, 1984, p. 261-277. Research supported by the Deutsche Forschungsgemeinschaft. refs

Aramid-reinforced aluminium laminates show excellent fatigue crack growth properties. Weight savings up to 30 percent, combined with improved damage tolerance, are possible as compared to monolithic high strength aluminium alloy structures. The improvement of the fatigue crack growth rate is merely due to the restraint on the crack opening by uncracked fibres in the wake of the crack. This effect becomes more active when favourable residual stresses are introduced by prestraining the whole laminate in the plastic region of the aluminium alloy. Author

A84-17121
MOISTURE TRANSPORT IN COMPOSITES DURING REPAIR WORK
J. M. AUGL (U.S. Navy, Naval Surface Weapons Center, Silver Spring, MD) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 273-286. refs

Attention is given to the problem posed by excessive void formation in the adhesive bonds used during field or depot repair of holed or delaminated composite aircraft structures. Void formation is due to the evaporation of water during the curing process, since moisture that had been sorbed into the composite may diffuse into the adhesive. If the partial pressure of the water dissolved in the still liquid adhesive exceeds the environmental (applied) pressure, voids will form and reduce the load-carrying strength of the bonded patch. An interactive computer program has been devised for moisture profile prediction in the composite and adhesive, during the predrying and patch bonding processes, on the basis of certain model principles. O.C.

A84-17130
POWDER METALLURGY (P/M) ALUMINUM ALLOYS FOR AEROSPACE USE
W. E. QUIST and G. H. NARAYANAN (Boeing Commercial Airplane Co., Seattle, WA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 374-391. refs

Attention is given to the development status and structural performance advantages of high temperature powder metallurgy (P/M) aluminum alloys, which rely on a high volume fraction of finely dispersed and stable intermetallic particles to impart high temperature and corrosion resistance properties. Applications for such P/M alloys, which in addition to increased fractions of the conventional alloying elements Cu, Mg, Zn, Mn, etc., may incorporate such novel elements as Fe, Co, Ce, Mo and Ni, will be in engine components and aircraft primary structures for the Mach 2-3 aerothermodynamic regime. O.C.

A84-17133
PROGRESS ON HOT ISOSTATIC PRESSING OF TITANIUM
R. H. WITT (Grumman Aerospace Corp., Bethpage, NY) and J. S. BRUCE (U.S. Navy, Naval Air Systems Command, Washington, DC) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 422-435. refs
(Contract N00019-80-C-0034)

The main objective of this program is to use the hot isostatic pressing (HIP) powder metallurgy process in conjunction with electron-beam welding (EBW) to facilitate the production of large, complex titanium structures as near-net shapes made from prealloyed powders. Other objectives include evaluation of Plasma-Rotating-Electrode Powder (PREP) for quality and the establishment of a design data base for various applications. Scale-up efforts on the HIP process employ the Crucible Research Center (CRC) ceramic mold process to produce EBW/HIP Ti-6Al-6V-2Sn titanium alloy parts weighing 50 lb or more with buy-to-fly (B/F) ratios reduced from 7:1 to less than 3:1. Included are discussions on powder production, cleanliness, characterization, mechanical properties, the use of CADAM, wax pattern design, production of ceramic molds, test specimens, component part iterations and cost comparisons for raw forgings and powder parts. Initial shapemaking results on 30and 88-lb parts show good dimensional control with virtually no distortion or twist. Author

A84-17148
PROCESSING CHARACTERISTICS OF T300-6K/V378A GRAPHITE/BIS-MALEIMIDE
L. MCKAGUE (General Dynamics Corp., Fort Worth, TX) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 640-646. Research supported by the General Dynamics Corp.

Processing characteristics of a relatively new graphite/bis-maleimide prepreg material were investigated through experimental and development manufacturing of aircraft structural skins. This involved purchase and use of several thousand pounds of prepreg in the fabrication of a variety of laminates including 80 skin components for two modified airplanes. These skin components were used in the fabrication of the wings for the F-16XL single and dual-seat aircraft. Skins ranged in weight from roughly 3 pounds to over 300 pounds each. Throughout the experimental and aircraft manufacturing effort, the new prepreg (U.S. Polymeric's T300-6K/V378A) was found to have processing characteristics that are quite similar to those normally exhibited by graphite/epoxy materials. Hand layup operations, sensitivities, and shop environment conditions are reviewed as they related to prototype manufacturing. Efforts to identify and characterize material effluents during layup and to determine the health safety of the material also are reviewed. Processing characteristics of the cure and postcure cycles ar discussed and compared with those of graphite epoxy. Finally, the resulting quality record for this new material is examined and compared with graphite/epoxy quality records on both a new material basis and a production environment basis. Author

A84-17150
SUPER MIRAGE 4000 GRAPHITE EPOXY VERTICAL STABILIZER
F. CORDIE and C. PICARD (Avions Marcel-Dassault-Breguet Aviation, Saint-Cloud, Hauts-de-Seine, France) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 658-669.

A development history is presented for proprietary design efforts toward the production of such lightweight secondary structural components for fighter aircraft as ailerons, horizontal stabilizers, and rudders. Attention is then given to the design, fabrication, and testing of the Mirage 4000 graphite/epoxy integrally stiffened skin stabilizer structure. Design requirements for this structure approximate those of a wing, in virtue of its size, relative thickness, and a fuel sealing requirement arising from the use of its torsion box as an integral fuel tank. O.C.

A84-17155
POLYMIDES FOR SERVICE AT 700 F
G. E. CHANG and R. J. JONES (TRW, Inc., Redondo Beach, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 728-739.

Three new linear aromatic polyimides have been synthesized which show promise as matrix resins for use at temperatures up to 371 C under pressures up to 0.1 MPa in air. These resins are based on modifications of two high-temperature polyimides which have been shown to be suitable for use at 357 C. All three new resins show similar thermo-oxidative stabilities when subjected to a thermal gravimetric analysis. Molding studies have shown that at least one of the new resins can be processed to give essentially void-free parts. V.L.

A84-17156
A SECOND GENERATION MODIFIED BISMALEMIDE RESIN WITH TG OF 570 F
D. LANDMAN (Dexter Corp., Hysol Div., Pittsburg, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 740-751. Research supported by the Dexter Corp.

EA9102 is a second generation modified bismaleimide resin which does not contain objectionable vinyl diluents, unlike current modified bismaleimides. The dry Tg of EA9102 determined by DMA is approximately 570 F. A wet Tg in excess of 390 F has also been measured. Additional neat resin properties are discussed. The adhesive properties of EA9102 include a flat profile for tensile shear strength (2000 psi) from 75 F to 550 F on aluminum substrates. EA9102,in tape form, shows virtually no change in tack or tensile shear strength after one month at 75 F. In addition, it has extremely reproducible (within + or - 50 psi) adhesive properties from batch to batch. Preliminary work on EA9102 resin in composite laminates has begun. Some data from this study are described. Similar to conventional epoxies, EA9102 can be cured at 350 F under standard low autoclave pressure (100 psi or less). Full properties are obtained by postcuring at 475 F in an unrestrained fashion. No volatile condensation produces are given off during the cure. Author

A84-17169
SOIL BARRIER COATING FOR IMPROVED CORROSION CONTROL
W. R. SMITH (McGean Rohco, Cee-Bee Div., Downey, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 958-965.

A maintenance program is proposed which employs a soil barrier coating and a temporary coating remover specifically designed for removing the soil barrier. The program includes the preparation and cleaning of aircraft, application of the soil barrier, and removal of the barrier after soil has accumulated during service. The result of a maintenance program using the soil barrier is that the contaminants will be prevented from reaching the aircraft surface, thus reducing or eliminating corrosion. V.L.

A84-17171
EVALUATION OF THE AF-10 ADHESIVE SEALING SYSTEM FOR USE ON THE C-130 AIRCRAFT
J. E. PEALE (USAF, Warner Robins Air Logistics Center, Robins AFB, GA), L. M. ATKINSON, M. G. BILLIAS, and M. V. COBB, JR. (Lockheed-Georgia Co., Marietta, GA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1000-1016.

In 1978, the USAF decided to replace the outer wings on many of its older C-130 aircraft. Overall objectives regarding this decision were related to an extension of the life of the aircraft and a reduction of the life cycle cost. In 1981, a contract was awarded to an American aerospace company to supply replacement outer wings for the C-130 aircraft, taking into account the use of the AF-10 Adhesive System for sealing. The adaptation of this adhesive system to the C-130 aircraft made it necessary to conduct a verification test program. It was found that the AF-10 adhesive could be used in approximately 85 percent of the joints of the C-130 wings. It could not be employed in the chordwise splice joints. Threaded fasteners must be retorqued after cure of the adhesive to reestablish fastener preload. G.R.

A84-17180
EVALUATION OF A PRIMARY ANTICORROSION SURFACE TREATMENT FOR ADHESIVELY BONDED ALUMINUM STRUCTURE
R. V. WOLF (General Dynamics Corp., Fort Worth, TX) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1155-1165.

A series of tests have been carried out to evaluate the chromic acid anodize (CAA) treatment with a sodium dichromate seal as an alternative to the FPL-etch for adhesively bonded aluminum airframe structures. It is found that for adhesive materials with a T-peel strength of 10 lb/in or greater, CAA is equivalent to the FPL-ech. For adhesive materials classified as brittle (i.e., having a T-peel strength of less than 10 lb/in) CAA does not yield shear strength values as great as the FPL-etch (approximately 15-20 percent lower). Environmental exposures and creep loading have approximately the same effect on adhesive systems regardless of whether the FPL-etch or CAA is used as the surface treatment. V.L.

A84-17181
RECENT DEVELOPMENTS IN TITANIUM SUPERPLASTIC FORMING/DIFFUSION BONDING
C. H. HAMILTON (Rockwell International Science Center, Thousand Oaks, CA) and G. STACHER (Rockwell International Corp., North American Aircraft Operations, El Segundo, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1166-1185. refs

Various strucural applications are reviewed, and the characteristics of the most generally used alloy, Ti-6Al-4V, are discussed. Special emphasis is given to the microstructural characteristics that lead to superplasticity. It is shown that an understanding of superplastic properties and related microstructural influences of the Ti-6Al-4V alloy provides a foundation for understanding alternate alloy systems and assessing the potential for these alternate alloys to be superplastically formed. The greatest superplasticity is generally observed in the alpha + beta titanium alloys, owing to the optimum combination of grain size control and easy diffusion and deformation through one of the two phases (the beta phase). It is pointed out that superplasticity in all alpha or near-alpha titanium alloys is difficult and holds substantially less promise than the alpha + beta titanium alloys. The possibilities for superplastic forming offered by beta and near-beta alloys are limited, primarily because of difficulties in controlling the grain size. C.R.

A84-17191
THE FIRST ALL COMPOSITE FIREWALL AS DEVELOPED AND DESIGNED FOR THE LEAR FAN 2100
B. M. FELL (Hexcel Corp. Dublin, CA) and P. CIRISCIOLI (Lear Fan, Ltd., Reno, NV) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1257-1265.

A series of ceramic cloth faced composite parts have been designed and tested to meet the FAA requirements for 2000 F flame protection for 15 min. These designs have shown that composites can and are being used as fire protection systems on aircraft and will out-perform the traditional materials (steel, etc.) through significant weight savings, better thermal insulation properties and retained structural properties after a fire. Author

A84-17195
HOT ISOSTATIC PRESSING OF ALUMINUM CASTINGS
G. V. SCARICH (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1329-1339.
(Contract N00019-80-C-0276)

A program is under way to demonstrate a manufacturing technology that can reduce the acquisition cost of selected F/A-18A structural components by 30-50 percent. The technology is hot isostatic pressing (HIP) of the aluminum casting alloy A201. Two F/A-18A lower centerline formers have been selected for development and evaluation. The use of near-net-shape HIPed A201 castings will reduce machining, assembly, and handling, resulting in significant cost savings. The projected cost savings for the two components as HIP A201 castings over that of machined components are 53 and 40 percent. HIP will also improve the static and dynamic mechanical properties of A201 castings to levels approaching those of wrought 7075 and 7050 products. V.L.

A84-17196
NEW TECHNOLOGY EXPANDS USES OF A PRECISION CAST-MACHINED ALUMINUM PLATE
W. C. HARVEY (Aluminum Company of America, Vernon Works, Los Angeles, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1340-1351.

The manufacturing steps and the quality control process employed to produce a precision cast machined aluminum plate with characteristics favorable for a wide range of engineering applications are described. In particular, attention is given to the remelting process, chemical composition control, metal treatment, grain refinement, casting, stress relieving, and machining. The instruments and procedures used to measure the surface smoothness, thickness, and flatness of the plates and to assure that the plates are free from metallurgical and handling defects are discussed. Detailed properties of the 7000 series aluminum alloy plates are given. V.L.

A84-17202* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PRELIMINARY EVALUATION OF LARGE AREA BONDING PROCESSES FOR REPAIR OF GRAPHITE/POLYIMIDE COMPOSITES
J. W. DEATON and N. A. MOSSO (NASA, Langley Research Center, Hampton, VA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1425-1442. refs

It is pointed out that graphite/polyimide (Gr/PI) composites are potential candidates for primary and secondary structural components in the next generation of reusable space vehicles and supersonic aircraft which are to possess operational capabilities involving the temperature range from 400 to 600 F. In connection with the considered applications, it is necessary to establish economic and reliable methods for the repair of Gr/PI composite components which have been damaged. The present investigation is concerned with the results of research conducted to develop a bonding process applicable to the repair of large areas in Gr/PI composite structural components. Attention is given to five repair techniques for Gr/PI composite materials. The techniques were employed to fabricate large panels from which flexure and short-beam-shear specimens were machined. G.R.

A84-17204
EVALUATION OF TI P/M TECHNOLOGY FOR NAVAL AIRCRAFT COMPONENTS
J. S. BRUCE (U.S. Navy, Naval Air Systems Command, Washington, DC), A. A. SHEINKER, J. W. BOHLEN, and G. R. CHANANI (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1454-1463. Navy-supported research. refs
(Contract F33615-77-C-5005)

The present investigation is concerned with the mechanical properties obtained from Ti-6Al-4V shapes produced from powder of two levels of purity. The arrestor hook support fitting (ARSF) for the F/A-18A aircraft was selected to demonstrate the viability of hot isostatic pressing (HIP) titanium P/M technology in the manufacture of large, complex, and structurally critical airframe parts. The mechanical properties of HIP P/M Ti-6Al-4V products made from rotating electrode process (REP) powder were found to be equivalent to those of comparable wrought products, with the exception of the smooth fatigue properties of the P/M material, which were inferior. However, with the use of powder made by the plasma rotating electrode process (PREP), in which contamination has been minimized, the smooth fatigue properties as well as the other mechanical properties of HIP P/M Ti-6Al-4V products are equivalent or projected to be equivalent to those of comparable wrought products. G.R.

A84-17206
ADVANCEMENTS IN TITANIUM CASTINGS
W. J. BARICE (Precision Castparts Corp., Portland, OR) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1503-1511.

The state-of-the-art for titanium investment castings has progressed tremendously in the last ten years. The capability transition from small hardware type parts to large critically stressed structural components was hastened by very real needs to conserve strategic materials and to reduce costs. Recently, significant mechanical property improvements have been achieved in titanium castings through heat treatment and through alloy development efforts. The combination of large part casting capabilities and improved mechanical properties holds great promise for widespread use of large structural titanium castings in both military and commercial engine and airframe applications. Author

A84-17251
MICRO-MECHANICAL MODELLING OF MODE III FATIGUE CRACK GROWTH IN ROTOR STEELS
H. NAYEB-HASHEMI (Northeastern University, Boston, MA), F. A. MCCLINTOCK (MIT, Cambridge, MA), and R. O. RITCHIE (California, University, Berkeley, CA) International Journal of Fracture (ISSN 0376-9429), vol. 23, Nov. 1983, p. 163-185. refs
(Contract W-7405-ENG-26; DE-AC03-76SF-00098)

Torsionally loaded, circumferentially notched cylindrical specimens of two commercial rotor steels are subjected to a mode III (antiplane shear) fatigue crack propagation study. On the basis of fractographic evidence of elongated voids parallel to the crack front, at the tip of the fatigue crack, several models of mode III crack growth are proposed on the basis of the concept that mode III crack advance occurs by the initiation and coalescence of voids formed at inclusions directly ahead of the crack tip. By considering that the linkage of these voids takes place through mode II shear, parallel to the main crack front, expressions for the mode III crack propagation rate are developed which are based either on local mode II crack tip displacement considerations or the mode II accumulated crack tip strain. The damage accumulation model provides excellent agreement with experimentally measured growth rates in these rotor steels. O.C.

A84-17411#
FRACTURE, LONGEVITY, AND DAMAGE TOLERANCE OF GRAPHITE/EPOXY FILAMENTARY COMPOSITE MATERIAL
J. W. MAR (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 77-83. USAF-supported research. refs

Fracture, longevity, and damage tolerance are among the barriers to be surmounted before full exploitation of the graphite/epoxy filamentary composite materials can occur. Fracture defines the conditions which will precipitate catastrophic failure, damage tolerance is the ability of the airframe to resist failure in the presence of damage, and longevity is the life of the airframe. The present state of knowledge with respect to these three characteristics is described. Static damage modes are not the same as those under cyclic loads. Fatigue is not a meaningful description of the behavior of the brittle filaments. Longevity is a natural outcome of designing for damage tolerance. Evidence is presented which suggests that damage tolerance of graphite/epoxy is as good if not better than the metals. Research emphasis should be directed toward the propagation of damage under cyclic loads and the amount of damage which will cause catastrophic failure. Author

A84-17439*# General Dynamics/Convair, San Diego, Calif.
EFFECTS OF 50,000 H OF THERMAL AGING ON GRAPHITE/EPOXY AND GRAPHITE/POLYIMIDE COMPOSITES
J. R. KERR and J. F. HASKINS (General Dynamics Corp., Convair Div., San Diego, CA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers, Part 1, p. 101-108) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 96-102.
(Contract NAS1-12308)

Previoulsy cited in issue 13, p. 2034, Accession no. A82-30087

A84-17444*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ENVIRONMENTAL AND HIGH STRAIN RATE EFFECTS ON COMPOSITES FOR ENGINE APPLICATIONS
C. C. CHAMIS and G. T. SMITH (NASA, Lewis Research Center, Cleveland, OH) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers, Part 1, p. 405-419) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 128-134. refs

Previously cited in issue 13, p. 2034, Accession no. A82-30118

A84-18044*# Army Aviation Research and Development Command, Cleveland, Ohio.
CERAMIC COMPOSITE LINER MATERIAL FOR GAS TURBINE COMBUSTORS
D. B. ERCEGOVIC, C. L. WALKER (U.S. Army, Propulsion Laboratory, Cleveland, OH), and C. T. NORGREN (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(AIAA PAPER 84-0363)

The application of ceramics to gas turbine combustor liners to reduce liner metal temperature was studied in an experiment in which yttria-stabilized zirconia plasma was sprayed on compliant metal substrates exposed to near stoichiometric combustion. The strain isolation pad materials chosen were Hoskins Alloy 875 and BRUNSLLOY 534 Fiber Metal of 0.25 and 0.38 cm thicknesses and 35 and 45 percent density levels. Combustor screening tests of all specimens showed no evidence of deterioration or failure. Specimens exposed to flame temperatures in excess of 2100 K were convectively or convective-transpiration cooled and were evaluated in a 10 cm sq flame tube at inlet air temperature of 533 K and pressure of 0.5 MPa. The results suggest the superiority of a system composed of the Hoskins Alloy 875 compliant pad with 0.25 cm thickness and 35 percent density coupled with a NiCrAlY bond coat and a 8 percent Y2O3-ZrO2 ceramic top coat of 0.19 cm thickness. J.N.

A84-18506
FUEL-AND-LUBRICANT CHEMISTRY IN CIVIL AVIATION: HANDBOOK [KHIMMOTOLOGIIA V GRAZHDANSKOI AVIATSII: SPRAVOCHNIK]
V. A. PISKUNOV, V. N. ZRELOV, V. T. VASILENKO, A. A. LITVINOV, and K. S. CHERNOVA Moscow, Izdatel'stvo Transport, 1983, 248 p. In Russian. refs

Basic information is provided about the physical-chemical, operational, and ecological characteristics of fuels and lubricants for use in civil aviation. Recommendations are made concerning the practical application of these substances. Particular consideration is given to methods for evaluating the quality of aviation fuels and lubricants, and to their consumption and costs during aircraft operation. B.J.

A84-18542#
LOCAL CHARGE DISTRIBUTION AND DEVELOPMENT ON INSULATING SURFACES
D. KOENIGSTEIN (Hamburg, Hochchule der Bundeswehr, Hamburg, West Germany) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. E8-1 to E8-7.

Because the local surface charge distribution on thin insulating layers may be inhomogeneous, and higher than expected, a computer-controlled measuring system has been developed in order to collect charge data over the entire surface of flat or cylindrical probes. In two minutes, 10,000 charge values can be collected by this method without influencing surface charges, allowing the time-dependent development of local charge distribution to be monitored during the discharging process. This instrument is presently applied to the charging and discharging characteristics of glass fiber-reinforced plastic, carbon fiber-reinforced plastic, and varnished aluminum, all of which can store up to 50 nanocoulombs/sq cm. Specific resistivity values were up to 1000 times higher than the results of conventional measurements. O.C.

A84-18722
CREEP AND FATIGUE INTERACTIONS IN A NICKEL-BASE SUPERALLOY
H. J. KOLKMAN and R. J. H. WANHILL (Nationaal Lucht- en Ruimtevaartlaboratorium, Emmeloord, Netherlands) IN: Strength of metals and alloys (ICSMA 6); Proceedings of the Sixth International Conference, Melbourne, Australia, August 16-20, 1982. Volume 2 . Oxford, Pergamon Press, 1983, p. 631-636. Research supported by the Royal Netherlands Air Force.

Cast bar specimens of the nickel-base superalloy Rene80 are subjected to heat treatment, fatigue cycling and creep testing in order to ascertain the influence of prior creep on fatigue life and prior fatigue on creep life. TEM was then used to determine microstructural features. The mutual influences of fatigue and creep are found to be potentially highly beneficial, rendering cumulative damage rules inappropriate for engineering design with this alloy. O.C.

A84-18948* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PHASE DISTRIBUTIONS IN PLASMA-SPRAYED ZIRCONIA-YTTRIA
R. A. MILLER, R. G. GARLICK, and J. L. SMIALEK (NASA, Lewis Research Center, Cleveland, OH) American Ceramic Society Bulletin (ISSN 0002-7812), vol. 62, Dec. 1983, p. 1355-1358. refs

The distribution of phases in plasma-sprayed zirconia-yttria has been determined over a range of yttria levels from 0 to 26.1 molpct YO(1.5) using room temperature X-ray diffractometry. Pure, plasma-sprayed zirconia is composed almost entirely of the monoclinic phase. At levels of yttria between 4 and 10 percent, a quenched-in tetragonal phase predominates, and at higher levels the cubic phase predominates. The phase distributions are compared with previously reported test lives of thermal barrier coatings formed from these materials. Regions of optimal lives were found to correlate with regions having high amounts of the tetragonal phase, small but nonzero amounts of the monoclinic phase, and little or none of the cubic phase. Possible relationships between phase composition and coating performance are discussed. Author

N84-14297# Rockwell International Science Center, Thousand Oaks, Calif.
DEFORMATION AND FATIGUE OF AIRCRAFT STRUCTURAL ALLOYS Final Report, 1 Jan. 1980 - 31 Dec. 1982
J. A. WERT, J. C. CHESNUTT, and M. R. MITCHELL Jul. 1983 106 p
(Contract F49620-80-C-0030; AF PROJ. 2306)
(AD-A133947; SC5254.2FR; AFOSR-83-0745TR; FR-1) Avail: NTIS HCA06/MFA01 CSCL 11F

This final report describes results obtained during the course of a two-part basic research program addressing problems of airframe structural materials. Both areas of investigation concentrated on deformation of alpha-Beta titanium alloys. 1n Part I, superplasticity of two-phase titanium alloys was investigated, with the goal of improving the superplastic forming capabilities through alloy modifications. Part 2 of this program concentrated on understanding the early stages of fatigue crack initiation and propagation in titanium alloys. GRA

N84-14301# Naval Postgraduate School, Monterey, Calif. Dept. of Mechanical Engineering.
THE STRUCTURE AND BEHAVIOR OF VACUUM PLASMA SPRAYED OVERLAY COATINGS ON NICKEL BASED SUPERALLOYS M.S. Thesis
P. R. NORTON Jun. 1983 49 p
(AD-A132631) Avail: NTIS HCA03/MFA01 CSCL 11F

The feasibility of using the plasma spray technique for the application of metallic overlay coatings to marine gas turbine components was evaluated. Nickel based superalloy pins were sprayed with various MCrAl coatings using the plasma spray technique, given several types of surface treatments, and then oxidized at 1000 Degrees Centigrade for 100 hours. The effects of the various post-coating treatments on the coating structure and subsequent oxide behavior were investigated. Author (GRA)

N84-14328# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
AIRCRAFT WATER-BASED SOLID FILM LUBRICANTS Final Report
A. A. CONTE, JR. 10 Jun. 1983 28 p
(Contract F61542)
(AD-A133732; NADC-83059-60) Avail: NTIS HCA03/MFA01 CSCL 11H

An improved MIL-L-81329 water based extreme temperature range solid film lubricant has been developed. This material provides corrosion protection and improved endurance life for steel on steel components while maintaining the other desirable properties such as oxidation resistance. An upgraded specification covering the properties of this material, which is designated 23C, is provided in appendix A. The goals of this program were twofold; 1) to develop a high temperature water resistant solid film lubricant based on lithium silicate; and 2) to develop a water based non-polluting solid film lubricant to replace MIL-L-8937 for moderate temperature applications. It was found that although lithium silicate films are resistant to solvation by water they are more permeable than sodium silicate films and thus allow corrosion of steel substrates to proceed at a faster rate. The addition inorganic nitrites as corrosion inhibitors causes an instability of the lithium silicate, with SiO_2 precipitating immediately. For the moderate temperature range application of MIL-L-8937, solid film lubricants containing water soluble resins were studied. The best material studies showed an endurance life of only one half that of MIL-L-8937. The use of an experimental strategy technique was found very beneficial in determining optimum composition ranges with a minimal amount of experimentation. Author (GRA)

N84-15251# Northrop Corp., Hawthorne, Calif. Aircraft Div.
INVESTIGATION OF FATIGUE CRACK-GROWTH RESISTANCE OF ALUMINUM ALLOYS UNDER SPECTRUM LOADING Final Report, 1 Oct. 1981 - 30 Nov. 1982
G. V. SCARICH and P. E. BRETZ Apr. 1983 187 p
(Contract N00019-81-C-0550)
(AD-A133206; AD-E000546; NOR-83-84) Avail: NTIS HCA09/MFA01 CSCL 11F

The purpose of this program is to obtain metallurgical guidelines and test methodologies for selection and development of spectrum fatigue resistant, high strength aluminum alloys for application to aircraft structures. Described in this report are the results of baseline characterizations of ten high strength aluminum alloys. Also described are results of fatigue crack growth tests under two F-18 load spectra and under modifications of these spectra. GRA

N84-15283*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
BROAD SPECIFICATION FUELS COMBUSTION TECHNOLOGY PROGRAM Final Report, Sep. 1979 - Feb. 1982
W. J. DODDS and E. E. EKSTEDT Jan. 1984 341 p refs
(Contract NAS3-22063)
(NASA-CR-168179; NAS 1.26:168179) Avail: NTIS HC A15/MF A01 CSCL 21D

Design and development efforts to evolve promising aircraft gas turbine combustor configurations for burning broadened-properties fuels were discussed. Design and experimental evaluations of three different combustor concepts in sector combustor rig tests was conducted. The combustor concepts were a state of the art single-annular combustor, a staged double-annular combustor, and a short single-annular combustor with variable geometry to control primary zone stoichiometry. A total of 25 different configurations of the three combustor concepts were evaluated. Testing was conducted over the full range of CF6-80A engine combustor inlet conditions, using four fuels containing between 12% and 14% hydrogen by weight. Good progress was made toward meeting specific program emissions and performance goals with each of the three combustor concepts. The effects of reduced fuel hydrogen content, including increased flame radiation, liner metal temperature, smoke, and NOx emissions were documented. The most significant effect on the baseline combustor was a projected 33% life reduction, for a reduction from 14% to 13% fuel hydrogen content, due to increased liner temperatures. Author

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ENGINEERING

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

A84-15909#
AE SOURCE IDENTIFICATION BY FREQUENCY SPECTRAL ANALYSIS FOR AN AIRCRAFT MONITORING APPLICATION
L. J. GRAHAM and R. K. ELSLEY (Rockwell International Science Center, Thousand Oaks, CA) Journal of Acoustic Emission (ISSN 0730-0050), vol. 2, Jan.-Apr. 1983, p. 47-55. refs

Computer pattern recognition has been used to separate acoustic emission signals generated by fretting, crack growth, and crack face rubbing in an effort to develop a method for unambiguously detecting the presence of a fatigue crack at a fastener hole in an aircraft structure by means of in-flight AE monitoring. In experiments conducted on the 7075 T651 aluminum plate, better than 90-percent separation of crack growth from crack face rubbing has been achieved by using frequency features of the waveform from two transducers. Better than 95-percent separation of fretting from crack growth or crack face rubbing, separately or combined, has been achieved using the ratios of the spectral energies detected at the two transducers. V.L.

A84-15928
ACOUSTIC EMISSION IN AIRCRAFT STRUCTURAL INTEGRITY AND MAINTENANCE PROGRAMS
J. RODGERS (Acoustic Emission Technology Corp., Sacramento, CA) Journal of Acoustic Emission (ISSN 0730-0050), vol. 1, April 1982, p. 113-120. refs

Past and present in-flight crack detection programs are reviewed. The success that the F-105 program has achieved in monitoring stable fatigue crack growth on a complex structure in a high-noise environment has established current techniques for application to the flight environment. It is noted that the use of acoustic emission for quantitative determinations of damage and residual strength in composite materials is being achieved both with conventional monitoring concepts and with a new acousto-ultrasonic technique developed at NASA-Lewis. Conventional AE monitoring and acousto-ultrasonic testing are the only techniques currently demonstrating feasibility for quantitative strength evaluation of composite materials in a wide variety of applications. C.R.

A84-15951*# Illinois Univ., Chicago.
KINEMATIC PRECISION OF GEAR TRAINS
F. L. LITVIN, R. N. GOLDRICH (Illinois, University, Chicago, IL), J. J. COY (U.S. Army, Propulsion Laboratory, Cleveland, OH), and E. V. ZARETSKY (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Mechanisms, Transmission, and Automation in Design, vol. 105, Sept. 1983, p. 317-326. refs
(ASME PAPER 82-WA/DE-34)

Kinematic precision is affected by errors which are the result of either intentional adjustments or accidental defects in manufacturing and assembly of gear trains. A method for the determination of kinematic precision of gear trains is described. The method is based on the exact kinematic relations for the contact point motions of the gear tooth surfaces under the influence of errors. An approximate method is also explained. Example applications of the general approximate methods are demonstrated for gear trains consisting of involute (spur and helical) gears, circular arc (Wildhaber-Novikov) gears, and spiral bevel gears. Gear noise measurements from a helicopter transmission are presented and discussed with relation to the kinematic precision theory. Previously announced in STAR as N82-32733 Author

A84-16309
ANALYSIS OF SWEPT PLATES WITH STRUCTURAL REDUCTION USING TRANSITION ELEMENT CONCEPT
B. R. SOMASHEKAR (National Aeronautical Laboratory, Bangalore, India) and C. S. NANJUNDA RAM (Malnad College of Engineering, Hassan, India) Computers and Structures (ISSN 0045-7949), vol. 18, no. 3, 1984, p. 409-416. refs

An economical numerical analysis of a cantilever swept plate is presented which combines plate theory with beam theory, using each where required and employing a specially designed interphase element for the interdomain transition. The plate region is modelled by the high-precision continuous triangular plate element of Cowper et al. (1969), while the beam region is modelled using a torsion-flexure coupled beam element. The transition element is constructed by initially treating the transition region as an assembly of plate elements and by a suitable variationally and kinematically consistent condensation procedure, producing the required nodes and nodal variables to effect the transition form. The procedure achieves a considerable reduction in problem size and solution time. C.D.

A84-16579
KALMAN FILTER APPLICATIONS IN HIGHLY MANEUVERABLE, INTELLIGENT TARGET TRACKING
C.-F. LIN and M. W. SHAFROTH (Wisconsin, University, Madison, WI) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 441-448. Research supported by the University of Wisconsin. refs

Solutions to the problem of filter initialization and divergence prevention are developed. These solutions are arrived at by introducing a lag of l so that l measurements beyond the time for which the state is being estimated are available. This means that it is possible to produce a local estimate of the state. This estimate can be compared with the filtered estimate of the state to check for divergence. If divergence is found, the filter can be reinitialized with this estimate. These solutions are then applied to the problem of tracking a maneuvering target. Approximate theoretical and actual simulated RMS position and velocity errors are given for the Bar-Shalom/Birmiwal trajectory. Author

A84-16603
THE USE OF EEPROMS IN EMBEDDED COMPUTERS FOR AVIONIC APPLICATIONS
T. M. STRIKE and G. E. SANDERS (Georgia Institute of Technology, Atlanta, GA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 611-617.

The use of embedded computers in Line Replaceable Units (LRUs) of avionic systems has led to problems related to the loading, modification, and verification of flight software. Through technology insertion, systems incorporating the more commonly used types of nonvolatile electronic memory devices can be upgraded by replacing these memory devices with electrically erasable programmable read-only memory (EEPROM). By using EEPROMs together with a common memory loader/verifier (ML/V) substantial improvements are realized in reliability, maintainability, and the ease with which software can be handled. A successful program of EEPROM technology insertion has resulted in significant improvement in system performance of a family of avionic devices. Author

A84-16610
BUFFERED RECEPTOR, AVIONICS INTEGRATION NETWORK (BRAIN) - A CONCEPT PROPOSED FOR MEMORY MANAGED AVIONICS
R. D. HAWKINS (Forecasting Integrated Technologies Corp., Arlington, VA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 659-668. refs

A concept is presented herein in which an advanced memory module is proposed as a medium to interface between the aircraft crew and its operational systems in such a manner as to synergistically integrate crew and aircraft into a more effective weapon system. The acronym chosen for the device is intended to be indicative of its function - in essence, the 'BRAIN' is meant to serve as an instrument of control, directly responsive to the needs and wishes of the aircrew, and completely competent to manage every function of the aircraft on a continuous basis. Therefore, by relieving the crew of the stress and tensions of monitoring such things as aircraft altitude, velocity, and heading; and by managing such functions as navigation, weapons delivery, damage assessment, etc., the combination of aircraft and crew will display a measure of performance considered unattainable beforehand. The BRAIN should be a standard device, applicable to all class and make of aircraft. It would perform all mission and maintenance oriented functions, as well as serving as an archival store. Its installation and removal for maintenance and replacement would be easily facilitated. It would be an asset without parallel in any aircraft weapons system. Author

A84-16692#
BRUSHLESS GENERATION WITH CASCADED DOUBLY FED MACHINES
T. H. ORTMEYER (Clarkson College of Technology, Potsdam, NY) and W. U. BORGER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1420-1425.
(Contract F49620-82-C-0035)
The solid state converter used by the system operates at a fraction of the system power and frequency. What is more, the system operates without hydraulics. The fundamental characteristics of operation are discussed. Attention is given to the choice of optimum speeds and pole numbers for a given speed range. It is shown that two discrete operating modes exist for this type of system, namely subsynchronous and supersynchronous. System analysis is treated, and particular power, var, and frequency requirements for a 1.5:1 speed range system are presented. Cascaded doubly fed machines are seen as forming a viable basis for a generator system that holds considerable promise for operation that is high in reliability and low in cost. C.R.

A84-16695
COMPUTER IMAGE GENERATOR SCENE MANAGEMENT SYSTEM
F. P. LEWANDOWSKI and J. W. NEWHARD (Singer Co., Link Flight Simulation Div., Binghampton, NY) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1441-1448. USAF-sponsored research.
A program that facilitates the maximization of the scene content displayed on the digital visual system of a flight simulator has been developed. Using information about the purpose of the mission and about the potential overload status of the subsystems of the image generator, this 'discriminator' program selects visual scene features from a dense general-purpose data base. The features stored in the data base (many at multiple levels of detail) are coded as to their importance to various missions. The program then determines what features should be displayed and at what level of detail they can be displayed at any given time. Author

A84-17157
TECHNOLOGY MODERNIZATION AT LOCKHEED-GEORGIA
J. TULKOFF (Lockheed-Georgia Co., Marietta, GA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 774-780.
Technology and systems modernization and development are viewed at Lockheed-Georgia as integral keys toward achieving the automated, integrated factory of the future. A formal Tech/Mod program in addition to a structured approach toward the introduction of advanced manufacturing technologies emphasizes such key areas as top-down factory analysis, state-of-the-art awareness, return on investment criteria, and risk assessment. Author

A84-17185
PROGRESS ON ISOTHERMAL SHAPE ROLLING
J. S. BRUCE (U.S. Navy, Naval Air Systems Command, Washington, DC), R. H. WITT (Grumman Aerospace Corp., Bethpage, NY), and K. C. WU (Northrop Corp., Hawthorne, CA) IN: Materials and processes - Continuing innovations; Proceedings of the Twenty-eighth National SAMPE Symposium and Exhibition, Anaheim, CA, April 12-14, 1983 . Azusa, CA, Society for the Advancement of Material and Process Engineering, 1983, p. 1214-1222.
(Contract N00019-78-C-0226; N00019-78-C-0411)
A study has been initiated to investigate the applicability of isothermal shape rolling to the fabrication of low-cost titanium components for Naval aircraft structures. Typical Naval aircraft parts, F-14A wing beams and F-18A fuel bay floor support, have been selected for the study. The results of initial process verification tests performed on subscale Ti-6Al-4V and Ti-6Al-6V-2Sn alloy components are reported which show that the mechanical properties and material quality are not detrimentally affected by the isothermal shape rolling process. Testing of full-scale components is now under way. V.L.

A84-17410#
AEROELASTIC FLUTTER AND DIVERGENCE OF STIFFNESS COUPLED, GRAPHITE/EPOXY CANTILEVERED PLATES
S. J. HOLLOWELL (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) and J. DUGUNDJI (MIT, Cambridge, MA) (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers. Part 2, p. 416-426) Journal of Aircraft (ISSN 0021-8669), vol. 21, Jan. 1984, p. 69-76. refs
(Contract F33615-77-C-5155)
Previously cited in issue 13, p. 2111, Accession no. A82-30172

A84-17427*# College of William and Mary, Williamsburg, Va.
NUMERICAL COMPUTATIONS OF TURBULENCE AMPLIFICATION IN SHOCK-WAVE INTERACTIONS
T. A. ZANG (College of William and Mary, Williamsburg, VA), M. Y. HUSSAINI (NASA, Langley Research Center; Institute for Computer Applications in Science and Engineering, Hampton, VA), and D. M. BUSHNELL (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 13-21. refs
(Contract NAG1-109; NAS1-15810; NAS1-16394; NAS1-17070)
Previously cited in issue 08, p. 1213, Accession no. A82-22085

A84-17442#
GENERIC APPROACH TO DETERMINE OPTIMUM AEROELASTIC CHARACTERISTICS FOR COMPOSITE FORWARD-SWEPT-WING AIRCRAFT
G. A. OYIBO (Fairchild Republic Co., Farmingdale, NY) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 117-123. refs
For a long time, an aeroelastic instability known as divergence had consistently frustrated attempts to utilize the superior aerodynamic and configurational characteristics of forward-swept aircraft. However, possibilities for overcoming this difficulty began to appear when Krone (1975), using a numerical approach, could show that a composite forward-swept wing can be aeroelastically tailored to overcome the divergence problem. Krone's work led to studies by Weisshaar (1980), who proposed an analytical model for the mechanism of aeroelastic tailoring involved. Now a need exists for a unified analysis which would permit the consideration of all variables. The present investigation shows that the critical aeroelastic characteristics can be expressed in terms of three bounded, generic stiffness variables and the fiber orientation angle. G.R.

A84-17443*# Iowa State Univ. of Science and Technology, Ames.
EXPERIMENTAL STRESS ANALYSIS OF A THIN WALLED PRESSURIZED TORUS LOADED BY CONTACT WITH A PLANE
J. R. BAUMGARTEN (Iowa State University of Science and Technology, Ames, IA) and D. E. HILL (Structures, Structural Dynamics and Materials Conference, 23rd, New Orleans, LA, May 10-12, 1982, Collection of Technical Papers, Part 1, p. 369-373) AIAA Journal (ISSN 0001-1452), vol. 22, Jan. 1984, p. 124-127. refs
(Contract NSG-1605)
Previously cited in issue 13, p. 2108, Accession no. A82-30114

A84-17531

TECHNOLOGY ADVANCES IN ENGINEERING AND THEIR IMPACT ON DETECTION, DIAGNOSIS AND PROGNOSIS METHODS; PROCEEDINGS OF THE THIRTY-SIXTH MEETING, SCOTTSDALE, AZ, DECEMBER 6-10, 1982

G. A. WHITTAKER, ED. (Honeywell, Inc., Minneapolis, MN), T. R. SHIVES, ED. (National Bureau of Standards, Gaithersburg, MD), and G. J. PHILIPS, ED. (David W. Taylor Naval Ship Research and Development Center, Annapolis, MD) Meeting sponsored by the Mechanical Failures Prevention Group, NBS, and U.S. Navy . Cambridge and New York, Cambridge University Press, 1983, 325 p.

Topics related to machinery health diagnostics are discussed, taking into account a graphic system of a fracture control program for pressure vessels and tanks, an automatic diagnosis for malfunctions of rotating machines by a fault matrix, a malfunction diagnosis of rolling element bearings, advances in design and testing for failure prevention in aircraft, a portable X-ray analyzer for wearmetal particles in lubricants, and an aerothermodynamic gas path analysis for health diagnostics of combustion gas turbines. Other subjects explored are concerned with sensors and instrumentation, new technologies and techniques, applications of data processing, and prognosis of failure. Attention is given to digital image processing for improved detection and diagnosis of hidden flaws, the impact of microprocessors on rotating machinery data acquisition and diagnostic information systems, and the automated inspection of hot steel slabs. G.R.

A84-17543* Martin Marietta Aerospace, Denver, Colo.

A PORTABLE X-RAY ANALYZER FOR WEARMETAL PARTICLES IN LUBRICANTS

B. C. CLARK, V. P. WOERDEMAN, M. G. THORNTON, B. J. COOK (Martin Marietta Aerospace, Denver, CO), P. W. CENTERS (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and W. C. KELLIHER (NASA, Langley Research Center, Hampton, VA) IN: Technology advances in engineering and their impact on detection, diagnosis and prognosis methods; Proceedings of the Thirty-sixth Meeting, Scottsdale, AZ, December 6-10, 1982 . Cambridge and New York, Cambridge University Press, 1983, p. 189-197.
(Contract F33615-80-C-2071)

An extensive program exists for the systematic sampling and analysis of lubricants in U.S. Air Force aircraft engines. The sudden development of excessive engine wear can usually be detected on the basis of monitoring the concentration of several key metallic elements for each aircraft engine. In many cases even the specific fault within an engine can be recognized. The two types of equipment which are currently being employed for the conduction of oil analyses make use of atomic emission or atomic absorption spectroscopy. In both cases, heavy, large, and relatively fragile pieces of equipment are involved. Difficulties concerning the transportation of these devices have led to the development of a small, sturdy, and easily portable wearmetal analyzer. The analyzer makes use of an X-ray fluorescence technique. G.R.

A84-17544

VEHICLE TEST RESULTS FOR THE GARRETT GT601 GAS TURBINE ENGINE

P. D. OLIVIER (Garrett Turbine Engine Co., Phoenix, AZ) IN: Technology advances in engineering and their impact on detection, diagnosis and prognosis methods; Proceedings of the Thirty-sixth Meeting, Scottsdale, AZ, December 6-10, 1982 . Cambridge and New York, Cambridge University Press, 1983, p. 207-227.

The GT601 gas turbine engine was designed and developed for vehicular use both in wheel and tracked vehicles. Operational level test programs for this engine in highway truck and tracked military vehicle applications have provided experience and developmental data far beyond the scope of the typical test cell environment. This paper presents vehicular engine test results in terms of problems incurred and design modifications initiated to improve the engine configuration. Author

A84-17545

AEROTHERMODYNAMIC GAS PATH ANALYSIS FOR HEALTH DIAGNOSTICS OF COMBUSTION GAS TURBINES

C. B. MEHER-HOMJI and M. P. BOYCE (Boyce Engineering International, Inc., Houston, TX) IN: Technology advances in engineering and their impact on detection, diagnosis and prognosis methods; Proceedings of the Thirty-sixth Meeting, Scottsdale, AZ, December 6-10, 1982 . Cambridge and New York, Cambridge University Press, 1983, p. 228-237.

The effect of a health monitoring and diagnostic system on the Life Cycle Costs (LCC) of a gas turbine is illustrated with the aid of a schematic. The LCC for turbines are very strongly affected by maintenance and fuel costs, and any system which can help to increase the thermodynamic efficiency, reduce maintenance costs, and minimize the probability of catastrophic failure would have a very significant effect on reducing LCC. It is emphasized that good overall diagnostics must be based on an integration of aerothermal analysis, vibration analysis, lube oil analysis, and possibly other techniques. The present investigation is mainly concerned with the aerothermodynamic gas path analysis. It is found that aerothermodynamic analysis can provide valuable information on gas turbine engine health. Attention is given to basic aerothermal performance equations, a gas path analysis technique developed by Urban (1972), and aspects of instrumentation. G.R.

A84-17704

THE DEVELOPMENT OF A THREE-DIMENSIONAL WAVE PACKET IN A BOUNDARY LAYER [RAZVITIE PROSTRANSTVENNOGO VOLNOVOGO PAKETA V POGRANICHNOM SLOE]

V. M. GILEV, IU. S. KACHANOV, and V. V. KOZLOV (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoi Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk (ISSN 0134-2428), Oct. 1983, p. 27-37. In Russian. refs

A detailed experimental study was made of the linear evolution of three-dimensional wave packets, including special measurements of the eigenfunctions of three-dimensional waves. The experiments were carried out in a low-turbulence subsonic wind tunnel on a flat plate. A combined frequency-wave Fourier analysis of the perturbations made it possible to determine the components of wave vectors and classify waves on the basis of their propagation angle. V.L.

A84-17835*# Tennessee Univ., Knoxville.

MEASUREMENTS OF LOCAL CONVECTIVE HEAT TRANSFER COEFFICIENTS ON ICE ACCRETION SHAPES

R. V. ARIMILLI, E. G. KESHOCK (Tennessee, University, Knoxville, TN), and M. E. SMITH (USAF, Arnold Engineering and Development Center, Arnold Air Force Station, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(Contract NAG3-83)
(AIAA PAPER 84-0018)

The thin-skin heat rate technique was used to determine local convective heat transfer coefficients for four representative ice accretion shapes. The shapes represented three stages of glaze ice formation and one rime ice formation; the ice models had varying degrees of surface roughness. In general, convective heat transfer was higher in regions where the model's surfaces were convex and lower in regions where the surfaces were concave. The effect of roughness was different for the glaze and rime ice shapes. On the glaze ice shapes, roughness increased the maximum Nu by 80 percent, but the other Nu values were virtually unchanged. On the rime ice shape, the Nu numbers near the stagnation point were unchanged. The maximum Nu value increased by 45 percent, and the Nu number downstream of the peak increased by approximately 150 percent. V.L.

A84-17871*# Kansas Univ. Center for Research, Inc., Lawrence.
AN ELECTROMAGNETIC VIBRATOR FOR USE IN FLUTTER TESTING
D. J. DEAM (University of Kansas Center for Research, Inc., Lawrence, KS) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p.
(Contract NSG-4019)
(AIAA PAPER 84-0086)

This paper describes a unique vibrator that can be used for the flutter testing of airplanes. The device is a variation of a linear electric motor; it uses alternating electromagnetic forces to move a magnetic mass and produce vibration. This design approach requires few components and makes the device attractively simple, reliable and efficient. Author

A84-17922#
A NATURAL FORMULATION FOR NUMERICAL SOLUTION OF THE EULER EQUATIONS
A. VERHOFF and P. J. ONEIL (McDonnell Aircraft Co., St. Louis, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0163)

QAZ1D, a formulation employing an arbitrary computational grid with natural streamline coordinates in the numerical solution of the Euler equations, is presented and demonstrated. Riemann variables extended to include entropy are used to express the multidimensional Euler equations, permitting their reduction to a mildly coupled quasi-1D system with unambiguously defined eigenvalues. The characteristic trajectories of the equations can control the reformulation of the Euler equations in the space-time domain and again reduce them to ordinary differential expressions soluble by quadrature and interpolation. The algorithm based on this procedure is found to be efficient, codable, explicit, and vectorizable. Its accuracy is demonstrated in sample applications to simple 1D and 2D flow problems at all Mach numbers. Graphs and diagrams are provided. T.K.

A84-18037*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PERFORMANCE OF LARGE-EDDY BREAKUP DEVICES AT POST-TRANSITIONAL REYNOLDS NUMBERS
J. B. ANDERS, J. N. HEFNER, and D. M. BUSHNELL (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. refs
(AIAA PAPER 84-0345)

Large-eddy alteration techniques were used to modify the drag characteristics of the turbulent boundary layer. Local skin-friction coefficients were measured for single and multi-element arrays of thin plates suspended in a fully turbulent, flat plate, boundary layer at R(theta) = 3,000. Effects of these devices were measured more than 300 boundary-layer thicknesses downstream to R(theta) = 17,000. It was found that although most of the devices reduced the local skin friction immediately downstream, this reduced skin-friction region persisted for only 100-120 delta-0, after which a rapid rise in skin-friction coefficient occurred, often exceeding flat plate values. Net drag reductions were obtained only for tandem configurations and these reductions were sensitive to device spacing and height. The maximum net drag reduction reported was approximately 7 percent with a device spacing of 10 delta-0 at a height of 0.8 delta-0. Author

A84-18524*# Johns Hopkins Univ., Baltimore, Md.
THE CONTAINMENT SET APPROACH TO DIGITAL SYSTEM TOLERANCE OF LIGHTNING-INDUCED TRANSIENT FAULTS
G. M. MASSON and R. E. GLASER (Johns Hopkins University, Baltimore, MD) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. C6-1 to C6-8. NASA-supported research.

A fault model and a system model are necessary to assess the tolerance or resilience of a digital system to lightning-induced transients. It is noted that these models are usually developed separately. A new approach is outlined here for this assessment problem which combines the fault and system models into an overall model. With this approach, referred to as the containment set approach, an assessment of the effects of lightning-induced transients can be made in terms of a state transition matrix. This matrix can be generated by means of fault injection experiments. In addition, certain nonredundancy-oriented design alternatives to the achievement of lightning-induced transient tolerance in digital systems are indicated by the containment set approach. C.R.

A84-18527#
EXPERIMENTAL AND THEORETICAL EVALUATION OF A FAST-RISETIME, HIGH CURRENT LIGHTNING INDIRECT EFFECTS SIMULATOR
J. D. ROBB (Lightning and Transients Research Institute, St. Paul, MN) and R. A. PERALA (Electro Magnetic Applications, Inc., Denver, CO) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. D3-1 to D3-7. USAF-supported research. refs

It is proposed that nuclear electromagnetic pulse generators with the front of the wave slowed down to 30 to 100 nanoseconds be used to supply a fast clean front of wave for indirect effects measurements of lightning coupling to digital avionics in full size aircraft. With the aid of coaxial return conductors, the approach also provides the fast radial electric field that may be of greater significance than previously believed. It is stressed that more realistic testing to provide these fast risetimes is especially important because of the increasing use of flight critical digital circuits and composite skins that have significantly reduced electromagnetic shielding. C.R.

A84-18537#
STATIC CHARGING BY COLLISIONS WITH ICE PARTICLES
A. J. ILLINGWORTH (University of Manchester Institute of Science and Technology, Manchester, England) and J. CARANTI IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. E2-1 to E2-6. refs

Recent laboratory work will be described which gives considerable insight into the fundamental processes of charge flow and separation which operate when small ice particles impact upon metal surfaces or upon a second ice surface. This work suggests that the charge transfer when ice contacts metal or ice should be to some extent predictable and dependent upon the work function of the metal and the surface or contact potential of the ice. This contact potential is different for ice formed in the atmosphere by different natural methods. Author

A84-18546#
LIGHTNING TRANSIENT INTERACTION CONTROL
E. F. VANCE and J. E. NANEVICZ (SRI International, Menlo Park, CA) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G2-1 to G2-8. refs

Transient or broadband interference from such sources outside an aircraft as lightning strikes can be controlled, through the application of topologically closed electromagnetic barriers. The appropriate choice of barrier configurations can reduce maintenance, increase reliability, and simplify specification and testing at the subsystem level. The appropriate allocation procedures can yield intrasystem compatibility, as well as immunity to lightning strikes. O.C.

A84-18550#
FLASHOVER VOLTAGE REDUCTION BY PROXIMATE CONDUCTORS
S. W. WATERMAN (British Aerospace PLC, Stevenage, Herts., England) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G6-1 to G6-5. Research supported by the Ministry of Defence.

An attempt was made to quantify the flashover voltage reduction observed when conducting bodies are adjacent to the flashover path, in order to more adequately protect aircraft radomes against lightning strikes. In the case of flashover voltage reduction in fiberglass-reinforced plastic panels by adjacent conductors, significant effects are found with conducting layers of resistance of less than 1 Megaohm/square, as well as with thin wires that are spaced up to 100 m apart. A combination of the two reduced flashover voltage, over 500 mm, from 300 to 50 kV. O.C.

A84-18551#
THE CALCULATION OF DIFFRACTION EFFECTS OF RADOME LIGHTNING PROTECTION STRIP
S. WATERMAN (British Aerospace PLC, Stevenage, Herts., England) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 2 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. G7-1 to G7-6. Research sponsored by the Ministry of Defence.

A method of calculating the near- or far-field diffraction effects of a cage of metal strips, such as is often used for the protection of aircraft radomes from lightning damage, is presented with attention to the prediction of boresight loss and aberration, sidelobe degradation to 90 deg off axis, reflection lobes, and the main features of the induced cross-polar fields. The minimum accuracy required is + or - 3 dB of the scattered power, when this is from zero to 40 dBs below the boresight power of the antenna. The technique presently employed represents the metal strip current as two line sources. Representative results of the computation method are presented. O.C.

A84-19183
CALCULATION OF THE LIFE OF A WING PANEL ELEMENT [RASCHET DOLGOVECHNOSTI ELEMENTA PANELI KRYLA]
A. V. KIRILLOV and A. S. MOSTOVOI (Kuibyshevskii Aviatsionnyi Institut, Kuibyshev, USSR) Problemy Prochnosti (ISSN 0556-171X), Dec. 1983, p. 32-36. In Russian. refs

A method is proposed for determining the fatigue life of a joint between a wing panel element and a stringer under asymmetrical cyclic loading. The method is based on the linear-discrete hypothesis of damage accumulation whereby linear damage accumulation is assumed till the moment of crack initiation, and discrete damage accumulation is assumed at the stage of crack growth. The results of a computer simulation based on the approach proposed here are found to be in reasonably good agreement with experimental data. V.L.

A84-19251#
LATERAL JET INJECTION INTO TYPICAL COMBUSTOR FLOWFIELDS
D. G. LILLEY (Oklahoma State University, Stillwater, OK), G. B. FERRELL, M. T. ABUJELALA, and A. A. BUSNAINA American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 14 p. refs
(AIAA PAPER 84-0374)

A research program is underway which deals both experimentally and theoretically with the problem of primary and dilution lateral jet injection into typical combustor flowfields in the absence of combustion. Parameter variations to be systematically investigated include: lateral jet velocity, combustor cross-flow inlet swirl strength, and downstream contraction nozzle. The basic aim is to characterize the time-mean and turbulence flowfield with a variety of parameter settings, recommend appropriate turbulence model advances, and implement and exhibit results of flowfield predictions. The present study emphasizes the predictive capability of a fully three-dimensional computer code with k-e turbulence model, with preliminary experimental evaluation using smoke and helium bubble flow visualization, and five-hole pitot probe time-mean velocity measurements. Author

N84-14355# Bell Aerospace Corp., Wheatfield, N. Y.
LACV-30 INCREASED PAYLOAD STUDY Report, for Sep. 1982 - Apr. 1983
Aug. 1983 141 p
(Contract DAAK70-82-C-0196)
(AD-A133804; REPT-7467-928028) Avail: NTIS HCA07/MFA01 CSCL 01C

This report summarizes the results of a six-month study directed at investigating a number of potential improvements to the U.S. Army's LACV-30. The objective of this program has been to examine and evaluate various ways of increasing the LACV-30's payload, without incurring a large increase in cost, or penalizing its performance, either over land or over water, in varying sea state conditions. The work performed identified several potential improvements which could be beneficial to the LACV-30, giving it greater load-carrying capacity. These include: (1) A reduction in the exit area of the stern seal cones; (2) Reversal of the direction of rotation of the LACV-30's port side lift fan, with a corresponding adjustment of the volutes to direct the flow of the air from the fan to the stern and side bags; and (3) Replacement of the LACV-30 lift fans, with new fans designed to operate at pressures and flow rates better matched with the seal system requirements. GRA

N84-14393# Lincoln Lab., Mass. Inst. of Tech., Lexington.
A PROGRAMMABLE VOICE PROCESSOR FOR FIGHTER AIRCRAFT APPLICATIONS
E. M. HOFSTETTER, E. SINGER, and J. TIERNEY 18 Aug. 1983 44 p
(Contract F19628-80-C-0002; AF PROJ. 2283; AF PROJ. 411L)
(AD-A133780; TR-653; ESD-TR-83-037) Avail: NTIS HCA03/MFA01 CSCL 17B

A flexible, high-speed digital voice processor has been designed for use in conjunction with the JTIDS communication terminal to be installed for testing on board F-15 fighter aircraft and in Army JTIDS installations. The processor, known as the Advanced Linear Predictive Microprocessor (ALPCM), has an architecture which is similar to that of its predecessor but contains significant improvements in speed, memory, and software development aids. The design includes an arithmetic section (four AMD 2901C bit-slice RALUs and an AMD 29517 16x16 multiplier), a doubly pipelined control path, and an I/O section based on a finite state machine implementation. Microcode development is enhanced by the presence of an interactive debugging system consisting of a plug-in monitor board controlled from a host computer. The ALPCM is capable of implementing conventional 2400-bps LPC vocoders in real time and is sufficiently powerful to accommodate more sophisticated, computationally intensive algorithms should the extra performance they provide be required in the severe F-15 operational environment. Author (GRA)

N84-14400# Ohio State Univ., Columbus. Electroscience Lab.
ANALYSIS OF ELECTROMAGNETIC BACKSCATTER FROM AN INLET CAVITY CONFIGURATION Final Technical Report, 1 Apr. 1980 - 1 Apr. 1982
P. H. PATHAK, C. C. HUANG, C. Y. LAI, and D. L. MOFFATT Griffiss AFB, N.Y. RADC Jan. 1983 298 p Sponsored in part by Rockwell Intern.
(Contract F19628-80-C-0056; AF PROJ. 2305)
(AD-A133626; ESL-712661-4; RADC-TR-83-5) Avail: NTIS HCA13/MFA01 CSCL 12A

The radar cross secction of jet engine configurations on modern aircraft is a most perverse problem analytically. An ability to predict

the radar cross section of loaded cavity structures, even when such structures are only very crude models of the actual engine, has been seriously lacking. At the same time it is well known that above a certain spectral range the engine configuration largely controls the radar cross section of the aircraft over a large span of noise and often stern aspects. Recently, the radar signal modulation produced by the engines has become of important analytical concern. This report is separated into two parts. Part I, Ray Analysis of EM Backscatter from a Cavity Configuration contains the major thrust of our research and basically details an asymptotic frequency domain analysis of various loaded cavity structures. Part II, Canonical Response Waveforms of Finite and Open Circular Waveguides is essentially a time domain analysis of the same types of problems. The parts are interrelated in the sense that results from one are used in the other. For example, Part II reproduces a portion of the exact Wiener-Hopf computations for an open circular waveguide. These results were used to verify a portion of the theory in Part I. Conversely, frequency computations from the analysis in Part I are used in Part II as part of a Fourier synthesis procedure to obtain canonical response waveforms.
GRA

N84-14416 Ohio State Univ., Columbus.
ANALYSIS OF AIRBORNE ANTENNA PATTERN AND MUTUAL COUPLING AND THEIR EFFECTS ON ADAPTIVE ARRAY PERFORMANCE Ph.D. Thesis
H. H. CHUNG 1983 285 p
Avail: Univ. Microfilms Order No. DA8318334

The uniform geometrical theory of diffraction (UTD) is employed in this high frequency study of airborne antenna radiation patterns. A numerical solution is developed to treat general type aircraft in which the fuselage is assumed to be a perfectly conducting composite prolate spheroid surface. The wings, stabilizers and cockpit are simulated by multiple finite flat plates. Various patterns are calculated for antennas mounted on a F-16 fighter and KC-135 aircraft. The validity of the solution is verified by comparing the computed results with scale model measurements. An element placement procedure for airborne adaptive arrays is presented and evaluated in terms of a practical example. The airborne antenna radiation pattern solution is used as the basic tool in developing this placement algorithm. It is shown using this algorithm that one is able to design a system to achieve the required minimum SINR performance as well as desired resolution using a highly thinned array. Dissert. Absrt.

N84-14439# Thomas Electronics Inc., Wayne N. J.
MANUFACTURING METHODS AND TECHNOLOGY (MM AND T) SPECIFICATIONS FOR MINIATURE CATHODE RAY TUBE Quarterly Report, 1 Apr. - 30 Jun. 1983
F. M. BRUNO 30 Jul. 1983 14 p
(Contract DAAK70-80-C-0168)
(AD-A132797; TEI-A009-11; QR-11) Avail: NTIS HCA02/MFA01 CSCL 09A

The object of this study is to develop design, performance, and test specifications for the Miniature Cathode Ray Tube (CRT) assembly suitable for use in the Integrated Helmet and Display Sight System (IHADSS) of the Army Advanced Attack Helicopter (AAH). Author (GRA)

N84-14463*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HEAT TRANSFER DISTRIBUTIONS AROUND NOMINAL ICE ACCRETION SHAPES FORMED ON A CYLINDER IN THE NASA LEWIS ICING RESEARCH TUNNEL
G. J. VANFOSSEN, R. J. SIMONEAU, W. A. OLSEN, and R. J. SHAW 1984 19 p refs Presented at the 22nd Aerospace Sci. Meeting, Reno, Nev., 9-12 Jan. 1984; sponsored by AIAA
(NASA-TM-83557; E-1905; NAS 1.15:83557) Avail: NTIS HC A02/MF A01 CSCL 20D

Local heat transfer coefficients were obtained on irregular cylindrical shapes which typify the accretion of ice on circular cylinders in cross flow. The ice shapes were grown on a 5.1 cm (2.0 in.) diameter cylinder in the NASA Lewis Icing Research Tunnel. The shapes were 2, 5, and 15 min accumulations of glaze ice and 15 min accumulation of rime ice. Heat transfer coefficients were also measured around the cylinder with no ice accretion. These icing shapes were averaged axially to obtain a nominal shape of constant cross section for the heat transfer tests. Heat transfer coefficients around the perimeter of each shape were measured with electrically heated copper strips embedded in the surface of the model which was cast from polyurethane foam. Each strip contained a thermocouple to measure the local surface temperature. The models were run in a 15.2 x 68.6 cm (6 x 27 in.) wind tunnel at several velocities. Background turbulence in the wind tunnel was less than 0.5 percent. The models were also run with a turbulence producing grid which gave about 3.5 percent turbulence at the model location with the model removed. The effect of roughness was also simulated with sand grains glued to the surface. Results are presented as Nusselt number versus angle from the stagnation line for the smooth and rough models for both high and low levels of free stream turblence. Roughness of the surface in the region prior to flow separation plays a major role in determining the heat transfer distribution. R.J.F.

N84-14465# Harry Diamond Labs., Adelphi, Md.
FLUIDICS: BASIC COMPONENTS AND APPLICATIONS
J. W. JOYCE Aug. 1983 24 p Original contains color illustrations
(Contract DA PROJ. 1L1-61102-AH-44)
(AD-A134046; HDL-SR-83-9) Avail: NTIS HCA02/MFA01 CSCL 13G

Since its discovery at Harry Diamond Lab. in 1959, fluidics has gradually been developed into a viable technology. This report describes fluidic components and systems now in use or ready for use in many applications. The fluidic technology provides sensing, computing, and controlling functions with fluid power through interaction of fluid streams. Since fluidics can perform these functions without mechanical moving parts that will wear out, it has the advantages of simplicity and reliability. Other advantages are the low cost, environmental insensitivity, and safety of fluidic systems. Commercial applications of fluidics in the aerospace industry, include medicine, and personal-use items. The first aerospace application in production in the United States was for the thrust-reverser control for a DC-10 airplane. In industry, fluidics has been applied to air-conditioning controls, machine controls, process controls, and production-line controls. One of the first commercial applications of fluidics was for life-support medical equipment. For military use, fluidics has been successfully applied to a fluidic generator to convert pneumatic energy into electrical energy, a fluidic stability augmentation system for helicopters, and a pressure-regulating system for aircraft. Under development are rate sensing circuits for roll rate control of cannon-launched guided projectiles and missiles, and a fluidic capillary pyrometer for continuous temperature measurements in high-temperature process control. GRA

N84-14468# George Washington Univ., Washington, D.C. School of Engineering and Applied Science.
RESEARCH ON NONSTEADY FLOW INDUCTION Annual Report, 1 Mar. 1982 - 23 Feb. 1983
C. A. GARRIS and J. V. FOA 14 Jul. 1983 11 p
(Contract F49620-80-C-0043; AF PROJ. 2307)
(AD-A133894; GWU-SEAS-TR-83-FI-3; AFOSR-83-0840TR)
Avail: NTIS HCA02/MFA01 CSCL 20D

A Flow Induction laboratory has been set up at The George Washington University for use in this project. Experimental work on the rotary jet and on the generation of rotary-jet pseudoblades through the utilization of propagating stall has produced encouraging performance results and useful new information. Additional observations have been made on the energetics of eddy formation. Improvements have been made in the design of rotary jets, and studies of further such improvements have been initiated. Author (GRA)

N84-15032# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
INSTRUMENTATION AND SIGNAL ANALYSIS
G. ELIAS *In* Von Karman Inst. for Fluid Dynamics Aeroacoustics: Ten Years of Res. 14 p 1983 refs Previously announced in IAA as A83-44311
Avail: NTIS HC A14/MF A01

Use of a single transducer to measure propeller aircraft flyover noise; and use of two transducers to obtain correlation coefficients for acoustic properties are described. Simultaneous use of many transducers is covered. A method to extract from a far field microphone the power spectral density associated with a component of a complex noise source is presented. A transducer located in the source area measures a parameter associated to a particuler noise source, s (t), and other fluctuations uncorrelated with s (t), that are considered as noise. A second transducer located near the first measures, with time delay, the same function s (t) and other fluctuations. Author (ESA)

N84-15055# Concordia Univ., Montreal (Quebec).
COMPUTER GRAPHICS TECHNIQUES FOR AIRCRAFT EMC ANALYSIS AND DESIGN
S. J. KUBINA (Defence Research Estab.) and P. BHARTIA *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 9 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

A comprehensive computer-aided system for the prediction of the potential interaction between avionics systems, with special emphasis on antenna-to-antenna coupling, is described. The methodology is applicable throughout the life cycle of an avionic/weapon system, including system upgrades and retrofits. As soon as aircraft geometry and preliminary systems information becomes available, the computer codes can be used to selectively display proposed antenna locations, emitter/receptor response characteristics, electromagnetic interference (EMI) margins and the actual ray-optical paths of maximum antenna-antenna coupling for each potential interacting antenna set. Antennas can be interactively relocated by track-ball (or joystick) and the analysis repeated at will for optimization or installation design study purposes. The codes can significantly simplify the task of the designer/analyst in effectively identifying critical interactions among an overwhelming large set of potential ones. In addition, it is an excellent design, development and analysis tool which simultaneously identifies both numerically and pictorially the EMI interdependencies among subsystems. M.G.

N84-15066# Boeing Military Airplane Development, Wichita, Kans.
DESIGN AND VERIFICATION OF ELECTROMAGNETIC COMPATIBILITY IN AIRBORNE WEAPONS SYSTEMS
W. R. JOHNSON *In* AGARD Advanced Concepts for Avionics/Weapon System Design, Develop. and Integration 6 p Oct. 1983 refs
Avail: NTIS HC A21/MF A01

To achieve electromagnetic compatibility (EMC) among the electric, electronic and electromechanical systems in a complex airborne weapons system, the coordination of many engineering disciplines is required from concept to delivery. Often the primary objectives of structural, mechanical and electrical design are in direct conflict with good EMC practices. Interaction of the EMC organization requires a flexible management structure with hard line reporting within the EMC organization and soft line ties to the supported organizations. The major milestones required to achieve an electromagnetically compatible system are: (1) planning for EMC control; (2) analysis to highlight potential problem areas; (3) engineering evaluation tests to prove design concepts; (4) qualification testing of subsystems/equipments; (5) safety of flight testing on airplane to assure flight safety; and (6) system level EMC testing where safety margin demonstrations may be required. The steps required to accomplish the milestones and to assure that the weapon system will have a high probability of passing the final system level electromagnetic compatibility demonstration are discussed. E.A.K.

N84-15079# Civil Aviation Authority, Redhill (England). Airworthiness Div.
THE CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME
H. D. RUBEN *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 18 p Oct. 1983
Avail: NTIS HC A15/MF A01

The idea of operational flight data recording started with the continuous recording of just two parameters velocity V and normal acceleration. The value of information gained from these simple recorders encouraged improved recorders and their development is traced up to the high capacity digital recorders available today. The data recording program operated jointly by the CAA and the participating airlines has grown considerably over the 20 years of its existence. Its present organization and activities are described, and a number of examples of the analyses performed on the data are given to illustrate the wide range of areas in which the data is useful. Author

N84-15365# Ohio State Univ., Columbus. Electroscience Lab.
RADIATION PATTERNS OF AN ANTENNA MOUNTED ON THE MID-SECTION OF AN ELLIPSOID Quarterly Report
J. G. KIM and W. D. BURNSIDE Jul. 1983 49 p
(Contract N00019-81-C-0424)
(AD-A133203; AD-E000546; ESL-714215-2) Avail: NTIS HCA03/MFA01 CSCL 20N

An efficient numerical solution for the high frequency radiation patterns of an Antenna mounted on the Mid-Section theta(S) = 90 degrees) of an Ellipsoid is studied in this report. The uniform geometrical theory of diffraction (UTD) is the basic approach applied here and the elliptic cylinder perturbation method is used to simulate geodesic paths on the ellipsoid surface. The radiation patterns obtained using this technique are compared to those for prolate spheroid mounted antennas, which have shown good agreement with measured data. Exact agreement between both results for typical spheroid geometry confirms that radiation patterns for ellipsoid mounted antennas can be solved efficiently by this numerical technique. Author (GRA)

N84-15395*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
VIDEO PROCESSOR FOR AIR TRAFFIC CONTROL BEACON SYSTEM Patent Application
F. BYRNE, inventor (to NASA) 28 Sep. 1982 10 p
(NASA-CASE-KSC-11155-1; US-PATENT-APPL-SN-425201)
Avail: NTIS HC A02/MF A01 CSCL 09C

A circuit is disclosed for use in a transponder located in an aircraft or the like for identifying a true side lobe suppression signal being transmitted by a ground located transmitted system. The true side lobe suppression signal includes at least pulses P1 and P2. The circuit causes the transponder to produce a reply signal upon the amplitude of the P1 pulse being a predetermined ratio to said P2 pulse. The circuit includes a pair of transistors with a capacitor connected to the output of the second transistor. The pulses P1 and P2 are supplied to the base electrode of the first transistor. Pulse P1 turns on the two transistors and charges the capacitor to a predetermined level so that when the second pulse P2 arrives, it does not turn on a transistor when it is equal to or less than the first pulse P1. NASA

N84-15398# AiResearch Mfg. Co., Torrance, Calif.
ADVANCED HIGH-POWER GENERATOR FOR AIRBORNE APPLICATIONS Interim Report, Mar. 1981 - Feb. 1982
A. R. DRUZSBA Wright-Patterson AFB, Ohio AFWAL Jun. 1983 198 p
(Contract F33615-80-C-2075; AF PROJ. 3145)
(AD-A133290; 82-18823; AFWAL-TR-82-2049) Avail: NTIS HCA09/MFA01 CSCL 10B

This report summarizes the work accomplished through Phase II of a four-phase program to design and build the stator and housing for a 5-Mw generator and test the complete 5-Mw generator. The PM rotor for this stator and housing is being built under a separate AF companion contract. This work is part of an

Air Force exploratory program for high-power airborne electrical power supply technology. Phases I and II encompassed a 10-month period from April 1981 to January 1982. In Phase I, a lightweight, high-power density stator/housing was designed and optimized with computer model BIGMAG for integration with a permanent *magnet rotor into a 5-Mw alternator with a specific weight of* 0.1 lb/kw or less. Components with potential for significant weight reduction were identified for testing in Phase II. Among these critical components are a novel liquid-cooling scheme for the stator and an elastomer bore seal. Fabrication drawings were prepared for all individual parts of the stator and housing along with a detailed fabrication plan. A plan for testing the complete 5-Mw generator under full-load conditions at the AF Compressor Research Facility also was prepared. Fabrication and testing will be done in Phases III and IV, respectively. Author (GRA)

N84-15409# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin (West Germany). Abteilung Turbulenzforschung.
PERIODIC FLOW NOISE REDUCTION USING FLOW-EXCITED RESONATORS: THEORY AND APPLICATION
G. H. KOOPMANN Apr. 1983 33 p refs Sponsored in part by Houston Univ., Houston, and EPRI, Palo Alto, California
(DFVLR-FB-83-29) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 11

Sound reduction by placing resonators on the cut-off surfaces of centrifugal fans was modeled as an acoustic dipole that results from the interaction of a moving fluid with a solid boundary. Part of the moving boundary is replaced with the fluid entrained in the open mouth surface of the fluid excited resonator. By proper tuning of the resonator, a source can be generated in antiphase to those generated at the remaining solid boundaries, reducing radiated sound. To position the resonator, pressure distribution over the surface of the solid boundary must be known. To tune the resonator for maximum sound reduction, several geometrical parameters can be varied. However, since the choice of the mouth surface area and porosity (hole number and size) is limited by the requirement that the resonator response be made as large as possible, the most straightforward way to tune the resonator is by varying the length of its cavity. Author (ESA)

N84-15448# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
TURBULENT SHEAR FLOWS
1983 528 p refs Proc. of Lecture Series, Rhode Saint Genese, Belgium, 28 Feb.- 4 Mar. 1983
(VKI-LS-1983-03) Avail: NTIS HC A23/MF A01

Experimental techniques for free edges of turbulent flows; asymmetric turbulent flows; the core region of channel flows; eddy detection within turbulent shear flows; bursting in bounded shear flows; large scale motion in turbulent boundary layers; two dimensional compressible turbulent boundary layers; effects of unsteadiness on turbulent boundary layers; three dimensional wake of a swept wing; three dimensional turbulent boundary layers; and three dimensional turbulent boundary layers in turbomachines were discussed.

N84-15458# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France).
THREE-DIMENSIONAL WAKE OF A SWEPT WING
J. COUSTEIX, G. PAILHAS, and B. AUPOIX *In* Von Karman Inst. for Fluid Dynamics Turbulent Shear Flows 11 p 1983 refs Presented at 2nd Symp. on Numerical and Phys. Aspects of Aerodyn. Flows, Long Beach, Calif., 17-20 Jan. 1983 Previously announced in IAA as A84-10102
Avail: NTIS HC A23/MF A01

Mean velocity profiles and six components of the Reynolds stress tensor profiles were obtained by studying a three dimensional turbulent wake. Agreement between hot-wire techniques used to measure Reynolds stress is good, with a four wire probe being particularly promising. An integral technique for calculating wake development is presented. For solving the partial differential equations, a simple model in which the shear stress is assumed to be aligned with the y-derivative of mean velocity works well. Author (ESA)

N84-15463# Aeronautical Research Inst. of Sweden, Bromma.
PRACTICAL THREE-DIMENSIONAL MESH GENERATION USING TRANSFINITE INTERPOLATION
L. E. ERIKSSON *In* Von Karman Inst. for Fluid Dynamics Computational Fluid Dyn., Vol. 1 53 p 1983 refs
Avail: NTIS HC A13/MF A01

A computational procedure for generating three dimensional nonorthogonal surface-fitted mesh systems is presented. The method is based on the concept of transfinite interpolation and uses normal derivatives of the mapping function at the boundaries to obtain the desired mesh control. The theory is presented together with 2D examples. The generation of 3D meshes of O-O type around wings and schematic wing-fuselage configurations is described and computed examples are shown. Author (ESA)

N84-15474# Genoa Univ. (Italy).
TURBINE AERODYNAMIC DESIGN USING THROUGH-FLOW THEORY. MERIDIONAL THROUGH-FLOW CALCULATION
M. TROILO *In* Von Karman Inst. for Fluid Dynamics Aerothermodyn. of Low Pressure Steam Turbines and Condensers, Vol. 1 44 p 1983 refs
Avail: NTIS HC A15/MF A01

The streamline curvature method (SCM) for calculating through flow in axial flow steam turbines is introduced. It consists of a row of one-dimensional calculations, along meridional streamlines, coupled by a radial equilibrium equation (REE). Along the meridional streamlines the energy law in the usual enthalpy formulation is used, together with kinematic relationships to switch from the absolute to the relative flow and vice-versa, and geometric relationships between flow angles and velocity components. The radial distribution of quantities is calculated by integration of REE, that may assume different forms. There are two main iteration levels: mass flow and streamline. Loss and flow angle calculation, and wetness effects are described. Application to a last stage design is summarized. Author (ESA)

N84-15479# Cambridge Univ. (England).
A METHOD OF CALCULATING FULLY THREE DIMENSIONAL INVISCID FLOW THROUGH ANY TYPE OF TURBOMACHINE BLADE ROW
J. D. DENTON *In* Von Karman Inst. for Fluid Dynamics Aerothermodyn. of Low Pressure Steam Turbines and Condensers, Vol. 1 40 p 1983 refs
Avail: NTIS HC A15/MF A01

A suite of computer programs to calculate the fully 3D inviscid flow through any type of turbomachine blade row was developed. The method is based on a pseudo time dependent solution of the Euler equations with convergence accelerated by a multigrid approach. It is shock capturing and has no Mach number limitations. The basic version of the program can cope with any type of single blade row, compressor or turbine with axial, mixed, or radial flow. Special versions of the code were developed for blade rows with part-pitch or part-span splitter blades and also for two blade rows in relative rotation, i.e., a complete stage. Viscous effects may be approximated by a transpiration type of boundary layer displacement model. Author (ESA)

N84-15480# Cambridge Univ. (England).
A REVIEW OF CURRENT RESEARCH ACTIVITY ON THE AERODYNAMICS OF AXIAL FLOW TURBINES
J. D. DENTON *In* Von Karman Inst. for Fluid Dynamics Aerothermodyn. of Low Pressure Steam Turbines and Condensers, Vol. 1 31 p 1983 refs
Avail: NTIS HC A15/MF A01

Design philosophy of axial flow turbines, flow and performance prediction methods, blade section design, secondary loss reduction, and last stage aerodynamics are reviewed, especially for large steam turbines. For most machines improvements are still possible through the use of smooth hub and casing shapes, twisted blades and reduced tip clearances. More general improvements are likely to come from methods of reducing loss in low aspect ratio blading. Last stage performance should benefit from better flow calculation methods and from the realization of the dangers of using too low a hub:tip ratio. Author (ESA)

N84-15481# Cambridge Univ. (England).
THREE-DIMENSIONAL FLOW CALCULATIONS ON A HYPOTHETICAL STEAM TURBINE LAST STAGE
J. D. DENTON *In* Von Karman Inst. for Fluid Dynamics Aerothermodyn. of Low Pressure Steam Turbines and Condensers, Vol. 1 13 p 1983
Avail: NTIS HC A15/MF A01

Fully three dimensional flow calculations were used to investigate the effects of geometry on the flow through a steam turbine last stage. The human effort involved is much less than when using iterative through flow blade to blade methods. Each of the solutions requires 1 hr human time and 4 hr computer time to prepare, plot and run the data. The results indicate that effects of nozzle lean are greater than those of any other modification. By use of lean, possibly in combination with twisted nozzle blades, large increases in rotor root reaction can be obtained. Author (ESA)

N84-15503# National Aeronautical Establishment, Ottawa (Ontario).
UNSTEADY PRESSURE AND FORCE MEASUREMENTS ASSOCIATED WITH TRANSONIC BUFFETING OF A TWO-DIMENSIONAL SUPERCRITICAL AIRFOIL
B. H. K. LEE and L. H. OHMAN Jun. 1983 89 p
(AD-A133139; NAE-AN-14; NRC-22448) Avail: NTIS HCA05/MFA01 CSCL 20D

Buffet characteristics of the BGK No. 1 shockless airfoil have been investigated. Fluctuating pressure measurements along the airfoil chord and unsteady force balance data have been obtained in various regions inside the buffet regime close to the onset boundary curve. The Mach number range where buffet intensity reaches high values is determined from balance measurements. The rms values of the fluctuating pressure show generally monotonic increase downstream of the shock to the trailing-edge in this speed range. Statistical data from pressure and normal force measurements have been processed and the appearance of distinct frequency peaks in the power spectral density curves has been detected. GRA

N84-15530# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
CALIBRATION OF AIR-DATA SYSTEMS AND FLOW DIRECTION SENSORS. AGARD FLIGHT TEST TECHNIQUES SERIES, VOLUME 1
J. A. LAWFORD (Aeroplane and Armament Experimental Establishment, Salisbury, England) and K. R. NIPPRESS (Aeroplane and Armament Experimental Establishment, Salisbury, England) Sep. 1983 67 p refs
(AGARD-AG-300-VOL-1) Avail: NTIS HC A04/MF A01

The calibration of air-data and flow direction measurement systems is discussed. The available flight test calibration methods are described and their applicability, accuracies, and limitations are reviewed. Author

N84-15552*# National Aeronautics and Space Administration, Washington, D. C.
DESIGN PROCEDURES FOR COMPRESSOR BLADES
H. STARKEN Jul. 1983 11 p Transl. into ENGLISH of "Entwurfsverfahren fuer Verdichterschaufeln" rept. DFVL-Nachrichten, Cologne, Nov. 1981 p 49-51 Original language document was announced as A82-17135 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASW-3541)
(NASA-TM-77085; NAS 1.15:77085) Avail: NTIS HC A02/MF A01 CSCL 21E

The conventional methods for the design of the blades in the case of axial turbomachines are considered, taking into account difficulties concerning the determination of optimal blade profiles. These difficulties have been partly overcome as a consequence of the introduction of new numerical methods during the last few years. It is pointed out that, in the case of the subsonic range, a new procedure is now available for the determination of the form of blade profile on the basis of a given velocity distribution on the profile surface. The search for a profile form with favorable characteristics is consequently transformed into a search for a favorable velocity or pressure distribution on the blade. The distribution of velocities depends to a large degree on the characteristics of the profile boundary layers. The considered concept is not new. However, its practical implementation has only recently become possible. The employment of the new design procedure is illustrated with the aid of an example involving a concrete design problem. G.R.

N84-15553*# National Aeronautics and Space Administration, Washington, D. C.
EXPERIMENTAL DETERMINATION OF GAP FLOW-CONDITIONED FORCES AT TURBINE STAGES AND THEIR EFFECT ON THE RUNNING STABILITY OF SIMPLE ROTORS Ph.D. Thesis
R. WOHLRAB Oct. 1983 184 p refs Transl. into ENGLISH of the mono. "Experimentelle Ermittlung Spaltstromungsbedingter Krafte an Turbinestufen und Deren Einfluss auf die Laufstabilitat Einfacher Rotoren" Munich, Technische Univ., 1975 p 1-161 Original language document was announced as A76-42648 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-3542)
(NASA-TM-77293; NAS 1.26:77293) Avail: NTIS HC A09/MF A01 CSCL 21E

Instabilities in turbine operation can be caused by forces which are produced in connection with motions involving the oil film in the bearings. An experimental investigation regarding the characteristics of such forces in the case of three typical steam turbine stages is conducted, taking into account the effect of various parameters. Supplementary kinetic tests are carried out to obtain an estimate of the flow forces which are proportional to the velocity. The measurements are based on the theoretical study of the damping characteristics of a vibrational model. A computational analysis of the effect of the measured fluid forces on the stability characteristics of simple rotor model is also conducted. G.R.

N84-15554*# General Motors Corp., Indianapolis, Ind. Engineering Dept.
ADVANCED GAS TURBINE (AGT) TECHNOLOGY DEVELOPMENT Semiannual Report
May 1983 49 p refs
(Contract DEN3-168; DE-AI01-77CS-1040)
(NASA-CR-168235; DOE/NASA/0168-6; NAS 1.26:168235; EDR-11443) Avail: NTIS HC A03/MF A01 CSCL 21A

A 74.5 kW (100 hp) automotive gas turbine was evaluated. The engine structure, bearings, oil system, and electronics were demonstrated and no shaft dynamics or other vibration problem were encountered. Areas identified during the five tests are the scroll retention features, and transient thermal deflection of turbine backplates. Modifications were designed. Seroll retention is addressed by modifying the seal arrangement in front of the gasifier turbine assembly, which will increase the pressure load on the scroll in the forward direction and thereby increase the retention forces. the backplate thermal deflection is addressed by geometric changes and thermal insulation to reduce heat input. Combustor rig proof testing of two ceramic combustor assemblies was completed. The combustor was modified to incorporate slots and reduce sharp edges, which should reduce thermal stresses. The development work focused on techniques to sinter these barrier materials onto the ceramic rotors with successes for both material systems. Silicon carbide structural parts, including engine configuration gasifier rotors (ECRs), preliminary gasifier scroll parts, and gasifier and power turbine vanes are fabricated. E.A.K.

N84-15555*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF A HIGH-FREQUENCY STIRLING CYCLE COMPRESSOR FOR CRYOGENIC COOLING IN SPACE
M. D. DESHPANDE (Catholic Univ.) and P. A. STUDER Jul. 1983 110 p refs
(Contract NAS5-27343)
(NASA-TM-85066; NAS 1.15:85066; REPT-83F0228) Avail: NTIS HC A06/MF A01 CSCL 13I

The dynamics of a compressor piston with a nonlinear gas spring (provided by the gas compression force) operating in a self resonant mode were analyzed to permit computer simulation. The intent was to increase the operating frequency to 270 Hz and to design a dynamically balanced compressor. These changes, which would allow greater specific power and eliminate a separate balancing device, are highly advantageous for cryogenic cooling in space. A short stroke large area piston allows a drive system to use electromagnetically coupled pistons with stationary excitation coils. This configuration and some test results are included. The performance of the drive system was studied analytically and computationally for operation under resonance conditions necessary for high efficiency. An acoustically tuned displacer is assumed. The analysis and computer model that was developed should allow optimization and miniaturization. M.G.

N84-15604*# Gates Learjet Corp., Denver, Colo.
DETERMINATION OF ELEVATOR AND RUDDER HINGE FORCES ON THE LEARJET MODEL 55 AIRCRAFT
R. R. BOROUGHS and V. PADMANABHAN *In* COSMIC 11th NASTRAN User's Colloq. p 226-248 Nov. 1983 refs
Avail: NTIS HC A14/MF A01 CSCL 20K

The empennage structure on the Learjet 55 aircraft was quite similar to the empennage structure on earlier Learjet models. However, due to an important structural change in the vertical fin along with the new loads environment on the 50 series aircraft, a structural test was required on the vertical fin, but the horizontal tail was substantiated by a comparative analysis with previous tests. NASTRAN analysis was used to investigate empennage deflections, stress levels, and control surface hinge forces. The hinge force calculations were made with the control surfaces in the deflected as well as undeflected configurations. A skin panel buckling analysis was also performed, and the non-linear effects of buckling were simulated in the NASTRAN model to more accurately define internal loads and stress levels. Comparisons were then made between the Model 55 and the Model 35/36 stresses and internal forces to determine which components were qualified by previous tests. Some of the methods and techniques used in this analysis are described. R.J.F.

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GEOSCIENCES

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

A84-16261
A SURVEY OF COMMUNITY ATTITUDES TOWARDS NOISE NEAR A GENERAL AVIATION AIRPORT
P. D. SCHOMER (Illinois, University, Urbana, IL) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 74, Dec. 1983, p. 1773-1781. Research supported by the Illinois Department of Energy and Natural Resources. refs

This paper describes a community attitudinal noise survey performed in the vicinity of the Decatur, Illinois Airport. Two hundred thirty-one respondents were drawn from four distinct noise zones in populated areas near the airport. The day/night average sound levels (DNL) ranged from 44-66 dB. The area is otherwise quiet, residential with large (1/2 acre) lots. The primary analysis arrayed the percent of respondents highly annoyed versus DNL. Good agreement was found between the results of this survey and the general relation developed by Schultz from surveys worldwide, primarily in the vicinity of large commercial airports and highways. In addition, reasonable comparisons were found between respondent estimates of the number of aircraft operations and actual traffic counts. It was also found that respondents who were highly annoyed by aircraft noise were three to four times as likely to be highly annoyed by some other noise than were other respondents. Author

A84-17887*# National Center for Atmospheric Research, Boulder, Colo.
THE JOINT AIRPORT WEATHER STUDIES PROJECT - CURRENT ANALYSIS HIGHLIGHTS IN THE AVIATION SAFETY CONTEXT
J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 10 p. Research supported by the National Center for Atmospheric Research, NSF, and NOAA; U.S. Department of Transportation. refs
(Contract DOT-FA01-82-Y-10513; NASA ORDER H-59314-B)
(AIAA PAPER 84-0111)

The principal objective of the Joint Airport Weather Studies Project was to obtain high-resolution velocity, turbulence, and thermodynamic data on a convective outflow called a microburst, an intense downdraft and resulting horizontal outflow near the surface. Data collection occurred during the summer of 1982 near Denver, CO. Data sensors included three pulsed-microwave Doppler and two pulsed CO2 lidar radars, along with 27 Portable Automated Mesonet surface weather stations, the FAA's low-level-wind-shear alert system (LLWSAS), and five instrumented research aircraft. Convective storms occurred on 75 of 91 operational days, with Doppler data being collected on at least 70 microbursts. Analyses reported included a thorough examination of microburst-climatology statistics, the capability of the LLWSAS to detect adequately and accurately the presence of low-altitude wind shear danger to aircraft, the capability of a terminal Doppler radar system development to provide improved wind-shear detection and warning, and progress toward improved wind-shear training for pilots. Author

A84-17890#
GENERAL AVIATION METEOROLOGICAL REQUIREMENTS
D. W. NEWTON American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. refs
(AIAA PAPER 84-0115)

A discussion is presented concerning the weather data requirements of pilots who own or rent aircraft, and generally covers that segment of general aviation which operates below an altitude of about 25,000 ft. The financial resources of such pilots are more limited than those of commercial operators. Convective outlook and associated severe weather outlook charts, thunderstorm tornado watches and warnings, stability charts, and radar summary charts, are noted to be the most valuable National Weather Service and FAA meteorological products. Those relating to icing conditions, by contrast, are considered inadequate. O.C.

A84-17935#
A NEW CHARACTERIZATION OF SUPERCOOLED CLOUD DESIGN CRITERIA FOR AIRCRAFT ICE PROTECTION SYSTEMS BELOW 10,000 FEET AGL
C. O. MASTERS (FAA, Technical Center, Atlantic City, NJ) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 6 p. refs
(AIAA PAPER 84-0182)

This paper discusses a new set of icing envelopes which effectively characterize supercooled clouds from ground level to 10,000 feet above ground level (AGL) over the conterminous United States. This new characterization was generated from a data base of 6,700 plus data miles of aerial observations, it groups the supercooled cloud properties for all cloud types observed into three temperature ranges and presents their associated values of liquid water content (LWC), range of median volume droplet diameters (MVD), and icing event duration. Details of the analysis process are discussed which use a least squares logarithmic regression estimation technique based upon the Weibull distribution to predict the extreme values of supercooled cloud properties, such that the probability of exceeding any of the key parameters of LWC, MVD, temperature or event duration during an icing encounter below 10,000 feet AGL will be less than 0.001. Comparisons are made between this new characterization and existing Federal Aviation Administration aircraft icing certification criteria. Author

A84-17988#
THE ANALYSIS AND PREDICTION OF CLEAR AIR TURBULENCE AT WESTERN AIRLINES
J. J. PAPPAS (Western Airlines, Inc., Los Angeles, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 5 p. refs
(AIAA PAPER 84-0269)

The introduction of high flying commercial jet transports during the 1950's established a requirement for forecasting clear air turbulence (CAT). This paper recounts the development of empirical prediction techniques by airline meteorologists based on model relationships of synoptic scale upper air patterns and the occurrence of CAT. The specific use of multi-level upper air analyses that allow recognition of most CAT producing features, as well as providing data for flight planning, is described. Author

A84-17989*# Arizona Univ., Tucson.
IDENTIFICATION OF VORTEX-INDUCED CLEAR-AIR TURBULENCE USING AIRLINE FLIGHT RECORDS
E. K. PARKS (Arizona, University, Tucson, AZ), R. C. WINGROVE, R. E. BACH, and R. S. MEHTA (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0270)

The nature and cause of clear-air turbulence is being investigated, in cooperation with the National Transportation Safety Board, using the flight records available from airline encounters with severe turbulence. This paper presents two case studies of severe turbulence which indicate that the airplanes involved encountered vortex arrays which were generated by destabilized wind-shear layers near the tropopause. In order to identify and analyze vortex patterns (i.e., vortex strength, size, and spacings), potential-flow models of vortex arrays were developed that describe reasonably well the wind patterns derived from the airliner flight records. The results of this analysis indicate that in the two cases studied, the vortex cores had diameters in the range of 900 to 1,200 ft with tangential velocities in the range of 70 to 85 ft/sec. This study presents the first identification and analysis of vortex arrays from airline flight data. The results are compared with theoretical predictions and previous observations. Author

A84-17990*# Dayton Univ., Ohio.
PERFORMANCE OF A QUANTITATIVE JET STREAM TURBULENCE FORECASTING TECHNIQUE - THE SPECIFIC CAT RISK (SCATR) INDEX
J. L. KELLER (Dayton, University, Dayton, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. NASA-supported research. refs
(AIAA PAPER 84-0271)

The SCATR index is showing considerable promise as a tool for operational, nonconvective, high altitude turbulence forecasting. The results of nine case studies are summarized. Attention is then focused on one of these cases for which the data base is most complete. In light of these case studies, the strengths and weaknesses of the current formulation and suggested improvements are discussed. The SCATR index has applications both as a diagnostic tool and in operational forecasting. Author

A84-18513#
CORRELATED AIRBORNE AND GROUND MEASUREMENT OF LIGHTNING
P. L. RUSTAN, B. P. KUHLMAN, G. A. DUBRO (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), M. J. REAZER, M. D. RISLEY, and A. V. SERRANO (Technology Scientific Services, Inc., Dayton, OH) IN: International Aerospace Conference on Lightning and Static Electricity, Oxford, England, March 23-25, 1982, Proceedings. Volume 1 . Abingdon, Oxon, England, Culham Laboratory, 1982, p. A10-1 to A10-11. refs

The three-year (1979-1981) program devised by the Air Force Wright Aeronautical Laboratories to determine the electromagnetic coupling to the aircraft for direct and nearby lightning is described. A WC-130 aircraft was instrumented with wideband electromagnetic field sensors and flown in close proximity to active thunderstorms to record the characteristics of the electric and magnetic fields in the aircraft environment. For the data analyzed thus far, it is pointed out that the pulse risetime is usually less than 400 nsec. What is more, about 50 percent of the airborne return strokes have a risetime of less than one microsecond. However, most of the return strokes which have been correlated when the aircraft was within 30 km of the central site have a risetime near one microsecond. The results of the data collected in the three years suggest that the risetime of the fastest pulses encountered in the different phases of a lightning flash ranges between 60 nsec and several microseconds. Thus far no analysis has been made to relate the experimental return stroke pulses obtained at the different heights to a theoretical return stroke model. C.R.

A84-19233*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LOW ALTITUDE WIND SHEAR STATISTICS DERIVED FROM MEASURED AND FAA PROPOSED STANDARD WIND PROFILES
R. E. DUNHAM, JR. and J. W. USRY (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p.
(AIAA PAPER 84-0114)

Wind shear statistics were calculated for a simulated data set using wind profiles proposed as a standard and compared to statistics derived from measured wind profile data. Wind shear values were grouped in altitude bands of 100 ft between 100 and 1400 ft, and in wind shear increments of 0.025 kt/ft between + or - 0.600 kt/ft for the simulated data set and between + or - 0.200 kt/ft for the measured set. No values existed outside the + or - 0.200 kt/ft boundaries for the measured data. Frequency distributions, means, and standard deviations were derived for each altitude band for both data sets, and compared. Also, frequency distributions were derived for the total sample for both data sets and compared. Frequency of occurrence of a given wind shear was about the same for both data sets for wind shears, but less than + or 0.10 kt/ft, but the simulated data set had larger values outside these boundaries. Neglecting the vertical wind component did not significantly affect the statistics for these data sets. The frequency of occurrence of wind shears for the flight measured data was essentially the same for each altitude band and the total sample, but the simulated data distributions were different for each altitude band. The larger wind shears for the flight measured data were found to have short durations. Author

A84-19274
THE ROLE OF THERMAL MOTIONS OF PARTICLES IN GASES OF FIREBALLS
V. PADEVET (Ceskoslovenska Akademie Ved, Astronomicky Ustav, Ondrejov, Czechoslovakia) Astronomical Institutes of Czechoslovakia, Bulletin (ISSN 0004-6248), vol. 34, Sept. 1983, p. 360-373. refs

A qualitative theory regarding the effect of thermal motions of gas particles on bolides is developed. For bolides penetrating deep into the atmosphere, the ambient medium has the properties of a continuous medium. The thermal motions of atmospheric particles behind the shock wave determine momentum and energy transfer to the particle. For bolides, these thermal motions practically replace the effect of the direct impacts of particles of the undisturbed atmosphere, adequate only under free-molecular conditions. Taking account of the role of the thermal motions of particles of ablated meteor material, it is possible to offer a qualitative explanation of some of the observed phenomena, e.g., the mass paradox. In addition, a hypothesis is presented concerning the correlation between I, II, IIIA, and IIIB bolides and H, L, CM, and CI chondrites. B.J.

N84-14646# California Univ., Livermore. Lawrence Livermore Lab.
MATHEMATICAL AND PHYSICAL SCALING OF TRIGGERED LIGHTNING
R. W. ZIOLKOWSKI and J. B. GRANT Dec. 1982 22 p refs
(Contract W-7405-ENG-48)
(DE84-002480; UCID-19655) Avail: NTIS HC A02/MF A01

As the aircraft industry incorporates current technology in airborne systems, electromagnetic compatibility can decrease. Composite fuselages can be more transparent to EMP, whether nuclear or lightning generated, than metal ones. Solid-state circuitry is sensitive to intense EM fluctuations whereas mechanical controls generally are not. With this increased vulnerability comes increased concern for these dangers. Recently the anxiety over lightning has risen. Answers are sought to such questions as: how do the lightning EM effects couple into the aircraft's interior. Do aircraft trigger lightning, and if so, can the triggering be minimized. An understanding, at least to some extent, of lightning would provide a needed foundation to examine the interaction of aircraft with lightning. A review of the literature on lightning and lightning-aircraft investigations, including triggered lightning, was conducted and is briefly summarized. In addition, scaling the lightning event to laboratory size is also discussed. The ability to scale would allow accurate investigation of lightning effects, as well as the triggering phenomena, in scaled experiments. DOE

N84-14650# National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.
AIRCRAFT HAZARD ASSESSMENT FROM A CLEAR-AIR RADAR AND METEOROLOGICAL TOWER STUDY OF GRAVITY WAVE EVENTS
E. E. GOSSARD, ed. Jun. 1983 23 p
(PB83-257139; NOAA-83090106) Avail: NTIS HC A02/MF A01 CSCL 04B

An exceptionally well-defined gravity wave event, recorded by radar and on the 300 meter meteorological tower near Erie, Colorado, is analyzed. Special attention is given the kinematic structure within the wave to assess possible hazards to aircraft. It is found that changes of about 5 ms in vertical velocity would be encountered by an aircraft in a time period of 6.5 s. A similar change in air speed would be encountered 90 degrees out of phase with the up-downdraft. The maximum effect in this event was at a height of 100-150 m above the ground. Events of this kind often occur in fair weather under thermally stable atmospheric conditions, and would not, therefore, be predicted from the usual reasoning about near-ground hazards to aircraft. GRA

N84-15087# Royal Aircraft Establishment, Bedford (England).
WORLDWIDE EXPERIENCE OF WIND SHEAR DURING 1981-1982
A. A. WOODFIELD and J. F. WOODS *In* AGARD Flight Mech. and System Design Lessons from Operational Experience 32 p Oct. 1983 refs
Avail: NTIS HC A15/MF A01

Large changes of wind and downdraughts (Wind Shears) which have caused several major aircraft accidents are discussed. Wind shear data from over 9000 landings at 71 airports around the world during 1981 and 1982 were analyzed by discrete gust methods. Time histories of wind velocities and aircraft reactions are presented for 9 of the more interesting events identified. These were selected from 86 examples of large wind shears where the three components of wind velocity were calculated. An example of a severe downburst in the vicinity of a thunderstorm is presented. Statistics on the probabilities of encountering wind shears with particular patterns of headwind speed changes were calculated from the 9000 landings. Effects at different airports, height bands, shear lengths, and patterns are compared. Suggestions are made for Design Cases of shear that could be used for testing autopilots and wind shear measuring systems. Criteria for the severity of single ramp changes in headwind are presented. E.A.K.

N84-15733# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AIRBORNE LIGHTNING CHARACTERIZATION Final Technical Report, Jun. 1979 - Aug. 1982
P. L. RUSTAN (AFIT), B. P. KUHLMAN (AFFDL), A. SERRANO, J. REAZER, and M. RISLEY (Technology Scientific Services Inc.) Jan. 1983 186 p refs
(Contract AF PROJ. 2402)
(AD-A130627; AFWAL-TR-83-3013) Avail: NTIS HC A09/MF A01 CSCL 14B

A WC-130 aircraft was instrumented with eleven electric and magnetic field sensors at different locations. The aircraft was flown in the vicinity of active thunderstorms at altitudes between 1500 and 16000 feet mean sea level (MSL). To correlate the electric fields produced by the lightning flashes and the respective location of the flashes, a ground station network was employed. The ground network consisted of a central station where the electric field and very high frequency (VHF) radiation were measured and four remote stations arranged in a wye configuration with a 20 kilometer (km) radius for measuring VHF. Fourteen channels of continuous analog data with 2 Mega hertz (MHz) bandwidth and ten channels of digital data of 164 microsecond (micro sec) windows with 20 MHz bandwidth at a maximum rate of two data windows per second were recorded in the aircraft. Analog data for the electric field and VHF radiation with 2 MHz bandwidth were recorded at the central ground site. In addition, VHF radiation with 2 MHz bandwidth were recorded at the central ground site. In addition, VHF radiation with 4 MHz bandwidth was recorded in modified video cassette recorders at all four ground sites. IRIG-B time code received at the ground site was retransmitted to the aircraft and remote stations and used for time synchronization. The aircraft and ground sensors were calibrated to detect lightning flashes between zero and 35 km away. GRA

15

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.

A84-16615
A DISTRIBUTED MICROPROCESSOR SYSTEM ARCHITECTURE FOR IMPLEMENTING MAINTENANCE TRAINERS WITH 3-D SIMULATION
G. FOY and R. SCHAEFER (Grumman Aerospace Corp., Bethpage, NY) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 698-702. refs

In this presentation, the generalized requirements for a maintenance trainer, that provides 3-D simulation, are decomposed into functional units. Standardized hardware/software modules implemented to perform these functions are described. These modules are combined, as necessary, to satisfy a wide range of individual trainer requirements without hardware or software modification. The system architecture features special purpose interpreters for 3-D simulation and lessonware. This approach fosters rapid customization to the requirements of a specific training program and reduces the effect of post development system updates. System reliability and flexibility are thus enhanced, while minimizing life cycle costs. Author

A84-16616
DISTRIBUTED MINI/MICROPROCESSOR ARCHITECTURE FOR AVIONICS SYSTEMS MAINTENANCE TRAINERS
G. MUDD and R. SAUNDERS (Honeywell, Inc., West Covina, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 703-710.

This paper describes the use of a computational architecture that is distributed between minicomputers and microprocessors to perform avionic systems maintenance training. The unique requirements posed by trainers are examined along with the rationale for allocating software functions to the different processors. The benefits and drawbacks of a distributed system are analyzed with respect to the total system life cycle costs. Two implementations of the distributed architecture are described, the F-15 Aircraft Maintenance Trainer (AMT) and the E-3A AWACS Radar Maintenance Training System (MTS). Both of these trainers use Honeywell Level-6 minicomputers for student interaction and Multiple Motorola MC68000 microprocessors for dynamic front-end processing. Author

A84-16618
SUCCESSFUL USER INVOLVEMENT IN TRAINER DESIGNS
W. L. AYLSWORTH (Honeywell, Inc., West Covina, CA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 New York, Institute of Electrical and Electronics Engineers, 1983, p. 725-728.

The design of a simulator for use in maintenance training is a complex task, and unique customer preferences in the application of the equipment to training activities must be taken into consideration. The end users (instructors) have, therefore, participated as an integral part of the design team in the development of the F-15 Aircraft Maintenance Trainer (AMT). The problems involved in the design and construction of a trainer are discussed, taking into account the provision of appropriate system responses, the incorporation of suitable instructional aspects, and the education of the using instructor in the capabilities and limitations of the trainer. Attention is given to the trainer architecture, details of the design process, and the obtained results. G.R.

A84-16636
THE SIMULATION OF TERRAIN-FOLLOWING TARGETS
P. J. COSTIGAN (GTE Products Corp., Sylvania Systems Group, Needham Heights, MA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 899-906.

The simulation of terrain-following targets in tactical air-defense scenario simulators is discussed with respect to sizing and/or timing problems in the simulation software. A critical analysis of the several less desirable consequences of direct approaches to this simulation puts this problem in a more realistic perspective. A near-perfect simulation (in principle) is described which represents the terrain via two-dimensional digital altitude data and makes the targets 'levitate' over the terrain thus simulated. The required data base is, however, prohibitively large and the number of altitude changes required is similarly objectionable. An image of the above-mentioned array, as a strange stairway that wanders along both horizontal axes, is shown to lead to certain simplifications. The principal simplification results from establishing a coordinate system whose origin is at the radar site. The second is suggested by the fact that one high step (or hill) near the site will obscure many other steps at longer ranges and increasing relative angle. Author

A84-16647
DISTRIBUTED AVIONICS PROCESSING USING ADA
S. E. ADAMS (Intermetrics, Inc., Cambridge, MA) and B. CLAUSING IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 979-983. refs

Problems that arise when implementing real-time avionics systems are discussed, with emphasis placed on the issues related to the use of the Ada language for programming single and multiple processor systems. Consideration is given to systematic and random timing errors, scheduling by time multiplexing, task partitioning, and problems arising from the use of two new language constructs (rendezvous and exception propagation). It is noted that in real-time distributed systems, the accuracy of calculations will be always affected by a time skew and that avionics systems must be designed to tolerate this variation. Care must be also taken to ensure a reasonable bound for the inherent latency of multiprocessor communications. V.L.

A84-16669
THE USE OF THE OPTIMAL OUTPUT FEEDBACK ALGORITHM IN INTEGRATED CONTROL SYSTEM DESIGN
A. K. CAGLAYAN (Bolt Beranek and Newman, Inc., Cambridge, MA), N. HALYO, and J. BROUSSARD (Information and Control Systems, Inc., Hampton, VA) IN: NAECON 1983; Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 17-19, 1983. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1983, p. 1242-1251. refs

The integrated design of control subsystems is formulated as a constrained output feedback problem for linear, discrete-time, stochastic, time-invariant systems. Expressions for the incremental cost and the necessary conditions for optimality are given. Two algorithms for solving the posed constrained output feedback problem are presented. The first one is an iterative application of a convergent algorithm for the unconstrained optimal output feedback problem whereas the second one is a generalization of this unconstrained algorithm to the decentralized case. Simulation results involving the integrated design of flight and engine control subsystems for a nontrivial 10th order system description of a jet aircraft demonstrate the utility of the proposed algorithms in integrated control. Author

A84-18145*# Analytical Mechanics Associates, Inc., Mountain View, Calif.
MODELING TO PREDICT PILOT PERFORMANCE DURING CDTI-BASED IN-TRAIL FOLLOWING EXPERIMENTS
J. A. SORENSEN and T. GOKA (Analytical Mechanics Associates, Inc., Mountain View, CA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 11 p. refs
(Contract NAS1-16135)
(AIAA PAPER 84-0517)

A mathematical model was developed of the flight system with the pilot using a cockpit display of traffic information (CDTI) to establish and maintain in-trail spacing behind a lead aircraft during approach. Both in-trail and vertical dynamics were included. The nominal spacing was based on one of three criteria (Constant Time Predictor; Constant Time Delay; or Acceleration Cue). This model was used to simulate digitally the dynamics of a string of multiple following aircraft, including response to initial position errors. The simulation was used to predict the outcome of a series of in-trail following experiments, including pilot performance in maintaining correct longitudinal spacing and vertical position. The experiments were run in the NASA Ames Research Center multi-cab cockpit simulator facility. The experimental results were then used to evaluate the model and its prediction accuracy. Model parameters were adjusted, so that modeled performance matched experimental results. Lessons learned in this modeling and prediction study are summarized. Author

A84-18170#
AN ON-LINE OBSERVER FOR SENSOR FAILURE DETECTION AND ISOLATION IN NONLINEAR PROCESSES
M. N. WAGDI (Suez Canel University, Port Said, Egypt) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(AIAA PAPER 84-0570)

A new methodology is introduced which results into an algorithm for computer monitoring of sensor output signals in nonlinear processes. The algorithm checks continuously the operational status of all sensors and determines its sensor mode of operation (operational mode/failure mode). The algorithm isolates the detected failed sensors by ignoring their output signals and reconfigures the system measurements to carry on the observations with the remaining unfailed sensors. An ideal trajectory of measurements propagation is constructed and allowable trajectory deviation is determined. Sensor failure detection criterion is then established. Both cases of nonredundant and redundant measurements are considered. The computations required for detecting sensor failures in redundant measurements are considerably more than those required in nonredundant measurements. Author

A84-18600
FIXED GAIN CONTROLLER AND FILTER DESIGN FOR STOCHASTIC SYSTEMS WITH APPLICATION TO AIRCRAFT
Y. BARAM and D. EIDELMAN (Tel Aviv University, Tel Aviv, Israel) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1003-1008. refs

A method for designing fixed-gain controllers and estimators for systems with large parameter variations or uncertainties is proposed. The approach is based on minimax criteria defined on Kullback's (1959) information measure; and the design objective is to minimize the maximal possible difference between the optimal system at the actual operating point (i.e., the optimal adaptive system) and the selected fixed-gain system. The proposed method is used to design a longitudinal backup control system for a given high-performance aircraft (the YF-16), and the resulting fixed-gain system shows good performance qualities and compares favorably with systems obtained by previous techniques. B.J.

A84-18611* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
FORMULATION OF A PRACTICAL ALGORITHM FOR PARAMETER ESTIMATION WITH PROCESS AND MEASUREMENT NOISE
R. E. MAINE and K. W. ILIFF (NASA, Flight Research Center, Edwards, CA) IN: Identification and system parameter estimation 1982; Proceedings of the Sixth Symposium, Washington, DC, June 7-11, 1982. Volume 2 . Oxford and New York, Pergamon Press, 1983, p. 1139-1144. refs

A new formulation is proposed for the problem of parameter estimation in dynamic systems with both process and measurement noise. The formulation applies to continuous-time state space system models with discrete-time measurements. Previous formulations of this problem encountered several theoretical and practical difficulties which are overcome by the new formulation. The most important element of the new formulation is a reparameterization of the unknown noise covariances. A computer program that implements the new formulation is available. Author

A84-19085* Rensselaer Polytechnic Inst., Troy, N. Y.
MODEL REFERENCE ADAPTIVE CONTROL FOR LINEAR TIME VARYING AND NONLINEAR SYSTEMS
L. ABIDA and H. KAUFMAN (Rensselaer Polytechnic Institute, Troy, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 1 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 287, 288.
(Contract NAG1-171; NSF ECS-80-16173)

Model reference adaptive control is applied to linear time varying systems and to nonlinear systems amenable to virtual linearization. Asymptotic stability is guaranteed even if the perfect model following conditions do not hold, provided that some sufficient conditions are satisfied. Simulations show the scheme to be capable of effectively controlling certain nonlinear systems. Author

A84-19113
AIRCRAFT CONTROL GAIN COMPUTATION USING AN ELLIPSOID ALGORITHM
M. KUPFERSCHMID, J. G. ECKER, H. KAUFMAN (Rensselaer, Polytechnic Institute, Troy, NY), and K. MOHRMANN (U.S. Military Academy, West Point, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 540-543. refs

The use of an ellipsoid algorithm for computing output feedback gains in a linear time-invariant control system is discussed. The gains are chosen to minimize a quadratic performance criterion subject to an explicit constraint on system stability. A numerical example is given in which not all of the state variables are accessible, and results obtained using the ellipsoid algorithm are compared to the published solution. Author

A84-19123
MICROPROCESSORS AS EMULATORS IN A CONTROL SYSTEM ENVIRONMENT
L. MINTZER (Rockwell International Corp., Marine Systems Div., Anaheim, CA) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 818-822.

Computers have been used in military systems for over two decades. There is interest in replacing some ancient computers with present day microprocessors, since a number of benefits may accrue. However, there may be some constraining factors, such as the retention of the original programs that require accurate emulation of the original machine. Some of these issues are discussed for a case study involving the replacement of a computer in a navigation control loop. Candidate microprocessor emulation approaches are outlined. Author

A84-19143
AN APPLICATION OF A FINITE SPECTRUM ASSIGNMENT TECHNIQUE TO THE DESIGN OF CONTROL LAWS FOR A WIND TUNNEL
A. Z. MANITIUS (Rensselaer Polytechnic Institute, Troy, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1078-1081. refs
(Contract NSF MCS-82-01719)

An application of a finite spectrum assignment method for time-delay systems to a feedback control of Mach number in a wind tunnel is presented. The linearized model of Mach number control is a system of three state equations with a delay in one of the state variables. The proposed feedback is a linear combination of state variables and weighted integrals of some of the state variables over a period equal to time delay. The spectrum of the closed loop system is finite and consists of three eigenvalues that can be placed arbitrarily. Four possible variants of the feedback control law are presented. The calculation of feedback coefficients is very simple. Systems dynamics and feedback laws were simulated numerically. Author

A84-19153
THE EFFECT OF DESIGN PARAMETERS ON THE TRACKING PERFORMANCE OF HIGH-GAIN ERROR-ACTUATED CONTROLLERS
D. B. RIDGELY, S. S. BANDA, and J. T. SILVERTHORN (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1982, p. 1152-1157. refs

The effect of varying the primary design parameters when designing noninteractive high-gain error-actuated controllers for tracking systems was studied. To obtain a physically realizable controller design it was critical to obtain slow but decoupled output response. This was done through properly calculating the transducer matrix and properly selecting the values of the fast modes. The effect of varying other design parameters, such as the asymptotic values of the slow modes and the scalar gain parameter, was also studied. The controller designed was shown to be robust to plant parameter variations. The data from a recent advanced figher aircraft was used to illustrate the results. Author

N84-15855# European Space Agency, Paris (France).
EXPLICIT SECOND ORDER SPLITTING SCHEMES FOR SOLVING HYPERBOLIC NONLINEAR PROBLEMS: THEORY AND APPLICATION TO TRANSONIC FLOW
P. LAVAL Oct. 1983 283 p refs Transl. into ENGLISH of "Schemas Explicites de Desintegration du Second Ordre pour la Resolution des Problemes Hyperbolics non Lineaires. Theorie et Applications aux Ecoulements Transsoniques" rept. ONERA-NT-1981-10 ONERA, Paris, 1981
(ESA-TT-768; ONERA-NT-1981-10) Avail: NTIS HC A13/MF A01

Explicit second-order splitting schemes for solving hyperbolic nonlinear unsteady two or three dimensional systems were constructed. They employ the one-dimensional second order accurate schemes of Lerat-Peyret at the fractional step stages. These integer step schemes, with 4, 6, or 8 parameters in the two-dimensional case and with 6, 10, or 12 parameters in the three-dimensional case, are shown to be second-order accurate. The differential systems which these schemes approximate are derived with third order accuracy. The splitting schemes are applied to the two-dimensional fluid dynamics equations for steady and unsteady transonic flow calculations, with shocks, over oscillating or fixed airfoils, in a wind tunnel with solid or perforated walls, and in an infinite domain. Results for an airfoil oscillating with small amplitude show that the behavior of the unsteady forces is close to harmonic, even though the shock motion is nonsinusoidal; the noncyclic transient state persists for only two cycles. Author (ESA)

N84-15860# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
SOME NEW DEVELOPMENTS IN EXACT INTEGRAL EQUATION FORMULATIONS FOR SUB- OR TRANSONIC POTENTIAL FLOW
J. W. SLOOFF 11 May 1982 25 p refs Presented at Intern. School of Appl. Aerodyn., 1st Course on Computational Meth. in Potential Aerodyn., Amalfi, Italy 31 May - 5 Jun. 1982
(NLR-MP-82024-U) Avail: NTIS HC A02/MF A01

Finite volume type spatial discretization schemes for the full potential equation based on flux splitting, and multigrid (multilevel) techniques for fast iterative solution of systems of equations associated with panel methods, including fast procedures for approximate evaluation of the integral representations required for the determination of the residuals at each iteration step, are described. Results suggest the feasibility of developing a next generation of boundary + field panel methods for sub and transonic potential flow equipped with fast-solvers that are almost an order of magnitude more efficient than those of the current boundary panel methods. Author (ESA)

N84-15876# Technion - Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
IMPROVED DYNAMIC MODELS FOR AIR COMBAT ANALYSIS
N. FARBER, M. NEGRIN, and J. SHINAR Mar. 1982 121 p refs
(TAE-483) Avail: NTIS HC A06/MF A01

A zero-order feedback solution to the three-dimensional medium range air-to-air interception engagement, formulated as a zero-sum differential game is provided. Realistic aerodynamic and propulsion models are used and control strategies are given in a feedback form, expressing explicitly the dependence on the measurable state variable and aircraft performance parameters. The successive analysis is based on an innovative, variable modelling approach applying the method of forced singular perturbations. An imaginary air defense scenario serves as an illustrative example, showing the efficiency and the usefullness of the method for a rapid systematical parametric study. The accuracy of the zero-order feedback approximation is satisfactory and for most cases, higher order terms may be not needed; however corrective terms can be obtained by additional off-line computation. The FSPT algorithm for optimal medium range air combat strategy in a future flight test program is recommended. A.R.H.

N84-15877*# Texas Technological Univ., Lubbock. Dept. of Electrical Engineering.
NONLINEAR TRANSFORMAT
H. FORD, L. R. HUNT, and R. SU Jan. 1983 8 p refs
(Contract NAG2-189; NAG2-203)
(NASA-CR-166506; NAS 1.26:166506) Avail: NTIS HC A02/MF A01 CSCL 12B

A technique for designing automatic flight controllers for aircraft which utilizes the transformation theory of nonlinear systems to linear systems is presently being developed at NASA Ames Research Center. A method is considered in which a given nonlinear is transformed to a controllable linear system in Brunovsky canonical form. A linear approximation is introduced to the nonlinear system called the modified tangent model. This model is easily computed. Constructing the transformation for this model enables the designer to find an approximate transformation for the nonlinear system. B.W.

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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.

A84-16260
NOISE MONITORING IN THE VICINITY OF GENERAL AVIATION AIRPORTS
P. D. SCHOMER (Illinois, University, Urbana, IL) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 74, Dec. 1983, p. 1764-1772. Research supported by the Illinois Department of Energy and Natural Resources. refs

Three sites in the vicinity of the municipal airport at Decatur, IL are monitored for five months in order to examine issues related to noise monitoring. Predicted and measured day/night average sound levels are compared, and individual aircraft levels are compared with predicted values. The temporal sampling requirements for monitoring are discussed, and the question whether the noise measured is from aircraft or from other sources is examined. The measured day/night average sound levels and the computer predictions are found to compare quite favorably, and most individual aircraft levels compare favorably with data in the FAA computer models. With regard to sampling requirements, it is contended that only four weeks out of the year are necessary, one in each quarter, to achieve a +2 dB to -3 dB tolerance. It is not possible to distinguish airport noise from other noise generated by the community. C.R.

A84-17823*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SILICON CARBIDE, A HIGH TEMPERATURE SEMICONDUCTOR
J. A. POWELL (NASA, Lewis Research Center, Cleveland, OH) Cleveland Electrical and Electronics Conference and Exposition, 28th,Cleveland, OH, Oct. 4-6, 1983, Paper. 5 p. refs

Electronic applications are described that would benefit from the availability of high temperature semiconductor devices. Comparisons are made among potential materials for these devices and the problems of each are discussed. Recent progress in developing silicon carbide as a high temperature semiconductor is described. Author

A84-17975*# Hamilton Standard, Windsor Locks, Conn.
PROPAGATION OF PROPELLER TONE NOISE THROUGH A FUSELAGE BOUNDARY LAYER
D. B. HANSON and B. MAGLIOZZI (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 12 p. refs
(Contract NAS2-11325)
(AIAA PAPER 84-0248)

In earlier experimental and analytical studies, it was found that the boundary layer on an aircraft could provide significant shielding from propeller noise at typical transport airplane cruise Mach numbers. In this paper a new three-dimensional theory is described that treats the combined effects of refraction and scattering by the fuselage and boundary layer. The complete wave field is solved by matching analytical expressions for the incident and scattered waves in the outer flow to a numerical solution in the boundary layer flow. The model for the incident waves is a near-field frequency-domain propeller source theory developed previously for free field studies. Calculations for an advanced turboprop (Prop-Fan) model flight test at 0.8 Mach number show a much smaller than expected pressure amplification at the noise directivity peak, strong boundary layer shielding in the forward quadrant, and shadowing around the fuselage. Results are presented showing the difference between fuselage surface and free-space noise predictions as a function of frequency and Mach number. Comparison of calculated and measured effects obtained in a Prop-Fan model flight test show good agreement, particularly near and aft of the plane of rotation at high cruise Mach number. Author

A84-17976*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF BOUNDARY LAYER REFRACTION AND FUSELAGE SCATTERING ON FUSELAGE SURFACE NOISE FROM ADVANCED TURBOPROP PROPELLERS
G. L. MCANINCH (NASA, Langley Research Center, Hampton, VA) and J. W. RAWLS, JR. (Kentron International, Inc., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0249)

An acoustic disturbance's propagation through a boundary layer is discussed with a view to the analysis of the acoustic field generated by a propfan rotor incident to the fuselage of an aircraft. Applying the parallel flow assumption, the resulting partial differential equations are reduced to an ordinary acoustic pressure differential equation by means of the Fourier transform. The methods used for the solution of this equation include those of Frobenius and of analytic continuation; both yield exact solutions in series form. Two models of the aircraft fuselage-boundary layer system are considered, in the first of which the fuselage is replaced by a flat plate and the acoustic field is assumed to be two-dimensional, while in the second the fuselage is a cylinder in a fully three-dimensional acoustic field. It is shown that the boundary layer correction improves theory-data comparisons over simple application of a pressure-doubling rule at the fuselage. O.C.

A84-18069#
THE ROLE OF HELMHOLTZ NUMBER IN JET NOISE
D. F. LONG and R. E. A. ARNDT (Minnesota, University, Minneapolis, MN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 8 p. refs
(Contract F49620-80-C-0053; N00014-83-K-0145)
(AIAA PAPER 84-0403)

By using the Helmholtz number to explore the characteristics of radiated noise, it is found that both excited jets and unexcited jets behave similarly. Qualitatively a high Helmholtz number corresponds to an increased broadband level and a low Helmholtz number corresponds to a decreased broadband level. This Helmholtz number is interpreted in terms of axisymmetric and helical structures and small scale turbulence. It is a function of both Reynolds number and Mach number. In particular, the Mach number plays an important role in the turbulence dynamics of a jet; it is not just a scaling factor for acoustic efficiency. Author

A84-18132*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A FLIGHT STUDY OF TONE RADIATION PATTERNS GENERATED BY INLET RODS IN A SMALL TURBOFAN ENGINE
J. S. PREISSER, R. J. SILCOX (NASA, Langley Research Center, Hampton, VA), W. EVERSMAN, and A. V. PARRETT (Missouri-Rolla, University, Rolla, MO) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 9 p. refs
(AIAA PAPER 84-0499)

This paper presents a flight study of tone radiation patterns from a small turbofan engine and compares results with similar static test stand data and a recently developed radiation theory. An interaction tone was produced by a circumferential array of inlet rods placed just upstream of the fan blades. Overhead and sideline flight directivity patterns showed cut-on of a dominant single mode occurred where predicted and the absence of any other significant circumferential or radial modes. In general, good agreement was found between measured flight and static data, with small differences being attributed to inlet geometry and/or forward speed effects. Good agreement was also obtained between flight data and theory for directivity pattern shape, however, the theory consistently predicted higher values for peak radiation angle over a wide range of frequency. Author

A84-18133*# Bionetics Corp., Hampton, Va.
FIELD-INCIDENCE NOISE TRANSMISSION LOSS OF GENERAL AVIATION AIRCRAFT DOUBLE WALL CONFIGURATIONS
F. W. GROSVELD (Bionetics Corp., Hampton, VA) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 13 p. refs
(Contract NAS1-16978)
(AIAA PAPER 84-0500)

Theoretical formulations have been developed to describe the transmission of reverberant sound through an infinite, semi-infinite and a finite double panel structure. The model incorporates the fundamental resonance frequencies of each of the panels, the mass-air-mass resonances of the structure, the standing wave resonances in the cavity between the panels and finally the coincidence resonance regions, where the exciting sound pressure wave and flexural waves of each of the panels coincide. It is shown that phase cancellation effects of pressure waves reflected from the cavity boundaries back into the cavity allows the transmission loss of a finite double panel structure to be approximated by a finite double panel mounted in an infinite baffle having no cavity boundaries. Comparison of the theory with high quality transmission loss data yields good agreement in the mass-controlled frequency region. It is shown that the application of acoustic blankets to the double panel structure does not eliminate the mass-air-mass resonances if those occur at low frequencies. It is concluded that this frequency region of low noise transmission loss is a potential interior noise problem area for propeller driven aircraft having a double panel fuselage construction. Author

A84-18134#
A MAPPED FACTORED IMPLICIT SCHEME FOR THE COMPUTATION OF DUCT AND FAR FIELD ACOUSTICS
J. W. WHITE and P. E. RAAD (Tennessee, University, Knoxville, TN) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan. 9-12, 1984. 7 p. refs
(AIAA PAPER 84-0501)
A transient factored-implicit algorithm and a general mapping procedure are presented for the calculation of duct and far field acoustics. The mapping is ideally suited for complex ducts with irregular surfaces and for surfaces with steep curvature. Grid points may be concentrated as desired over boundary sections of special interest and through the use of grid control terms, interior coordinate lines may also be concentrated for increased resolution. Due to the spatial factoring, the factored-implicit method requires only the inversion of tri-diagonal matrices of moderate size. The factored-implicit algorithm allows a wide variation in grid increment sizes without a restriction on the allowable time increment of integration. In addition, the factored scheme produces acoustic profiles with less unsteadiness ('jitter') about the periodic steady-state than has been experienced with explicit methods. The method is presented for a two-dimensional duct and far field; however, both the mapping and factored-implicit algorithms can be applied in three dimensions. Author

A84-18662
MEASUREMENT OF AIR IONIZATION BEHIND INTENSE SHOCK WAVES
V. A. GORELOV, L. A. KILDIUSHOVA, and V. M. CHERNYSHEV (Teplofizika Vysokikh Temperatur, vol. 21, May-June 1983, p. 449-453) High Temperature (ISSN 0018-151X), vol. 21, no. 3, Nov. 1983, p. 335-339. Translation. refs
Ionization is measured in a quasisteady flow behind intense shock waves moving at 4.3-16 km/sec with the aid of a new method for measuring ion densities, in which thin disposable electrostatic probes are used. Test measurements of the electron density were carried out by using microwave techniques at shock-wave velocities 5-7 km/sec and by recording the Stark broadening of the 486.10-nm H-beta line for velocities 10-15 km/sec. The experimental findings confirm that local thermodynamic equilibrium breaks down behind intense shock waves at velocities above 9 km/sec when small probes are used and the initial pressures are low. Author

N84-14873* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPARATUS AND METHOD FOR JET NOISE SUPPRESSION Patent
L. MAESTRELLO, inventor (to NASA) 16 Aug. 1983 9 p Filed 27 Feb. 1981 Supersedes N82-20465 (20 - 11, p 1504) Continuation of abandoned US Patent Appl. SN-753971, filed 23 Dec. 1976
(NASA-CASE-LAR-11903-2; US-PATENT-4,398,667; US-PATENT-APPL-SN-238791; US-PATENT-APPL-SN-753971; US-PATENT-CLASS-239-265.17) Avail: US Patent and Trademark Office CSCL 20A
A method and apparatus for jet noise suppression through control of the static pressure of the jet and control of the rate of entrainment of ambient fluid into the jet downstream of the exhaust nozzle is disclosed. The momentum flux over an extended region of the jet is regulated, affecting Reynolds stresses in the jet and the spreading angle of the jet. Static pressure is controlled through a long hollow, porous nozzle plug centerbody which may be selectively vented to ambient conditions, connected to a vacuum source, or supplied with fluids of various densities for injection into the stream. Sound in the jet may be channeled along the nozzle plug centerbody by injecting coolant such as a cryogenic fluid throughout the center-body into the jet.
Official Gazette of the U.S. Patent and Trademark Office

N84-14905# Joint Technical Coordinating Group for Aircraft Survivability, Washington, D.C. Countermeasures Subgroup.
THE AIRCRAFT INFRARED MEASUREMENTS GUIDE Final Report
W. L. CAPPS, D. POWLETTE, S. E. TATE, G. S. AMICK, and D. STOWELL Mar. 1983 133 p
(AD-A132598; JTCG/AS-81-C-002) Avail: NTIS HCA07/MFA01 CSCL 17E
A reference source for the aircraft infrared measurement community is proposed. The guide provides standard nomenclature, suggested data formats, calibration requirements (including derived mathematics), and measurement methodology. Chapters are also included on developing test plans and writing the formal report. An extensive bibliography contains sections on calculations aid/equation, calibration, radiometry/spectrometry, and radiation sources. Author (GRA)

N84-15027# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
HELICOPTER NOISE
S. LEWY and M. CAPLOT *In* Von Karman Inst. for Fluid Dynamics Aeroacoustics: Ten Years of Res. 44 p 1983 refs Previously announced in IAA as A83-48195
Avail: NTIS HC A14/MF A01
Helicopter turboshaft engine noise, especially rotor noise, is discussed. Physiological acoustics attempts to characterize helicopter noise effects due to the impulsive nature of main rotor acoustic emission are described. Experimental data are often contradictory, but solutions which remove the antitorque rotor are attractive. Although the tail rotor does not produce impulsive noise, acoustic level is comparable to the main rotor, and the sound has a higher, more disagreeable, frequency. Author (ESA)

N84-15028# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
EXPERIMENTAL METHODS IN COMPRESSOR NOISE STUDIES
S. LEWY and B. JUBELIN (SNECMA, Moissy-Cramayel, France) *In* Von Karman Inst. for Fluid Dynamics Aeroacoustics: Ten Years of Res. 37 p 1983 refs Previously announced in IAA as A83-48194
Avail: NTIS HC A14/MF A01
Resolution of sound wave equations in a guided medium, cut off properties of ducts, and azimuthal modes generated by a rotating source are discussed. Sound emission upstream of a compressor at subsonic and transonic speeds is compared. Ground-based and in flight measurement of compressor noise is described. A method of determining the spectrum of azimuthal or axial wave numbers by deriving the mean product of two signals filtered on a pure tone, one of which comes from a fixed microphone, and the other from a moving probe is illustrated.
Author (ESA)

N84-15894*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLUID SHIELDING OF HIGH-VELOCITY JET NOISE
J. H. GOODYKOONTZ Jan. 1984 22 p refs
(NASA-TP-2259; E-1705; NAS 1.60:2259) Avail: NTIS HC A02/MF A01 CSCL 20A
Experimental noise data for a nozzle exhaust system incorporating a thermal acoustic shield (TAS) are presented to show the effect of changes in geometric and flow parameters on attenuation of high-velocity jet exhaust noise in the flyover plane. The results are presented for a 10.00-cm-diameter primary conical nozzle with a TAS configuration consisting of a 2.59- or 5.07-cm-wide annular gap. Shield-stream exhaust velocity was varied from 157 to 248 m/sec to investigate the effect of velocity ratio. The results showed that increasing the annular gap width increases attenuation of high-frequency noise when comparisons are made on the same ideal thrust basis. Varying the velocity

ratio had a minor effect on the noise characteristics of the nozzles investigated. Author

N84-15896*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPINNING MODE ACOUSTIC RADIATION FROM THE FLIGHT INLET Final Report
W. F. MOSS Nov. 1983 33 p refs Prepared in cooperation with Clemson Univ., S.C.
(Contract NAS1-16394; NAS1-17130)
(NASA-CR-172273; NAS 1.26:172273; REPT-83-63) Avail: NTIS HC A03/MF A01 CSCL 20A

A mathematical model was developed for spinning mode acoustic radiation from a thick wall duct without flow. This model is based on a series of experiments (with and without flow). A nearly pure azimuthal spinning mode was isolated and then reflection coefficients and far field pressure (amplitude and phase) were measured. In our model the governing boundary value problem for the Helmholtz equation is first converted into an integral equation for the unknown acoustic pressure over a disk, S1, near the mouth of the duct and over the exterior surface, S2, of the duct. Assuming a pure azimuthal mode excitation, the azimuthal dependence is integrated out which yields an integral equation over the generator C1 of S1 and the generator C2 of S2. The sound pressure on C1 was approximated by a truncated modal expansion of the interior acoustic pressure. Piecewise linear spline approximation on C2 was used. Author

N84-15899# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
TRANSONIC NOISE GENERATION BY DUCT AND PROFILE FLOW Annual Report, Apr. 1982 - Apr. 1983
G. E. A. MEIER, R. TIMM, and F. BECKER London European Research Office Apr. 1983 45 p refs
(Contract DAJA37-81-C-0251)
(AD-A129367; AR-2) Avail: NTIS HC A03/MF A01 CSCL 20A

Aeroacoustic sound generation is discussed. The strong sound generation in helicopter rotor vortex interaction was studied and a vortex profile flow interaction experiment was performed in a transonic duct. Vortices are generated upstream of a NACA 0012 profile and the pressure fields are analyzed digitally. An automatic interferogram analysis technique is adapted to the problem to evaluate densities, pressures and vortex traces from the interferograms. It is found that a separation bubble is formed at the leading edge of the wing when the vortex passes over the profile. It is suggested that complicated flow at the boundary of the profile is one of the keys to the understanding of vortex profile interaction. E.A.K.

N84-15900# Federal Aviation Administration, Washington, D.C. Office of Environment and Energy.
AIRPORT NOISE CONTROL STRATEGIES
P. A. CLINE Jun. 1983 91 p
(AD-A133137; FAA/EE-83-3) Avail: NTIS HCA05/MFA01 CSCL 20A

This report provides a comprehensive listing of noise control strategies employed by the nation's airports. Forty-four categories of noise control actions have been identified and are in use, singly or in combination, by over 540 airports. Updated versions of this report will be issued periodically. GRA

N84-15903# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DISTRIBUTED SENSOR NETWORK Semiannual Technical Summary Report, 1 Oct. 1982 - 31 Mar. 1983
R. T. LACOSS 31 Mar. 1983 45 p
(Contract F19628-80-C-0002; ARPA ORDER 3345; DA PROJ. 3D30; DA PROJ. 3T10)
(AD-A133250; ESD-TR-83-028) Avail: NTIS HCA03/MFA01 CSCL 17A

The Distributed Sensor Networks (DSN) program is aimed at developing and extending target surveillance and tracking technology in systems that employ multiple spatially distributed sensors and processing resources. Such a system would be made up of sensors, data bases, and processors distributed throughout an area and interconnected by an appropriate digital data communication system. Surveillance and tracking of low-flying aircraft has been selected to develop and evaluate DSN concepts in the light of a specific system problem. A DSN test bed that will make use of multiple small acoustic arrays as sensors for low-flying aircraft surveillance is being developed and will be used to test and demonstrate DSN techniques and technology. This Semiannual Technical Summary (SATS) reports results for the period 1 October 1982 though 31 March 1983. Initial validation tests of a three-node message-based distributed acoustic surveillance system were conducted during this reporting period. The system consisted of three test-bed nodes interconnected and controlled by a separate experiment control and communication (ECC) computer. In addition to providing message based internodal communications, the ECC also serves as a system user interface. Improvements needed to support detailed distributed system experiments were identified and have been partially implemented. GRA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A84-19175
COMPUTER AIDED DESIGN OF A CONTROL SYSTEM FOR A HOVERCRAFT
R. GRAN, G. CARPENTER, and R. W. KLEIN (Grumman, Aerospace Corp., Bethpage, NY) IN: Conference on Decision and Control, 21st, Orlando, FL, December 8-10, 1982, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1982, p. 1347-1353.

The JEFF(B) is a hovercraft air cushion vehicle that was designed to be an amphibious assault vehicle for the Navy. It proved difficult to handle during engineering trials due to the number of controls that the pilot had to manipulate and the fact that instabilities were encountered during turns. To correct the operational difficulties, an Integrated Control System was designed for the JEFF(B) hovercraft. Utilizing a computer aided design approach, optimal nonlinear and linear controls were developed for the high speed turn, low speed turn, and translation modes. The JEFF(B) turn rate and translation performance were maximized, and the hovercraft was stabilized over the entire operating regime. The original four cockpit controls were reduced to two (independently commanded turn rate and velocity). Nonlinear simulation results and actual sea tests demonstrated dramatic improvements in handling qualities with the Integrated Control System. Author

N84-14964# Committee on Science and Technology (U. S. House).
NASA'S FIVE-YEAR PLAN
Washington GPO 1983 169 p Hearings before the Subcomm. on Space Sci. and Appl. of the Comm. on Sci. and Technol., 98th Congr., 1st Sess., no. 38, 26; 28 Jul. 1983
(GPO-27-459) Avail: Subcommittee on Space Science and Applications

The long range goals of NASA and how they fulfill national policy as established in the 1958 National Aeronautics and Space Act are reviewed. Specific plans for the next five years in the space flight, space technology, space science and applications, and space tracking and data systems programs are examined. A.R.H.

N84-16022*# Alabama Univ., Huntsville. Dept. of Mechanical Engineering.
RESEARCH REPORTS: 1983 NASA/ASEE SUMMER FACULTY FELLOWSHIP PROGRAM
G. R. KARR, J. B. DOZIER, (NASA. Marshall Space Flight Center), L. OSBORN, (NASA. Marshall Space Flight Center), and M. FREEMAN Dec. 1983 891 p refs Fellowship program held in Huntsville, Ala., 6 Jun. - 12 Aug. 1983
(Contract NGT-01-005-021)
(NASA-CR-170942; NAS 1.26:170942) Avail: NTIS HC A99/MF A01 CSCL 05I

Thirty-five technical reports contain results of investigations in information and electronic systems; materials and processing; systems dynamics; structures and propulsion; and space sciences. Ecology at KSC, satellite de-spin, and the X-ray source monitor were also studied.

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GENERAL

N84-15024# Naval Postgraduate School, Monterey, Calif.
A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM Technical Report, 1 Oct. 1981 - 30 Sep. 1982
W. M. TOLLES May 1983 433 p
(AD-A132871; NPS-012-83-004PR) Avail: NTIS HCA19/MFA01 CSCL 05I

This report contains 249 summaries on research projects which were carried out under funding to the Naval Postgraduate School Research Program. This research was carried out in the areas of Computer Science, Mathematics, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical Engineering, Meteorology, Aeronautics, Oceanography and Mechanical Engineering. The Table of Contents identifies the areas of research. Author (GRA)

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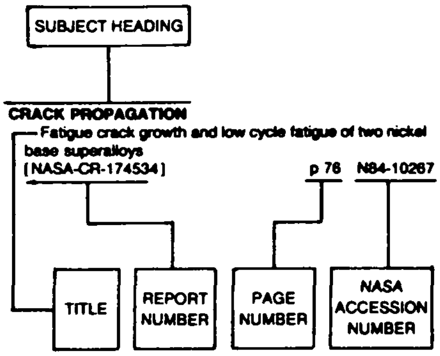

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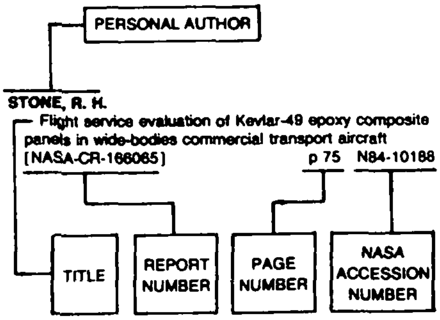

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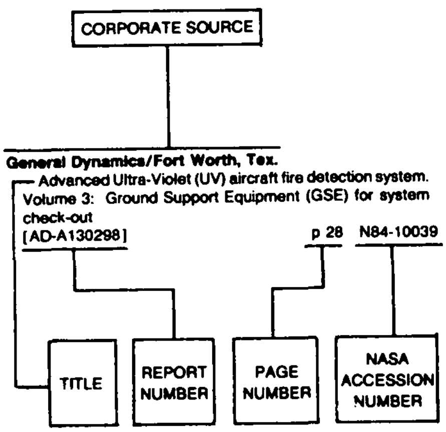

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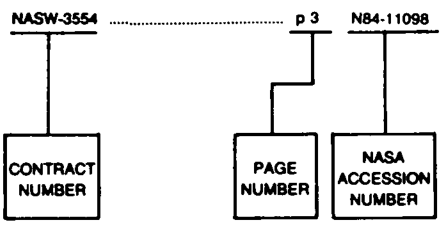

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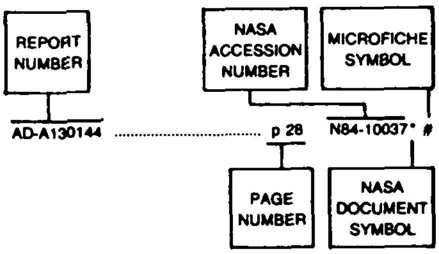

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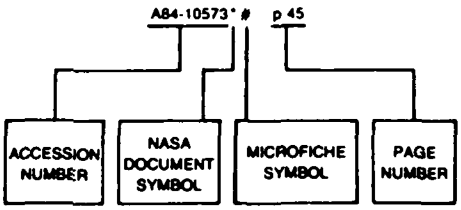

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7037(173)		

4. Title and Subtitle	5. Report Date
Aeronautical Engineering A Continuing Bibliography (Supplement 173)	April 1984
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7. Author(s)	8. Performing Organization Report No.
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