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Engineering
A Continuing
Bibliography
with Indexes

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National Aeronautics and
Space Administration



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STAR (N-10000 Series)	N84-26565 - N84-28725
IAA (A-10000 Series)	A84-36463 - A84-39762

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 179)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in September 1984 in

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

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INTRODUCTION

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

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 693 reports, journal articles, and other documents originally announced in September 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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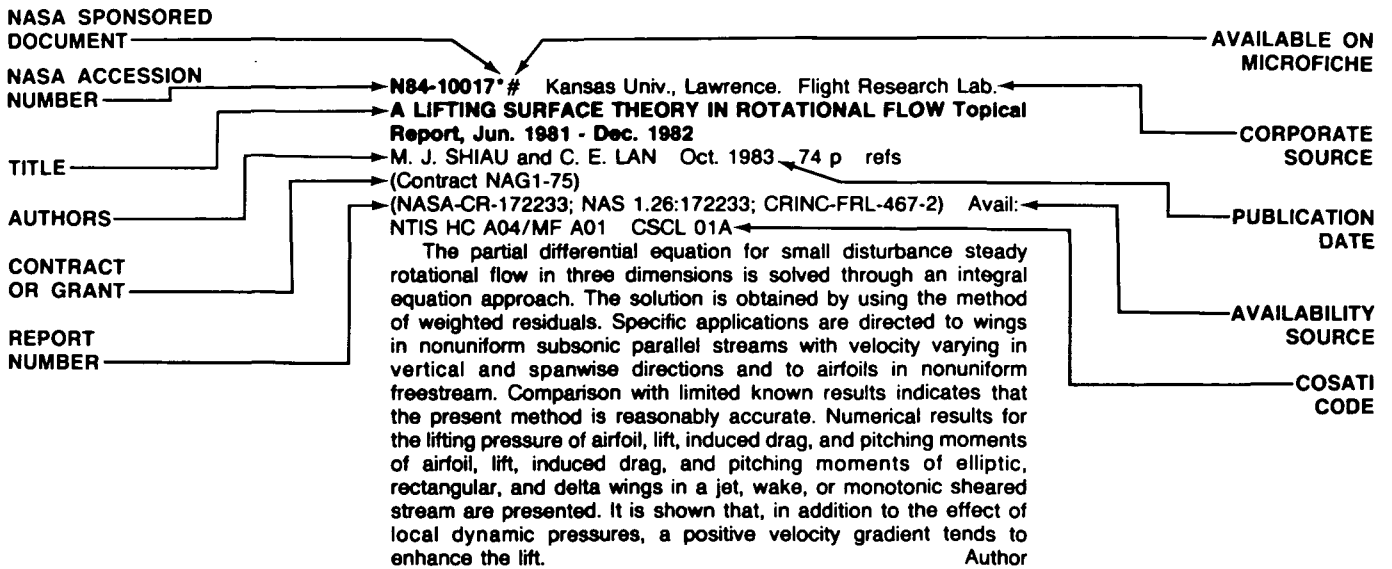
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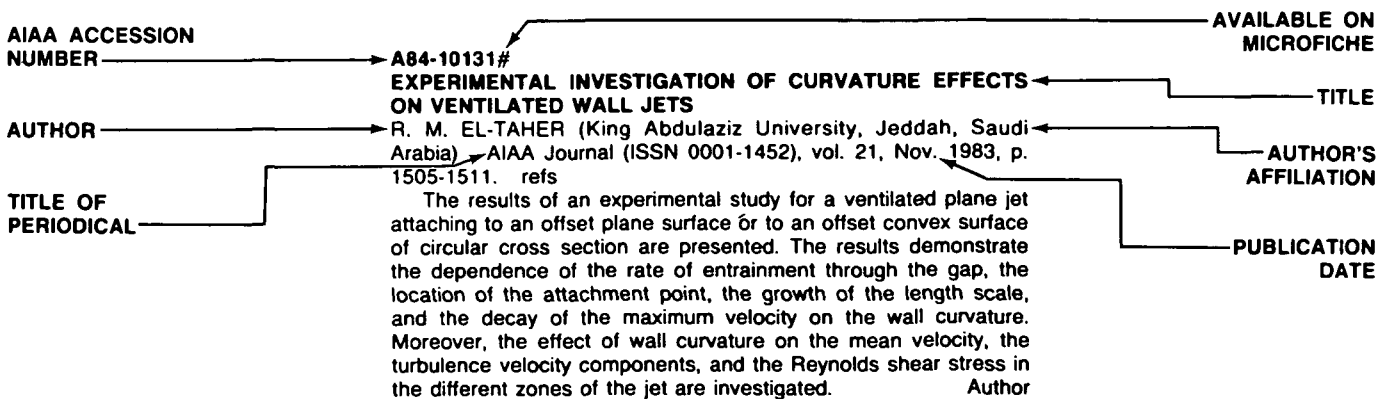
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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 179)

OCTOBER 1984

01

AERONAUTICS (GENERAL)

A84-36966#

SUPPORTABILITY CONSIDERATIONS OF ADVANCED FIGHTER ENGINES

J. T. RADEMACHER, W. W. SHOEMAKER, J. F. MONTGOMERY, III, and T. R. SEWALL (General Electric Co., Evendale, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p.
(AIAA PAPER 84-1257)

Issues in the effort to increase the supportability of next generation engines for the Advanced Tactical Fighter (ATF) are discussed. Rising government costs have led to the establishment of standards for engine supportability as part of the Joint Advanced Fighter Engine (JAFE) development program. Among the requirements specified are: a 700 percent improvement in engine-caused shop visit rate; a 500 percent improvement in mean time between engine failures; a 600 percent improvement in in-flight shutdown rate; a 400 percent improvement in parts consumption and labor costs per engine flight hour, and a 200 percent improvement in mean repair time. Additional expectations are listed in a 'lessons learned' data base. Efforts by one contractor to meet these standards are discussed. New engine design concepts will consider supportability and reliability issues from the beginning of the design process. It is the intent of the contractors to duplicate and improve upon the demonstrated supportability of current engine design, while maintaining JAFE engine performance standards.

I.H.

A84-36977#

TEMS/CEMS IV - AN ADVANCED ON-CONDITION MAINTENANCE CONCEPT UNDERGOING EVALUATION ON THE A-10/GE TF34-100

L. R. LAPIERRE (General Electric Co., Lynn, MA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 14 p.
(AIAA PAPER 84-1413)

Most of the newer gas turbine engines used in military applications are now equipped with some form of health monitoring system. While the sophistication and intended scope of these systems varies, most have similar functions: overlimit or out-of-schedule parameter detection, data recording at the time of such events, parts life usage information and performance monitoring/trending. In preparation for fleetwide introduction in 1985/86 on the A-10/TF34-100 a unique engine monitoring/maintenance management concept is undergoing operational development on an A-10 squadron. This system marries conventional event detection and data acquisition capabilities with mass data storage, analysis, and display techniques. Incorporation of engine oil analysis and maintenance records in the data base is an additional enhancement over other systems. Specific cases illustrating the diagnostic and early detection capabilities of this system are presented. Both proven and potential applications of

this system for engine maintenance management are also discussed. Author

A84-37034

AERODYNAMICS AND AERODYNAMICISTS IN THE YEAR 2000 [L'AERODYNAMIQUE ET LES AERODYNAMICIENS DE L'AN 2000]

P. PERRIER (Avions Marcel Dassault-Breguet Aviation, Vaucresson, Hauts-de-Seine, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 103-105, 107, 110. In French.

Aerodynamics is the most complex branch of fluid mechanics and is practiced to predict the velocity, pressure, and temperature at all points of a flow, particularly in unsteady and turbulent conditions. It is asserted that the current level of aerodynamics calculations is sufficiently sophisticated that young aerodynamicists now working will not make major contributions until the year 2000. The time will be spent learning grid construction, computer codes, iterations, models, subroutines, and computer capabilities. Extremely turbulent flows will remain the main topic of study, while computers will carry an increasingly larger share of the research work load relative to wind tunnels. Supercomputers and other floating point arithmetic devices will enhance simulations to a degree that real-time data acquisition technology will be pressed to provide data of comparable quality for comparisons. The computations will be carried out by researchers at terminals distributed across continents. M.S.K.

A84-37036

THE FUTURE OF THE DIRIGIBLE [L'AVENIR DU DIRIGEABLE]

R. M. HILLSDON (Airship Industries, Ltd., London, England) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 131-136, 138. In French.

Technical advances, projected uses, and limitations of modern airships are described. The flights of the Skyships 500 and 600 in 1983 and 1984, respectively, marked the return of airships to commercial applications. All new designs for the gas envelope are soft instead of rigid and are constrained by weight, permeability, durability, and manufacturing costs. The gas of choice is atomic He, which may eventually be extracted from the air with on-board apparatus. The containment must resist leakage and degradation caused by solar UV radiation. A plastic material impregnated with TiO₂ is used for the Skyship series. It is predicted that by the year 2000 airships will carry 50 ton payloads, will have polyamide gas bags to reduce weight, and will be equipped with automatic pilots. Control surfaces will be constructed of composite materials. Low speed control has been effected with vectored thrusters on the Skyships. Future uses of the airships include passenger and cargo transport, forward alert, and electronic warfare functions for the military. M.S.K.

A84-37039

THE FUTURE EVOLUTION OF CAD/CAM IN THE AEROSPACE INDUSTRY [L'EVOLUTION FUTURE DE LA CFAO DANS L'INDUSTRIE AERONAUTIQUE]

M. N. EGLISE (Avions Marcel Dassault-Breguet Aviation, Vaucresson, Hauts-de-Seine, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 159, 163, 164 (3ff). In French.

Areas of aeronautical design and engineering that will benefit from advances in CAD/CAM capabilities are outlined. Three-dimensional studies of the geometric shape of new aircraft

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designs will aid in reconciling design, visualization, interaction, and manufacturing constraints. Multiple user systems employing distributed terminals and a common data base will enhance coherence, integrity and the security of the data base. The development of artificial intelligence will permit progress in the recognition, memory storage and exploitation of design expertise. The entire design-to-manufacture process will become integrated. Several examples of design and design specification projections are cited, along with instances of robot manufacturing configurations. M.S.K.

A84-37528#

THE INTRODUCTION OF GENERALIZED AUTOMATIC CONTROL IN AVIONICS AND FLIGHT SAFETY [L'INTRODUCTION DU CONTROLE AUTOMATIQUE GENERALISEEN AVIONIQUE ET LA SECURITEDE VOL]

J. TAILLET and PH. POISSON-QUINTON (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Societesdes Electriciens, des Electroniciens et des Radioelectriciens, Conference sur l'Electricite, l'Electronique et la Civilisation, Paris, France, Dec. 6-9, 1983) ONERA, TP, no. 1984-6, 1984, 18 p. In French.

(ONERA, TP NO. 1984-6)

A review of generalized automatic control (GAC) of aircraft avionics systems through data processing technology is presented. Attention is given to the role of GAC data processing technology in improving aircraft safety, cutting pilot workload, reducing fuel costs, and increasing aircraft reliability. Current research is discussed which is investigating methods of protecting onboard GAC avionics systems from damage caused by internal electronic failure, natural electrostatic discharges (lightning), and electromagnetic pulses from nuclear devices detonated in the air. Block diagrams and drawings are provided which describe some possible configurations for GAC systems. I.H.

A84-38288

MICROGRAVITY SYSTEM BY USING STRATOSPHERIC BALLOONS

M. NAMIKI, S. OHTA, H. AKIYAMA, T. YAMAGAMI, Y. KOMA, and J. NISHIMURA (Tokyo, University, Tokyo, Japan) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings . Tokyo, AGNE Publishing, Inc., 1982, p. 1195-1200.

A system for microgravity experiments using a stratospheric balloon has been developed. A free-fall body, which is released from a balloon, has the shape of a cylinder with a nose cone and tail wings. The body contains accelerometers, attitude sensors, a telemetry transmitter, an electric timer, an experimental room, parachutes and a floating mechanism for recovery. In the flight test in 1981, a body with a length of 1.8 m, a diameter of 0.31 m and a weight of 90 kg was released from a balloon at an altitude of 29 km. The observed gravity inside the body was almost as expected, and was less than 2×10^{-3} G approximately for 10 sec. Author

A84-38401

FORWARD SWEEP WING AIRCRAFT; PROCEEDINGS OF THE INTERNATIONAL CONFERENCE, UNIVERSITY OF BRISTOL, BRISTOL, ENGLAND, MARCH 24-26, 1982

R. K. NANGIA, ED. (Bristol, University, Bristol, England) Conference sponsored by the University of Bristol and Royal Aeronautical Society; U.S. Air Force and U.S. Navy. Bristol, University of Bristol, 1983, 316 p.

(Contract AF-AFOSR-82-0075; N00014-82-G-0020)

Subjects related to aerodynamics, configurations, and control are discussed, taking into account the X-29A forward swept wing advanced technology demonstrator program, forward swept wings at a British aerospace company, an experimental investigation into forward swept wings for a light-weight combat aircraft, the design of a forward swept wing fighter aircraft, forward swept wings and commuter aircraft, and a comparison between forward and aft swept wings on V/STOL combat aircraft. Other topics considered are related to structures and aeroelasticity, and current research

programs. Attention is given to flight demonstrations and the forward swept wing, trends in modern high performance aircraft, integration of technologies of the X-25A, transonic aerodynamics of forward swept wings analyzed as a lifting-line problem, the configuration development of a highly-maneuverable research aircraft with forward swept surfaces, the aeroelastic stability of forward swept composite winged aircraft, and the divergence of forward swept wings. G.R.

A84-38402

FLIGHT DEMONSTRATIONS AND THE FORWARD SWEEP WING

N. J. KRONE IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982 . Bristol, University of Bristol, 1983, p. 1.1-1.5.

In 1935, Busemann had suggested the use of 'arrow-wings' (swept wings) to delay the onset of high drag at transonic speeds. It is pointed out, however, that even today, despite advances in computational capabilities and in wind tunnel testing, actual flying experiments are still vital for developments related to human flight. In recognition of this importance, Germany built the JU287, a flight demonstration aircraft which had a leading edge sweep of 15 deg. The aircraft flew 17 times during 1944. In 1977, the Defense Advanced Research Projects Agency (DARPA) initiated a program aimed at developing the Forward Swept Wing concept to a point where it would be an acceptable alternative for future military aircraft requirements. Two distinct approaches were considered, including an employment of remotely piloted research vehicles (RPRV's) and manned demonstrators. G.R.

A84-38714#

25 000 AIRPLANES, HELICOPTERS AND GLIDERS FOR 40 YEARS OF THE POLISH PEOPLE'S REPUBLIC

A. GLASS Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 39, Apr.-May 1984, p. 1-14. In English and Polish.

On the occasion of the anniversary of the aircraft industry in the Polish People's Republic, a historical review is presented of the first 40 years of aircraft design and development in Poland. Special attention is given to experience gained in the production of fighter aircraft based on Soviet models including the LIM-1 (MiG-15), the LIM-2 (MiG-15 bis), and the LIM-5 (MiG-17). Agricultural applications of Polish aircraft designs are also discussed. Examples of specific aircraft designs are provided in the form of a series of black and white photographs. I.H.

A84-38715#

COOPERATION IN PRODUCTION OF THE IL-86 AIRPLANE

S. ZIOMEK Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 39, Apr.-May 1984, p. 38-40. In English and Polish.

Cooperation between Polish and Soviet aircraft industries in the development of the IL-86 commercial aircraft is discussed. Attention is given to the role of the Polish aircraft industry in producing several finished parts for the aircraft, including the tail assembly, the outer and inner engine pylons, the outer and inner flaps and flap carriages, and the flap and slat screw control mechanisms. The necessary plant modernization and technical advice provided by the Soviets are seen as a firm foundation for prolonged growth in the industry and it is expected that a similar cooperative approach will be taken in the development of the IL-96 commercial aircraft. I.H.

A84-38876

ANNUAL MINI-SYMPOSIUM ON AEROSPACE SCIENCE AND TECHNOLOGY, 10TH, USAF INSTITUTE OF TECHNOLOGY, WRIGHT-PATTERSON AFB, OH, MARCH 20, 1984, PROCEEDINGS

Symposium sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, 1984, 233 p.

The present conference covers computational aerodynamics and fluid mechanics, terrain/vehicle interaction technologies, aerodynamic and fluid mechanical aspects of heat transfer, flight and spacecraft control, composite materials, experimental facilities,

applied mathematics and statistical analysis methods, structural dynamics and vibration damping, energy management, fatigue and fracture, propulsion systems, and computational engineering. Attention is given to two-dimensional and axisymmetric internal separated flows, ramp takeoff performance for fighter aircraft, research concerning dynamic stall, microprocessor-based flight control, an edge delamination test for composite materials fracture, optics technology improvements in solar simulation, the application of fuzzy logic in system interaction models, laser vibration control, high current inductive energy storage, the effect of blade tip vanes on helicopter rotor performance, the distribution of the likelihood ratio test criterion in testing the equality of several two-parameter exponential distributions, a dynamic stability analysis of a hose/drogue refueling system, an evaluation of crack closure, the rotary rocket concept, and the use of a LISP-based expert system in describing the equations of motion of a dynamical system.

O.C.

A84-39276*
GENERAL AVIATION TECHNOLOGY CONFERENCE,
HAMPTON, VA, JULY 10-12, 1984, TECHNICAL PAPERS

Conference sponsored by the American Institute of Aeronautics and Astronautics and NASA. New York, American Institute of Aeronautics and Astronautics, 1984, 99 p.

The present conference on general aviation aircraft design considers the performance tradeoffs involved in two- and three-control surface aerodynamic configurations, wing design criteria for increased resistance to spins, the performance levels obtained by flight and wind tunnel tests of an 'electroimpulse' deicing system, and the characteristics of lightning strikes experienced by the NASA F-106B research aircraft. Also considered are the application of speech recognition and synthesis systems to general aviation cockpits, control and display requirements for single-pilot Instrument Flight Rules, pilot interfacing with advanced avionics and automated cockpit systems, the feasibility of sidestick controllers for general aviation aircraft, the acoustic prediction methods incorporated by the NASA Generalized Advanced Propeller Analysis System, and the adhesively bonded structure of the Citation II business jet aircraft.

O.C.

A84-39287#
CITATION III BONDED STRUCTURE

R. B. HELD (Cessna Aircraft Co., Wichita, KS) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 91-96.
 (AIAA PAPER 84-2244)

This paper presents an overview of the structural certification program for the Citation III adhesive bonded structure, the major steps in the bonding process and the evaluation that produced the final bonding process. In addition to applying Cessna's metal bonding experience, the knowledge and experience from other aircraft companies was reviewed and consulted to help establish the adhesive bonding process for the Citation III airframe. The Cessna Citation III is a business jet aircraft certified to the Federal Regulation Part 25 Airworthiness Standards. Adhesive bonding was used to increase the structural efficiency of the structure for strength, durability and damage tolerance. The airframe is more weight efficient with smoother exterior surfaces. The airplane benefit is improved performance and lower life cycle costs.

Author

N84-26565# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flugfunk und Flugdatentechnik.

PROCEEDINGS OF THE 12TH SYMPOSIUM ON AIRCRAFT INTEGRATED DATA SYSTEMS

Feb. 1984 578 p refs Symp. held at Brunswick, 20-22 Sep. 1983

(DFVLR-MITT-84-01) Avail: NTIS HC A25/MF A01

Problems associated with the application of aircraft integrated data systems (AIDS) were discussed. The AIDS-systems used for monitoring and recording flight and aircraft condition and

performance were described. Safety, reliability and economy of aircraft operation were considered. The present state and future developments in this field were outlined.

N84-26596# Dayton Univ., Ohio.
CONFERENCE ON AEROSPACE TRANSPARENT MATERIALS AND ENCLOSURES

S. A. MAROLO Dec. 1983 166 p Held at Scottsdale, Ariz. on 11-14 Jul. 1983

(Contract F33615-80-C-3401; AF PROJ. 1926)

(AD-A140701; AFWAL-TR-83-4154) Avail: NTIS HC A08/MF A01 CSCL 01C

The purpose of this report is to make available the technical papers presented at the Fourteenth Conference on Aerospace Transparent Materials and Enclosures. Fifty three technical papers are presented in seven sessions that address transparent material for enclosures, coatings for transparencies; transparency design; bird impact resistance; human factor and optics; operational problems; design criteria on transparent plastics, glasses, and elastomers; aircraft-structural integration of windshields and canopies; testing techniques; and cost of ownership reduction. The papers contained herein have been reproduced directly from the original manuscripts.

N84-26621# Defence Materiel Administration, Stockholm (Sweden). Flight Safety Unit.

SWEDISH AIR FORCE MAINTENANCE PROGRAMME FOR AGED TRANSPARENT ENCLOSURES FOR JET TRAINER AND JET FIGHTER AIRCRAFT

R. FORSS /n Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 553-569 Dec. 1983

(AD-P003208) Avail: NTIS HC A08/MF A01 CSCL 01C

An investigation involving FMV, SAAB-SCANIA and FFV Maintenance triggered a chain of activities concerning questions about the structural reliability of acrylic enclosures 10-15 years old or more, and questions about different types of edge attachment defects, and methods for the detection of hidden edge defects. The Acrylics Defect Prism Inspection Method was re-invented and further developed, making it possible to detect defects such as cracks, delaminations and bond separations within the otherwise concealed regions of the edge attachments of windshields and canopies. The prism inspection of the inner sides of the transparency edges is done from the outside of the enclosure. Today the aged windshields and canopies of the SAAB-SCANIA 35 Draken and the canopies of the SAAB-SCANIA 105 trainer are periodically inspected and the defects are traced. The SAAB-SCANIA 37 Viggen enclosures are due for a similar inspection program.

GRA

N84-26637# Micro-Surface Finishing Products, Inc., Wilton, Iowa.

THE REDUCTION OF LIFE-CYCLE COSTS THROUGH CONTINUING ACRYLIC MAINTENANCE

R. J. STILLMAN and H. A. WILSON /n Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 825-848 Dec. 1983

(AD-P003224) Avail: NTIS HC A08/MF A01 CSCL 01C

With the development of cushioned abrasives in 1960, a promising repair system for the maintenance of quality surfaces evolved, and in 1969 and 1970 the Military introduced the RS-69 repair kit and Mil-Spec 58091-A. Training programs at Ft. Rucker and other bases showed the way to extended life and reduced life cycle costs of aircraft transparencies. The process was adopted by all manufacturers of aircraft acrylics in the U.S. and abroad. Airlines were quick to realize the value of line maintenance to restore cabin or cockpit windows in place. Northrup Corporation in 1978 collaborated in the design of a new kit, the NC-78-1, which may become the new military kit, replacing the outdated RS-69. Air rework facilities are conducting seminars to upgrade the skill levels at their installations, and the aviation technical schools of the country are all teaching acrylic maintenance using cushioned abrasives.

GRA

01 AERONAUTICS (GENERAL)

N84-26650# Air Force Systems Command, Bolling AFB, Washington, D.C.
GUIDE TO CANADIAN AEROSPACE RELATED INDUSTRIES
R. L. MCKENNEY, JR. and D. J. PEARSON Mar. 1984 124 p
(AD-A140606; AFSC-TR-84-001) Avail: NTIS HC A06/MF A01
CSCL 13H

This guide is a contracting source list of Canadian aerospace related industries to be used by USAF procurement offices, project engineers, and scientists. It provides company profiles, a company keyword index, and contact points for each company.

Author (GRA)

N84-26652# Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
5 Jun. 1984 76 p Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-016) Avail: NTIS HC A05/MF A01

Various aspects of transportation in the Soviet Union are discussed. Civil aviation, motor vehicles and highways, rail transportation, maritime shipping, and port facilities are reviewed.

N84-26653# Joint Publications Research Service, Arlington, Va.
ACHIEVEMENTS OF KAMOV HELICOPTER DESIGN BUREAU
S. V. MIKHEYEV *In its* USSR Rept.: Transportation
(JPRS-UTR-84-016) p 1-4 5 Jun. 1984 Transl. into ENGLISH from *Grazhdanskaya Aviats.* (Moscow), no. 2, Feb. 1984 p 34-35
Avail: NTIS HC A05/MF A01

The Kamov series helicopters designed and produced in the Soviet Union for civil aviation purposes are discussed. Helicopter design, performance capabilities, aerial reconnaissance, and control are addressed. Ice reconnaissance is emphasized. R.S.F.

N84-27660*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ADVANCED AERODYNAMICS. SELECTED NASA RESEARCH
Washington Dec. 1981 97 p refs Presented at the 5th Ann. Status Rev. of the NASA Aircraft Energy Efficiency (ACEE) Energy Efficient Transport Prog., Edwards, Calif., 14-15 Sep. 1981
(NASA-CP-2208; L-14949; NAS 1.55:2208) Avail: NTIS HC A05/MF A01 CSCL 01B

This Conference Publication contains selected NASA papers that were presented at the Fifth Annual Status Review of the NASA Aircraft Energy Efficiency (ACEE) Energy Efficient Transport (EET) Program held at Dryden Flight Research Center in Edwards, California on September 14 to 15, 1981. These papers describe the status of several NASA in-house research activities in the areas of advanced turboprops, natural laminar flow, oscillating control surfaces, high-Reynolds-number airfoil tests, high-lift technology, and theoretical design techniques.

N84-27667*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AERODYNAMIC CHARACTERISTICS OF 2 NASA SUPERCRITICAL AIRFOILS WITH DIFFERENT MAXIMUM THICKNESS
C. D. HARRIS Apr. 1972 58 p refs
(NASA-TM-X-2532; L-8173; NAS 1.15:2532) Avail: NTIS HC A04/MF A01 CSCL 01A

Transonic wind tunnel tests were conducted at Mach numbers from 0.60 to 0.81 to determine the aerodynamic characteristics of two NASA supercritical airfoils. The airfoils had maximum thicknesses of 10 and 11 percent of the chord. Normal forces and pitching moments acting on the airfoils were determined from surface static pressure measurements. Drag forces acting on the airfoils were derived from vertical variations of the total and static pressures measured across the wake. For the thinner airfoil, stall begins at approximately 0.1 higher normal-force coefficient at the higher test Mach numbers, and the drag divergence Mach number at a normal-force coefficient of 0.7 was 0.01 higher. R.S.F.

N84-27668 Joint Publications Research Service, Arlington, Va.
USSR REPORT: TRANSPORTATION
2 Mar. 1984 94 p refs Transl. into ENGLISH from various Russian articles
(JPRS-UTR-84-005) Avail: NTIS HC A05

This U.S.S.R. report describes major developments in the area of civil aviation. Subject matter covered includes: projected developments in design of civil aircraft; soviet-built aircraft performance; and the use of aircraft and helicopters for arctic air drop operations.

B.W.

N84-27669 Joint Publications Research Service, Arlington, Va.
DESIGNER, SCIENTIST ON PROJECTED DEVELOPMENTS IN AVIATION

D. GAY *In its* USSR Rept.: Transportation (JPRS-UTR-84-005) p 1-10 2 Mar. 1984 Transl. into ENGLISH from *Znamya* (Moscow), no. 9, Sep. 1983 p 198-212
Avail: NTIS HC A05

Projected developments in soviet aircraft design are discussed. Maintainability reliability, engine performance and configuration were found to be the most important factors involved in aerodynamic design. B.W.

02

AERODYNAMICS

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

A84-36476#
BOUNDARY-LAYER CALCULATIONS IN THE INVERSE MODE FOR INCOMPRESSIBLE FLOWS OVER INFINITE SWEEP WINGS

S. F. RADWAN and S.G. LEKOUDIS (Georgia Institute of Technology, Atlanta, GA) *AIAA Journal* (ISSN 0001-1452), vol. 22, June 1984, p. 737-743. Research supported by the Lockheed-Georgia Co. refs

Previously cited in issue 06, p. 714, Accession no. A83-19590

A84-36477#
PERFORMANCE PREDICTION OF HIGH-INLET-BLOCKAGE DIFFUSERS

M. S. GREYWALL (Wichita State University, Wichita, KS) *AIAA Journal* (ISSN 0001-1452), vol. 22, June 1984, p. 744, 745. refs

Previously cited in issue 05, p. 636, Accession no. A83-16733

A84-36478*# Missouri Univ., Rolla.
A FAST VISCOUS CORRECTION METHOD FOR UNSTEADY TRANSONIC FLOW ABOUT AIRFOILS

S. C. LEE (Missouri-Rolla, University, Rolla, MO) *AIAA Journal* (ISSN 0001-1452), vol. 22, June 1984, p. 746, 747. refs
(Contract NCA2-OR-450-201)

Previously cited in issue 05, p. 583, Accession no. A83-16621

A84-36481*# Florida Univ., Gainesville.
PROGRESS TOWARD A MODEL TO DESCRIBE JET/AERODYNAMIC-SURFACE INTERFERENCE EFFECTS

R. L. FEARN (Florida, University, Gainesville, FL) *AIAA Journal* (ISSN 0001-1452), vol. 22, June 1984, p. 752, 753; Abridged.
(Contract NSG-2288)

Previously announced in STAR as N83-34903

A84-36482#

THREE-DIMENSIONAL NONEQUILIBRIUM VISCOUS SHOCK-LAYER FLOWS OVER COMPLEX GEOMETRIES

C. H. LEWIS (Virginia Polytechnic Institute and State University, Blacksburg, VA), S. SWAMINATHAN, and M. D. KIM AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 754, 755. refs

Previously cited in issue 16, p. 2292, Accession no. A83-36048

A84-36484#

A NEW AND IMPROVED COMPUTATIONAL TECHNIQUE FOR TWO-DIMENSIONAL, UNSTEADY, COMPRESSIBLE FLOWS

L. ZANNETTI (Torino, Politecnico, Turin, Italy) and G. MORETTI AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 758-765. refs

Previously cited in issue 06, p. 797, Accession no. A82-17818

A84-36487*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FLOW AND HEAT TRANSFER MEASUREMENTS ALONG A COOLED SUPERSONIC DIFFUSER

L. H. BACK, R. F. CUFFEL, and P. F. MASSIER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 777-780. refs

An experimental investigation was conducted to ascertain the mean flowfield, including shock wave structure, separated flow regions, turbulent boundary-layer growth, static pressure variations, wall heat transfer, and shear stresses in a second-throat, axisymmetric, supersonic diffuser with wall cooling. The diffuser inlet Mach number of the heated air flow was 3.76, the stagnation pressure was 6.8 atm, the ratio of wall to total gas temperature was 0.44, and the diffuser discharged to the atmosphere. The complex flowfield involved deceleration and acceleration regions, supersonic and embedded subsonic regions, and strong viscous regions with relatively large radial and axial variations. The heat transfer and wall static pressure distributions were remarkably similar, and heat transfer rates were high locally at oblique shock/turbulent boundary-layer interactions, in the pseudoshock region, and in the separation region in the diffuser outlet section.

Author

A84-36940

VORTICES AROUND AIRFOILS

P. FREYMUTH, W. BANK (Colorado, University, Boulder, CO), and M. PALMER American Scientist (ISSN 0003-0996), vol. 72, May-June 1984, p. 242-248. USAF-supported research. refs

The questions as to whether an unsteady wind aids airfoil lift, and whether such lift is less influenced by stall in an unsteady wind, are presently addressed in view of smoke-generating liquid-employing flow visualization studies in a wind tunnel. Although the results obtained are far from definitive, novel insights have been gained into a variety of vortical phenomena over a wide range of Reynolds numbers. The vortex flow phenomenon-revealing photographs presented were taken for different airfoil chord lengths and angles of attack.

O.C.

A84-36960*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

REDESIGN AND CASCADE TESTS OF A SUPERCRITICAL CONTROLLED DIFFUSION STATOR BLADE-SECTION

J. F. SCHMIDT, T. F. GELDER, and L. F. DONOVAN (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs

(AIAA PAPER 84-1207)

A supercritical stator blade section, previously tested in cascade, and characterized by a flat-roof-top suction surface Mach number distribution, has been redesigned and retested. At near design conditions, the losses and air turning were improved over the original blade by 50 percent and 7 percent, respectively. The key element in the improved performance was a small blade reshaping. This produced a continuous flow acceleration over the first one-third chord of the suction surface which successfully prevented a

premature laminar separation bubble. Several recently available inviscid analysis codes and one fully viscous (Navier-Stokes) analysis code were used in the redesign process. The validity of these codes was enhanced by the test results. Previously announced in STAR as N84-22533

Author

A84-36968#

IMPROVED STATISTICAL ANALYSIS METHOD FOR PREDICTION OF MAXIMUM INLET DISTORTION

D. SEDLOCK (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 15 p. refs

(AIAA PAPER 84-1274)

An analytical method is described that uses inlet total pressure statistical properties and a random number process to predict the most probable maximum pressure distortion and pressure distortion map. The validity of the method is demonstrated by comparing predicted maximum distortion levels and pressure contour maps with measured peak distortion levels and pressure contour maps obtained from analog screening of inlet pressure data.

Author

A84-36971*# Pennsylvania State Univ., University Park.

COMPUTATION OF THREE-DIMENSIONAL VISCOUS FLOWS USING A SPACE-MARCHING METHOD

K. N. S. MURTHY and B. LAKSHMINARAYANA (Pennsylvania State University, University Park, PA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 9 p. refs

(Contract NSG-3266)

(AIAA PAPER 84-1298)

A space-marching method, developed to compute three-dimensional flows for internal geometries, has been utilized to predict viscous flows through a curved duct and over a swept wing. The Navier-Stokes equations have been posed as an initial value problem by neglecting the streamwise viscous diffusion terms and by treating the pressure gradient as a known source term. The resulting equations have been solved by a non-iterative (single pass) algorithm at each streamwise step. The results are compared with earlier computations (based on iterative methods) and the experimental data. The agreement between the present predictions, the experimental data, and the earlier predictions is good for the cases computed. The computation time is only a fraction of the iterative methods.

Author

A84-36992

THE AERODYNAMIC OPTIMIZATION OF WINGS IN THE SUBSONIC SPEED RANGE AND THE INFLUENCE OF THE DESIGN OF THE WING TIPS [DIE AERODYNAMISCHE OPTIMIERUNG VON TRAGFLUEGELN IM UNTERSCHALLGESCHWINDIGKEITSBEREICH UND DER EINFLUSS DER GESTALTUNG DER FLUEGELENDEN]

H. ZIMMER Stuttgart, Universitaet, Fakultae fuer Luft- und Raumfahrttechnik, Dr.-Ing. Dissertation, 1983, 122 p. In German. refs

Some of the objectives of modern aircraft development are related to an achievement of a lower fuel consumption and the reduction of aircraft noise. The present investigation is mainly concerned with the aerodynamic aspects of the objectives of aircraft development. The principal aim is related to a critical discussion of the possibilities for the reduction of the induced drag. New studies regarding the design of the wing, and in particular, the wing tips are considered. The induced drag is important, because in cruising flight it accounts generally for approximately one-third of the entire drag for the aircraft, while in climbing one-half of the entire drag is provided by the induced drag. A survey is presented of the wing geometries and wing tip designs studied, and theoretical investigations of different planar wings with systematically varied wing tip forms are conducted. Attention is also given to a theoretical study of some planar and nonplanar wings and a comparison with experimental data. G.R.

02 AERODYNAMICS

A84-37051

NUMERICAL METHODS IN AERONAUTICAL FLUID DYNAMICS

P. L. ROE, ED. (Royal Aircraft Establishment, Aerodynamics Dept., Bedford, England) London and New York, Academic Press, 1982, 564 p.

The present conference considers recent advancements and shortcomings in the calculation of inviscid flows with shock waves, the characterization of parallel-processing computers and algorithms, coordinate systems developed for flow field problems, approximate factorization methods, FEMs for transonic flows, and an improved time-marching method for turbomachinery flow calculation. Attention is also given to the numerical modeling of shock waves and other discontinuities, a novel finite volume method for the Euler equations that is applicable to transonic flows, finite element and alternating direction method numerical solutions of the time-dependent Navier-Stokes equations for incompressible viscous fluids, techniques for the estimation of viscous effects in external aerodynamics, the modeling of highly swept flow separations, and boundary integral methods. O.C.

A84-37052

NUMERICAL METHODS IN AERONAUTICAL FLUID DYNAMICS - AN INTRODUCTION

J. E. GREEN (Royal Aircraft Establishment, Farnborough, Hants., England) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 1-32. refs

An assessment is made of the recent development history, state-of-the-art, and future prospects of computational fluid dynamics, with attention to the range of physical phenomena with which aerodynamic design methods must deal. The range of applications, advantages, and limitations of the numerical methods in current use are noted. The prospects for the state-of-the-art in 1991 include the use of panel methods, transonic small perturbation and full potential methods together with viscous layers, as well as Reynolds-averaged Navier-Stokes methods and large eddy simulations in the Navier-Stokes equations. O.C.

A84-37055

DEVELOPMENTS IN COORDINATE SYSTEMS FOR FLOW FIELD PROBLEMS

M. P. CARR and C. R. FORSEY (Aircraft Research Association, Ltd., Bedford, England) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 75-114. refs

The generation of computing grids for use in the numerical solution of partial differential equations, such as those describing fluid motion, is a subject growing in importance as such methods are applied to ever more complex problems. A general survey of grid generation techniques is presented which covers grids for specific problems, grids for more general problems based on algebraic or numerical techniques, and some other approaches. Emphasis is placed on techniques which have already been used successfully on practical problems or appear to have such potential. In particular, the methods being developed at various sites in the UK, for use in aeronautical flow field problems, are described. Author

A84-37056

APPROXIMATE FACTORISATION METHODS

T. J. BAKER (Aircraft Research Association, Ltd., Bedford, England) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 115-141. refs

Alternating Direction Implicit or Approximate Factorization methods were originally developed for parabolic and elliptic equations. The recent application of these ideas to equations of mixed elliptic and hyperbolic type has led to significant improvements in the iterative techniques for computing transonic potential flow. This paper discusses some of the theory on which Approximate Factorization methods are based and illustrates their application to various transonic flow problems. Author

A84-37057

A SURVEY OF FINITE ELEMENT METHODS FOR TRANSONIC FLOWS

CH. HIRSCH and H. DECONINCK (Brussel, Vrije Universiteit, Brussels, Belgium) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 143-188. refs

The transonic flow calculation research results assessed were obtained through the use of a finite element formulation for discretized flow equations applicable to both cascade and isolated airfoil computations. Attention is given to efforts directed toward the incorporation of artificial compressibility and iterative methods. The efficient codes that have been developed include higher order elements, successive line relaxation, alternating direction Galerkin method iterative schemes and body-fitted meshes. Convergence-accelerating techniques, such as grid refining, and multigrid methods have been implemented for an arbitrary grid. A novel Euler equations method based on orthogonal shape functions has been developed in order to allow nonimplicit treatments of time-dependent terms. O.C.

A84-37058

NUMERICAL MODELLING OF SHOCKWAVES AND OTHER DISCONTINUITIES

P. L. ROE (Royal Aircraft Establishment, Fluid Mechanics Div., Bedford, England) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 211-243. refs

Numerical implications of the distinction between equilibrium and evolutionary problems are considered. The simple example of scalar advection shows that for evolutionary problems accuracy is gained by giving the algorithm a bias towards the direction of propagation. Methods are described which apply appropriate bias to complex problems where many interacting effects may be present. A computer program is described which applies one of these methods to solve the Euler equations, and an application to transonic flow over a plane aerofoil is given. Author

A84-37059

A NEW FINITE-VOLUME METHOD FOR THE EULER EQUATIONS WITH APPLICATIONS TO TRANSONIC FLOWS

A. LERAT (Ecole Nationale Supérieure d'Arts et Métiers; Paris VI, Université, Paris, France) and J. SIDES (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 245-288. Research supported by the Direction des Recherches, Etudes et Techniques. refs

A finite volume method is presented for the solution of the Euler equations. The method is based on a new explicit scheme of second-order accuracy which has been selected in an extended class of S sub beta super alpha schemes for a hyperbolic system of conservation laws in two space variables. The method is applied to the calculation of transonic flows over the NACA 0012 airfoil and over the RAE 2822 supercritical airfoil. The increase in accuracy over a classical method clearly appears in the numerical results: an improved pressure jump across shock waves, a weakening of spurious oscillations, and a reduction of the entropy error in the expansion waves upstream of the shocks. The calculation of an unsteady transonic flow over an oscillating airfoil is also presented. Author

A84-37060

TRANSONIC AEROFOIL CALCULATIONS USING THE EULER EQUATIONS

A. JAMESON (Princeton University, Princeton, NJ) IN: Numerical methods in aeronautical fluid dynamics. London and New York, Academic Press, 1982, p. 289-308.

The Rizzi and Vivand (1981) finite-volume code, based on a time-split version of the MacCormack scheme in order to account for the gradients in each coordinate direction separately, is converted into a scheme in which central differencing is used in space together with a three-stage, time-stepping process which is stable for Courant numbers up to 2.0. The four conservation laws

for mass, momentum and energy are solved. The calculations are performed on an O-grid, for the nonlifting case. O.C.

A84-37062**SURVEY OF TECHNIQUES FOR ESTIMATING VISCOUS EFFECTS IN EXTERNAL AERODYNAMICS**

R. C. LOCK and M. C. P. FIRMIN (Royal Aircraft Establishment, Farnborough, Hants., England) IN: Numerical methods in aeronautical fluid dynamics . London and New York, Academic Press, 1982, p. 337-430. refs

An assessment is made of recent developments in the design of aircraft wings by an iterative procedure that involves the calculation of external inviscid flow, and the turbulent viscous flow in the boundary layer and wake, linked by a suitable model of their interaction. In the theoretical foundations of this method, attention is given to second-order effects. An explanation is undertaken of the ways in which an iterative computational procedure for solving complete interactive problems can be built up, together with a linearized stability analysis of the convergence process. Also discussed is the relative success of viscous airfoil and wing theory problem-solving methods, in view of experimental results. O.C.

A84-37063**ACHIEVEMENTS AND PROBLEMS IN MODELLING HIGHLY-SWEPT FLOW SEPARATIONS**

J. H. B. SMITH (Royal Aircraft Establishment, Farnborough, Hants., England) IN: Numerical methods in aeronautical fluid dynamics . London and New York, Academic Press, 1982, p. 431-467. refs

After a brief consideration of some kinematic differences between separated flow in two and three dimensions, the vortex-sheet model of separated flow originating from a highly-swept separation line is introduced. Some evidence for the adequacy of the model is reviewed before a presentation of two recent applications. The first is a treatment, by staff of the Boeing Company, of separation from the highly-swept leading edges of a wing of low aspect ratio in subsonic flow, by means of a panel method. The second is an attempt, made at RAE, to reproduce the mechanism of separation from the curved surface of a slender cone at incidence, including the prediction of the laminar separation line. Author

A84-37064**A SURVEY ON BOUNDARY INTEGRAL METHODS**

D. J. BUTTER, G. R. HARGREAVES (British Aerospace PLC, Woodford, Ches., England), and B. HUNT (British Aerospace PLC, Warton Div., Preston, Lancs., England) IN: Numerical methods in aeronautical fluid dynamics . London and New York, Academic Press, 1982, p. 469-515. refs

The major classes of flow for which solutions can be obtained with panel methods are illustrated, and the techniques used to extend the solutions beyond the normal linear inviscid results are given. Attention is given to the way in which a correctly formulated panel method can be used to yield solutions for a wide variety of nonaerodynamic problems efficiently and economically. Recent developments allow complete aircraft problems to be tackled with an unprecedented degree of realism. O.C.

A84-37065**REQUIREMENTS AND DEVELOPMENTS SHAPING A NEXT GENERATION OF INTEGRAL METHODS**

J. W. SLOOFF (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Numerical methods in aeronautical fluid dynamics . London and New York, Academic Press, 1982, p. 517-548. refs

Factors driving the development of the next generation of integral or panel methods for aerodynamic applications include interest in extending their range of applicability and in integrating them with other disciplines, as well as the continuing growth of computational power for their implementation. Extended mathematical models and more efficient multigrid algorithms are also counted among these influences. It is noted that the techniques of modern informatics are indispensable for efficient

application and integration with other disciplines. Attention is given to the manner in which a next-generation integral method could be imbedded in an aerodynamic information system. O.C.

A84-37070**THE CONNECTED PROBLEM OF FLEXIBLE WING OSCILLATIONS IN A COMPRESSIBLE FLOW [SVIAZANNAIA ZADACHA O KOLEBANII GIBKOGO KRYLA V SZHIMAEMOM POTOKE]**

B. A. ERSHOV Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), April 1984, p. 91-93. In Russian.

The connected problem of the oscillations of a flexible wing moving with a supersonic velocity in an ideal compressible fluid is analyzed for the two-dimensional case. The problem is reduced to a partial integro-differential equation to solve for the wing deformation. A solution is obtained in the form of a small parameter series whose terms are calculated using the Bubnov-Galerkin method. V.L.

A84-37081**A STUDY OF WALL TURBULENCE IN JET FLOW PAST AN OBSTACLE [ISSLEDOVANIE PRISTENNOI TURBULENTNOSTI PRI STRUINOM OBEKANII PREGRADY]**

G. F. GORSHKOV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Mar.-Apr. 1984, p. 73-82. In Russian. refs

For a subsonic axisymmetric gas jet flowing onto a plane obstacle normal to the jet axis, several characteristic flow regions can be distinguished. These include the nonperturbed flow region, the interaction region, the radial wall jet region, and the wall boundary layer. The present paper summarizes and generalizes the available data on the microstructure of an axisymmetric flow around an obstacle in the above flow regions. V.L.

A84-37089**WELL POSEDNESS OF A CERTAIN FORMULATION OF THE PROBLEM OF CONTOURING A LAVAL NOZZLE [O KORREKTNOSTI ODNOI POSTANOVKI ZADACHI PROFILIROVANNIA SOPLA LAVALIA]**

I. L. OSIPOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 24, May 1984, p. 767-771. In Russian. refs

The paper examines the well posedness of a certain formulation of the problem of contouring the subsonic part of a two-dimensional Laval nozzle bounded by a straight sonic line. In this formulation the pressure distribution is prescribed not along the nozzle axis but along the unknown wall. The inverse problem is reduced to the Dirichlet problem for a second-order quasi-linear elliptic equation with degeneracy on part of the boundary of the region. The uniqueness of the solution to this problem is demonstrated, along with the continuous dependence of the solution on the pressure prescribed on the nozzle generatrix. B.J.

A84-37216#**DESIGN STUDY OF AN EXTERNAL COMPRESSION SUPERSONIC INLET USING A FINITE DIFFERENCE TWO-DIMENSIONAL NAVIER-STOKES CODE**

A. F. CAMPBELL and J. SYBERG (Boeing Military Airplane Co., Seattle, WA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 11 p. (AIAA PAPER 84-1275)

Progress on the development and application of an analytical design procedure for the aperture region of two-dimensional external compression inlets is presented. The ultimate objective of the study is to derive from analysis additional design information that can be used to optimize external compression inlet performance. The major elements of the design procedure are a geometry generation code and a two-dimensional finite-difference Navier-Stokes code. The results of a grid refinement study using the Navier-Stokes code are presented as well as the results of a study of the effect of cowl lip spillage flow on ramp wall pressure distribution. Validation of the analysis is still in the preliminary

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stages. A comparison of analytical results with experimental data for one aperture region geometry at one operating point is given.

Author

A84-37217#

TESTS OF WALL BLOWING CONCEPTS FOR DIFFUSER BOUNDARY LAYER CONTROL

W. H. BALL (Boeing Military Airplane Co., Seattle, WA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 9 p.

(AIAA PAPER 84-1276)

Tests were conducted in the Boeing Diffuser Test Facility to investigate the effect on three-dimensional offset diffuser performance of a wide variety of wall blowing concepts and entrance boundary layer conditions. The blowing configurations included discrete tangential jets of various distributions, blowing vortex generators, vortex generators plus jets, and a variety of canted blowing holes. The variations in diffuser entrance boundary layer conditions included a thin, uniform boundary layer, a thick boundary layer, and a thick boundary layer with a distorted profile. All tests were accomplished using a three-dimensional offset diffuser with a centerline offset-to-exit-diameter ratio of 1.66 and an area ratio of 1.84. Test results indicate that significant improvements in diffuser boundary layer control can be achieved over a range of entrance conditions using a blowing mass flow of approximately one-half percent of diffuser entrance flow. Author

A84-37228

EXTREMUM PROBLEM OF A WING WITH MAXIMUM LIFT NEAR A SCREEN [EKSTREMAL'NAIA ZADACHA O KRYLE S MAKSIMAL'NOI POD'EMNOI SILOI VBLIZI EKRANA]

L. V. ARSHINSKII IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 60-72. In Russian. refs

The extremum problem of a wing with maximum lift coefficient moving near a screen is examined in the framework of quadrupole theory. The distribution function of angles of attack $\alpha(x, y)$ is taken as the admissible control. The relationship between the geometrical parameters of the wing for small perturbations is derived, and it is shown that the optimization of the lateral edge of the wing leads to an appreciable increase in the lift coefficient.

B.J.

A84-37229

OPTIMIZATION OF THE PROFILE OF A PLANE WING IN SUPERSONIC AND HYPERSONIC FLOWS [OPTIMIZATSIYA PROFILIA PLOSKOGO KRYLA V SVERKH- I GIPERZVUKOVYKH POTOKAKH]

A. V. DANEEV IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 72-82. In Russian.

The paper examines the optimization of the profile of a plane wing with respect to wave drag in a linearized supersonic flow, Newton and Newton-Busemann hypersonic flows, and free molecular flow. The study is based on Panchenkov's method for treating ill posed extremum problems. Since the thickness is specified, the number of boundary conditions exceeds the order of the differential equation of the necessary condition of the extremum.

B.J.

A84-37231

OPTIMAL SHAPE OF A BODY OF REVOLUTION IN A TRANSONIC GAS FLOW WITH CONSTRAINTS ON LENGTH AND VOLUME [OPTIMAL'NAIA FORMA TELA VRASHCHENIIA V OKOLOZVUKOVOM POTOKE GAZA S OGRANICHENIIAMI NA DLINU I OB'EM]

G. F. SIGALOV IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 101-117. In Russian. refs

A description is given of the theoretical principles underlying the determination of the shapes of bodies of revolution, assuring minimum wave drag for transonic flows with Mach numbers slightly greater than 1. The asymptotic method of complete approximation is used to solve the boundary value problem for the nonlinear differential equation of transonic gas dynamics. The optimal shape

of the body is determined in the form of an analytical relationship, and this shape is shown to depend significantly on Mach number. It is emphasized that, in contrast to linear theory, the present solution has demonstrated the effect of Mach number on the shape of the optimal profile.

B.J.

A84-37378

UNDERSTANDING AND COUNTERING THE SWIRL IN S-DUCTS - TESTS ON THE SENSITIVITY OF SWIRL TO FENCES

J. SEDDON Aeronautical Journal (ISSN 0001-9240), vol. 88, April 1984, p. 117-127. refs

Wind tunnel tests have been made on the effect of bottom wall and sidewall fences of various sizes and combinations in reducing the swirl of an S-duct at high angle of attack. It is shown that large reductions can be made: in some cases, the swirl is eliminated or even reversed. Fences of modest size can be chosen to combine a large swirl reduction with an improvement of the total pressure distortion at high incidence and only a small effect on mean pressure recovery at low incidence. Some further observations are made on the nature of the general swirl phenomenon.

Author

A84-37533#

A SURVEY OF RECENT ONERA EXPERIMENTAL STUDIES ON TURBULENT SEPARATED FLOWS

J. M. DELERY (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Symposium on Fluid Dynamics, University of Illinois, Urbana, IL, Apr. 26, 27, 1984) ONERA, TP, no. 1984-14, 1984, 16 p. Research supported by the Societe Nationale Industrielle Aerospatiale. refs

(ONERA, TP NO. 1984-14)

Detailed experimental investigations of turbulent separated flows have been performed by using a Two-Color Laser Velocimeter. Three kinds of flow have been considered: strong shock-wave/boundary-layer interaction in transonic channels, base-flow behind missile afterbodies and interactions between a vortex and a shock normal to its streamwise axis. In each case, the mean and turbulent field properties have been carefully measured. The data thus obtained constitutes a basis for the development of more accurate theoretical models than those existing presently.

Author

A84-37535#

APPLICATION OF 2D AND 3D CRITERIA TO THE CALCULATION OF THE TRANSITION AND THE BOUNDARY LAYER OF SWEEPBACK WINGS [APPLICATION DE CRITERES BI ET TRIDIMENSIONNELS AU CALCUL DE LA TRANSITION ET DE LA COUCHE LIMITE D'AILES EN FLECHE]

D. ARNAL and E. COUSTOLS (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France) (NATO, AGARD, Symposium on the Improvement of Aerodynamic Performance through Boundary Layer Control and High Lift Systems, Brussels, Belgium, May 21-25, 1984) ONERA, TP, no. 1984-16, 1984, 20 p. In French. refs

(ONERA, TP NO. 1984-16)

The effect of sweepback angle on the position of the transition region and on the boundary layer is investigated analytically. The fundamental principles of turbulence generation on an aircraft wing are reviewed; equations for the calculation of the laminar boundary layer on a sweptback wing of infinite length are developed and solved numerically; the transition region is calculated on the basis of both transverse and longitudinal criteria; an OAP 01 profile is analyzed at sweepback angles 0, 20, and 30 deg; and the results are presented graphically. It is found necessary to compromise between measures to combat transverse and longitudinal transitions, since these measures are antagonistic. The use of wall suction to stabilize the boundary layer is shown to be effective in delaying both types of transition, although technical realization of such suction may be difficult.

T.K.

A84-37536#

DETAILED STUDY OF THE FLOW AROUND A PROFILE WITH HIGH-LIFT DEVICES - COMPARISON WITH CALCULATIONS [ETUDE DETAILLEE DE L'ECOULEMENT AUTOUR D'UN PROFIL HYPERSUSTENTE- COMPARAISONS AVEC LES CALCULS]

B. PORCHERON and J. J. THIBERT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on the Improvement of Aerodynamic Performance through Boundary Layer Control and High Lift Systems, Brussels, Belgium, May 21-25, 1984) ONERA, TP, no. 1984-17, 1984, 17 p. In French.

(ONERA, TP NO. 1984-17)

The two-dimensional flow around a supercritical RA16SC1 profile equipped with a fixed-slat leading edge and a trailing-edge flap adjustable to 20 or 40 degrees of deflection is investigated experimentally in the plane-flow channel of the F-1 wind tunnel at velocity 40 m/s, pressure 1.3 bar, and Reynolds number 1.8×10^6 to the 6th. Measurements are obtained using pressure sensors mounted on the model surface and hot-wire, crossed-wire, and straight-wire probes. The results are presented in graphs and diagrams and compared with calculations performed using a singularity method of mixed type for the inviscid flow and taking strong viscous interactions into account. Boundary-layer/wake interactions are demonstrated even in cases where no merging is present. Good agreement is obtained between experimental and calculated results, except in the region above the flap. T.K.

A84-37629*# Boeing Aerospace Co., Seattle, Wash.

AN EXPERIMENTAL AND ANALYTICAL STUDY OF FLOW THROUGH A SUPERSONIC OPEN CHANNEL WITH CONTOURED FLOOR

F. P. SAHELI, B. DUNN, K. MARRS (Boeing Aerospace Co., Seattle, WA), A. KUMAR (NASA, Langley Research Center, Hampton, VA), and K. M. PEERY (AMTEC Engineering, Inc., Bellevue, WA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 11 p.

(AIAA PAPER 84-1179)

A wind tunnel experiment was performed to study the characteristics of supersonic airflow ($M(\infty) = 2.5-3.86$) through an open channel with a contoured floor. The measured static pressures along the centerline of the channel floor exhibited an unexpected rise at the end of the channel. Complex three-dimensional interactions of compression and expansion waves within the channel coupled with external flow perturbations caused by model/tunnel wall interference were the suspected sources of this flow behavior. Three-dimensional inviscid flow analysis procedures were used to investigate and explain this phenomenon. The results of the computations and the experiment are presented and discussed. Author

A84-37630#

CONSERVATIVE CALCULATIONS OF NON-ISENTROPIC TRANSONIC FLOWS

M. M. HAFEZ (Computer Dynamics, Inc., Virginia Beach, VA), W. G. HABASHI (Concordia University, Montreal, Canada), and P. L. KOTIUGA (Pratt and Whitney Canada, Longueuil, Quebec, Canada) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p. Research supported by the Pratt and Whitney Canada; Natural Sciences and Engineering Research Council of Canada. refs

(Contract NSERC-PRAI-P-8219; NSERC-A-3662)

(AIAA PAPER 84-1182)

The classical potential formulation of inviscid transonic flows is modified to account for non-isentropic effects. The density is determined in terms of the speed as well as the pressure, which in turn is calculated from a Poisson equation derived from the momentum equations. The present model differs in general from the exact inviscid Euler equations since the flow is assumed irrotational. On the other hand, since the shocks are not isentropic, they are weaker and are placed further upstream compared to the classical potential solution. Furthermore, the streamline leaving the airfoil does not necessarily bisect the trailing edge. Results

for the present conservative calculations are presented for nonlifting and lifting airfoils at subsonic and transonic speeds and compared to potential and Euler solutions. Author

A84-37634#

FIRST STAGE STATOR VANE UNSTEADY AERODYNAMIC RESPONSE IN A MULTI-STAGE COMPRESSOR

V. R. CAPECE and S. FLEETER (Purdue University, West Lafayette, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p. USAF-supported research. refs

(AIAA PAPER 84-1209)

A basic experimental study of the time-variant pressure distributions on the first stage vane row of a three-stage axial flow compressor, with the primary source of excitation being the wakes from the first stage rotor blades, has been performed. The unsteady aerodynamic response on the vanes was measured by means of embedded Kulite dynamic pressure transducers. These dynamic data were analyzed using data averaging and FFT techniques and correlated with appropriate predictions. In particular, the chordwise distribution of the dynamic pressure difference coefficient and its aerodynamic phase lag were measured and correlated with a small perturbation, compressible, nonseparated and separated, transverse gust aerodynamic analysis over a range of incidence angles at high reduced frequency values on two streamlines. Author

A84-37641#

IMPROVED SUPERSONIC PERFORMANCE DESIGN FOR THE F-16 INLET MODIFIED FOR THE J-79 ENGINE

L. G. HUNTER and J. A. CAWTHON (General Dynamics Corp., Fort Worth, TX) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 14 p.

(AIAA PAPER 84-1272)

The F-16 inlet modified for the J79-GE-119 engine, the integration of a new inlet incorporated into the F-16A/B airframe, a new inlet bleed system, the design philosophy, development tests and performance of the inlet throughout the flight and maneuver envelope are reviewed. Model data are included which show the performance of the inlet in terms of pressure recovery, distortion and turbulence. An engine bypass system was developed for providing cooling air for the hot engine case and exhaust nozzle, to provide good ejector exhaust nozzle performance, and to maintain stable inlet operation at high Mach numbers. The F-16/79 inlet retains the same location, capture area, cross-sectional shape and duct length. The additions are a longer compression ramp composed of a fixed and curved ramp surface for improved high-Mach number performance and a throat slot boundary-layer-control for reduced shock-interaction. These improvements provide a 20 percent increase in pressure recovery and 60 percent decrease in spill drag at Mach 2.0. Author

A84-37644#

EFFICIENT AND ACCURATE NUMERICAL SOLUTIONS OF THE EULER AND NAVIER-STOKES EQUATIONS FOR TURBOMACHINERY APPLICATIONS

B. N. SRIVASTAVA (Avco Everett Research Laboratory, Inc., Everett, MA) and R. BOZZOLA (Avco Corp., Avco Lycoming Div., Stratford, CT) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 19 p. Research supported by the Avco Corp. refs

(AIAA PAPER 84-1300)

The prediction of flowfield behavior in a turbomachinery cascade requires a computational effort which carefully addresses numerical accuracy and efficiency issues in capturing such physical processes as shock formation and its resolution, boundary layer growth, shock-boundary layer interaction, flow separation and turbulence effects. These numerical issues are individually addressed in the present paper by developing an Euler and a thin-layer viscous computational procedure that utilizes an explicit approach to integrate the relevant flow conservation equations in a generalized coordinate system. Numerical results are presented for subsonic, transonic and supersonic inviscid flows and for laminar and

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turbulent, attached and separated including shock-boundary layer interactions subsonic/supersonic viscous flows. Relevant accuracy issues of mass and/or stagnation pressure preservation and efficiency issues related to boundary approaches are discussed. The content of this paper represents a first step in developing a more general computational analysis tool for two-dimensional turbine/compressor cascades. Author

A84-37647#

A REVIEW OF THE STATUS OF THE APPLICATION OF COMPUTATIONAL FLUID DYNAMICS (CFD) TO THE INSTALLATION/INTEGRATION OF TURBOFANS AND TURBOPROPS IN SUBSONIC AIRCRAFT

P. R. A. KERN, G. C. PAYNTER (Boeing Military Airplane Co., Seattle, WA), F. A. DVORAK, and D. R. CLARK (Analytical Methods, Inc., Redmond, WA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 19 p. refs (AIAA PAPER 84-1333)

The state-of-the-art of computational fluid dynamics (CFD) techniques for analyzing nacelle installation/integration flows of turbofans and turboprop subsonic aircraft is assessed. Attention is given to progress in zonal analysis, i.e., the complexity of the flow determining the complexity of the model used. Available techniques and the effectiveness of coupling of analyses zones across common boundaries are examined. The applications of panel, full potential, Euler, Navier-Stokes, streamtube curvature, and small disturbance theory codes are reviewed. Further work is needed to quantify numerical errors, format validation test data to be compatible with statistical analyses, couple exhaust and nacelle analyses, and evaluate the effects of the CFD model component parameters chosen. M.S.K.

A84-37682

NUMERICAL TREATMENT OF THE VISCOUS INTERACTION PROBLEM FOR BLOWN TRANSONIC AIRFOILS

W. D. MURPHY, N. D. MALMUTH (Rockwell International Science Center, Thousand Oaks, CA), and J. D. COLE (California, University, Los Angeles, CA) IN: Computational and asymptotic methods for boundary and interior layers; Proceedings of the Second BAIL Conference, Dublin, Ireland, June 16-18, 1982. Dublin, Boole Press, 1982, p. 75-89. refs

A coupling procedure has been developed to treat the flow over tangentially blown transonic airfoils. Such shapes are used to enhance the transonic maneuverability of fighter aircraft. The numerical method employed is successive line overrelaxation (SLOR) to treat the dominantly inviscid part of the flow field. For the boundary layer, Keller's box scheme was adopted in favor of integral methods to treat the multiple extrema in the velocity profiles occurring with blowing. The viscous interaction with the outer flow leading to jump conditions on the boundary layer and wake is discussed as well as the convergence of the iterative coupling procedure. Results showing the lift augmentation and other modifications of the aerodynamic characteristics due to blowing are indicated. Author

A84-37746

TRANSONIC SUPERSONIC FLOW FROM A WEDGE [DIE SCHALLNAHE UEBERSCHALLUMSTROEMUNG VON KEILEN]

M. ABOUD (Karlsruhe, Universitaet, Karlsruhe, West Germany) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hamburg, West Germany, Mar. 28-31, 1983) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 64, no. 4, 1984, p. T170-T172. In German. refs

The flow field between the head wave and the Mach boundary line in the flow around a wedge is analyzed. Gasdynamic laws are utilized, and it is assumed that the flow is even and two-dimensional. The entropy layer behind the shock is neglected. A hodographic approach is used in order to simplify the problem of the boundary of the homoentropic flow field. C.D.

A84-37751

LAMINAR INTERACTION PROCESSES AT VARIABLE-GEOMETRY WINGS IN SUPERSONIC FLOW [LAMINARE WECHSELWIRKUNGSVORGAENGE AM SCHIEBENDEN FLUEGEL BEI UEBERSCHALLSTROEMUNG]

PH. GITTNER (Wien, Technische Universitaet, Vienna, Austria) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hamburg, West Germany, Mar. 28-31, 1983) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 64, no. 4, 1984, p. T198-T200. In German. Sponsorship: Fonds zur Foerderung der wissenschaftlichen Forschung. refs (Contract FFWF PROJECT 4802)

A stationary, laminar interaction process at a flat plate against which a compressible medium of given kinematic stiffness is flowing at a certain angle and velocity is studied using triple-deck theory to clarify nonlinear effects in supersonic flow. The system of equations for the lower deck is transformed into a form without parameters associated with undisturbed flow. These equations are numerically solved using a spectral method. C.D.

A84-37756

PREDICTION OF PRESSURE DISTRIBUTION CP ON A LONG RECTANGULAR WING IN TRANSONIC-SUPERSONIC FLOW

A. NASTASE and U. WEISENSEE (Aachen, Rheinisch-Westfaelische Technische Hochschule, Aachen, West Germany) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hamburg, West Germany, Mar. 28-31, 1983) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 64, no. 4, 1984, p. T212-T214. refs

Beginning with an exact solution for the boundary value problem concerning the determination of the dimensionless axial disturbance velocity on a rectangular wing, equations are obtained for the dimensionless axial velocities for thin and thick symmetrical, rectangular wings. Expressions are given in the frame of linearized theory for the pressure coefficients on the upper and lower sides of the thick lifting rectangular wing. Theoretical results are plotted for aspect ratio $\lambda = 5$. D.H.

A84-37758

STEADY TRANSONIC PROFILE FLOW WITH ADDITION OF HEAT BY CONDENSATION [STATIONAERE TRANSSONISCHE PROFILUMSTROEMUNG MIT WAERMEZUFUHR DURCH KONDENSATION]

G. SCHNERR (Karlsruhe, Universitaet, Karlsruhe, West Germany) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hamburg, West Germany, Mar. 28-31, 1983) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 64, no. 4, 1984, p. T224-T227. In German. refs

The effect of water-vapor content on the steady two-dimensional transonic flow around a circular-arc profile is investigated experimentally. The theoretical principles governing the condensation process at transonic speeds are reviewed, and the results of pressure measurements at freestream Mach number 0.792, 0.787, and 0.784 and rest-state relative humidity 0, 40, 41.5, 52, and 62.1 percent are presented graphically. Increased relative humidity reduces the negative pressure in the local supersonic region, increasing drag near the base and leading to the formation (at high humidity) of two consecutive standing shock waves at the profile surface, like those observed by Leipmann (1946) for laminar boundary layers. Overall normal pressure drag is reduced by humidity up to about 45 percent but increased by humidity above 50 percent. T.K.

A84-37901#

A BOUNDARY ELEMENT TECHNIQUE IN TRANSONIC FLOW

Z. YANG (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 1-11. In Chinese, with abstract in English. refs

The boundary element technique is used to study the nonlinear transonic flow about three-dimensional wings. A weighted residual

formulation, valid throughout a Mach number range which includes the transonic, is developed and directly applied to both the nonviscous full velocity potential equation and the transonic small perturbation equation. An artificial viscosity term is introduced to ensure the irreversible character of the shock wave and to make the solutions stable and convergent. The flow domain is partitioned into a number of small elements and the Green theorem is applied to each element. Boundary integral equations are obtained by using an interpolation function which is C-1 continuous for velocity potential, and the equations are solved by the finite element collocation method. C.D.

A84-37904#**A NUMERICAL COMPUTATION FOR THE INVISCID SUPERSONIC FLOW AROUND BENT CONE**

C. JI (Beijing Institute of Aerodynamics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 29-39. In Chinese, with abstract in English.

A numerical computation method for inviscid supersonic flow around a bent cone using the finite difference method and shock-capturing technique is presented. The bend in the cone axis is treated by considering the solution plane of the Euler equation as an inclined plane and transforming the independent variables in the forward direction. A second-order, two-step McCormack scheme is used. The boundary computation equation system is derived via the characteristic computability relationships of the body surface or shock wave and the corresponding boundary conditions. The flow properties of the singular points on the line of intersection between two cones surfaces are solved individually. Nonuniform computational meshes are used along the body radius direction in order to increase computational accuracy for very large entropy gradients near the body surface. The results obtained for sample problems show the method to be a good one. C.D.

A84-37905#**COMPRESSIBLE POTENTIAL FLOWS IN ARBITRARY TWO-DIMENSIONAL AND AXIALLY SYMMETRIC SLENDER NOZZLES**

C. LIN, X. HAN, and X. ZHU (Northwestern Polytechnical University, Xian, Shaanxi, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 40-48. In Chinese, with abstract in English. refs

A simple and approximate analytical method for calculations of compressible potential flows in arbitrary two-dimensional and axially symmetric slender nozzles is given using perturbation technique. The solutions of the flow field are expanded asymptotically with respect to a small parameter defining the slenderness of the nozzle, whereas the local one-dimensional solutions are taken as the leading terms in the expansions. Two term expansions are obtained for the velocity components. Numerical examples show that the relative error for the magnitude of the velocity is less than 1 percent, provided the slope of the nozzle wall is less than about 20 deg and the radius of the curvature of the nozzle wall is greater than about four to five times the half height of the nozzle throat. The present theory can be used for the calculations of the flow field in Laval nozzles accelerating from subsonic to supersonic. Author

A84-37906#**THEORY OF SIMILARITY AND THE PROFILE OF THE MEAN DENSITY DISTRIBUTION OF HYPERSONIC BOUNDARY LAYER**

S. CAI (University of Science and Technology of China, Hefei, People's Republic of China) and S. GAO (Hangzhou Teachers College, Hangzhou, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 49-55. In Chinese, with abstract in English.

A84-37907#**THE ENGINEERING NUMERICAL TECHNIQUE FOR THE DETERMINATION OF THE INVISCID FLOW FIELD AND HEATING RATE ON BALLISTIC RE-ENTRY VEHICLES**

M. YANG and F. HE (China Aerodynamic Research and Development Centre, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 56-63. In Chinese, with abstract in English. refs

The Ballistic Reentry Vehicle Shock Pressure and Heating Rate Computer Code, an approximate numerical technique for determining the inviscid aerodynamics and heat transfer of reentry vehicles, is discussed. The surface heating rate of a reentry rocket is calculated on the basis of inviscid calculations, using a noniterative entropy swallowing calculation code. Results on shock shape, surface pressure distribution, and flow field profiles through the shock layer, as well as results for the surface heating rate distribution, are compared with more rigorous solutions and experimental data, and good agreement is found. C.D.

A84-37908#**VISUALIZATION OF THREE DIMENSIONAL SEPARATED FLOWS USING THE SMOKE WIRE TECHNIQUE**

X. XIA (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 71-76. In Chinese, with abstract in English.

The smoke wire technique is used for visualization of the vortex flow in the near wake of an axisymmetric body and the asymmetric vortices which emanate from the nose of body at high angles of attack, as well as the vortex breakdown above the wing. The smoke wire technique is available for automatic photograph by the sequential circuit, conditional photographs or manual operation. Author

A84-37910#**SIMPLIFIED NAVIER-STOKES EQUATIONS AND THEIR NUMERICAL SOLUTIONS**

R. WANG, L. JIAO, and X. LIU (Chinese Academy of Sciences, Computing Center, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 85-93. In Chinese, with abstract in English. refs

The purpose of this paper is to review computation methods for simplified Navier-Stokes equations (SNSE) which have been used by authors for several years. The governing system of the SNSE and their mathematical properties are discussed, and numerical solutions for supersonic viscous flow over a blunt body are introduced in detail. Finally some aspects of the numerical solutions for three-dimensional SNSE, especially calculations of crossflow separation, are analyzed. Author

A84-37911#**A CALCULATION METHOD FOR PROPELLER-WING INTERFERENCES**

Z. CHEN (China Aerodynamic Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 94-99. In Chinese, with abstract in English.

A calculation method, which can account for propeller-wing aerodynamic interferences by means of the finite elementary solution method, is given in this paper. A FORTRAN program has been designed, several examples (lifting surface with one, two, or four propellers) have been calculated, and the results agree with the experiment data very well. It seems a great improvement on the analytic theory. Author

A84-37926#**COMPRESSIBILITY CORRECTION FOR FLOW ABOUT WING SURFACES**

D. A. DIETRICH, S. L. KROMER, and N. O. STOCKMAN (General Electric Co., Cincinnati, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 449, 450.

Previously cited in issue 05, p. 581, Accession no. A83-16575

02 AERODYNAMICS

A84-37927*# 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) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 451, 452. refs
(Contract NCC1-41)

Previously cited in issue 06, p. 704, Accession no. A84-17904

A84-37931#
DEVELOPMENT OF ADVANCED CIRCULATION CONTROL WING HIGH-LIFT AIRFOILS

R. J. ENGLAR and G. G. HUSON (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 476-483. refs

Recent experimental and flight test programs have developed and confirmed the high-lift capability of the Circulation Control Wing (CCW) concept. These CCW airfoils employ tangential blowing of engine bleed air over circular or near-circular trailing edges and are capable of usable lift coefficients three times those of simple mechanical flaps. Earlier versions of these blown airfoils made use of relatively complex leading- and trailing-edge devices which would have to be retracted mechanically for cruise flight. In a continuing program to reduce the complexity, size, and weight of the CCW system, several series of advanced CCW airfoils have been developed which can provide STOL capability for both military and commercial aircraft using much smaller, less complex high-lift systems. This paper will describe these configurations, present the experimental results confirming their aerodynamic characteristics, and also make comparisons with previous CCW and more conventional high-lift systems. Author

A84-37932*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
SURFACE PRESSURES ON A FLAT PLATE WITH DUAL JET CONFIGURATIONS

J. A. SCHETZ, A. K. JAKUBOWSKI (Virginia Polytechnic Institute and State University, Blacksburg, VA), and K. AOYAGI (NASA, Ames Research Center, Moffett Field, CA) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 484-490. refs

Previously cited in issue 17, p. 2456, Accession no. A83-38677

A84-37940#
APPLICATION OF PANEL METHODS IN EXTERNAL STORE LOAD CALCULATIONS

G. J. VAN DEN BROEK (South African Council for Scientific and Industrial Research, National Institute for Aeronautics and Systems Technology, Pretoria, Republic of South Africa) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 537-539.

The effect of aircraft wind modelling on the external store loads is investigated by computing that effect for the external flow field generated by the wing. The application of the panelling/boundary condition method to the perturbation flow field below the wing is first considered; then, the effect of the wing panelling in the leading edge region, where the singularity distributions show large gradients, on the flow field is studied. Both lift and thickness effects are taken into account. C.D.

A84-37941#
A NONLINEAR ANALYSIS OF THE CUSHION STABILITY OF SLOWLY OSCILLATING ACV'S

H. MATSUO (Kumamoto University, Kumamoto, Japan) and K. MATSUO (Kumamoto Institute of Technology, Kumamoto, Japan) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 539-541. refs

The quasi-steady analysis of air cushion vehicles (ACV) presented in an earlier study (Matsuo and Matsuo, 1983) is extended here to include a nonlinear analysis of large-amplitude oscillations and the effect of unsteady flow in the ducting. Analytical results are compared with the results of a forced oscillation test of a fan-duct-plenum model, and good agreement is obtained between the two sets of data. The discrepancy which appeared

in the previous quasi-steady analysis at frequencies above 1 Hz is no longer present in the results reported here. V.L.

A84-37943*# Missouri Univ., Rolla.
A METHOD FOR MEASURING SKIN FRICTION DRAG ON A FLAT PLATE IN CONTAMINATED GAS FLOWS

R. B. OETTING and G. K. PATTERSON (Missouri-Rolla, University, Rolla, MO) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 543, 544. refs
(Contract NSG-1452)

A technique for measuring friction drag in turbulent gas and gas/particle flows over flat plates is presented, and preliminary results are reported. A 0.25-in.-thick 72 x 6-in. Al plate is suspended by six horizontal support air bearings and four vertical alignment air bearings between fixed dummy plates and leading-edge and trailing-edge fairings in the 32-in.-high 48-in.-wide 11-ft-long test section of a closed-circuit atmospheric wind tunnel operating at 50-150 ft/sec. Particles of Fe and Al oxides of diameter 20-150 microns and density up to 0.3 lb particles per lb air are injected via a 6 x 0.167-in. nozzle; turbulence is induced by a roughened section of the leading-edge fairing; and friction drag is measured using a load-cell pressure transducer. Sample results are shown in a graph, demonstrating good agreement with theoretical drag calculations. T.K.

A84-37951*# Science Applications, Inc., Princeton, N.J.
PARABOLIZED NAVIER-STOKES ANALYSIS OF THREE-DIMENSIONAL SUPERSONIC AND SUBSONIC JET MIXING PROBLEMS

S. M. DASH, D. E. WOLF, and N. SINHA (Science Applications, Inc., Propulsion Gas Dynamics Div., Princeton, NJ) *American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984.* 21 p. refs
(Contract NAS1-16535)
(AIAA PAPER 84-1525)

Three-dimensional jet mixing problems are addressed by means of two parabolized Navier-Stokes models. The first of these analyzes supersonic, overexpanded or underexpanded nonaxisymmetric jets, and yields results that exhibit complex, three-dimensional interactions. The second model uses the same numerical framework as the first, and analyzes rectangular jets by means of a pressure-split formulation. Square and rectangular mixing jet problems that highlight this model's capabilities and exhibit the distortion of the nearfield jet contours associated with the streamwise vortices generated by two corner regions are presented. O.C.

A84-37952#
THE SEPARATE SPATIAL EXTENTS OF THE TRAILING HORSESHOE ROOT VORTEX LEGS FROM A WING AND PLATE JUNCTION

E. P. ROOD (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) *American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984.* 7 p. refs
(Contract NAVY PROJECT RR-023-01-01)
(AIAA PAPER 84-1526)

An experimental investigation of the spatial extents of the trailing horseshoe vortex legs from the wing and plate junction was conducted by measuring two-point spectral velocity correlations as well as the mean velocity. The results indicate that the larger of the two vortex legs produced by the wing at incidence dominates the downstream flow and that the wake deficit, or trough, does not necessarily indicate the division of the flows from the two sides of the wing. There is evidence that the Kutta-Joukowski condition may not be fulfilled inside the plate boundary layer even though it is satisfied outside the boundary layer. Author

A84-37953*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

BODY-TURBULENCE INTERACTION

D. M. BUSHNELL (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984.

30 p. refs
(AIAA PAPER 84-1527)

The paper reviews the area of body-turbulence interaction with particular emphasis upon the influence of the body upon an incident turbulent field. Cases considered include two-dimensional (high and low fineness ratio, porous, and impervious) and three-dimensional bodies in-stream, adjacent to, and attached to walls. Particular physics common to several geometric and incident flow configurations include (1) eddy severing at relatively sharp leading edges, (2) production of vorticity of the opposite sense on bluff bodies, and (3) body region production of control vortices which affect the incident turbulence field for the order of 100 boundary-layer thicknesses downstream. The major local effects of the body upon the incident turbulent field include (1) a blocking effect, (2) influence of the body momentum deficit/near wake, (3) distortion due to the body time-averaged flow field, and (4) unsteady body circulation. The review may be of particular interest for turbulence alteration/control using fixed geometry in applications such as drag reduction, separation control, noise reduction, and augmentor optimization. Author

A84-37954#

EXPERIMENTAL STUDY OF THE BEHAVIOR OF 3D-TURBULENT BOUNDARY LAYER IN A SIMPLIFIED WING/BODY JUNCTION

T.-D. HSING and H.-Y. TENG (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. Research supported by the Chinese Academy of Sciences. refs

(AIAA PAPER 84-1529)

Low to subsonic speed experimental studies have been conducted for the behavior of a three-dimensional boundary layer at a simplified wing/fuselage junction. Pressure gradient and streamline curvature effects on the wall wake law and mixing length distributions are noted in the attached flow region's boundary layer behavior. The horseshoe vortex formed in the separated flow region dominates the junction flow, including both its mean velocity distribution and turbulent behavior. O.C.

A84-37955*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPLICATIONS OF A CONSERVATIVE ZONAL SCHEME TO TRANSCENT AND GEOMETRICALLY COMPLEX PROBLEMS

K. A. HESSENIUS (NASA, Ames Research Center, Moffett Field, CA) and M. M. RAI (Informatics General Corp., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs

(AIAA PAPER 84-1532)

A conservative zoning technique, wherein the flow field for a finite-difference calculation is divided into several regions to simplify grid generation, is discussed and is applied in the solution of a two-dimensional problem of complex topology. Calculations are performed on two zonal, or patched, grid systems for the supersonic flow over a double-airfoil configuration. The solution is smooth and continuous across the zonal interfaces, and shock waves pass through the boundaries without distortion. In addition, the time-accuracy of the zonal-boundary method is verified by a two-zone cylinder calculation with a stationary inner and a rotating outer mesh. The feasibility of the zonal approach for use in the solution of geometrically complex and unsteady problems is thus demonstrated. Author

A84-37962#

NUMERICAL SIMULATION OF LEADING-EDGE VORTEX FLOWS

D. P. RIZZETTA and J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984.

11 p. refs
(AIAA PAPER 84-1544)

Steady flow fields describing respectively the distinguished structure for subsonic, sonic, and supersonic leading-edge flow about a thin delta wing at angle of attack in a supersonic freestream are calculated numerically by time integration of the unsteady three-dimensional compressible laminar Navier-Stokes equations. Details of these solutions demonstrate that the essential physical behavior of such flows, including both primary and secondary vortex motions, has been simulated. For the case of a subsonic leading edge, comparison is made with a corresponding inviscid numerical calculation. It is shown that although secondary features are absent, the gross dominant characteristics of the flow field are reproduced by the Euler equations. Effects of turbulence are assessed by incorporating a simple closure model in the viscous computation. Reasonable agreement between numerical solutions and experimental data was obtained for all flow regimes. Author

A84-37967*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NUMERICAL SIMULATION OF THE VISCOUS FLOW FIELDS OVER THREE-DIMENSIONAL COMPLICATED GEOMETRIES

K. FUJII and P. KUTLER (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 14 p. refs

(AIAA PAPER 84-1550)

A 'thin-layer' Navier-Stokes code capable of predicting steady state viscous flows is applied to complicated three-dimensional flow fields. The code is written in a generalized coordinate system, and a recently developed grid generation procedure is used for the flow-field discretization. Application is made to the vortical flow over a delta wing at high angle of attack, and the computed results are compared with experimental results. The results indicate that the present method can capture the physical phenomenon well. It is observed that a leading-edge separation vortex is formed over the wing, as is a secondary separation vortex near the leading edge. The flow field behind the trailing edge is also well described. Application is also made to the transonic flow over the Shuttle configuration. The result appears to be reasonable even though no experimental data are available for comparison. These results indicate that the present approach is capable of computing complicated three-dimensional flow fields. Author

A84-37968*# Mississippi State Univ., Mississippi State. **THREE-DIMENSIONAL UNSTEADY EULER EQUATIONS SOLUTION USING FLUX VECTOR SPLITTING**

D. L. WHITFIELD (Mississippi State University, Mississippi State, MS) and J. M. JANUS American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs (Contract NAG1-226; F08635-82-K-0409)

(AIAA PAPER 84-1552)

A method for numerically solving the three-dimensional unsteady Euler equations using flux vector splitting is developed. The equations are cast in curvilinear coordinates and a finite volume discretization is used. An explicit upwind second-order predictor-corrector scheme is used to solve the discretized equations. The scheme is stable for a CFL number of 2 and local time stepping is used to accelerate convergence for steady-state problems. Characteristic variable boundary conditions are developed and used in the far-field and at surfaces. No additional dissipation terms are included in the scheme. Numerical results are compared with results from an existing three-dimensional Euler code and experimental data. Author

02 AERODYNAMICS

A84-37969*# Massachusetts Inst. of Tech., Cambridge.

A COMPUTATIONAL METHOD FOR HELICOPTER VORTEX WAKES

T. W. ROBERTS and E. M. MURMAN (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs
(Contract NGT-22-009-901; NAG2-105)
(AIAA PAPER 84-1554)

A method for calculating the wake geometry and blade loads for a hovering helicopter rotor is presented. The approach incorporates a simplified free wake model of the rotor in a finite difference calculation of the flow field. A variation of the 'cloud-in-cell' technique, modified to eliminate self-induced velocity errors for curved vortex filaments, is used. Simple lifting line theory is used to calculate the blade loads. Calculations showing the effect of vortex core size and the number of vortex filaments representing the wake are presented. For large numbers of vortices, it is seen that the wake geometry fails to converge. However, only a few vortices are needed to adequately represent the wake. Comparisons with experimental results are also presented.

Author

A84-37970*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A COMPUTATIONAL STUDY OF COMPLEX THREE-DIMENSIONAL COMPRESSIBLE TURBULENT FLOW FIELDS

C. C. HORSTMAN (NASA, Ames Research Center, Experimental Fluid Dynamics Branch, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs
(AIAA PAPER 84-1556)

Solutions of the time dependent, Reynolds-averaged, Navier-Stokes equations are presented and are compared with a family of experimental results for the three-dimensional interaction of a shock wave with a turbulent boundary layer. The solutions correctly predict the major features of the flow field independent of the shock strength and the extent of separation when using a two-equation turbulence model with wall functions. The experimentally observed boundary between cylindrical and conical flow regimes is also predicted. However, for the flow fields with large separated zones, the details of the measured pressure distributions are not accurately computed, which indicates a need for improved turbulence modeling and/or grid resolution. Author

A84-37971#

NUMERICAL SIMULATION OF 3-D SHOCK-TURBULENT BOUNDARY LAYER INTERACTION GENERATED BY A SHARP FIN

D. D. KNIGHT (New Jersey, State University, New Brunswick, NJ) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs
(Contract AF-AFOSR-82-0040)
(AIAA PAPER 84-1559)

A hybrid explicit-implicit numerical algorithm for the compressible Navier-Stokes equations is used to solve a three-dimensional oblique shock-turbulent boundary layer interaction formed by the presence of a sharp fin or wedge attached normal to a flat plate. An oblique shock wave generated by the deflection of the fin intersects a supersonic equilibrium turbulent boundary layer on the plate. Turbulence is incorporated into the theoretical formulation through the turbulent eddy viscosity model of Baldwin and Lomax (1978). The flowfield for the interaction was computed at Mach 3 for a wedge angle of 10 deg and a Reynolds number of 280,000 based on the undisturbed boundary layer thickness upstream of the sharp fin. The computed results are in good agreement with experimental data and sufficiently predict the recovery of the boundary layer to a nominal two-dimensional state downstream of the interaction. The calculated flowfield also provides details on the pitch angle behavior near the leading edge of the fin and the

intersection of shock wave and flat plate and in the region of observed 'overshoot' in the pitot pressure. J.N.

A84-37972#

FLOW VISUALIZATION STUDIES OF A 3-D SHOCK/BOUNDARY LAYER INTERACTION IN THE PRESENCE OF A NON-UNIFORM APPROACH BOUNDARY LAYER

M. S. JURKOVICH (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 7 p. refs
(AIAA PAPER 84-1560)

The effects of a nonuniform boundary layer on the interaction of an oblique shock wave with a three-dimensional turbulent boundary layer were investigated in the 1 ft by 1 ft test section of the supersonic wind tunnel at the NASA-Lewis Research Center. Oil flow tests revealed that an extensive separation develops on the tunnel floor and corner regions as the generator angle of attack is increased. The floor separated region was marked by the presence of a vortex pair symmetric about the tunnel centerline. Vapor screen tests revealed that a maximum in the separation height exists above the vortex pair as well as at the tunnel centerline. Tests conducted with a more uniform boundary layer revealed a more two-dimensional separation with no evidence of a vortex structure. A strong similarity between the variation of the displacement thickness across the tunnel and the variation in the separation height of the separated region was observed in the nonuniform approach boundary layer. J.N.

A84-37973*# State Univ. of New York, Oneonta.

HYBRID APPROACH TO STEADY TRANSONIC NORMAL-SHOCK COMPRESSIBLE LAMINAR BOUNDARY-LAYER INTERACTIONS OVER AIRFOILS

R. B. RAM (New York, State University, Oneonta, NY) and W. D. HARVEY (NASA, Langley Research Center, Airfoil Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 16 p. refs
(AIAA PAPER 84-1561)

A simulation of steady transonic viscous-inviscid interactions through a combination of zonal solution methods (involving different equation sets and numerical regions for various flow regions) is used in an investigation of a fluid mechanics problem in which the pressure distribution is determined by the interaction between transonic inviscid flow and an inner laminar viscous layer. The results obtained are in good agreement with laminar experimental data. Both attached and separated boundary layer flows are considered for either weak or strong interactions. O.C.

A84-37974#

INSTANTANEOUS FLOW FIELD MEASUREMENTS OF STALLED REGIONS ON AN OSCILLATING AIRFOIL

J. DE RUYCK and C. HIRSCH (Brussel, Vrije Universiteit, Brussels, Belgium) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 14 p. Research supported by the Nationaal Fonds voor Wetenschappelijk Onderzoek. refs
(Contract DAJA45-83-C-0021)
(AIAA PAPER 84-1565)

The main objective of the present work is to provide experimental data of velocity fields and turbulence structures in unsteady flows. A NACA 0012 airfoil oscillates around an axis at 25 percent chord distance from the leading edge with a sinusoidal motion, at non-stalled to deep-stalled flow conditions. Instantaneous distributions of velocity as well as all non-zero Reynolds stresses are determined in the blade boundary layers. The reduced frequency is 0.3 at a chord Reynolds number of 300,000. A slanted rotating hot wire is used and the angular calibration characteristics of the wire are applied in order to detect and measure reversed flows. Instantaneous detailed flow and turbulence patterns of the periodic separation vortex are presented and discussed. These patterns are obtained from traverses at 8 chordwise positions along the suction side of the blade. Author

A84-37975#

UNSTEADY AERODYNAMIC MODELING OF A FIGHTER WING IN TRANSONIC FLOW

J. B. MALONE (Lockheed-Georgia Co., Marietta, GA), N. L. SANKAR (Georgia Institute of Technology, Atlanta, GA), and W. A. SOTOMAYER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 15 p. Research supported by the Lockheed-Georgia Co. refs (Contract F33615-83-C-3215) (AIAA PAPER 84-1566)

A numerical method is presented for predicting steady and unsteady aerodynamic flows about aircraft wing configurations. The numerical procedure solves the three-dimensional full-potential equation by a strongly implicit, approximate factorization algorithm. Steady-flow analyses are obtained by relaxation, while unsteady analyses are calculated by time-accurate marching. Numerical results are presented for an F-5 fighter wing and compared to experimental data for subsonic and transonic flight conditions.

Author

A84-37976#

AN ALGORITHM FOR UNSTEADY TRANSONIC FLOW ABOUT TAPERED WINGS

C. J. BORLAND (Boeing Military Airplane Co., Seattle, WA) and W. A. SOTOMAYER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. Research supported by the Boeing Military Airplane Co. and U.S. Air Force. refs (AIAA PAPER 84-1567)

An algorithm, known as XTRAN3S, was recently modified to perform numerical computations of unsteady transonic flow about highly tapered wings. Modifications to XTRAN3S were comprised of constructing a non-uniform coordinate transformation. This non-uniform transformation was found to eliminate the skewness of the mesh and the irregular behavior of the metric coefficients. In this paper, numerical computations are presented for $M = .6, .8, .9,$ and $.95$ for steady and unsteady flow about a model of the F-5 wing tested by NLR of the Netherlands. In addition, numerical computations were performed for trailing edge flap deflection on the F-5 wing.

Author

A84-37977#

ANALYSIS OF VORTEX DEVELOPMENT FROM VISUALIZATION OF ACCELERATING FLOW AROUND AN AIRFOIL, STARTING FROM REST

M. PALMER and P. FREYMUTH (Colorado, University, Boulder, CO) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 9 p. refs (Contract AF-AFOSR-81-0037) (AIAA PAPER 84-1568)

Wind tunnel flow visualization techniques identified and characterized the vortex structures formed around a NACA 0015 airfoil in a constantly accelerating flow. Acceleration was 8 ft/s for 5 s. A TiCl₄ solution was deposited on the airfoil to generate pure white smoke and pictures were taken every 1/32 s. Angles of attack from 0-90 deg were examined. Relationships were defined among the times of vorticity separation, turbulence onset, and the formation of an induced trailing edge vortex and the location on the airfoil of the vorticity separation with angle of attack. The implications are considered important for aircraft dynamic stall, take-off and landing, rocket launches, helicopter blades, turbomachinery, and wind turbines experiencing unsteady flows.

M.S.K.

A84-37983#

A SURVEY OF MODERN RESEARCH IN HYPERSONIC AERODYNAMICS

J. D. ANDERSON, JR. (Maryland, University, College Park, MD) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 25 p. refs (AIAA PAPER 84-1578)

Activities in the past decade that represent the state-of-the-art in hypersonic aerodynamic research are reviewed. The research is undergoing a revival in response to new vehicle concepts such as the aero-assisted orbital transfer vehicle, a transatmospheric vehicle, a second generation Shuttle, and low hypersonic missiles at sea level. Problems peculiar to hypersonic research are thin boundary layers, an entropy layer, viscous interaction phenomena, a chemically reacting boundary layer, aerodynamic heating, low density flows, and chemically reacting flows. Research is dominated by computational fluid dynamics and data from manned hypersonic flight. Studies on waveriders, scramjets, and hypersonic wind tunnel design are outlined.

M.S.K.

A84-37984#

THE EFFECT OF FREESTREAM TURBULENCE ON PRESSURE FLUCTUATIONS IN TRANSONIC FLOW

S. RAGHUNATHAN (Queen's University, Belfast, Northern Ireland) and R. J. W. MCADAM (Short Brothers, Ltd., Belfast, Northern Ireland) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. refs (AIAA PAPER 84-1581)

Pressure fluctuation measurements were on an 18 per cent thick biconvex aerofoil in the region of shock boundary layer interaction at various levels of free stream flow unsteadiness. Experiments were performed with free transition and transition fixed models at a shock Mach number of 1.44 and blade chord Reynolds number of 160,000. The transition free model with a laminar boundary layer showed the presence of periodic flows at low turbulence levels which disappeared with the increase in turbulence levels. The general effect of free stream turbulence on transition fixed models is one of broad band amplification of pressure fluctuation levels in the region of shock interactions.

Author

A84-38003#

AN ADAPTIVE GRID SCHEME APPLIED TO TWO-DIMENSIONAL AIRFOIL PROBLEMS

J. P. STEINBRENNER, D. A. ANDERSON (Iowa State University of Science and Technology, Ames, IA), and Y. TASSA (Lockheed-Georgia Co., Marietta, GA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. Research supported by the Iowa State University of Science and Technology and Lockheed-Georgia Co. refs (Contract AF-AFOSR-83-0167) (AIAA PAPER 84-1608)

A dynamically adaptive grid scheme based on equidistribution in one computational coordinate is applied for the first time to inviscid transonic flow numerically solved on C-type airfoil grids. Steady-state solutions are obtained for NACA0012 and RAE2822 airfoils using both fixed and solution adaptive grids, and results for both grids are compared with previous numerical and experimental data. The adaptive grid algorithm is seen to resolve details of the flow field near the upper-surface midchord shock not seen in the fixed grid solution, thus eliminating the need for a priori grid point clustering in the region of the anticipated shock. In addition, problems inherent to schemes of this type are discussed, and suggestions for further study are also made.

Author

02 AERODYNAMICS

A84-38004*# Scientific Research Associates, Inc., Glastonbury, Conn.

DYNAMIC RESPONSE OF SHOCK WAVES IN TRANSONIC DIFFUSER AND SUPERSONIC INLET - AN ANALYSIS WITH THE NAVIER-STOKES EQUATIONS AND ADAPTIVE GRID

N.-S. LIU, S. J. SHAMROTH, and H. MCDONALD (Scientific Research Associates, Inc., Glastonbury, CT) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs

(Contract NAS3-23053)

(AIAA PAPER 84-1609)

An existing method which solves the multi-dimensional ensemble-averaged compressible time-dependent Navier-Stokes equations in conjunction with mixing length turbulence model and shock capturing technique has been extended to include the shock-tracking adaptive grid systems. The numerical scheme for solving the governing equations is based on a linearized block implicit approach. The effects of grid-motion and grid-distribution on the calculated flow solutions have been studied in relative detail and this is carried out in the context of physically steady, shocked flows computed with non-stationary grids. Subsequently, the unsteady dynamics of the flows occurring in a supercritically operated transonic diffuser and a mixed compression supersonic inlet have been investigated with the adaptive grid systems by solving the Navier-Stokes equations. Author

A84-38007*# United Technologies Research Center, East Hartford, Conn.

ANALYSIS OF AIRFOIL TRANSITIONAL SEPARATION BUBBLES

R. L. DAVIS and J. E. CARTER (United Technologies Research Center, East Hartford, CT) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 11 p. refs

(Contract NAS1-16585)

(AIAA PAPER 84-1613)

A previously developed local inviscid-viscous interaction technique for the analysis of airfoil transitional separation bubbles, ALESEP (Airfoil Leading Edge Separation), has been modified to utilize a more accurate windward finite difference procedure in the reversed flow region, and a natural transition turbulence model has been incorporated for the prediction of transition within the separation bubble. Numerous calculations and experimental comparisons are presented to demonstrate the effects of the windward differencing scheme and the natural transition turbulence model. Grid sensitivity and convergence capabilities of this inviscid-viscous interaction technique are briefly addressed. A major conclusion of this paper is that a second, counter-rotating eddy has been found to exist in the wall layer of the primary separation bubble with the use of windward differencing. Author

A84-38008#

A PROCEDURE FOR SOLVING THE COMPRESSIBLE INTERACTING BOUNDARY-LAYER EQUATIONS FOR SUBSONIC AND SUPERSONIC FLOWS

R. T. DAVIS (Cincinnati, University, Cincinnati, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. refs

(Contract N00014-76-C-0364)

(AIAA PAPER 84-1614)

The present paper is an extension of a procedure developed for solving the incompressible interacting boundary-layer equations described in Davis and Werle (1982) and Rothmayer and Davis (1983). The extensions consist of the incorporation of the compressibility terms into the interacting boundary-layer equations and the development of a new ADE (alternating direction explicit) method for handling the pressure interaction in supersonic flows past flat plate related bodies. The method allows one to handle both subsonic and supersonic cases in a routine manner using the same computer program. The convergence of the method is rapid with converged solutions being achieved in about 20-30 global

iterations. The overall code is fast enough to be run on a microcomputer, in this case a 68,000 based system with floating point accelerator. Execution times are about 20 minutes per case.

Author

A84-38010*# Notre Dame Univ., Ind.

THE INFLUENCE OF LAMINAR SEPARATION AND TRANSITION ON LOW REYNOLDS NUMBER AIRFOIL HYSTERESIS

T. J. MUELLER (Notre Dame, University, Notre Dame, IN) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 14 p. refs

(Contract NSG-1419; N00014-81-K-2036; N00014-83-K-0239)

(AIAA PAPER 84-1617)

An experimental study of the Lissaman 7769 and Miley MO6-13-128 airfoils at low chord Reynolds numbers is presented. Although both airfoils perform well near their design Reynolds number of about 600,000, they each produce a different type of hysteresis loop in the lift and drag forces when operated below chord Reynolds numbers of 300,000. The type of hysteresis loop was found to depend upon the relative location of laminar separation and transition. The influence of disturbance environment and experimental procedure on the low Reynolds number airfoil boundary layer behavior is also presented. The use of potential flow solutions to help predict how a given airfoil will behave at low Reynolds numbers is also discussed. Author

A84-38011#

STEADY AND UNSTEADY SEPARATED FLOW COMPUTATIONS FOR TRANSONIC AIRFOILS

R. HOUWINK and A. E. P. VELDMAN (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. Research supported by the Netherlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart. refs

(AIAA PAPER 84-1618)

This paper describes a strong interaction coupling which was applied between the LTRAN2-NLR code (low frequency transonic small perturbation theory) and Green's lag-entrainment method for a steady turbulent boundary layer. This coupling consists of a simultaneous solution of inviscid flow and boundary layer equations in order to eliminate numerical problems associated with the computation of separated flow. The effectivity of this coupling procedure is demonstrated by computations of steady and unsteady separated flow about a supercritical airfoil. Unsteady airloads have been computed for a pitching oscillation in transonic flow with shock-induced separation and for an oscillating spoiler. Correlations are made with experimental data which illustrate the applicability of the present approach and its importance for aeroelastic applications. Author

A84-38015#

INTERACTION BETWEEN AN AIRFOIL AND A STREAMWISE VORTEX

K. W. MCALISTER and C. TUNG (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 24 p. refs

(AIAA PAPER 84-1626)

The tip of a finite-span airfoil was used to generate a streamwise vortical flow, the strength of which could be varied by changing the incidence of the airfoil. The vortex that was generated traveled downstream and interacted with a second airfoil on which measurements of lift, drag, and pitching moment were made. The flow field, including the vortex core, was visualized in order to study the structural alterations to the vortex resulting from various levels of encounter with the downstream airfoil. These observations were also used to evaluate the accuracy of a theoretical model.

Author

A84-38016#

SUBSONIC/TRANSONIC, VISCOUS/INVISCID RELAXATION PROCEDURES FOR STRONG PRESSURE INTERACTIONS

D. R. REDDY and S. G. RUBIN (Cincinnati, University, Cincinnati, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 10 p. refs (Contract N00014-79-C-0849) (AIAA PAPER 84-1627)

A multi-sweep relaxation procedure is considered for inviscid and viscous flows using reduced (pressure-elliptic) Navier-Stokes (RNS) equations. Subsonic and transonic, inviscid, laminar and turbulent flows are solved for NACA0012 airfoil and parabolic-arc airfoil geometries. The incompressible turbulent flow field in the wake of a flat plate trailing edge is also examined. The equations are written in conformal body-fitted coordinates and differenced on a staggered grid to obtain accuracy between first and second-order for the RNS system. The velocities, pressure and density are fully coupled in the algorithm and the pressure gradient in the axial momentum equation is split into a hyperbolic or marching component and an elliptic or relaxation component. These represent the supersonic and incompressible limits respectively. For subsonic flow an optimum combination of these two elements helps to improve the rate of convergence as well as the accuracy. For transonic flows, preliminary results are presented and the question of shock capturing is addressed. Author

A84-38019*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AEROTHERMAL LOADS ANALYSIS FOR HIGH SPEED FLOW OVER A QUILTED SURFACE CONFIGURATION

G. C. OLSEN and R. E. SMITH (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. refs (AIAA PAPER 84-1630)

Attention is given to hypersonic laminar flow over a quilted surface configuration that simulates an array of Space Shuttle Thermal Protection System panels bowed in a spherical shape as a result of thermal gradients through the panel thickness. Pressure and heating loads to the surface are determined. The flow field over the configuration was mathematically modeled by means of time-dependent, three-dimensional conservation of mass, momentum, and energy equations. A boundary mapping technique was then used to obtain a rectangular, parallelepiped computational domain, and an explicit MacCormack (1972) explicit time-split predictor-corrector finite difference algorithm was used to obtain steady state solutions. Total integrated heating loads vary linearly with bowed height when this value does not exceed the local boundary layer thickness. O.C.

A84-38020#

COMPUTATION OF COMPRESSIBLE FLOW AROUND A CIRCULAR CYLINDER

K. ISHII and K. KUWAHARA (Tokyo, University, Tokyo, Japan) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs (AIAA PAPER 84-1631)

The transonic flows past a circular cylinder have been calculated by the full Navier-Stokes equations using the Beam-Warming-Steger scheme. The accuracy of computation of unsteady flows is improved by eliminating the second-order implicit smoothing terms. The shock waves are captured in the turbulent wake at Mach number $M = 0.95$ and 0.98 . It was found that the shock wave suppresses the width of the wake behind the cylinder. No sharp shock can be observed in a flow at $M = 0.8$. Recent development of supercomputers has made the computation of these complex flows possible and reliable. Author

A84-38023#

STRUCTURE OF SELF-EXCITED OSCILLATIONS IN TRANSONIC DIFFUSER FLOWS

T. J. BOGAR (McDonnell Douglas Corp., St. Louis, MO) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs (AIAA PAPER 84-1636)

Two-component laser Doppler velocimeter (LDV) measurements were made in a supercritical, separated, transonic diffuser flow exhibiting self-excited oscillations. The velocity data were ensemble-averaged with respect to the shock oscillation phase, and maps of various flow quantities were generated. The time evolution of the fluctuating velocity field shows a large, rotating structure which originates near the upstream edge of the separation bubble and is convected downstream. The streamwise velocity fluctuation pattern for the self-excited oscillations resembles the oscillation pattern which occurs when the flow is mechanically excited at the downstream end. Velocity fluctuations calculated from ensemble-averaged core-total- and static-pressure data show good agreement with the LDV data. Author

A84-38027#

FINITE ELEMENT APPROXIMATION TO THEODORSEN'S SOLUTION FOR NON-STEADY AERODYNAMICS OF AN AIRFOIL SECTION

R. E. DUFFY (Rensselaer Polytechnic Institute, Troy, NY), E. A. CZAJKOWSKI, and C. JARAN American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 10 p. refs (Contract DAAG29-82-K-0093) (AIAA PAPER 84-1640)

The aerodynamic forces acting on a helicopter rotor blade have been calculated by a number of investigators using finite element methods and theories. All these results depend to some extent on the proper modeling of the wake behind the rotor blade. In order to evaluate the importance of proper modeling of the near wake behind a rotor blade, a simpler, but related, problem is addressed; namely the modeling of the flow field about a two-dimensional, flat plate airfoil section which is undergoing simple harmonic motion in both vertical translation and pitch. An exact closed form solution of this problem has been obtained by Theodorsen. This study evaluates how the circulation on the airfoil and in the wake has to be modeled in order to predict the proper value of lift and pitching moment as determined by Theodorsen. The goal is to use the least number of elements in the model. It is shown that it is only necessary to follow the wake, at most, one cycle length downstream. The cycle length can be divided as coarsely as ten increments and as few as two and no more than ten wake vortex filaments must be considered. The accuracy of prediction decreases slightly as the number of bound vortex lifting lines increases. Author

A84-38031#

SPURIOUS ENTROPY PRODUCTION AND VERY ACCURATE SOLUTIONS TO THE EULER EQUATIONS

A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. (AIAA PAPER 84-1644)

Two-dimensional solutions to the Euler equations generated by several different techniques are described. The level of spurious entropy, i.e., the equivalent loss of energy, was used to evaluate the accuracy of the solutions. Examinations of a Mach 0.85 flow past a NACA 0012 airfoil at a small angle of attack and a Mach 0.721 flow past an NLR airfoil at a small negative angle of attack were studied. Use of an artificial viscosity model and the definitions of the boundary conditions caused the largest error, compared to the choices of mesh size and use of a convective differencing scheme. Exact solutions are presented and methods capable of

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limiting the errors in all four solution procedures are defined.

M.S.K.

A84-38032*# Boeing Commercial Airplane Co., Seattle, Wash.
FLOW PREDICTION FOR PROPFAN CONFIGURATIONS USING EULER EQUATIONS

N. J. YU, S. S. SAMANT, and P. E. RUBBERT (Boeing Commercial Airplane Co., Seattle, WA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 10 p. Research supported by the Boeing Independent Research and Development Program. refs
(Contract NAS1-17250)
(AIAA PAPER 84-1645)

An Euler code has been developed for the analysis of a wing-mounted propfan configuration. Surface-fitted grids are used to represent the wing, fuselage, and nacelle geometry. The propeller is simulated by an actuator disk along a computational plane. A grid embedding technique is employed to capture detailed flow field resolution in the vicinity of the engine exhaust plume. Results of a NASA turboprop configuration are compared with test data. Specific issues on grid embedding and methods of resolving them are discussed. Author

A84-38033#
HISSE - A HIGHER-ORDER SUBSONIC/SUPERSONIC SINGULARITY METHOD FOR CALCULATING LINEARIZED POTENTIAL FLOW

L. FORNASIER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. refs
(AIAA PAPER 84-1646)

Attention is given to the features of a new subsonic/supersonic panel method code which has been developed, following the very general higher order formulation of Ehlers et al., (1976), for the aerodynamic modeling of complex aircraft configurations. The most significant configurations to which the code has been applied are assessed, noting geometry and singularity modeling, doublet matching conditions, the calculation of panel influence coefficients, boundary conditions, the features of the numerical code, and vortex flow model calculations. O.C.

A84-38038*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

EFFECTS OF MACH NUMBER ON THE DEVELOPMENT OF A SUBSONIC MULTIPLE JET

B. G. MCLACHLAN (NASA, Ames Research Center, Aerodynamics Research Branch, Moffett Field, CA) and A. KROTHAPALLI (Florida State University, Tallahassee, FL) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 10 p. USAF-supported research. refs
(AIAA PAPER 84-1656)

Results of an experimental study of the flow structure of a subsonic jet issuing from an array of rectangular lobes, equally spaced with their small dimensions in a line, are presented. The tests determined the affect of jet exit Mach number variations (0.3 to 0.8) on the flow field. Measurements of the mean velocity field and centerline rms velocity, along with schlieren flow visualization, were made. It was found that Mach number had no significant affect on the general flow field characteristics; and, that the flow field far downstream resembles that of a jet exiting from a two-dimensional nozzle with its short dimension being the long dimension of the lobe. Author

A84-38040#

EXPERIMENTAL STUDY AND MODELLING OF THE INFLUENCE OF A PERIODIC WAKE ON A LIFTING SURFACE

C. MARESCA and D. FAVIER (Aix-Marseille II, Universite, Marseille, France) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. Sponsorship: Service Technique des Programmes Aeronautiques. refs
(Contract STPA-82,95,004)
(AIAA PAPER 84-1660)

Related to the interaction of the flow shed from a stalled retreating blade of helicopter rotor with the following blade and its consequence on the rotor performances, the paper presents an experimental study in 2-D configurations of the effect produced on lifting airfoils by periodic wakes. The periodic wake is generated by an upstream airfoil oscillating in fore and aft motion. The results obtained show that the aerodynamic behavior of the interacted downstream airfoil could be theoretically approached by the more simple study of a fixed isolated airfoil submitted to simultaneous variations of amplitude velocity and incidence. Author

A84-38042*# California Univ., Los Angeles.

AN ANALYTICAL MODEL FOR THE VORTICITY ASSOCIATED WITH A TRANSVERSE JET

A. R. KARAGOZIAN (California, University, Los Angeles, CA) and I. GREBER (Case Western Reserve University, Cleveland, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. NASA-supported research. refs
(AIAA PAPER 84-1662)

A two dimensional model is developed for a turbulent jet injected normally into a uniform crossflow, in which particular emphasis is placed on the contra-rotating vortex pair associated with the jet. By approximating the forces acting on each of the viscous vortices, equations governing the vortex spacing and downstream jet velocity are evolved. No empirical information is incorporated into this model. A description of the variation in total vortex strength is utilized in which vorticity generated by the jet's impulse dominates the farfield. Numerical solution of the governing equations yields results for the vortex trajectory, half spacing, varying circulation, and viscous core size that correlate quite well with experimental data and asymptotic relations. Based on these findings, we conclude that vortex separation and other important characteristics of the jet cross-section are two dimensional and viscous in nature. Hence it becomes possible to predict, on purely theoretical grounds, the behavior of the vortex pair and of the jet itself. Author

A84-38043*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

ANALYSIS OF INVISCID AND VISCOUS FLOWS IN CASCADES WITH AN EXPLICIT MULTIPLE-GRID ALGORITHM

R. V. CHIMA (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs
(AIAA PAPER 84-1663)

A rapid technique is used for calculating inviscid and viscous flows in turbomachinery cascades. The Euler and thin-layer Navier-Stokes equations are solved using the original explicit MacCormack algorithm. The Baldwin-Lomax eddy viscosity model is used for turbulent flows. Convergence to a steady state is accelerated by use of a variable time-step and a multiple-grid scheme. Computer time is reduced through vectorization. Details of the numerical method are presented along with computed results for two low-speed wind tunnel turning vanes, a space shuttle fuel pump turbine rotor, and a supersonic inflow compressor rotor. The method can predict subtle viscous flow phenomena in cascades and is fast enough to be used as a design tool. Previously announced in STAR as N84-22527 M.A.C.

A84-38044#

GRID GENERATION AND FLOW CALCULATIONS FOR COMPLEX AIRCRAFT GEOMETRIES USING A MULTI-BLOCK SCHEME

N. P. WEATHERILL and C. R. FORSEY (Aircraft Research Association, Ltd., Bedford, England) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 9 p. Research supported by the Ministry of Defence (Procurement Executive). refs

(AIAA PAPER 84-1665)

A method for calculating the flow field around complex aircraft configurations based on a multi-block grid generation approach coupled with an Euler flow algorithm is presented. In this approach the flow field is sub-divided into a set of non-overlapping blocks. Grids are generated simultaneously in all the blocks using an elliptic grid generation method. Appropriate boundary conditions on the block faces ensure that grid lines pass smoothly between adjacent blocks leaving a grid which is globally smooth except for a few isolated geometric singularities. A geometry package for use with the grid generator based on bi-cubic surface patches and with component intersection capability is briefly described and the generation of grids on the configuration surfaces is treated in some detail. An explicit finite volume Euler algorithm has been developed for use with the multi-block grids. This is described and some preliminary results obtained using the multi-block system are presented. Author

A84-38052#

MEASUREMENTS OF THE 3D TURBULENT FLOW BEHIND A PROPELLER IN A SHEAR FLOW

J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA) and M. A. KOTB (American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. Navy-supported research. refs

(AIAA PAPER 84-1676)

Attention is given to wind tunnel test results for the three-dimensional turbulent flow behind a propeller operating in shear flow, which include results for overall thrust and torque, mean velocity and static pressure components, and rms and anemometer measurements. These yield all components of the turbulence intensities and stresses at a point that is averaged over many passes of the propeller blades, and are processed to yield profiles of the mean velocities and turbulence intensities, as well as the stress, behind an individual blade at numerous radial stations. O.C.

A84-38053#

EXPERIMENTAL AND COMPUTATIONAL STUDY OF ROUGHNESS EFFECTS AT $M = 6$

G. H. CHRISTOPH (Science Applications, Inc., Wayne, PA) and A. W. FIORE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 7 p. refs

(AIAA PAPER 84-1681)

An experimental and computational study has been carried out to determine the effects of roughness on turbulent boundary layer profiles. Tests were conducted in the Mach 6 high Reynolds number wind tunnel located in the Flight Dynamics Laboratory at Wright-Patterson Air Force Base, Dayton, Ohio. Two flat plate models were used, one was a smooth flat plate while the second model was a rough flat plate. The roughness pattern consisted of protuberances whose length and width were 0.10 cm while their height was 0.05 cm. Both the lateral and longitudinal gaps between the roughness protuberances were held constant at 0.10 cm. Boundary layer profiles were made at $X = 0.44$ meters from the leading edge of both models. These profiles were made by using standard boundary layer probes and a laser velocimeter. The data are compared to the rough-wall, finite-difference boundary layer method of Christoph and Pletcher. Agreement between the

experimental measurements and theory is considered to be relatively good. Author

A84-38054*# Rensselaer Research Corp., Troy, N. Y.

POROSITY EFFECT ON SUPERCRITICAL AIRFOIL DRAG REDUCTION BY SHOCK WAVE/BOUNDARY LAYER CONTROL

H. T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY), R. D. OROZCO (USAF, Eglin AFB, FL), and D. C. LING (American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 7 p. refs

(Contract NAG1-330)

(AIAA PAPER 84-1682)

An investigation of the passive shock wave/boundary layer control for reducing the drag of 14 percent-thick supercritical airfoil was conducted in the 3 in. x 15.4 in. RPI Transonic Wind Tunnel at transonic Mach numbers. Various porous surfaces with a cavity beneath it was positioned on the area of the airfoil, mounted on the test section bottom wall, where the shock wave occurs. The static pressure distributions over the airfoil, the wake impact pressure survey for determining the profile drag and the Schlieren photographs for porous surfaces are presented and compared with the results for solid surface airfoil. With a uniform porosity surface the normal shock wave for solid surface was changed to a lambda shock wave, and the wake impact pressure data indicated an appreciable drag reduction at transonic Mach numbers. For a free stream Mach number of 0.81 the profile drag coefficient for the airfoil top surface with uniform porosity was 46 percent lower than for the solid surface airfoil. Author

A84-38081#

COMPRESSOR CASCADE OPTIMIZATION BASED ON INVERSE BOUNDARY LAYER METHOD AND INVERSE CASCADE METHOD. I - AN INVERSE CASCADE METHOD FOR INCOMPRESSIBLE TWO-DIMENSIONAL POTENTIAL FLOW

M. SHIRAKURA (Nikkiso Co., Ltd., Tokyo, Japan) and A. GOTO JSME, Bulletin (ISSN 0021-3764), vol. 27, April 1984, p. 653-659. refs

An aerodynamic approach to an optimum compressor cascade in a two-dimensional incompressible flow is described on the basis of two inverse problems; namely, inverse boundary layer problem to produce the optimum velocity distribution and inverse cascade problem to obtain a blade section which realizes a prescribed velocity distribution. A new method for the latter problem is developed in this report. In this method a cascade is transformed into a row of circular cylinders and the blade section is calculated for prescribed velocity distribution, velocity triangle and solidity by solving simultaneous equations about the mapping function. The mapping distortion is exceedingly small in this transformation, and so the inverse problem about the potential flow through a cascade whose solidity, stagger angle and load per blade are high can be solved accurately even near the leading- and trailing-edge. Author

A84-38082#

INFLUENCE OF A PERIODICAL FLUCTUATION ON A PROFILE LOSS OF A CASCADE. I - DETERMINATION OF THE TOTAL PRESSURE LOSS COEFFICIENT. II - BEHAVIOR OF A BOUNDARY LAYER

S. TANAKA (Toyota Technological Institute, Nagoya, Aichi, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, April 1984, p. 660-674. refs

The influence of periodic fluctuations (PF) induced by a rotating cylinder row on the flow parameters and profile loss of a test cascade composed of untwisted two-dimensional 60-mm-chord-length NACA-65(0)10 airfoils is investigated experimentally. Flow fields, time-averaged velocity profiles, ensemble-averaged instantaneous velocity distributions, and boundary-layer turbulence are obtained using hot-wire probes; the results are presented in graphs. PFs are found to increase total pressure loss by 1.1-1.25 times in a lightly loaded cascade, while the range of unstalled operation increases with PF intensity (up to

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a saturation point of 8-10 percent PF intensity) due to suppression of boundary-layer turbulence. T.K.

A84-38093#

A SEMI-IMPLICIT AND UNSTEADY NUMERICAL METHOD OF VISCOUS-INVISCID INTERACTION FOR TRANSONIC SEPARATED FLOWS

J. C. LE BALLEUR and P. GIRODROUX-LAVIGNE (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aérospatiale (English Edition) (ISSN 0379-380X), no. 1, 1984, p. 15-37. refs

A new unsteady calculation method, implicit, solving transonic viscous flows with separations over airfoils is presented. The method suggests a new numerical technique for strongly coupling viscous and inviscid calculations, using a semi-implicit relaxation, and convenient for steady and unsteady flows. The boundary layers and wakes are computed with an unsteady defect integral method, marching in the free stream direction, and solving either a direct or an inverse problem, for attached or separated flows respectively. The inviscid flow is presently computed with a transonic small perturbation method. A consistent strong-coupling is achieved at each time-step; it ensures the upstream influence in supersonic zones, and solves the shock wave-boundary layer interactions by using simply a local clustering of the mesh. Transonic calculations have been performed with the NACA 64A010 airfoil, oscillating in pitch with shock-induced separation. Results have also been obtained on self-induced oscillations generated by the unsteady separation over the symmetrical biconvex circular 18 percent airfoil at transonic speed. Author

A84-38360*# California Polytechnic State Univ., San Luis Obispo.

EFFECTS OF SMALL-SCALE, HIGH INTENSITY INLET TURBULENCE ON FLOW IN A TWO-DIMENSIONAL DIFFUSER

J. A. HOFFMANN (California Polytechnic State University, San Luis Obispo, CA) and G. GONZALEZ ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 106, June 1984, p. 121-124. refs

(Contract NSG-2391)

The flow through a 2D experimental diffuser with channel width 2.60 cm and divergence angle (2θ) 9 or 20 deg is investigated experimentally for inlet Reynolds number 78,300 and velocity 43.9 m/s, with and without vertical rods to generate inlet turbulence in excess of the limits defined by Hoffmann (1981) and Hoffmann and Gonzales (1983). Measurements are obtained using a thermal wall-flow-direction probe and a single hot-wire velocity probe, and the results are presented graphically. Significant increases in the pressure-recovery coefficient of the diffuser (10 percent at 9 deg and 22 percent at 20 deg) are attributed to the action of turbulence to reduce distortion and delay separation, thus creating an altered flow condition with symmetrical velocity profiles. T.K.

A84-38412

A COMPARATIVE THEORETICAL STUDY OF THE BOUNDARY-LAYER DEVELOPMENT ON FORWARD SWEEP WINGS

E. H. HIRSCHL and P. SACHER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.11.1-I.11.10. refs

Forward-swept and aft-swept wings are compared by studying the planform effects. Three-dimensional boundary-layer calculations by means of an integral method are made for the wings at several angles of attack. The inviscid flow is found from panel method calculations, boundary-layer interactions are not considered. The boundary-layer development, skin-friction line patterns and separation patterns in the frame of boundary-layer theory are studied and compared. Author

A84-38413

LAMINAR FLOW AND TRANSITION ON SWEEP WINGS

D. J. PAISLEY and D. I. A. POLL (Cranfield Institute of Technology, Cranfield, Beds., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.12.1-I.12.8. Research supported by the Ministry of Defence (Procurement Executive). refs

An experimental study has been made of the transitional behavior of the leading edge flow on a swept wing when subjected to various levels of disturbance. Initial investigations carried out on a model with effectively infinite swept leading edge conditions have been supplemented by tests carried out on a tapered model. This tapered model has been tested in both the forward and aft swept configurations. Analysis of the results shows that a swept forward wing may be capable of supporting a much greater region of laminar leading edge flow. Author

A84-38414

ASPECTS OF THE AERODYNAMIC DESIGN OF A THIN SUPERCRITICAL, FORWARD SWEEP WING FOR A COMBAT AIRCRAFT

D. R. STANNILAND (Aircraft Research Association, Ltd., Bedford, England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.13.1-I.13.13. refs

This paper describes some considerations relating to the aerodynamic design of a forward swept wing for a combat aircraft. It begins by considering the validity of the theoretical methods for forward sweep. These methods are then applied to various simplified configurations in order to highlight some of the problems and suggest possible solutions to them. It is concluded that the theoretical methods are capable of predicting the wing pressure distributions reasonably well, but the results for the inner wing must be used with some caution. The inner wing needs careful attention, including consideration of the canard interference and body shaping to obtain an optimum design. Author

A84-38415

TRANSONIC AERODYNAMICS OF FORWARD SWEEP WINGS ANALYSED AS A LIFTING-LINE PROBLEM

H. K. CHENG (Southern California, University, Los Angeles, CA) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.14.1-I.14.15. Navy-supported research. refs

Flow field around a forward-swept wing is analysed as a lifting-line problem, using an asymptotic theory which allows for an embedded supercritical component flow. The paper summarizes essential aspects of the theory and discusses features which may be useful in aerodynamic design considerations and to aeroelastic analyses. Examples of computed aerodynamic loads on a swept-forward wing in high subcritical and super-critical component flows are shown and compared with corresponding results for an aft-swept wing. The analysis confirms the significant increase in the aerodynamic effects of the forward-sweep angle and of the aspect ratio with increasing flight Mach number (towards unity); similar enhancements in these effects are also found with reducing wing thickness. The analysis traces the significant difference between the forward- and aft-sweep to a 'logarithmic downwash'; the latter is amplified further by the existence of a high maximum and a low minimum in downwash, and of a bound-vortex induced velocity. The study may serve a more concrete basis for explaining and controlling the aerodynamic characteristics peculiar to a forward-swept wing. The aerodynamic merit of the forward sweep as an option for the design involving an extend-span-planform is pointed out. Author

A84-38418

EXPERIMENTAL DOCUMENTATION OF THE LIFTING SURFACE WAKES OF A CANARD AND FORWARD SWEEP WING CONFIGURATION

K. E. GRIFFIN (U.S. Air Force Academy, Colorado Springs, CO) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. 1.18.1-1.18.14. refs

Presented is a summary of experimental lifting surface wake data taken from a canard/forward swept wing reflection plane wind tunnel model. The data include distributions of total, dynamic, and static pressures as well as cross velocity magnitudes and directions for an array of points around the model, both near the model and in its free stream wake. This experiment is preliminary to testing a more realistic forward swept aircraft configuration.

Author

A84-38420

A COMPARISON OF THE AERODYNAMIC CHARACTERISTICS OF SWEEP FORWARD AND SWEEP BACK WINGS INCLUDING THE EFFECT OF STRAKES

D. I. A. POLL (Cranfield Institute of Technology, Cranfield, Beds., England) and C.-H. QIU (Beijing Institute of Aeronautics and Astronautics, Beijing, People's Republic of China) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. 1.20.1-1.20.15. refs

An experimental investigation has been carried out to compare the effects of sweep direction on the aerodynamic characteristics of three typical wing planforms. Each wing has a biconvex aerofoil section which allows it to be tested in both the forward-swept and backward-swept configuration. Measurements of lift, drag and pitching moment are presented for angles of incidence in the range -5 deg to +50 deg. To complement the overall force data a comprehensive series of surface oil-flow visualisations has also been obtained. In addition, the aerodynamic effects of simple strakes (wing root fillets) on both the swept-forward and swept-back configurations have been investigated.

Author

A84-38485#

FLOW ANALYSIS IN THE EXIT PLANE OF HIGH TURNING ANGLE TURBINE BLADES

J. H. T. WADE (McMaster University, Hamilton, Ontario, Canada) and S. C. SUTRADHAR Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, March 1984, p. 55-61. refs

The operation of a high turning angle turbine passage requires the attention of specifying the operating pressure ratio to avoid the formation of any compression wave after the geometric throat which would otherwise generate a total pressure loss for the system. The two-dimensional supersonic flow field existing after a choked passage is analysed using the Euler Predictor-Corrector method. For different pressure ratios the characteristic lines as well as the pressure distributions are presented which would provide a theoretical analysis for the presence of possible compression waves after the geometric throat of the passage.

Author

A84-38672

HEAT TRANSFER ON THE OBLAKO METEOROLOGICAL ROCKET IN THE PRESENCE OF BOUNDARY LAYER SEPARATION [TEPLOOBMEN NA METEORAKETE TIPA 'OBLAKO' PRI NALICHII OTRYVA POGRANICHNOGO SLOIA]

A. M. PAVLIUCHENKO, A. A. TIUTIN, and A. V. KORABLEV (Novosibirskii Gosudarstvennyi Universitet; Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskikh Nauk (ISSN 0002-3434), March 1984, p. 52-63. In Russian. refs

Data on the wall temperature distribution in the head section of the Oblako meteorological rocket during flight have been obtained for the region of boundary layer separation for Mach less than 2 and Reynolds numbers less than or equal to 2×10 to the 7th. A temperature peak is found to exist in the separation region, which is formed ahead of a step 6 mm high. The temperature

distributions are approximated by Chebyshev polynomials of degree 7. Heat fluxes in the separation region are estimated, and it is shown that the boundary layer separates in the laminar state and that the reattachment occurs in the transition mode in the separated boundary layer, resulting in a temperature peak. V.L.

A84-38673

METHODOLOGICAL ASPECTS OF THE TESTING OF AERODYNAMIC MODELS WITH COMBUSTION IN HIGH-ENTHALPY BLOWDOWN WIND TUNNELS [METODICHESKIE VOPROSY ISPYTANIIA AERODINAMICHESKIKH MODELEI S GORENIEM V VYSOKOENTAL'PIINYKH KRATKOVREMENNOGO REZHIMA]

V. K. BAEV, V. V. SHUMSKII, and M. I. IAROSLAVTSEV (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskikh Nauk (ISSN 0002-3434), March 1984, p. 68-77. In Russian. refs

The methodological aspects of using aerodynamic models with combustion for studying power characteristics and process parameters under shock conditions are examined. Various ways of feeding gaseous and liquid media into the models are discussed, and various designs of aerodynamic scales for measuring the drag and thrust of models with a mass of 5-8 kg and designs of heat flux transducers are reviewed. Methods for measuring flow rates, forces, pressures, and heat fluxes in aerodynamic models with combustion during tests in a blowdown wind tunnel are outlined.

V.L.

A84-38826#

AERODYNAMIC PROPERTIES OF A TWO-DIMENSIONAL INEXTENSIBLE FLEXIBLE AIRFOIL

S. GREENHALGH (U.S. Navy, Naval Air Development Center, Warminster, PA), H. C. CURTISS, JR. (Princeton University, Princeton, NJ), and B. SMITH AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 865-870. refs

Previously cited in issue 17, p. 2453, Accession no. A83-38635

A84-38827*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

TURBULENT BOUNDARY-LAYER RELAXATION WITH APPLICATION TO SKIN-FRICTION DRAG REDUCTION

J. N. HEFNER and D. M. BUSHNELL (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 871, 872; Abridged. refs

Previously cited in issue 05, p. 584, Accession no. A83-16633

A84-38828*# Purdue Univ., Lafayette, Ind.

THREE-DIMENSIONAL FLOW SIMULATIONS FOR SUPERSONIC MIXED-COMPRESSION INLETS AT INCIDENCE

J. D. HOFFMAN (Purdue University, West Lafayette, IN), A. R. BISHOP (NASA, Lewis Research Center, Propulsion Aerodynamics Div., Cleveland, OH), and J. VADYAK AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 873-881. refs (Contract NSG-3311)

Previously cited in issue 07, p. 965, Accession no. A82-19778

A84-38829#

TRANSONIC FULL POTENTIAL SOLUTIONS BY AN INTEGRAL EQUATION METHOD

R. SINGH (Indian Institute of Technology, Kanpur, India), K. S. RAVICHANDRAN, and N. L. ARORA AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 882-888. Research supported by the Ministry of Defence of India. refs

A hybrid computational procedure combining the integral equation method with elements of finite difference techniques is developed to obtain two-dimensional transonic flow solutions with embedded shocks to the full potential equation at subsonic freestream Mach numbers. Integral equations for the perturbation velocity components are formulated in terms of an internal

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singularity distribution and a nonlinear field source distribution representing compressibility effects. For supercritical flows the field source term is augmented by the addition of an artificial viscosity term. Derivative computations are carried out on a transformed plane using finite difference formulas and physical plane derivatives obtained using the Jacobian of the transformation. A simple direct iteration scheme is employed for the numerical solution of the integral equations for the velocity field. Surface pressure distributions obtained for subcritical as well as supercritical cases compare favorably with earlier results. Author

A84-38830*# Princeton Univ., N. J.
TURBULENCE MEASUREMENTS IN A COMPRESSIBLE REATTACHING SHEAR LAYER

K. HAYAKAWA, A. J. SMITS, and S. M. BOGDONOFF (Princeton University, Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 889-895. refs
(Contract NAGW-240)

Previously cited in issue 05, p. 591, Accession no. A83-17917

A84-38831#
CALCULATIONS OF A PLANE TURBULENT JET

S. B. POPE (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 896-904. refs
(Contract NSF CPE-80-00026)

Previously cited in issue 05, p. 634, Accession no. A83-16631

A84-38832*# Science Applications, Inc., Princeton, N.J.
INTERACTIVE PHENOMENA IN SUPERSONIC JET MIXING PROBLEMS. I PHENOMENOLOGY AND NUMERICAL MODELING TECHNIQUES

S. M. DASH and D. E. WOLF (Science Applications, Inc., Propulsion Gas Dynamics Div., Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 905-913. refs
(Contract NAS1-16535)

The interactive phenomena that occur in supersonic jet mixing flowfields, and numerical modeling techniques developed to analyze such phenomena are discussed. A spatial marching procedure based on solving the parabolized Navier-Stokes jet mixing equations is presented. This procedure combines shock-capturing methodology for the analysis of supersonic mixing regions with pressure-split methodology for the analysis of subsonic mixing regions. The two regions are coupled at viscous sonic lines utilizing a viscous-characteristic coupling procedure. Specialized techniques for the treatment of jet boundary growth, strong discontinuities (Mach disks), and small embedded subsonic zones (behind Mach disks) are presented. Turbulent processes are represented by two-equation turbulence model formulations. In Part II of this article, numerical studies are presented for a variety of supersonic jet interactive phenomena. Author

A84-38834#
THE BALDWIN-LOMAX TURBULENCE MODEL FOR TWO-DIMENSIONAL SHOCK-WAVE/BOUNDARY-LAYER INTERACTIONS

D. KNIGHT (Rutgers University, New Brunswick, NJ) and M. VISBAL AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 921-928. refs
(Contract AF-AFOSR-82-0040; AF-AFOSR-80-0072)

Previously cited in issue 17, p. 2445, Accession no. A83-37195

A84-38836#
CALCULATION OF VISCOUS HYPERSONIC FLOW OVER A SEVERELY INDENTED NOSETIP

T. HSIEH (U.S. Navy, Naval Surface Weapons Center, Silver Spring, MD) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 935-941. Navy-sponsored research. refs

Previously cited in issue 05, p. 582, Accession no. A83-16596

A84-38839*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

IMPROVED DESIGN OF SUBCRITICAL AND SUPERCRITICAL CASCADES USING COMPLEX CHARACTERISTICS AND BOUNDARY-LAYER CORRECTION

J. M. SANZ (NASA, Lewis Research Center, Fluid Mechanics and Acoustics Div., Cleveland, OH; Universities Space Research Association, Columbia, MD) (International Symposium on Air Breathing Engines, 6th, Paris, France, June 6-11, 1983) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 950-956.

The method of complex characteristics and hodograph transformation for the design of shockless airfoils was extended to design supercritical cascades with high solidities and large inlet angles. This capability was achieved by introducing a conformal mapping of the hodograph domain onto an ellipse and expanding the solution in terms of Tchebycheff polynomials. A computer code was developed based on this idea. A number of airfoils designed with the code are presented. Various supercritical and subcritical compressor, turbine and propeller sections are shown. The lag-entrainment method for the calculation of a turbulent boundary layer was incorporated to the inviscid design code. The results of this calculation are shown for the airfoils described. The elliptic conformal transformation developed to map the hodograph domain onto an ellipse can be used to generate a conformal grid in the physical domain of a cascade of airfoils with open trailing edges with a single transformation. A grid generated with this transformation is shown for the Korn airfoil. Previously announced in STAR as N83-24474 S.L.

A84-38844#
POROUS AIRFOILS IN TRANSONIC FLOW

G. SAVU and O. TRIFU (Institutul National Pentru Creatie Stiintifica si Tehnica, Bucharest, Rumania) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 989-991. refs

A method is proposed for creating shockless supercritical flow around an airfoil in a broader transonic Mach number range. The method demonstrates that the pressure jump (shock wave) intensity on thick airfoils in the transonic regime is considerably reduced by setting up a secondary flow through the porous surface between the external region and the internal cavity of the airfoil. Such a secondary flow is subjected to the Darcy law which states that the normal velocity on a porous surface is proportional to the pressure gradient between its two sides. The method is analyzed in an experiment involving inviscid flow over a NACA 0012 airfoil at zero incidence and at various Mach numbers. A graphic representation of the pressure distributions on the airfoil during the experiment shows that flow was shockless and that the shockless flow was maintained over a large Mach number domain. I.H.

A84-38848#
AXISYMMETRIC NONCONICAL SUPERSONIC POTENTIAL FLOW WITH EMBEDDED SUBSONIC REGIONS

M. J. SICLARI (Grumman Aerospace Corp., Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 998, 999. refs

A new, efficient, and accurate procedure for computing flows with attached bow shocks at low supersonic freestream Mach numbers that result in embedded subsonic flow regions is described. This procedure is mesh-efficient in that the computation is bounded by a fitted bow shock and hyperbolic upstream and downstream conditions, and an iterative procedure need be implemented only in a localized region of subsonic flow. C.D.

A84-38850*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

PREDICTION OF TRANSONIC SEPARATED FLOWS

C. C. HORSTMAN and D. A. JOHNSON (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 1001-1003. refs

Johnson et al. (1982) have provided a detailed comparison between a thoroughly documented transonic flow with shock-induced separations and solutions of the flow using the Navier-Stokes equations. According to this comparison, there were

several deficiencies in the computations. The present investigation takes into account new experimental data which have been obtained in a larger wind tunnel with the same test model for a wider range of freestream Mach numbers. The results of new Navier-Stokes computations using more compatible boundary conditions are shown, and the effects of the turbulence model choice on predicting Mach number trends are assessed. G.R.

**A84-38852#
SHOCK SHAPE OVER A SPHERE CONE IN HYPERSONIC HIGH ENTHALPY FLOW**

R. J. SANDEMAN, P. LYONS (Australian National University, Canberra, Australia), S. L. GAI, and D. KILPIN AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 1007-1010. refs

The flow of dissociated nitrogen with $c(1) = 0.01-0.5$, freestream velocity 5-8 km/s, Mach number about 6, and reservoir enthalpy 15-50 MJ/kg over a 26-deg spherical-nose cone at angle of attack 6, 12, 15, or 20 deg is investigated experimentally using self-luminosity photography in the free-piston shock tunnel T3 at Australian National University. The theoretical analysis of the problem by Traugott (1962) is reviewed along with the results of previous experiments; the present setup is described; and photographs of the sphere-cone body shocks are provided. Significant nonequilibrium effects are observed, the shock wave moving closer to the body with increasing enthalpy and exhibiting an inflection point which moves upstream as angle of attack is increased. T.K.

**A84-38880#
A SUMMARY OVERVIEW OF WORK ON DYNAMIC STALL**

E. J. JUMPER (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 3-1-1 to 3-1-4. refs

Attention is given to the results of both theoretical and experimental studies of dynamic stall, for the cases of unsteady boundary layer and unsteady potential flow. Experimental lift curves exhibit spikes which denote the importance of the role of separated flow in stall phenomena. It is noted that the Strickland (1983) technique for separated flow can directly incorporate unsteady integral methods in order to determine the separation locations. O.C.

**A84-38881#
SUPERSONIC AERODYNAMIC CHARACTERISTICS OF ELLIPTIC CROSS SECTION BODIES**

P. F. AMIDON (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 3-2-1 to 3-2-5. refs

Experimental studies have been conducted to develop more accurate aerodynamic design methods. A series of tests on bodies with elliptic cross section were made in the VKF Tunnel A at AEDC. Three models, with ellipticity ratios of 2:1, 2.5:1, and 3:1 were run at Mach numbers from 1.75 to 5.0 at angles of attack up to 20 degrees. Both pressure and force and moment data were obtained. The purpose was to obtain detailed data for comparison with analytical methods. Vapor screen and oil flow runs were also made. Results were compared with similar tests done by NASA. Author

**A84-38898#
LDV MEASUREMENTS OF THREE-DIMENSIONAL FLOW DEVELOPMENT IN A CURVED RECTANGULAR DUCT WITH INLET SHEAR PROFILE**

M. MALAK and A. HAMED (Cincinnati, University, Cincinnati, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 10-1-1 to 10-1-5. refs (Contract AF-AFOSR-80-0242)

The results of an experimental investigation of the three-dimensional flow development in a highly curved duct with inlet shear profile are presented. Laser Doppler velocimetry in the backward scatter mode is used to measure the three components of the air velocity in a curved duct with a rectangular cross section. The experimental measurements of the primary and secondary velocity components are presented. Significant secondary velocity development of magnitudes up to 0.25 of the bulk velocity were measured, associated with through velocity contour rotations of over 90 deg. Author

**A84-38899#
THE EFFECT OF BLADE TIP VANES ON HELICOPTER ROTOR PERFORMANCE**

T. M. BOYD, JR. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 10-3-1 to 10-3-4. refs

The aerodynamic performance of a helicopter rotor blade may be improved by the addition of small vanes to the tip of the blade. These vanes reduce blade drag by moving the tip vortex to an optimum outboard location. Tests were conducted at the Georgia Institute of Technology rotor test facility to determine the thrust and drag characteristics of a modified blade. Various vane lengths and incidence angles were tested at different rotor blade angles. Test results indicate that an increase in rotor performance can be obtained by use of the vanes. Author

**A84-39171
HYPERSONIC FLOW OF A MIXTURE PAST BLUNT BODIES [K VOPROSU OBTEKANIIA TUPONOSYKH TEL GIPERZVUKOVYIM POTOKOM SMESI]**

A. IA. SAGOMONIAN Moskovskii Universitet, Vestnik, Seria 1 - Matematika, Mekhanika (ISSN 0579-9368), May-June 1984, p. 50-54. In Russian.

The problem of hypersonic flow of a two-phase mixture (a gas containing solid or liquid particles) past a rigid sphere is analyzed with all the constraints of Lighthill (1957). In the analysis, no allowance is made for the forces of friction between the phase particles. Two wave surfaces are shown to exist, with the region between the sphere and the nearest wave surface occupied exclusively by the solid or liquid phase of the mixture. V.L.

**A84-39301#
SIMILARITY CONDITIONS FOR CONICAL SHOCKWAVE TURBULENT BOUNDARY-LAYER INTERACTIONS**

G. S. SETTLES (Pennsylvania State University, University Park, PA) and R. L. KIMMEL American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs (Contract F49620-81-K-0018) (AIAA PAPER 84-1557)

A parametric experimental study has been made of the quasi-conical shock boundary-layer interactions produced by three families of shock generators: fins, semicones, and swept compression corners. The experiments were carried out at Mach 2.95 and $Re/m = 6.3 \times 10$ to the 7th, using a flat plate turbulent boundary layer. Over 50 distinct shock generator configurations were considered. The results consist of surface flow patterns, pressure distributions, and flowfield visualizations. An analysis of these results reveal that the interaction characteristics depend primarily on the inviscid shockwave strength and shape. Given

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similar values of these parameters, 'conical free interaction' similarity results even for disparate shock generators. The similarity conditions among fin, semicone, and swept corner interactions are further explored in terms of normal Mach number scaling and flow regime changes with geometry variation. Author

A84-39304*# Pennsylvania State Univ., University Park.
LASER DOPPLER VELOCIMETER MEASUREMENT IN THE TIP REGION OF A COMPRESSOR ROTOR

K. N. S. MURTHY and B. LAKSHMINARAYANA (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 15 p. refs

(Contract NSG-3212)
(AIAA PAPER 84-1602)

The axial and tangential velocity components near the tip region of a compressor rotor were measured by a laser Doppler velocimeter. The measurements were taken at 25 radial locations in the outer twenty percent of the blade span and at 10 axial locations upstream, inside and at the exit of the rotor. The results are interpreted to derive the behavior of the leakage flow, annulus wall boundary layer growth, inviscid effects and the rotor wake decay characteristics in the tip region. The inviscid and annulus wall boundary layer effects dominate up to quarter chord, beyond which the leakage phenomena has a major influence in altering the flow characteristics in the outer ten percent of the blade span. The annulus wall boundary layer undergoes drastic change through the passage. The velocity field measured near the leading edge reveals the effects of rapid acceleration near the suction surface and the stagnation point on the pressure surface. Author

A84-39307#
NUMERICAL SIMULATION OF AXISYMMETRIC BASE FLOW ON TACTICAL MISSILES WITH PROPULSIVE JET

P. D. THOMAS, R. P. REKLIS, R. R. ROLOFF, and R. J. CONTI (Lockheed Research Laboratories, Palo Alto, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. Research sponsored by the Lockheed Independent Research Program and U.S. Army. refs
(AIAA PAPER 84-1658)

The axisymmetric Lockheed Viscous Implicit Solver (LVIS) Navier-Stokes computer code has been modified to incorporate the capability for computing the flow in the base region of a tactical missile with propulsive jet. Modifications include generalization of the computational space to accommodate the geometry of the base, and implementation of two turbulence models of the two-equation type (k-epsilon and k-W). Computer runs are made with both turbulence models. The results of these computations are similar, but some differences are observed in the recirculating near-wake flow and in the shear layers that separate it from the high-speed streams of the propulsive jet and of the external flow. These differences are attributed to the greater eddy viscosity predicted by the k-epsilon model. Author

A84-39311*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THREE-DIMENSIONAL NAVIER-STOKES CALCULATIONS OF MULTIPLE INTERACTING VORTEX RINGS

J. P. CHAMBERLAIN and R. P. WESTON (NASA, Langley Research Center, Low-Speed Aerodynamics Div., Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs
(AIAA PAPER 84-1545)

Results from a finite-difference Navier-Stokes code for three-dimensional, unsteady, vortical flows in unbounded domains are presented and analyzed in this paper. The vortical flows presented are representative of vortex rings and other closed vortical tubes or structures in fluid mechanics. Such structures are important elements in fluid flows such as jets, atmospheric turbulence, and the far-field wakes of aircraft, and studies of their

interaction may aid in an understanding of complex fluid flows. The paper demonstrates that computational methods can be used as a viable alternative or supplement to experimental techniques for studying the physics of vortex flows. The separate visualization of vortex stretching, convection, and diffusion is presented in this paper for a single elliptical vortex ring. The calculations employ a truncated series expansion technique to simulate the unbounded nature of the fluid flow with a finite computational domain, which is a more accurate technique than the conventional freestream boundary specification. The numerical divergence of the three-dimensional vorticity field is considered as a useful estimate of truncation error, and the use of a kinetic energy decay law as a calculation check is demonstrated. Results from the Navier-Stokes code are presented for the unsteady motion of two and four vortex rings along parallel axes, and the results agree qualitatively with experimental flow visualization. Author

A84-39313*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NUMERICAL STUDIES OF MOTION OF VORTEX FILAMENTS - IMPLEMENTING THE ASYMPTOTIC ANALYSIS

C.H. LIU (NASA, Langley Research Center, Analytical Methods Branch, Hampton, VA), J. TAVANTZIS (New Jersey Institute of Technology, Newark, NJ), and L. TING (New York University, New York, NY) American Institute of Aeronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 15 p. refs

(Contract N00014-80-C-0324; NCC1-58)
(AIAA PAPER 84-1542)

A computational code is developed for the integro-differential equations governing the motion of the centerlines of vortex filaments submerged in a background potential flow. These equations, which are derived from the method of matched asymptotic analysis, include the effect of the decaying large-magnitude circumferential and axial velocity components in the vortical cores. Numerical examples are presented to assess the effect of a large axial velocity and that of nonsimilar initial profiles in the vortical cores. The initial configurations of the filaments are chosen so as to fulfill the basic assumption of the asymptotic analysis, which is that the effective vortical core size is much smaller than all the other length scales in the flowfield, e.g., the radius of curvature and the interfilament distance. The computations are continued until the basic assumption is no longer valid, that is when the merging or intersection of filaments has begun. A classification of the various types of local or global merging or intersection of filaments is made and demonstrated by numerical examples. It is then shown that the asymptotic solution not only provides the initial data but also can be used to formulate the appropriate boundary conditions for the numerical solution of a merged region. Author

A84-39314*# Iowa State Univ. of Science and Technology, Ames.

NUMERICAL CALCULATIONS OF COMPLEX MACH REFLECTION

O. YAMAMOTO, D. A. ANDERSON (Iowa State University of Science and Technology, Ames, IA), and M. D. SALAS (NASA, Langley Research Center, Theoretical Aerodynamics Branch, Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. Research supported by the Iowa State University of Science and Technology. refs
(Contract NCC1-17)

(AIAA PAPER 84-1679)

Numerical simulations of the interaction of a planar blast wave with a compression ramp are presented. The split coefficient matrix (SCM) method in conjunction with boundary shock and floating discontinuity-fitting procedures was employed to obtain the time-asymptotic solutions of the two-dimensional, unsteady Euler equations. The solutions were computed for the complex Mach reflection (CMR) regime of the shock diffraction problem in an attempt to explore the basic physical process governing the evolution of an incipient second Mach stem and the associated

topological changes. Numerical results were obtained for shock diffraction over a 40 degree ramp with varying incident shock Mach numbers. The validity of the present approach has been substantiated by experimental observations and earlier numerical calculations. Author

A84-39315*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE EFFECTS OF GUSTS ON THE FLUCTUATING AIRLOADS OF AIRFOILS IN TRANSONIC FLOW

W. J. MCCROSKEY (NASA, Ames Research Center, Thermo- and Gas-Dynamics Div.; U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. refs (AIAA PAPER 84-1580)

Unsteady interactions of distributed and sharp-edged gusts with a stationary airfoil have been analyzed in two-dimensional transonic flow. A simple method of introducing such disturbances has been numerically implemented within the framework of unsteady, transonic small-disturbance theory. Representative solutions for various airfoils subjected to chordwise and transverse gusts show that the strength and unsteady motion of the shock wave on the airfoil significantly affect the flowfield development and, consequently, the dynamic airloads. Also a study was made of the reductions in the unsteady airloads that can be achieved by the proper active control motion of a trailing-edge flap, and a simple gust-alleviation strategy was developed. However, the chordwise pressure distributions associated with gusts are very different from those produced by trailing-edge flap oscillations. Consequently, the fluctuating lift and the unsteady pitching moments cannot both be eliminated simultaneously. Author

A84-39317#

PREDICTION OF THE FLOW OVER SUPERCRITICAL HIGH-LIFT CONFIGURATIONS BY A MULTIGRID ALGORITHM

G. VOLPE (Grumman Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs (AIAA PAPER 84-1664)

A fast numerical procedure for computing the inviscid transonic flow over two-element airfoil configurations is described in this paper. The doubly connected infinite domain around the two contours is conformally mapped into the annular region between two concentric circles and is covered by a stretched polar coordinate grid. Singularities introduced by the mapping are removed analytically. The continuity equation is discretized in full conservation form with appropriate upstream biasing of the difference equations in supersonic regions. The difference equations are solved by an algorithm that couples multigrid sequencing of the computational meshes with an approximate factorization scheme to sweep through the field. The scheme is fully second order accurate in subsonic regions and partially so in supersonic zones except locally near shock waves and has proven stable and reliable in a wide variety of cases. Author

A84-39318#

ENTROPY CORRECTIONS TO SUPERSONIC CONICAL NONLINEAR POTENTIAL FLOWS

M. J. SICLARI and A. RUBEL (Grumman Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 14 p. refs (AIAA PAPER 84-1683)

Entropy corrections are applied to full potential supersonic conical flows that have the bow shock fit as a boundary. The entropy corrections require the implementation of the Rankine-Hugoniot shock relations instead of the isentropic shock conditions. In addition, the pressure must be corrected to account for the bow shock induced entropy variation. For high Mach number and/or large deflection angles, the correction to the potential

pressures can be of the same order of magnitude as the Euler pressures. Considering the simplistic nature of the corrections, remarkably accurate results are achieved for circular and elliptical cones. Additional corrections account for embedded crossflow shocks. Author

A84-39319#

JET, WAKE AND WALL JET SIMILARITY SOLUTIONS USING A K-EPSILON TURBULENCE MODEL

A. RUBEL and R. E. MELNIK (Grumman Research and Development Center, Bethpage, NY) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 6 p. refs (AIAA PAPER 84-1523)

A k-epsilon turbulence model is used to represent free mixing in incompressible strong jets, weak jets (wakes) and in the outer layer of wall jets. The ordinary differential equations governing these self-preserving flows exhibit a singular behavior at the finite edge of the shear layer. A transformation of the similarity variable moves the finite edge to infinity and decouples much of the governing equation set. Care must be exercised in application to the wall jet outer layer since the dissipation is unbounded at the wall. The transformed equations are solved numerically without difficulty. Wake and jet growth rate results compare reasonably well with parabolic marching scheme computations. Author

A84-39320*# Stanford Univ., Calif.

WAVE INTERACTIONS IN SWEEP-WING FLOWS

H. L. REED (Stanford University, Stanford, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 16 p. refs (Contract NAG1-402) (AIAA PAPER 84-1678)

Crossflow instabilities dominate disturbance growth in the leading-edge region of swept wings. It is well known that streamwise vortices in a boundary layer strongly influence the behavior of other disturbances. Amplification of crossflow vortices near the leading edge produces a residual spanwise nonuniformity in the mid-chord regions where Tollmien-Schlichting (T-S) waves are strongly amplified. Should the T-S wave undergo double-exponential growth because of this effect, the usual transition prediction methods would fail. Thus, it is important to study interactions of this sort and to develop more realistic criteria for transition prediction. Author

A84-39367*# Iowa State Univ. of Science and Technology, Ames.

NUMERICAL SOLUTION OF SPACE SHUTTLE ORBITER FLOW FIELD INCLUDING REAL GAS EFFECTS

D. K. PRABHU and J. C. TANNEHILL (Iowa State University of Science and Technology, Ames, IA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 19th, Snowmass, CO, June 25-28, 1984. 17 p. Research supported by the Iowa State University of Science and Technology. refs (Contract NGR-16-002-038; NAG2-245) (AIAA PAPER 84-1747)

The hypersonic, laminar flow around the Space Shuttle Orbiter has been computed for both an ideal gas ($\gamma = 1.2$) and equilibrium air using a real-gas, parabolized Navier-Stokes code. This code employs a generalized coordinate transformation; hence, it places no restrictions on the orientation of the solution surfaces. The initial solution in the nose region was computed using a 3-D, real-gas, time-dependent Navier-Stokes code. The thermodynamic and transport properties of equilibrium air were obtained from either approximate curve fits or a table look-up procedure. Numerical results are presented for flight conditions corresponding to the STS-3 trajectory. The computed surface pressures and convective heating rates are compared with data from the STS-3 flight. Author

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A84-39369*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PROBLEMS OF RATE CHEMISTRY IN THE FLIGHT REGIMES OF AEROASSISTED ORBITAL TRANSFER VEHICLES

C. PARK (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 19th, Snowmass, CO, June 25-28, 1984. (AIAA PAPER 84-1730)

The dissociating and ionizing nonequilibrium flows behind a normal shock wave are calculated for the density and vehicle regimes appropriate for aeroassisted orbital transfer vehicles; the departure of vibrational and electron temperatures from the gas temperature as well as viscous transport phenomena are accounted for. From the thermodynamic properties so determined, radiative power emission is calculated using an existing code. The resulting radiation characteristics are compared with the available experimental data. Chemical parameters are varied to investigate their effect on the radiation characteristics. It is concluded that the current knowledge of rate chemistry leads to a factor-of-4 uncertainty in nonequilibrium radiation intensities. The chemical parameters that must be studied to improve the accuracy are identified. Author

A84-39371*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AEROTHERMODYNAMIC ENVIRONMENT AND THERMAL PROTECTION FOR A TITAN AEROCAPTURE VEHICLE

M. J. GREEN (NASA, Ames Research Center, Moffett Field, CA), J. N. MOSS (NASA, Langley Research Center, Hampton, VA), and J. F. WILSON (Informatics General Corp., Palo Alto, CA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 19th, Snowmass, CO, June 25-28, 1984. 12 p. refs (AIAA PAPER 84-1714)

This paper presents thermal protection system (TPS) requirements for a potential Titan aerocapture vehicle. Shock-layer solutions are obtained for a nominal trajectory through the current Titan model atmosphere. Fully laminar and fully turbulent solutions are presented along the blunted fore-cone in the windward symmetry plane of a bent-biconic vehicle. Using these solutions to define the aerothermodynamic environment, transient material-response solutions are obtained for a Galileo-type TPS with a carbon-phenolic ablator heat shield. Shock-layer results indicate that turbulent flow is the more realistic flow condition. They also show that the lengthy aerocapture heating pulse is dominated by convective heating. The TPS results show that the required insulation thickness is uniformly about 4 cm along the fore-cone because of the long heat-soak period. The total heat-shield thickness is 6.4 cm at the stagnation point, and 4.7 cm near the end of the fore-cone. These TPS requirements are greater than those presented in a previous Titan aerocapture study. Author

A84-39424#

COMPUTATIONAL PROBING OF HYPERSONIC LAMINAR WAKES

R. P. REKLIS and R. J. CONTI (Lockheed Research Laboratories, Palo Alto, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs (Contract N00014-82-C-0690) (AIAA PAPER 84-1579)

A numerical tool for simulating laminar wakes near the base of hypersonic cones is described. Comparisons with experimental data are made to validate the numerical method. Numerical simulations are presented for a cone with a 7 degree half-angle in an airstream at Mach number 6.32, for four values of the Reynolds number ranging from 21,500 to 172,000 referenced to the base diameter. The dependence of major features of the flow on Reynolds number is reported. Author

A84-39425*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EXPERIMENTAL STUDY OF A VORTEX/MIXING-LAYER INTERACTION

R. D. MEHTA (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 18 p. refs (AIAA PAPER 84-1543)

The first phase of a subsonic experimental investigation of the structure of a longitudinal vortex and the effect of the vortex on a two-stream turbulent mixing layer has been completed. A stable and well-defined longitudinal vortex was generated by mounting a half-delta-wing vortex generator in the wind-tunnel settling chamber. A detailed flow-visualization study, using the smoke-laser technique, was conducted, and X-wire probes were used to measure the mean-flow and turbulence quantities. At the upstream locations, the vortex was found to develop some normal stresses within the core region. The vortex also induced strong secondary motions and small increases in the normal stresses within the mixing layer. The normal stresses then combined with the appropriate mean-velocity gradients to generate shear stresses farther downstream. The results indicate that more sophisticated turbulence models will have to be developed if such complex interactions are to be computed accurately. Author

A84-39720

THE FLOWS OVER TAPERED FLAT PLATES NORMAL TO THE STREAM

M. GASTER and P. J. PONSFORD (NMI, Ltd., Teddington, Middx., England) Aeronautical Journal (ISSN 0001-9240), vol. 88, May 1984, p. 206-212. refs

Experimental measurements of the separated flows around a range of tapered flat plates normal to a uniform stream are presented. Both the surface pressures and velocities in the wake are discussed. It turns out that even slight taper can modify the wake region of the flow significantly, and so produce a surprising degree of three-dimensionality into the overall flow structure. These experimental results point to the dangers in applying simple strip theories to highly separated flows. Author

A84-39736

OPTIMAL CONCEPTION OF AERODYNAMIC FORM [CONCEPTION OPTIMALE DE FORME AERODYNAMIQUE]

D. VOLPERT and D. KALFON (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France) IN: Control of distributed parameter systems; Symposium, 3rd, Toulouse, France, June 29-July 2, 1982, Preprints. Oxford, Pergamon Press, Ltd., 1982, p. XII.9-XII.13. In French. Research supported by the Societe Nationale Industrielle Aerospaciale. refs

Optimal control methods have been used to resolve a problem involving a free boundary with constraints. The boundary is considered as a control, while the constraint is cast in the form of a minimization criterion. This formalism, however, does not permit the acquired results to be used in the context of existing theory, nor can the existence and uniqueness of the solution be demonstrated. The problem was therefore attacked in numerical fashion. By utilizing a discretized criterion and the finite element method to solve the equations of state and related equations, the problem was reduced to one of finite dimension. The successful result may allow the existence and uniqueness conditions of the solution to be obtained. C.D.

N84-26620# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

IN-FLIGHT MEASUREMENT OF PRESSURE DISTRIBUTION OVER T-38 STUDENT CANOPY

W. R. PINNELL In Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 527-552 Dec. 1983 (AD-P003207) Avail: NTIS HC A08/MF A01 CSCL 01C

As part of a current in-house effort supporting the development of bird impact resistant transparencies for T-28 aircraft, a system for measuring aerodynamic pressure distribution over a T-38

student canopy has been developed. Static pressures were measured at 103 positions on the canopy of an aircraft in flight. Flight conditions included speeds in the range from 50 (taxi) to 500 knots, 5 degree side slip, and stalled flight. The paper includes a description of the in-flight recording system, the utilization of a microcomputer and software for data reduction and analysis, and test results. This concept of testing and measurement is believed to be unique and to have potential application to other transparency testing including measurement of in-flight loads and temperatures.

GRA

N84-26654 Illinois Inst. of Tech., Chicago.
CONTROL OF SEPARATED FLOWFIELDS USING FORCED UNSTEADINESS Ph.D. Thesis

D. J. KOGA 1983 274 p

Avail: Univ. Microfilms Order No. DA8405625

Locally introduced unsteady vorticity is capable of manipulating the separated flow region and its reattachment characteristics. This is achieved using a model unsteady separated flow field generated by a computer controlled, variable waveform spoiler like flap in a flat plate turbulent boundary layer with and without upstream separation. The generation of local unsteady flow vorticity and the management of separated flow regions are investigated utilizing smoke wire flow visualization, surface pressure measurements and multiprobe hot wire velocity mapping techniques. Local lifting surface mean pressure coefficient increases of nearly one hundred percent and a reduction of flow reattachment lengths to thirty percent of the natural steady flow separation cases are shown.

Dissert. Abstr.

N84-26655 Purdue Univ., Lafayette, Ind.
TRANSONIC AEROELASTIC STABILITY AND RESPONSE OF CONVENTIONAL AND SUPERCRITICAL AIRFOILS INCLUDING ACTIVE CONTROLS Ph.D. Thesis

J. T. BATINA 1983 191 p

Avail: Univ. Microfilms Order No. DA8407506

Transonic aeroelastic stability and response analyses are performed for two conventional airfoils, NACA 64A006 and NACA 64A010, and one supercritical airfoil, MBB A-3. Three d.o.f.'s are considered: plunge, pitch, and aileron pitch. A set of aeroelastic parameters are selected for which the flutter speeds are near the bottom of a transonic dip. A Pade' state-space aeroelastic model is formulated using generalized aerodynamic forces approximated by an interpolating function in the variables. The coefficient matrices of this function are determined by a least-squares curve fit of harmonic transonic aerodynamic data. Three sets of aerodynamic data are computed using three different transonic computational codes (LTRAN2-NLR, LTRAN2-HI, and USTS) for comparison purposes. In general, the Pade' interpolating function provides a good approximation of the unsteady aerodynamic coefficients predicted by the transonic codes. The state-space aeroelastic model, formulated by using the Pade' interpolating function, results in a set of linear, first-order, constant coefficient, different equations.

Dissert. Abstr.

N84-26656 Kansas Univ., Lawrence.
DEVELOPMENT OF A THERMAL AND STRUCTURAL MODEL FOR A NASTRAN FINITE-ELEMENT ANALYSIS OF A HYPERSONIC WING TEST STRUCTURE Ph.D. Thesis

J. LAMERIS 1983 281 p

Avail: Univ. Microfilms Order No. DA8403708

As part of NASA's continuing research program into hypersonics, Dryden Flight Research Facility has conducted extensive heating and mechanical tests on a Hypersonic Wing Test Structure (HWTS). This structure was based on a structural concept developed for a hypersonic research airplane that would cruise at Mach 8. For future designs of structural concepts and space transportation systems operating at high temperatures, accurate prediction methods of thermal deflections and strains are required. An accurate prediction of the temperature distribution is a major prerequisite for obtaining this goal. In this context, the goal of NASA Dryden's HWTS project is to perform a coordinated analysis and test of a medium-sized existing specimen to obtain a

detailed evaluation of state-of-the-art predictive techniques for thermal structures. This report describes the development of a thermal and structural model for this HWTS structure using the NASTRAN finite-element method as its primary analytical tool. A detailed analysis was defined to obtain the temperature and thermal stress distribution in the whole wing as well as at the five upper and lower root panels.

Dissert. Abstr.

N84-26657 Cornell Univ., Ithaca, N.Y.
CALCULATION OF TRANSONIC POTENTIAL FLOW PAST WING-TAIL-FUSELAGE CONFIGURATIONS USING THE MULTIGRID METHOD Ph.D. Thesis

A. SHMILOVICH 1984 175 p

Avail: Univ. Microfilms Order No. DA8407377

A computer program for calculating transonic potential flow fields about three-dimensional wing-tail-fuselage configurations has been developed. Such computations provide insight into the nature of the flow patterns for closely-coupled multi-wing systems in cases for which flow analyses of the individual components in isolation (say, wing-body and tail-body combinations) can not be expected to be adequate for realistic modeling. An efficient procedure has been devised for generating boundary conforming coordinate systems for wing-tail-body configurations. A sequence of conformal and shearing transformations is employed to yield a slotted and nearly orthogonal computational domain. The analysis has been extended to construct body fitted grids for combinations which have an empennage consisting of twin vertical fins as well as twin horizontal tails. Computational grids for several existing aircraft have been used to demonstrate the ability of the mesh generation module to treat lifting surfaces of arbitrary planform and location. The possibility of constructing meshes for other multiple-component aircraft has also been investigated.

Dissert. Abstr.

N84-26658 Georgia Inst. of Tech., Atlanta.
A NUMERICAL ANALYSIS FOR BLADE TIP LOADINGS ON A THICK BLADED HOVERING HELICOPTER ROTOR Ph.D. Thesis

T. C. WEY 1983 187 p

Avail: Univ. Microfilms Order No. DA8405607

An iterative vortex panel method and a simple model for vortex/surface interaction have been developed here to predict the pressure and the velocity distributions over a thick-blade rotor. The whole rotor system is represented by a system of vortices. It includes a bound vortex, a wake vortex system and a freestream vortex. The bound vortex consists of spanwise and chordwise vortex sheets on the blade surface. The wake vortex system is composed of an inner wake vortex sheet, a far-field tip vortex and a near-field tip vortex. The far-field tip vortex geometry is prescribed from experiments. The linear wake vortex sheet and a first approximation to the blade bound vorticity distribution are computed using a lifting line theory. The near-field tip vortex is computed by imposing the force-free condition. A new set of vorticity values on the blade surface are obtained by computing the tangential velocity induced at the mid-point of each panel on the surface.

Dissert. Abstr.

N84-26659 New York Univ., New York.
THE METHOD OF COMPLEX CHARACTERISTICS FOR DESIGN OF TRANSONIC COMPRESSORS Ph.D. Thesis

M. R. BLEDSOE 1983 190 p

Avail: Univ. Microfilms Order No. DA8405755

Shockless transonic flows past two-dimensional cascades of airfoils characterized by a prescribed speed distribution were calculated. Solutions for a partial differential equation describing transonic flow were determined by the method of complex characteristics. Analytic continuation, conformal mapping, and a spectral method in the hodograph plane were used to investigate the flow. The computational methods were utilized in a computer code to design two-dimensional cascades of shockless compressor airfoils with gap-to-chord ratios as low as 0.5 and supersonic zones on both the upper and lower surfaces. The complex characteristics method may be extended to solve more general

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boundary value problems for second order partial differential equations in two independent variables. Dissert. Abstr.

N84-26660*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NATURAL LAMINAR FLOW EXPERIMENTS ON MODERN AIRPLANE SURFACES

B. J. HOLMES, C. J. OBARA (Kentron International, Inc., Hampton, Va.), and L. P. YIP Jun. 1984 145 p refs (NASA-TP-2256; L-15552; NAS 1.60:2256) Avail: NTIS HC A07/MF A01 CSCL 01A

Flight and wind-tunnel natural laminar flow experiments have been conducted on various lifting and nonlifting surfaces of several airplanes at unit Reynolds numbers between 0.63×10^6 to the 6th power/ft and 3.08×10^6 to the 6th power/ft, at Mach numbers from 0.1 to 0.7, and at lifting surface leading-edge sweep angles from 0 deg to 63 deg. The airplanes tested were selected to provide relatively stiff skin conditions, free from significant roughness and waviness, on smooth modern production-type airframes. The observed transition locations typically occurred downstream of the measured or calculated pressure peak locations for the test conditions involved. No discernible effects on transition due to surface waviness were observed on any of the surfaces tested. None of the measured heights of surface waviness exceeded the empirically predicted allowable surface waviness. Experimental results consistent with spanwise contamination criteria were observed. Large changes in flight-measured performance and stability and control resulted from loss of laminar flow by forced transition. Rain effects on the laminar boundary layer caused stick-fixed nose-down pitch-trim changes in two of the airplanes tested. No effect on transition was observed for flight through low-altitude liquid-phase clouds. These observations indicate the importance of fixed-transition tests as a standard flight testing procedure for modern smooth airframes. B.W.

N84-26661*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va. Dept. of Aeronautics and Astronautics.

AERODYNAMIC DESIGN USING NUMERICAL OPTIMIZATION

E. M. MURMAN and G. T. CHAPMAN Cambridge, Mass. MIT Feb. 1983 34 p refs Submitted for publication (Contract NAG2-115) (NASA-TM-85550; NAS 1.15:85550; CFDL-TR-83-2) Avail: NTIS HC A03/MF A01 CSCL 01A

The procedure of using numerical optimization methods coupled with computational fluid dynamic (CFD) codes for the development of an aerodynamic design is examined. Several approaches that replace wind tunnel tests, develop pressure distributions and derive designs, or fulfill preset design criteria are presented. The method of Aerodynamic Design by Numerical Optimization (ADNO) is described and illustrated with examples. M.A.C.

N84-26662*# Vought Corp., Dallas, Tex.

ADVANCED PREDICTION TECHNIQUE FOR THE LOW SPEED AERODYNAMICS OF V/STOL AIRCRAFT. VOLUME 1: TECHNICAL DISCUSSION Final Report, Mar. 1982 - Mar 1983

T. D. BEATTY and M. K. WORTHEY 15 Mar. 1984 148 p 2 Vol.

(Contract NAS2-11156)

(NASA-CR-166442-VOL-1; NAS 1.26:166442-VOL-1; REPT-2-55110/3R-53463-VOL-1) Avail: NTIS HC A07/MF A01 CSCL 01A

The V/STOL Aircraft Propulsive Effects (VAPE) computerized prediction method is evaluated. The program analyzes viscous effects, various jet, inlet, and Short TakeOff and Landing (STOL) models, and examines the aerodynamic configurations of V/STOL aircraft. M.A.C.

N84-26663*# Vought Corp., Dallas, Tex.

ADVANCED PREDICTION TECHNIQUE FOR THE LOW SPEED AERODYNAMICS OF V/STOL AIRCRAFT. VOLUME 2: USER'S MANUAL Final Report, Mar. 1982 - Mar. 1983

T. D. BEATTY and M. K. WORTHEY 15 Mar. 1984 127 p 2 Vol.

(Contract NAS2-11156)

(NASA-CR-166442-VOL-2; NAS 1.26:166442-VOL-2; REPT-2-55110/3R-53463-VOL-2) Avail: NTIS HC A07/MF A01 CSCL 01A

A computerized prediction method known as the Vought V/STOL Aircraft Propulsive Effects computer program (VAPE) for propulsive induced forces and moments in transition and Short TakeOff and Landing (STOL) flight is improved and evaluated. The VAPE program is capable of evaluating: (1) effects of relative wind about an aircraft, (2) effects of propulsive lift jet entrainment, vorticity and flow blockage, (3) effects of engine inlet flow on the aircraft flow field, (4) engine inlet forces and moments including inlet separation, (5) ground effects in the STOL region of flight, and (6) viscous effects on lifting surfaces. M.A.C.

N84-26667*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LOW-SPEED INVESTIGATION OF EFFECTS OF WING LEADING- AND TRAILING-EDGE FLAP DEFLECTIONS AND CANARD INCIDENCE ON A FIGHTER CONFIGURATION EQUIPPED WITH A FORWARD-SWEPT WING

T. G. GAINER, M. J. MANN, and J. K. HUFFMAN Jul. 1984 51 p refs

(NASA-TM-85795; L-15746; NAS 1.15:85795) Avail: NTIS HC A04/MF A01 CSCL 01A

An advanced fighter configuration with a forward-swept wing of aspect ratio 3.28 is tested in the Langley 7 by 10 Foot High Speed Tunnel at a Mach number of 0.3. The wing has 29.5 degrees of forward sweep of the quarter chord line and is equipped with 15 percent chord leading edge and 30 percent chord trailing edge flaps. The canard is sweptback 45 degrees. Tests were made through a range of angle of attack from about -2 degrees to 22 degrees. Deflecting the flaps significantly improves the lift drag characteristics at the higher angles of attack. The canard is able to trim the configurations with different flap deflections over most of the range of angle of attack. The penalty in maximum lift coefficient due to trimming is about 0.10. M.A.C.

N84-26668*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CALCULATION OF VERTICAL AND RAMP-ASSISTED TAKEOFFS FOR SUPERSONIC CRUISE FIGHTERS

G. C. LIU Jun. 1984 32 p refs

(NASA-TM-85818; NAS 1.15:85818) Avail: NTIS HC A03/MF A01 CSCL 01A

A procedure that allows rapid preliminary evaluations of the vertical, short, and normal takeoff performance of supersonic cruise aircraft concepts was developed into a numerical computer program. The program is used to determine the effects on takeoff performance of various parameters, such as thrust-weight ratio, wing loading, thrust vector angle, and flap setting. Ramp-assisted takeoffs for overloaded configurations typical of a ground-attack mission are included. The effects of wind on the takeoff performance are also considered. Author

N84-26670# Calspan Advanced Technology Center, Buffalo, N.Y.

STUDIES OF BOUNDARY LAYER TRANSITION AND SURFACE ROUGHNESS EFFECTS IN HYPERSONIC FLOW Final Report, 1 Nov. 1978 - 30 Sep. 1982

M. S. HOLDEN Oct. 1983 160 p

(Contract F49620-79-C-0003; AF PROJ. 2307)

(AD-A140803; CALSPAN-6430-A-5; AFOSR-84-0251TR) Avail: NTIS HC A08/MF A01 CSCL 20D

The first of the studies was a detailed experimental investigation of the effects of the shape and spacing of roughness elements on a maneuverable re-entry vehicle configuration on the

roughness-enhanced heating and skin friction. Measurements were made on slender cones and control flaps to define the relationships between roughness-element shape and spacing and the incremental heating and skin friction induced by the surface roughness. It was demonstrated that similar measurements in subsonic flows cannot be directly extrapolated to predict trends in high-speed compressible flows. In the second study, the transition process in the stagnation region of a blunt body in hypersonic flows was examined in detail. The main focus was on determining what fluid-dynamic mechanics are responsible for enhanced heating in the stagnation region of high Reynolds number blunt-body flows. Investigated was whether upstream influence from transition, surface roughness in the stagnation region, minute dust particles interact with the shock layer ahead of a blunt body. The resulting considerable increases in stagnation heating were linked with the shear layers generated by particle-shock/bow-shock interactions and the tripping of the boundary layer in the stagnation region as each dust particle enters it. In the fourth study, microsecond photographs and high-frequency thin-film measurements on slender cones were used to examine breakdown of flow in and preceding the hypersonic boundary layer transition region. The results obtained provide insight into the mechanisms by which the laminar/turbulent boundary becomes unstable in high-speed boundary layers. GRA

N84-26671# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INTERNATIONAL AVIATION (SELECTED ARTICLES)

G. RUIZHANG and Z. XUJUN 18 Apr. 1984 21 p Transl. into ENGLISH from Guoji Hangkong (China), no. 237, 23 Nov. 1982 p 2-5

(AD-A140895; FTD-ID(RS)T-0041-84) Avail: NTIS HC A02/MF A01 CSCL 20D

The aerodynamic drag was assessed for the Y-11 agricultural aircraft model on which was installed wing tip sails. The results of low-speed wind tunnel tests are reported. The effect of the sails on lift and drag characteristics is presented. In addition, the contents of an aerodynamic handbook are reviewed. Aerodynamic calculations and symbols along with a discussion of aircraft wing and fuselages are included therein. R.S.F.

N84-26672# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

A QUASI-SIMULTANEOUS CALCULATION METHOD FOR STRONGLY INTERACTING VISCOUS FLOW AROUND AN INFINITE SWEEP WING

A. E. P. VELDMAN and J. P. F. LINDHOUT 3 Jan. 1983 8 p refs Presented at 2nd Symp. on Numerical and Phys. Aspects of Aerodyn. Flows, Long Beach, Calif., 17-20 Jan. 1983 (Contract NIVR-1865)

(NLR-MP-83001-U; AD-B082665) Avail: NTIS HC A02/MF A01

A code, called VISIAN, for the analysis of aerodynamic flows with strong viscous-inviscid interaction is presented. The code is based on quasi-simultaneous methods for the calculation of strongly interacting boundary layers. The numerical algorithm with which the viscous and inviscid flow region are coupled; the modeling of the flow in the viscous region, especially in the regions of strong interaction; and the informatics structure of the code are discussed. Author (ESA)

N84-26673# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

INTEGRATING MULTIGRID RELAXATION INTO A ROBUST FAST-SOLVER FOR TRANSONIC POTENTIAL FLOWS AROUND LIFTING AIRFOILS

J. W. BOERSTOEL and A. KASSIES 28 Apr. 1983 18 p refs Presented at 6th AIAA Computational Fluid Dyn. Conf., Danvers, Mass., 13-15 Jul. 1983

(Contract NIVR-1853) (NLR-MP-83021-U) Avail: NTIS HC A02/MF A01

A robust fast-solver for the calculation of transonic potential flows around lifting airfoils, a combination of Newton iteration and correction scheme multigrid relaxation is presented. This

combination allows a simpler analysis of convergence properties than the full approximation storage multigrid relaxation that is usually applied. The circulation in the asymptotic far field solution is computed by a procedure based on Newton iteration applied to the Kutta condition. In order to exclude expansion shock and to reduce artificial viscosity in shocks and the associated stiffness effects, upwinding based on mass-flux-vector splinting was introduced. Velocity overshoots and corresponding potential jumps at shocks are allowed. The algorithm can compute subsonic and transonic potential flows around lifting airfoils in 8 to 25 work units. Author (ESA)

N84-26674# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

TRANSONIC PANEL METHOD FOR THE FULL POTENTIAL EQUATION APPLIED TO MULTI-COMPONENT AIRFOILS

B. OSKAM 31 May 1983 14 p refs Presented at 6th AIAA Computational Fluid Dyn. Conf., Danvers, Mass., 13-15 Jul 1983 (Contract NIVR-1866)

(NLR-MP-83030-U) Avail: NTIS HC A02/MF A01

The panel method is extended to obtain numerical solutions of the full potential equation for transonic flow by adding a field distribution of source singularities to the conventional distribution of singularities over the boundaries of the field. The unknown source distribution in the field is determined by solving the full potential equation, written as mass conservation law and approximated by the fully-conservative finite volume technique. Shock waves are captured automatically by splitting the transformed flux components, and applying upwind-differencing to the monotonic, supersonic parts. The transonic panel method reduces the computational domain to those parts of the flow field where the nonlinear compressibility effects are nonnegligible. The method is tested by computing the potential flow over single and multicomponent airfoils. Author (ESA)

N84-26675# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

HALF-MODEL TESTING IN THE NLR HIGH SPEED TUNNEL (HST): ITS TECHNIQUE AND APPLICATION

S. J. BOERSEN and A. ELSENAAR 15 Jul. 1983 19 p refs Presented at AGARD Fluid Dyn. Panel Symp. on Wind Tunnels and Testing Tech., Cesme, Turkey, 26-29 Sep. 1983

(NLR-MP-83036-U) Avail: NTIS HC A02/MF A01

The half-model test technique based on a systematic comparison of half-model test results with the corresponding full-model data is evaluated. It is shown that the most important problems with this technique originate from half-model mounting and wall interference effects. These effects can only be determined empirically using the full-model test results as a reference. It can then be shown that the pressure distribution on the wing and the off-design boundaries are well represented in the half-model tests. Applications of this technique, in which half-model test results are used on a relative basis, are presented. Author (ESA)

N84-26915# Joint Publications Research Service, Arlington, Va. **AERODYNAMIC AND THERMAL CHARACTERISTICS OF 3-DIMENSIONAL STELLATE BODIES IN RAREFIED GAS Abstract Only**

A. I. BUNIMOVICH and V. I. KUZMENKO *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 21-22 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekh. Zhidk. i Gaza (Moscow), no. 4, Apr. 1983 p 181-183

Avail: NTIS HC A04/MF A01

In search for the aerodynamically optimum shape of bodies to be launched into space, studies were made of stellate bodies flying at hypersonic velocities through rarefied air at various altitudes. The specific shape under consideration is a body consisting of a regular n-arm star in front and a round back with a smooth transition between them. The aerodynamic drag coefficient and the heat transfer coefficient at the front were calculated and measured as functions of the characteristic relative body width r/L (ratio of radius at midspan to total length) and of the altitude H or air density. Author

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N84-26917# Joint Publications Research Service, Arlington, Va.
INTERACTION OF JET DISCHARGED FROM CONTAINER AND OPPOSING SUPERSONIC STREAM OF RAREFIED GAS Abstract Only

I. N. LARINA *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 24 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekh. Zhidk. i Gaza (Moscow), no. 4, Apr. 1983 p 132-137
Avail: NTIS HC A04/MF A01

The problem addressed is the interaction of a supersonic stream of rarefied mono-atomic gas and an opposing jet discharged through a nozzle (radius r) from a spherical container (radius R) in that stream. The flow function, describing the state of the gas, is assumed to satisfy either the Crooke relaxation equation of S-model kinetics. The temperature dependence of dynamic viscosity is assumed to correspond to the Lennard-Jones model of particle-particle interaction. The dimensionless equations of interaction in integral representation, four nonlinear ones for Crooke kinetics or six nonlinear ones for S-model kinetics, are solved by numerical iteration for boundary conditions of unperturbed flow at infinity and diffuse reflection by the outside container surface. The distribution function of discharged gas particles at the nozzle orifice is given. Author

N84-26918# Joint Publications Research Service, Arlington, Va.
METHOD OF CALCULATING STRONG VISCOUS INTERACTION AT DELTA WING Abstract Only

G. I. DUDIN and D. O. LYZHIN *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 25 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekh. Zhidk. i Gaza (Moscow), no. 4, Apr. 1983 p 119-124
Avail: NTIS HC A04/MF A01

A method of iteration is proposed for calculating the parameters of a three-dimensional boundary layer at the surface of a thin delta wing in a hypersonic stream of viscous gas. The model is a semi-infinite equilateral triangular plate oriented at a zero angle of attack, in a Cartesian system of coordinates with the origin at the vortex point and the x-axis as axis of symmetry. The equations of flow are reduced to a system of equations in two independent variables, through use of self-adjoint variables, with singularities of the flow function in the vicinity of the leading edges accounted for by means of similarity variables. The temperature dependence of dynamic viscosity is assumed to be linear and the Prandtl number appears as a characteristic parameter. The equation are solved by the shearing wedge method. At the beginning of each iteration is given the transverse pressure profile (z - or span coordinate) so that the pressure at both edges equals the pressure of the stream at corresponding points. Iteration proceeds according to the relaxation method, with directions varied to conform with changes in the propagation of perturbations through the backstream regions. The fields of flow functions are calculated which then yield the displacement thickness of the boundary layer. Iteration continues until the calculated pressure profile coincides with the initially stipulated one. Author

N84-26923# Joint Publications Research Service, Arlington, Va.
AERODYNAMICS OF HOVERING Abstract Only

A. A. ZAYTSEV and L. V. SHARINA *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 28 13 Apr. 1983 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 4, Apr. 1983 p 71-78
Avail: NTIS HC A04/MF A01

Hovering aerodynamics based on a three dimensional model of nonsteady flow past a pair of flapping wings in motionless air were analyzed. The house fly, whose flight characteristics and wing parameters are known was taken as an example. The kinetic model is supplemented with the theory of a supporting surface, with such a surface and the companion vortex sheet each described in a system of its two Lagrangian coordinates. The system of equations was solved numerically, with the flow function approximated by a bicubic spline in Lagrangian variables at discrete instants of time. The effects of kinematic factors on the wing aerodynamics are shown and it is indicated and the needed wing

parameters are indicated to ensure an adequate supporting force at a given flapping frequency. E.A.K.

N84-26925# Joint Publications Research Service, Arlington, Va.
EFFECT OF INJECTION INTO BOUNDARY LAYER ON FLOW OF SUPERSONIC STREAM PAST OSCILLATING CONE Abstract Only

Y. S. KORNIYENKO and V. N. SHMANENIKOV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 29 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 4, Apr. 1983 p 43-46
Avail: NTIS HC A04/MF A01

Interaction of a stream of ideal gas and a boundary layer for a supersonic stream and an acute cone oscillating about its zero angle of attack position were analyzed. The equations of a nonviscous gas were solved and a zero thickness of the boundary layer was assumed. The equations of a boundary layer are solved for the normal component of velocity at the outer edge of the laminar sublayer, whereupon the equations of an ideal gas are solved with the injection velocity at that edge set equal to that normal component. The cone is referred to as a Cartesian system of coordinates whose one axis coincides with the cone axis and to a spherical system of coordinates with the origin at the cone vertex. The equations of motion for a gas through the boundary layer at the surface of a cone oscillating with small amplitude are written in Blasius variables and the equations of state are solved by separation of variables with each sought function expressed in the form of a power series in the Strouhal number. The effect of gas injection on the damping of cone oscillations is evaluated for heating and sublimation of the cone material by a nonsteady thermal flux. It is indicated that a boundary layer decreases the damping when the injection rate is low, but increases it more than in the case of a nonviscous gas when the injection rate becomes sufficiently high. E.A.K.

N84-26933# Joint Publications Research Service, Arlington, Va.
SEPARATION FLOW AT CONCAVE CONICAL WINGS Abstract Only

V. V. KRAVETS and A. I. SHVETS *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 34-35 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 2, Feb. 1983 p 83-91
Avail: NTIS HC A04/MF A01

An experimental study of flow at conically concave delta wings was made, a particular concern being the pressure distribution and the lift force. Two sets of wing models with fixed sweepback angles, 73 deg (three models) and 78.7 deg (two models) respectively, were tested at a Mach number $M = 3$ in the supersonic wind tunnel at the Institute of Mechanics (Moscow State University). The angle of attack was varied from 0 to 15 deg. Taper and width of the concavity were defined by angles 17 deg, 17.5 deg, 18.5 deg, 11.3 deg, 11.7 deg and 90 deg, 102.5 deg, 113.5 deg, 90 deg, 108.5 deg. For control, a flat delta wing (taper angle 0 deg, width angle 180 deg) was added to each set. Pressure was measured with an inductive transducer through a pneumatic commutator switch, with an rms relative error of + or - 3%. The data reveal a positive pressure jump across the cavity, except in the vicinity of the leading edges. They also reveal a drop of total pressure in the wake behind wings with zero angle-of-attack orientation. The results are interpreted in terms of interaction of the density jump and the boundary layer near the edges, with attendant separation, and interaction of viscous and nonviscous streams outside the pressure jump. B.W.

N84-26949# Joint Publications Research Service, Arlington, Va.
EFFECT OF ELASTICALLY SUSPENDED MASSES ON STABILITY OF ELASTIC PANELS IN SUPERSONIC STREAM
 Abstract Only

V. V. BOLOTIN and B. P. SIMONOV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 46 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Tverdogo Tela (Moscow), no. 3, Mar. 1983 p 149-156
 Avail: NTIS HC A04/MF A01

The aerodynamic problem of stability was solved for a horizontal plane panel mounted into a perfectly rigid and infinitely large frame. Its top surface was swept by a supersonic stream occupying the upper half-space and flowing at an unperturbed velocity parallel to that surface. The panel was treated as a thin elastic plate deformable according to Kirchhoff's theory. Viscoelastic bodies were suspended from the panel in the lower half space at discrete points. The equation of vibrations for the panel was supplemented with one equation of motion for a suspended point-mass or with two equations of motion for a suspended line-mass. Integration of the flow function yielded the aerodynamic lift and drag coefficients. The linearized Cauchy-Lagrange integral yielded the perturbed pressure. Approximations of quasi-steady motion and steady motion were checked at moderate velocities of supersonic air flow and moderate frequencies of panel vibration. An analysis of panel stability on the basis of those equations and their solution revealed the effect of suspended masses. R.S.F.

N84-27663*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.

MEASURED TRANSONIC UNSTEADY PRESSURES ON AN ENERGY EFFICIENT TRANSPORT WING WITH OSCILLATING CONTROL SURFACES

F. W. CAZIER, JR., J. J. WATSON, R. V. DOGGETT, JR., M. C. SANDFORD, and R. H. RICKETTS *In its* Advan. Aerodyn.: Selected NASA Res. p 21-36 Dec. 1981 refs
 Avail: NTIS HC A05/MF A01 CSCL 01A

Highlight results are presented from subsonic and transonic pressure measurement studies conducted in the Langley Transonic Dynamics Tunnel on a supercritical wing model representative of an energy efficient transport design. Steady- and unsteady-pressure data were acquired on the upper and lower wing surface at an off-design Mach number of 0.60 and at the design Mach number of 0.78, for a Reynolds number of 2.2×10^6 (based on the wing average chord). The model configuration consisted of a sidewall-mounted half-body fuselage and a semi-span wing with an aspect ratio of 10.76, a leading-edge sweepback angle of 28.8 degrees, and supercritical airfoil sections. The wing is instrumented with 252 static pressure orifices and 164 dynamic pressure gages. Model test variables included wing angle of attack, control-surface mean deflection angle, control-surface oscillating deflection angle and frequency, and phasing between oscillating leading-edge and trailing-edge controls when used together. B.G.

N84-27665*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.

LANGLEY HIGH-LIFT RESEARCH ON A HIGH-ASPECT-RATIO SUPERCRITICAL WING CONFIGURATION

H. L. MORGAN, JR. and S. O. KJELGAARD *In its* Advan. Aerodyn.: Selected NASA Res. p 55-77 Dec. 1981 refs
 Avail: NTIS HC A05/MF A01 CSCL 01A

To determine the low speed performance characteristics of a representative high aspect ratio supercritical wing, two low speed jet transport models were fabricated. A 12-ft. span model was used for low Reynolds number tests in the Langley 4- by 7-Meter Tunnel and the second, a 7.5-ft. span model, was used for high Reynolds number tests in the Ames 12-foot Pressure Tunnel. A brief summary of the results of the tests of these two models is presented and comparisons are made between the data obtained on these two models and other similar models. Follow-on two and three dimensional research efforts related to the EET high-lift configurations are also presented and discussed. Author

N84-27674*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.
BIBLIOGRAPHY OF SUPERSONIC CRUISE RESEARCH (SCR) PROGRAM FROM 1980 TO 1983

S. HOFFMAN Jul. 1984 56 p
 (NASA-RP-1117; L-15740; NAS 1.61:1117) Avail: NTIS HC A04/MF A01 CSCL 01A

A bibliography for the Supersonic Cruise Research (SCR) and Variable Cycle Engine (VCE) Programs is presented. An annotated bibliography for the last 123 formal reports and a listing of titles for 44 articles and presentations is included. The studies identifies technologies for producing efficient supersonic commercial jet transports for cruise Mach numbers from 2.0 to 2.7. M.A.C.

N84-27675*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.

RECENT MODIFICATIONS AND CALIBRATION OF THE LANGLEY LOW-TURBULENCE PRESSURE TUNNEL

R. J. MCGHEE, W. D. BEASLEY, and J. M. FOSTER 1984 65 p refs
 (NASA-TP-2328; L-15728; NAS 1.60:2328) Avail: NTIS HC A04/MF A01 CSCL 01A

Modifications to the Langley Low-Turbulence Pressure Tunnel are presented and a calibration of the mean flow parameters in the test section is provided. Also included are the operational capability of the tunnel and typical test results for both single-element and multi-element airfoils. Modifications to the facility consisted of the following: replacement of the original cooling coils and antiturbulence screens and addition of a tunnel-shell heating system, a two dimensional model-support and force-balance system, a sidewall boundary layer control system, a remote-controlled survey apparatus, and a new data acquisition system. A calibration of the mean flow parameters in the test section was conducted over the complete operational range of the tunnel. The calibration included dynamic-pressure measurements, Mach number distributions, flow-angularity measurements, boundary-layer characteristics, and total-pressure profiles. In addition, test-section turbulence measurements made after the tunnel modifications have been included with these calibration data to show a comparison of existing turbulence levels with data obtained for the facility in 1941 with the original screen installation. M.G.

N84-27676*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.

EFFECT OF FUSELAGE UPWASH ON THE SUPERSONIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF 2 FIGHTER CONFIGURATIONS

R. M. WOOD and D. S. MILLER Jul. 1984 61 p refs
 (NASA-TP-2330; L-15758; NAS 1.60:2330) Avail: NTIS HC A04/MF A01 CSCL 01A

An experimental and theoretical investigation of fuselage incidence effects on two fighter aircraft models, which differed in wing planform only, has been conducted in the Langley Unitary Plan Wind Tunnel at Mach numbers of 1.6, 1.8, and 2.0. Results were obtained on the two models at fuselage incidence angles of 0 deg, 2 deg, and 5 deg. The fuselage geometry included two side-mounted, flow-through, half-axisymmetric inlets and twin vertical tails. The two planforms tested were cranked wings with 70 deg/66 deg and 70 deg/30 deg leading-edge sweep angles. Experimental data showed that fuselage incidence resulted in positive increments in configuration lift and pitching moment; most of the lift increment can be attributed to the fuselage-induced upwash acting on the wing and most of the pitching-moment increment is due to the fuselage. Theoretical analysis indicates that linear-theory methods can adequately predict the overall configuration forces and moments resulting from fuselage upwash, but a higher order surface-panel method (PAN AIR) more accurately predicted the distribution of forces and resulting moments between the components. Author

02 AERODYNAMICS

N84-27678*# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

COMPUTATION OF IMAGINARY-SIDE PRESSURE DISTRIBUTIONS OVER THE FLEXIBLE WALLS OF THE TEST SECTION INSERT FOR THE 0.3-M TRANSONIC CRYOGENIC TUNNEL Progress Report

M. J. GOODYER Jun. 1984 16 p
(Contract NAS1-16000)

(NASA-CR-172363; NAS 1.26:172363) Avail: NTIS HC A02/MF A01 CSCL 01A

Two dimensional airfoil testing in an adaptive wall test-section wind tunnel requires the computation of the imaginary flow fields extending outward from the top and bottom test section walls. A computer program was developed to compute the flow field which would be associated with an arbitrary test section wall shape. The program is based on incompressible flow theory with a Prandtl-Glauert compressibility correction. The program was validated by comparing the streamline and the pressure field generated by a source in uniform flow with the results from the computer program. A listing of the program, the validation test results, and a sample program are included. Author

N84-27679*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

UNCONVENTIONAL MISSILE CONCEPTS FROM CONSIDERATION OF VARIOUS MISSION REQUIREMENTS

M. L. SPEARMAN Jun. 1984 31 p refs

(NASA-TM-85829; NAS 1.15:85829) Avail: NTIS HC A03/MF A01 CSCL 01A

Missile concepts for volumetric efficiency, minimum carriage constraints, and aerodynamic performance to achieve mission requirements. The mission requirements considered include air to surface roles such as defense suppression or antishipping where payload and range may have priority over high maneuver capability, and air to air and surface to air roles paying attention to good maneuvering capability. The concepts are intended to provide for ease of storage or carriage. The concepts include monoplanes with highly swept, thick delta wings, highly swept delta wings mounted either high or low on a semicircular body, some ring wing and semiring wing arrangements, parasol wing, and elliptical lifting bodies. The missile configurations indicate possible approaches toward resolving problems of carriage and storage while retaining good volumetric and aerodynamic efficiency. The configurations can accomplish a variety of possible missions with relatively simple vehicle shapes. E.A.K.

N84-27680*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPLICATION OF SUPERCOMPUTERS TO COMPUTATIONAL AERODYNAMICS

V. L. PETERSON Jun. 1984 12 p refs Presented at the Summer Computer Simulation Conf., Boston, 23-25 Jul. 1984; sponsored by the Society for Computer Simulation Submitted for publication

(NASA-TM-85965; A-9762; NAS 1.15:85965) Avail: NTIS HC A02/MF A01 CSCL 01A

Computers are playing an increasingly important role in the field of aerodynamics such that they now serve as a major complement to wind tunnels in aerospace research and development. Factors pacing advances in computational aerodynamics are identified, including the amount of computational power required to take the next major step in the discipline. Example results obtained from the successively refined forms of the governing equations are discussed, both in the context of levels of computer power required and the degree to which they either further the frontiers of research or apply to problems of practical importance. Finally, the Numerical Aerodynamic Simulation (NAS) Program - with its 1988 target of achieving a sustained computational rate of 1 billion floating point operations per second and operating with a memory of 240 million words - is discussed in terms of its goals and its projected effect on the future of computational aerodynamics. Author

N84-27681*# Stanford Univ., Calif. Thermosciences Div.

AN ANALYSIS OF WAVE INTERACTIONS IN SWEEP-WING FLOWS Progress Report

H. L. REED Jul. 1984 61 p refs

(Contract NAG1-402)

(NASA-CR-173723; NAS 1.26:173723) Avail: NTIS HC A04/MF A01 CSCL 01A

Crossflow instabilities dominate disturbance growth in the leading-edge region of swept wings. Streamwise vortices in a boundary layer strongly influence the behavior of other disturbances. Amplification of crossflow vortices near the leading edge produces a residual spanwise nonuniformity in the mid-chord regions where Tollmien-Schlichting (T-S) waves are strongly amplified. Should the T-S wave undergo double-exponential growth because of this effect, the usual transition prediction methods would fail. The crossflow/Tollmien-Schlichting wave interaction was modeled as a secondary instability. The effects of suction are included, and different stability criteria are examined. The results are applied to laminar flow control wings characteristic of energy-efficient aircraft designs. Author

N84-27683*# Douglas Aircraft Co., Inc., Long Beach, Calif.

SELECTED ADVANCED AERODYNAMIC AND ACTIVE CONTROL CONCEPTS DEVELOPMENT Final Report

Washington NASA Oct. 1981 76 p refs

(Contract NAS1-14744)

(NASA-CR-3469; NAS 1.26:3469) Avail: NTIS HC A05/MF A01 CSCL 01A

A task for the Energy Efficient Transport program conducted: (1) The design and wind tunnel development of high-aspect-ratio supercritical wings, investigating the cruise speed regime and also high-lift. (2) The preliminary design and evaluation of an aircraft combining a high-aspect-ratio supercritical wing with a winglet. (3) Active Controls: The determination of criteria, configuration, and flying qualities associated with augmented longitudinal stability of a level likely to be acceptable for the next generation transport; and the design of a practical augmentation system. The baseline against which the work was performed and evaluated was the Douglas DC-X-200 twin engine derivative of the DC-10 transport. The supercritical wing development showed that the cruise and buffet requirements could be achieved and that the wing could be designed to realize a sizable advantage over today's technology. Important advances in high lift performance were shown. The design study of an aircraft with supercritical wing and winglet suggested advantages in weight and fuel economy could be realized. The study of augmented stability, conducted with the aid of a motion base simulator, concluded that a negative static margin was acceptable for the baseline unaugmented aircraft. B.W.

N84-27684*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

HIGH REYNOLDS NUMBER TESTS OF A BOEING BAC I AIRFOIL IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL

W. G. JOHNSON, JR., A. S. HILL, E. J. RAY, R. A. ROZENDAAL (Boeing Commercial Airplane Co., Seattle), and T. W. BUTLER (Boeing Commercial Airplane Co., Seattle) Apr. 1982 131 p refs

(NASA-TM-81922; L-15011; NAS 1.15:81922) Avail: NTIS HC A07/MF A01 CSCL 01A

A wind tunnel investigation of an advanced-technology airfoil was conducted in the Langley 0.3-Meter Transonic Cryogenic Tunnel (TCT). This investigation represents the first in a series of NASA/U.X. industry two dimensional airfoil studies to be completed in the Advanced Technology Airfoil Test program. Test temperature was varied from ambient to about 100 K at pressures ranging from about 1.2 to 6.0 atm. Mach number was varied from about 0.40 to 0.80. These variables provided a Reynolds number (based on airfoil chord) range from about .000044 to .00005. This investigation was specifically designed to: (1) test a Boeing advanced airfoil from low to flight-equivalent Reynolds numbers; (2) provide the industry participant (Boeing) with experience in cryogenic wind-tunnel model design and testing techniques; and

(3) demonstrate the suitability of the 0.3-m TCT as an airfoil test facility. All the objectives of the cooperative test were met. Data are included which demonstrate the effects of fixed transition, Mach number, and Reynolds number on the aerodynamic characteristics of the airfoil. Also included are remarks on the model design, the model structural integrity, and the overall test experience. Author

N84-27685*# Boeing Commercial Airplane Co., Seattle, Wash. Preliminary Design Dept.
NACELLE AERODYNAMIC AND INERTIAL LOADS (NAIL) PROJECT Final Technical Report
 Hampton, Va. NASA. Langley Research Center Apr. 1982 70 p refs
 (Contract NAS1-15325)
 (NASA-CR-165807; NAS 1.26:165807; D6-49360) Avail: NTIS HC A04/MF A01 CSCL 01A

A flight test survey of pressures measured on wing, pylon, and nacelle surfaces and of the operating loads on Boeing 747/Pratt & Whitney JT9D-7A nacelles was made to provide information on airflow patterns surrounding the propulsion system installations and to clarify processes responsible for inservice deterioration of fuel economy. Airloads at takeoff rotation were found to be larger than at any other normal service condition because of the combined effects of high angle of attack and high engine airflow. Inertial loads were smaller than previous estimates indicated. A procedure is given for estimating inlet airloads at low speeds and high angles of attack for any underwing high bypass ratio turbofan installation approximately resembling the one tested. Flight procedure modifications are suggested that may result in better fuel economy retention in service. Pressures were recorded on the core cowls and pylons of both engine installations and on adjacent wing surfaces for use in development of computer codes for analysis of installed propulsion system aerodynamic drag interference effects. A.R.H.

N84-27686*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
KC-135 WINGLET PROGRAM REVIEW
 Washington Jan. 1982 193 p refs Symp. held in Edwards, Calif., 16 Sep. 1981
 (NASA-CP-2211; H-1165; NAS 1.55:2211) Avail: NTIS HC A09/MF A01 CSCL 01A

The results of a joint NASA/USAF program to develop flight test winglets on a KC-135 aircraft are reviewed. The winglet development from concept through wind tunnel and flight tests is discussed. Predicted, wind tunnel, and flight test results are compared for the performance, loads and flutter characteristics of the winglets. The flight test winglets had a variable winglet cant and incidence angle capability which enabled a limited evaluation of the effects of these geometry changes.

N84-27687*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
KC-135 WINGLET PROGRAM OVERVIEW
 M. R. BARBER and D. SELEGAN (AFWAL, Wright-Patterson AFB, Ohio) *In its* KC-135 Winglet Program Rev. p 1-46 Jan. 1982 refs
 Avail: NTIS HC A09/MF A01 CSCL 01A

A joint NASA/USAF program was conducted to accomplish the following objectives: (1) evaluate the benefits that could be achieved from the application of winglets to KC-135 aircraft; and (2) determine the ability of wind tunnel tests and analytical analysis to predict winglet characteristics. The program included wind-tunnel development of a test winglet configuration; analytical predictions of the changes to the aircraft resulting from the application of the test winglet; and finally, flight tests of the developed configuration. Pressure distribution, loads, stability and control, buffet, fuel mileage, and flutter data were obtained to fulfill the objectives of the program. M.G.

N84-27688*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
KC-135 WING AND WINGLET FLIGHT PRESSURE DISTRIBUTIONS, LOADS, AND WING DEFLECTION RESULTS WITH SOME WIND TUNNEL COMPARISONS
 L. C. MONTOYA, P. JACOBS (NASA. Langley Research Center, Va.), S. FLECHNER (NASA. Langley Research Center, Va.), and R. SIMS *In its* KC-135 Winglet Program Rev. p 47-102 Jan. 1982 refs
 Avail: NTIS HC A09/MF A01 CSCL 01A

A full-scale winglet flight test on a KC-135 airplane with an upper winglet was conducted. Data were taken at Mach numbers from 0.70 to 0.82 at altitudes from 34,000 feet to 39,000 feet at stabilized flight conditions for wing/winglet configurations of basic wing tip, 15/-4 deg, 15/-2 deg, and 0/-4 deg winglet cant/incidence. An analysis of selected pressure distribution and data showed that with the basic wing tip, the flight and wind tunnel wing pressure distribution data showed good agreement. With winglets installed, the effects on the wing pressure distribution were mainly near the tip. Also, the flight and wind tunnel winglet pressure distributions had some significant differences primarily due to the oilcanning in flight. However, in general, the agreement was good. For the winglet cant and incidence configuration presented, the incidence had the largest effect on the winglet pressure distributions. The incremental flight wing deflection data showed that the semispan wind tunnel model did a reasonable job of simulating the aeroelastic effects at the wing tip. The flight loads data showed good agreement with predictions at the design point and also substantiated the predicted structural penalty (load increase) of the 15 deg cant/-2 deg incidence winglet configuration. M.G.

N84-27689*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
IN-FLIGHT LIFT AND DRAG MEASUREMENTS ON A FIRST GENERATION JET TRANSPORT EQUIPPED WITH WINGLETS
 D. P. LUX *In its* KC-135 Winglet Program Rev. p 103-116 Jan. 1982 refs
 Avail: NTIS HC A09/MF A01 CSCL 01A

A KC-135A aircraft equipped with wing tip winglets was flight tested to demonstrate and validate the potential performance gain of the winglet concept as predicted from analytical and wind tunnel data. Flight data were obtained at cruise conditions for Mach numbers of 0.70, 0.75, and 0.80 at a nominal altitude of 36,000 ft. and winglet configurations of 15 deg cant/-4 deg incidence, 0 deg cant/-4 deg incidence, and baseline. For the Mach numbers tested the data show that the addition of winglets did not affect the lifting characteristics of the wing. However, both winglet configurations showed a drag reduction over the baseline configuration, with the best winglet configuration being the 15 deg cant/-4 deg incidence configuration. This drag reduction due to winglets also increased with increasing lift coefficient. It was also shown that a small difference exists between the 15 deg cant/-4 deg incidence flight and wind tunnel predicted data. This difference was attributed to the pillowing of the winglet skins in flight which would decrease the winglet performance. M.G.

N84-27691*# Boeing Military Airplane Development, Seattle, Wash.
COMPARISON OF FLIGHT MEASURED, PREDICTED AND WIND TUNNEL MEASURED WINGLET CHARACTERISTICS ON A KC-135 AIRCRAFT
 R. O. DODSON, JR. *In* NASA. Dryden Flight Research Facility KC-135 Winglet Program Rev. p 145-170 Dec. 1982 refs
 Avail: NTIS HC A09/MF A01 CSCL 01A

One of the objectives of the KC-135 Winglet Flight Research and Demonstration Program was to obtain experimental flight test data to verify the theoretical and wind tunnel winglet aerodynamic performance prediction methods. Good agreement between analytical, wind tunnel and flight test performance was obtained when the known differences between the tests and analyses were accounted for. The flight test measured fuel mileage improvements for a 0.78 Mach number was 3.1 percent at 8×10^5 pounds W/delta and 5.5 percent at 1.05×10^6 pounds W/delta. Correcting

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the flight measured data for surface pressure differences between wind tunnel and flight resulted in a fuel mileage improvement of 4.4 percent at 8 x 10(5) pounds W/delta and 7.2 percent at 1.05 x 10(6) pounds W/delta. The performance improvement obtained was within the wind tunnel test data obtained from two different wind tunnel models. The buffet boundary data obtained for the baseline configuration was in good agreement with previous established data. Buffet data for the 15 deg cant/-4 deg incidence configuration showed a slight improvement, while the 15 deg cant/-2 deg incidence and 0 deg cant/-4 deg incidence data showed a slight deterioration. Author

N84-27692*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
KC-135A WINGLET FLIGHT FLUTTER PROGRAM
M. W. KEHOE /n NASA. Dryden Flight Research Facility KC-135 Winglet Program Rev. p 171-188 Dec. 1982 refs
Avail: NTIS HC A09/MF A01 CSCL 01A

The evaluation techniques, results and conclusions for the flight flutter testing conducted on a KC-135A airplane configured with and without winglets are discussed. Test results are presented for the critical symmetric and antisymmetric modes for a fuel distribution that consisted of 10,000 pounds in each wing main tank and empty reserve tanks. The results indicated that a lightly damped oscillation was experienced for a winglet configuration of a 0 deg cant and -4 deg incidence. The effects of cant and incidence angle variation on the critical modes are also discussed. Lightly damped oscillations were not encountered for any other winglet cant and incidence angles tested. M.G.

N84-27693*# General Dynamics Corp., Fort Worth, Tex.
STUDY OF AERODYNAMIC TECHNOLOGY FOR SINGLE-CRUISE-ENGINE VSTOL FIGHTER/ATTACK AIRCRAFT, PHASE 1 Final Report, Jun. 1981 - Feb. 1982
W. H. FOLEY, A. E. SHERIDAN, and C. W. SMITH Feb. 1982 170 p refs Sponsored in part by Naval Ship Research and Development Center and Naval Air Systems Command (Contract NAS2-11000)
(NASA-CR-166268; NAS 1.26:166268) Avail: NTIS HC A08/MF A01 CSCL 01A

A conceptual design and analysis on a single engine VSTOL fighter/attack aircraft is completed. The aircraft combines a NASA/deHavilland ejector with vectored thrust and is capable of accomplishing the mission and point performance of type Specification 169, and a flight demonstrator could be built with an existing F101/DFE engine. The aerodynamic, aero/propulsive, and propulsive uncertainties are identified, and a wind tunnel program is proposed to address those uncertainties associated with wing borne flight. M.A.C.

N84-27694*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TWO-DIMENSIONAL AERODYNAMIC CHARACTERISTICS OF AN AIRFOIL DESIGNED FOR TWO
G. J. BINGHAM (Army Aviation Research and Development Command, St. Louis), K. W. NOONAN (Army Aviation Research and Development Command, St. Louis), and W. G. SEWALL Dec. 1981 79 p refs
(Contract DA PROJ. 1L1-61102-AH-45)
(NASA-TP-1965; L-14825; NAS 1.60:1965; AVRADCOM-TR-81-B-6) Avail: NTIS HC A05/MF A01 CSCL 01A

An airfoil designed for helicopter rotor application is investigated. The airfoil is designed to increase maximum normal force coefficient while maintaining favorable drag divergence and pitching moment characteristics. Two modifications are also tested. Maximum normal force coefficient varies from 1.14 to 0.90 at Mach numbers from about 0.35 to 0.65. Both modifications decreased drag coefficient at zero normal force coefficient for Mach numbers near drag divergence, but were less beneficial at a normal force coefficient of -0.2. M.A.C.

N84-27695*# Kansas Univ. Center for Research, Inc., Lawrence.

THE INVESTIGATION OF A VARIABLE CAMBER BLADE LIFT CONTROL FOR HELICOPTER ROTOR SYSTEMS
A. O. AWANI Jan. 1982 130 p refs
(Contract NCC-292)
(NASA-CR-3505; NAS 1.26:3505) Avail: NTIS HC A07/MF A01 CSCL 01A

A new rotor configuration called the variable camber rotor was investigated numerically for its potential to reduce helicopter control loads and improve hover performance. This rotor differs from a conventional rotor in that it incorporates a deflectable 50% chord trailing edge flap to control rotor lift, and a non-feathering (fixed) forward portion. Lift control is achieved by linking the blade flap to a conventional swashplate mechanism; therefore, it is pilot action to the flap deflection that controls rotor lift and tip path plane tilt. This report presents the aerodynamic characteristics of the flapped and unflapped airfoils, evaluations of aerodynamics techniques to minimize flap hinge moment, comparative hover rotor performance and the physical concepts of the blade motion and rotor control. All the results presented herein are based on numerical analyses. The assessment of payoff for the total configuration in comparison with a conventional blade, having the same physical characteristics as an H-34 helicopter rotor blade was examined for hover only. B.W.

N84-27696*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
XSECT: A COMPUTER CODE FOR GENERATING FUSELAGE CROSS SECTIONS - USER'S MANUAL
K. R. AMES Feb. 1982 65 p refs
(NASA-TM-83218; NAS 1.15:83218) Avail: NTIS HC A04/MF A01 CSCL 01A

A computer code, XSECT, has been developed to generate fuselage cross sections from a given area distribution and wing definition. The cross sections are generated to match the wing definition while conforming to the area requirement. An iterative procedure is used to generate each cross section. Fuselage area balancing may be included in this procedure if desired. The code is intended as an aid for engineers who must first design a wing under certain aerodynamic constraints and then design a fuselage for the wing such that the constraints remain satisfied. This report contains the information necessary for accessing and executing the code, which is written in FORTRAN to execute on the Cyber 170 series computers (NOS operating system) and produces graphical output for a Tektronix 4014 CRT. The LRC graphics software is used in combination with the interface between this software and the PLOT 10 software. Author

N84-27698*# Boeing Military Airplane Development, Seattle, Wash.

PAN AIR: A COMPUTER PROGRAM FOR PREDICTING SUBSONIC OR SUPERSONIC LINEAR POTENTIAL FLOWS ABOUT ARBITRARY CONFIGURATIONS USING A HIGH ORDER PANEL METHOD. VOLUME 2: USER'S MANUAL (VERSION 1.1) Final Report, Jan. 1978 - May 1980
K. W. SIDWELL, P. K. BARUAH, and J. E. BUSSOLETTI Washington NASA 30 Nov. 1981 704 p refs Sponsored in part by AFWAL, ASD and Naval Coastal Systems Center 2 Vol. (Contract NAS2-9830)
(NASA-CR-3252; NAS 1.26:3252; D180-24910-2) Avail: NTIS HC A99/MF A01 CSCL 01A

A comprehensive description of user problem definition for the PAN AIR (Panel Aerodynamics) system is given. The PAN AIR system solves the three dimensional linear integral equations of subsonic and supersonic flow. Influence coefficient methods are used which employ source and doublet panels as boundary surfaces. Both analysis and design boundary conditions can be used. The information needed to use the PAN AIR system is described. The structure and organization of PAN AIR are described, including the job control and module execution control languages for execution of the program system. The engineering

input data are described, including the mathematical and physical modeling requirements. M.A.C.

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AIR TRANSPORTATION AND SAFETY

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

N84-27699# Ballistic Research Labs., Aberdeen Proving Ground, Md.

BASE PRESSURE MEASUREMENTS ON A PROJECTILE SHAPE AT MACH NUMBERS FROM 0.91 TO 1.20 Final Report

L. D. KAYSER Apr. 1984 34 p
(Contract DA PROJ. 1L1-62618-AH-80)
(AD-A141341; AD-E300423; ARBRL-MR-03353) Avail: NTIS HC A03/MF A01 CSCL 19A

Base pressure measurements were obtained on an axisymmetric projectile shape with and without a boattail. The tests were conducted in a transonic wind tunnel at Mach numbers of 0.91, 0.94, 0.96, 0.98, 1.10, and 1.20. Data were obtained at angles of attack of 0, 2, 3, 6, and 10 degrees and at circumferential positions around the model in 22.5 degree increments. Results were presented in both graphical and tabular form. GRA

N84-27700# Naples Univ. (Italy). Ist. di Tecnica dell Costruzioni.

AERODYNAMIC INSTABILITY OF CABLE-STAYED BRIDGES: THEORETICAL EXPERIMENTAL STUDY OF STALL FLUTTER [INSTABILITA' AERODINAMICA DEI PONTI STRALLATI DI GRANDE LUCE: STUDIO TEORICO-SPERIMENTALE DELLO STALL FLUTTER]

M. COMO, L. LECCE, F. MARULO, and L. PAGNINI Oct. 1983 35 p refs In ITALIAN
Avail: NTIS HC A03/MF A01

A mathematical model of continuous cable stayed bridges is developed. The relative velocity for torsional or stall flutter in nonsteady aerodynamic conditions is estimated. Wind tunnel experiments were carried out to verify the model predictions. The preliminary results obtained with three types of thin airfoil bridge models confirm the validity of the proposed model. The experimental technique was adjusted using a NACA 0016 profile, for which the stall flutter started at + or - 10 deg at 12 m/sec wind velocity, while the predicted value is 12.4 m/sec.

Author (ESA)

N84-27701# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flaechenflugzeuge.

FLIGHT MECHANICS TEST WITH A RESTRICTED FLYING AIRCRAFT MODEL IN A WIND TUNNEL Ph.D. Thesis - Technische University, Brunswick

H. SUBKE Dec. 1983 156 p refs In GERMAN; ENGLISH summary Original will also be announced as translation (ESA-TT-885)
(DFVLR-FB-84-13; ESA-TT-885) Avail: NTIS HC A08/MF A01; DFVLR, Cologne DM 45

A wind tunnel test of a dynamically scaled aircraft model equipped with sensors and actuators is presented. The dynamic response was compared with the result of a computer simulation. A good correlation is obtained after adjustment of the dynamic derivatives. The natural dynamic behavior of the model was changed in order to simulate different aircraft in different missions.

Author (ESA)

A84-36942

DEREGULATION AND COMMUTER AIRLINE SAFETY

C. V. OSTER, JR. and C. K. ZORN (Indiana University, Bloomington, IN) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 49, no. 2, 1984, p. 315-335. refs

The effect of the 1978 Airline Deregulation Act on the level of safety in the commuter airline industry is examined. Through a comparison of the safety records of different segments of the commuter industry with that of the major jet carriers, the question of whether the growing role of commuter airlines is inconsistent with the goal of maintaining air safety is analyzed. As part of the analysis, the safety performance of the commuter industry between 1970 and 1980 is examined with a focus on systematic differences among major subsets of the industry. It is concluded that, in general, the safety record of domestic commuter airlines has not been affected by deregulation, and that it is virtually identical to the superior safety record of the larger jet carriers. Moreover, the introduction of the next generation of turbine-powered commuter aircraft should contribute to improved commuter safety due to the small carriers' ability to operate turbine-powered aircraft much more safely than piston aircraft. I.H.

A84-36943

RECOMMENDATIONS FOR COPING WITH MICROBURST WIND SHEAR - AN AVIATION HAZARD

J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 49, no. 2, 1984, p. 337-359. refs

Progress made during the Joint Airport Weather Studies (JAWS) project in the identification, description, and detection of low-altitude microburst wind shear is examined in detail. The inadequacy of current microburst wind shear detection and control techniques is illustrated in a table listing the 27 aircraft accidents and incidents directly attributed to the wind shear phenomenon in the last 20 years. Recommendations are made as to how to improve the techniques by which wind shear is detected and how to cope with it in flight. Among these are: increasing pilot and aircraft controller awareness regarding the serious nature of low-altitude wind-shear, improving the sensitivity of Low-Level Wind Shear Alert Systems (LLWSAS) by increasing station density and by enhancing the capability of the centerfield sensor, and the development of terminal Doppler radar systems based on pulsed microwaves which could be capable of detecting wind shear in all known conditions several miles ahead of an aircraft. I.H.

A84-37924#

SKYSHIP DEMONSTRATION BETWEEN PARIS AIRPORTS

N. RAZAVI (Airship Industries, Paris, France) Airship, Dec. 1983, p. 10-16.

The viability of commuter airship service between Roissy and Orly airports in France is investigated. The aspects of the service that are considered include the technical aspects, the economic and commercial aspects, and the political and psychological aspects. Fly-overs between Roissy and Orly were made by the British Skyship 500. Average traveling time between the destinations was estimated between 20 and 25 minutes, and turnaround time was 5 minutes at each end. The service was considered commercially viable on the basis of the number of requests to fly on the airship (2000) in relation to the number of seats (20). Because of the possibility of delays, an open-schedule system of tourist flights was preferred to a fixed-schedule commuter service. Customer anxiety about the safety of the operation was considered insignificant. I.H.

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A84-37925#

AIRSHIP REQUIREMENTS FOR THE US SERVICES

R. A. K. CRABTREE (Aircraft and Armament Experimental Establishment, Boscombe Down, England) *Airship*, Dec. 1983, p. 16-23.

Following a brief review of the historical importance of LTA aircraft to the U.S. Navy, operational requirements for a fleet of modern airships are discussed with respect to a variety of different roles. Estimates are made of airship capabilities in the areas of heavy-lift transport, antisubmarine warfare barrier operations, towed-array surveillance operations, airborne early warning, mine sweeping operations, and off-shore patrol of the 200 nm economic zone. Both rigid and non-rigid LTA aircraft are considered, and the natural advantages of LTA over fixed-wing aircraft and helicopters are taken into account. These advantages include longer time on station, greater cruising ranges, and small IR and look-down radar signatures. I.H.

A84-37935*# Ohio State Univ., Columbus.

EFFECT OF GEOMETRY ON AIRFOIL ICING CHARACTERISTICS

M. B. BRAGG (Ohio State University, Columbus, OH) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 505-511. refs (Contract NAG3-28)

A droplet trajectory computer code is used to predict the water droplet impingement characteristics of several low- and medium-speed airfoils. The maximum impingement efficiency, total collection efficiency, and limits of impingement are analyzed as functions of the airfoil geometry and freestream conditions. The airfoil geometry is represented by leading edge radius, maximum thickness, maximum camber, and angle of attack. The analysis shows that the primary effects are an increase in maximum impingement efficiency with a decrease in leading edge radius, a reduction in total collection efficiency for thicker airfoils, and a change in the limits of impingement for airfoils of different maximum camber. Author

A84-37936#

NONLINEAR FINITE ELEMENT METHOD IN CRASHWORTHINESS ANALYSIS OF AIRCRAFT SEATS

A. O. BOLUKBASI (Simula, Inc., Tempe, AZ) and D. H. LAANANEN (Arizona State University, Tempe, AZ) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 448-456) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 512-519. Sponsorship: U.S. Department of Transportation. refs (Contract DOT-FA03-80-C-00098)

Previously cited in issue 12, p. 1699, Accession no. A83-29855

A84-37939#

THERMODYNAMIC PERFORMANCE OF AN AIRPLANE WING LEADING EDGE ANTI-ICING SYSTEM

R. ROSS (Ross Aviation Associates, Sedgwick, KS) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, July 1984, p. 536, 537.

Previously cited in issue 15, p. 2352, Accession no. A82-31871

A84-38289

DEVELOPMENT OF RELAY BALLOON SYSTEM

H. HIROSAWA, S. OHTA, and H. AKIYAMA (Tokyo, University, Tokyo, Japan) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 1201-1205.

A relay balloon system for long-duration or large-area observations is described. The relay link between a relay balloon and a balloon for observations (named a main balloon) consists of VHF band. The position of a main balloon is determined by using the Omega signal. In 1979, the relay balloon was applied to the observation of electric power fields (50 and 60 Hz) over the Pacific Ocean. The maximum distance between the relay balloon and the main balloon reached about 1100 km. The final position

of the main balloon was about 1300 km eastwards of the Sanriku Balloon Center. Author

A84-38290

BALLOON ACTIVITIES IN INDONESIA

J. SOEGIJO and T. S. TATANG (Indonesian National Institute of Aeronautics and Space, Bondung, Indonesia) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 1207-1216. refs

Balloon launching calculation theory, the atmospheric conditions over Java, and a balloon tracking and recovery system are discussed. Formulas are presented for the ascent force and the equilibrium level, taking into account the expansion of the balloon with altitude and temperature changes of the gas. The pressure and atmospheric density over Java are modeled to 40 km altitude. Operational parameters of the tracking and telecommand transmitter/receivers are provided, as are functional details of the destruction unit which releases a knife to tear the balloon at 400 mb. Plans for long duration equatorial flights are being considered. M.S.K.

A84-38291

SCIENTIFIC BALLOON IN CHINA

Y.-T. ZHANG (Chinese Academy of Sciences, Institute of Atmospheric Physics, Beijing, People's Republic of China) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 1217-1220.

The development and state-of-the-art of scientific balloon flights in China are summarized. Balloon launches are usually scheduled for the end of May and beginning of September, when winds above 22 km are easterly and westerly, respectively, and the velocity averages 10 mps. The polyethylene balloons carry telemetry, remote control apparatus, radios, attitude control, and ranging systems. Applications thus far have been gamma ray observation, measurement of the low-energy gamma rays from PSR 0531 + 21 and studies of primary cosmic ray nuclei. Improvements are in progress for the pointing system, reliability, and sun-sensor attitude control. M.S.K.

A84-38292

METEOROLOGICAL FEASIBILITY OF TRANSPACIFIC BALLOONS AND RELATED PROBLEMS

M. FUJII, J. NISHIMURA, and H. HIROSAWA (Tokyo, University, Tokyo, Japan) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 1221-1225.

Balloon trajectory analyses were made on the basis of past meteorological data to find the success rate of the transpacific balloon flight. It was found that the October to November time period is the most favorable for flights at 5 and 2 mb. The success rate of North American landfall of balloons launched in Japan increases substantially if the launching date selected satisfies some restricted conditions. Author

A84-38293

FEASIBILITY STUDIES ON TRANS-OCEANIC FLIGHTS FROM JAPAN

J. NISHIMURA, H. AKIYAMA (Tokyo, University, Tokyo, Japan), and M. D. YAMANAKA IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 1227-1232. refs

The meteorological feasibility of the long duration flights from Japan to China with an aid of trans-oceanic flights is studied. The balloon trajectory could be extended up to 1000-2000 km. Wind data at 15-5 mb over the East China Sea are analyzed, taking into account two feasible cases: (1) launching from Kyushu Island in May, September or October, observation durations are expected to be 20-55 hours; (2) launching from Ogasawara Islands in July, durations of 15-25 hours can be achieved. In the latter case, with launching from Kyushu, observation durations are too short with

only 10 hours or so. In respect of telecommand-telemetry coverage ranges, the first case is considered to be more practical. However, in point of meridional deviation of landfall, the mid-summer case is rather reliable. For safety of successful flights, wind forecasting methods are also considered, and in May a diurnal wave of 1000 km in zonal wavelength is found. Author

A84-38879#

A STUDY ON THE POSSIBILITY OF STONE INGESTION INTO THE ENGINE INLETS OF JET AIRCRAFT

A. L. BOEHMAN IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings . New York, American Institute of Aeronautics and Astronautics, 1984, p. 2-5-1 to 2-5-5.

Theoretical and experimental results of a study on the possibility of small stones being ingested by the inlet of jet aircraft engines are presented. In principle, small stones lying on a runway could be flipped by the nose wheel landing gear into the airstream feeding the aircraft engines. In spite of the strong airstreams around the inlets, the results found thus far indicated that the number of stones actually ingested by the inlets is small due to a large downward component of velocity near the nose wheel. Computer simulations using potential flow theory show a relatively small capture rate for inlets, and this result is confirmed experimentally by actual testing on a United States Air Force F-4E Phantom jet aircraft. Author

A84-39085

AIRCRAFT ACCIDENT INVESTIGATION - WHOSE INTEREST PREVAILS?

L. BARRON Air Law (ISSN 0165-2079), vol. 9, no. 2, 1984, p. 87-92.

The conflict of interest between the goal of objective aircraft-accident investigation (without assignment of blame) and the right of injured passengers or survivors to sue for damages is discussed, and proposals to overcome it are considered. The governmental-compensation scheme being used in New Zealand and the unlimited-liability/insurance plan (channeled through the air carriers) proposed by Cheng (1980) are both found to fulfill the need for a separation of investigation and compensation, but are deemed impractical (for global coverage) under present political conditions. A pooled commercial insurance plan in which carriers, manufacturers, and all other potential defendants would participate and which governments would agree to back up in the event of a major disaster is proposed. The insurance would provide automatic compensation with unlimited liability regardless of the cause of the accident. D.G.

A84-39280*# Wichita State Univ., Kans.

FLIGHT AND WIND TUNNEL TESTS OF AN ELECTRO-IMPULSE DE-ICING SYSTEM

G. W. ZUMWALT (Wichita State University, Wichita, KS) and A. A. MUELLER (Cessna Aircraft Co., Wichita, KS) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 26-36. Research supported by the Kansas State Advance Technology Commission. refs (Contract NAG3-284) (AIAA PAPER 84-2234)

A joint University-Industry project has been sponsored by NASA Lewis Research Center to develop the Electro-Impulse method for de-icing aircraft. The program has consisted of basic analyses, laboratory testing, icing tunnel tests, and flight tests. During the past two years, the EIDI system has been tested and refined, and has been shown to be a low-energy, highly reliable de-icing system for a wide range of conditions. This paper gives a brief review of conditions. This paper gives a brief review of the basic principles, the development history, and results of recent flight tests by NASA and by Cessna Aircraft Company. Author

A84-39281*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CHARACTERISTICS OF LIGHTNING STRIKES EXPERIENCED BY THE NASA F-106B AIRPLANE

B. D. FISHER (NASA, Langley Research Center, Hampton, VA), V. MAZUR (Oklahoma, University, Norman, OK), J. A. PLUMER (Lightning Technologies, Inc., Pittsfield, MA), and J. C. GERLACH (NASA, Wallops Flight Center, Wallops Island, VA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers . New York, American Institute of Aeronautics and Astronautics, 1984, p. 37-48. refs

Thunderstorm penetrations were made during the 1980-1983 thunderstorm seasons by a NASA F-106B instrumented research aircraft in order to record lightning strike data and associated flight conditions. In 1980 and 1981, 10 direct lightning hits were received each year, with most penetrations occurring near the freezing level. In 1982 and 1983, a ground-based UHF-band radar was used to guide this aircraft through the upper, electrically active regions of thunderstorms (at altitudes above 6 km, corresponding to temperatures of less than -20 C), and 370 direct hits were recorded. The results of analyses of the radar, photographic, and surface inspection data are presented. The highest risk of lightning strike in the upper portions of a thundercloud occurred in regions where the ambient temperature was -40 to -50 C. Lightning strikes appear to be triggered by the aircraft. O.C.

A84-39701

THE DESTRUCTION OF THE KAL 007 (KE 007) - HOW DID IT HAPPEN?

F. MACHADO (Institut du Transport Aerien, Paris, France) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 5-14.

Some technical issues arising from the ICAO investigation of the destruction of Korean Airlines flight KE 007 are discussed. Reports by both ICAO and the USSR Air Defense authorities are used to reconstruct the sequence of events which led up to the tragedy on August 31, 1983. Several different reasons why KAL 007 could have deviated from its preassigned route are eliminated because they seemed improbable, including intentional illegal incursion into Soviet airspace, crew incapacity, deliberate action by the crew to save fuel, and serious system failures affecting the avionics or airborne navigation systems. The ICAO committee considered the most probable scenario to involve an uncorrected data-insertion error affecting one of the aircraft's onboard Internal Navigation Systems (INS) . A three-tiered strategy is proposed involving the policy, legal and technical fields in order to avoid similar tragedies in the future. I.H.

A84-39705

PAST AND FUTURE IN AIR SAFETY

J. LEDERER International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 35-39.

A review of the history and future of innovations in air safety is presented. Attention is given improvements made since the earliest years of the Air Mail delivery system when one in six pilots was killed in flight accidents. The possibility of improving air safety in the future is also considered, and recent progress in addressing a number of unresolved safety problems is assessed. Among the safety problems discussed are: in-flight and post-crash fire; heavy rain showers at landing; windshear; terrorism; collisions and drug abuse among pilots. It is expected that continuing progress in the automation of aircraft systems and participative management schemes in the airline industry will maximize aircraft safety in the years to come. I.H.

A84-39708

THE LAST 500 FEET

J. LAMING International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 51-54.

The causes and prevention of aircraft accidents occurring during the last 500 feet of descent in VOR, NDB, or category-1 ILS landings are examined. A review of accident reports reveals that the required standard callouts by the pilot not flying (PNF) of

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deviations from programmed airspeed, descent rate, or other instrument readings indicating that the approach has become unstabilized were often not made. Several reports are summarized, and the phenomenon of runway fixation (when the PNF and pilot both watch for visual cues through the cockpit window and ignore the instruments) is considered as a possible cause for neglecting the callout procedures. Strict adherence to a reasonable system (with required callouts at 500 and 200 ft) is recommended. T.K.

A84-39709

A REVIEW OF UK REGISTERED HELICOPTER DITCHINGS IN THE NORTH SEA

D. J. ANTON (RAF, Institute of Aviation Medicine, Farnborough, Hants., England) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 55-63.

A84-39710

TWIN ENGINED COMMERCIAL OPERATIONS

H. M. VERMEULEN International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 69-71.

The problem of redundancy requirements for two-engine commercial jet aircraft is examined from a pilot's perspective. The aim of the current ICAO requirement (that an aircraft with two engines be operated within 90 min cruising time of an airfield suitable for an emergency landing if one engine should fail) is to provide an alternative equivalent to real redundancy (in this case a third engine). It is argued that the technical sophistication of current aircraft imposes additional redundancy requirements, since proper operation of the new types of equipment is necessary to make a safe landing. Comments on the (limited) role of pilots in the formulation and legislation of regulations are included. T.K.

A84-39711

FUEL CONTAMINATION - MORE TO IT THAN A LITTLE WATER

H. J. WILKERSON and M. W. MILLIGAN (Tennessee, University, Knoxville, TN) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 72-75.

The problem of Jet-A turbine-fuel contamination of fuel for piston aviation engines is discussed. This type of contamination can lead to detonation (knock) followed by preignition and loss of power and destruction of the engine, and the presence of the colorless Jet-A fuel in the mixture is not detectable by visual inspection or by smell. In addition to increased precautions in ordering fuel, providing tank-opening labels, and observing the fueling process personally, a finger test and a paper test for oily residues after the fuel has evaporated are recommended. T.K.

A84-39713

KEY FACTORS DETERMINING BIRDSTRIKE AND RISKS

S. BUURMA (Royal Netherlands Air Force, The Hague, Netherlands) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 91-107. refs

An attempt is made to identify the factors which are of greatest importance in the compilation and analysis of birdstrike statistics, thereby serving as the primary parameters for determinations of birdstrike rates and risks. Birdstrikes are sorted by altitude, aircraft speed, and bird weight. Attention is given to Dutch Air Force birdstrike data for 1965-1976 and 1977-1982. The pronounced difference between military and civil birdstrike problems, with the former being far more aggravated, illustrates the influence of flying altitude on birdstrike rate. Civil airliners climb quickly above the 'bird layer', while military aircraft are forced for operational reasons to cruise at increasingly lower altitudes. About 75 percent of all collisions between birds and aircraft have occurred in the lowest 100 m. O.C.

N84-26597# Space Ordnance Systems, Inc., Saugus, Calif. PYROTECHNIC CLEAR PATH EGRESS SYSTEM FOR THE T-38 TRAINER AIRCRAFT

S. PHILLIPS /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 2-24 Dec. 1983
(AD-P003184) Avail: NTIS HC A08/MF A01 CSCL 01C

Training for low altitude flying has resulted in the need to upgrade windshield and forward canopy structures to eliminate bird impact related injuries. The existing canopy and structure provides little protection against impact on a four pound bird at 400 knots. The primary T-38 egress system using ballistic gas for canopy jettison is compatible with the bird resistant canopy requirement. However, the backup modes are incompatible. In these modes the seat/man ejects through the canopy for in-flight egress, with ground egress achieved by piercing the canopy with a weighted blade. This incompatibility has created the need for a safe, reliable pyrotechnic backup system for incorporation with the thicker, stronger bird resistant canopy requirement. However, the backup modes are incompatible. In these modes the seat/man ejects through the canopy for in-flight egress, with ground egress achieved by piercing the canopy with a weighted blade. This incompatibility has created the need for a safe, reliable pyrotechnic backup system for incorporation with the thicker, stronger bird resistant canopy. GRA

N84-26602# PPG Industries, Inc., Pittsburgh, Pa. Glass Research Center.

T-38 STUDENT WINDSHIELD BIRDPROOFING EFFORTS UTILIZING METAL AND COMPOSITE MATERIALS FOR AFT ARCH REINFORCEMENT

J. M. SCHLUETER /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 108-133 Dec. 1983
(AD-P003189) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper provides a review of the T-38 arch reinforcement as it relates to the T-38 Birdproofing Program. Due to the increase in low level training missions in the T-38 aircraft, there exists a need for an improved transparency system capable of withstanding a four (4) pound bird impact at 400 knots. The existing student windshield frame is made of cast magnesium alloy (AS9LC-T6) and is neither strong enough nor stiff enough to support a windshield or canopy during the bird resistant transparency system for the T-38. As a result, three methods of reinforcing the frame are under consideration: (1) a three piece metal casting, (2) a continuous composite, and (3) a continuous machined or stretched formed high strength metal reinforcement. GRA

N84-26608# Materials Research Labs., Melbourne (Australia). SERVICE-LIFE INDUCED FAILURE OF BIRD IMPACT RESISTANT WINDSHIELDS

P. J. BURCHILL and R. H. STACEWICZ /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 238-259 Dec. 1983

(AD-P003195) Avail: NTIS HC A08/MF A01 CSCL 01C

Bird-impact resistant transparencies (BIRT), which are laminates of modified poly(methylmethacrylate), polycarbonate and a rubbery interlayer, have been fitted to all Royal Australian Air Force F111C aircraft. However, their service-life has often been severely limited by factors other than bird-impact, and in one instance was as little as 30 flying hours for an alternate design bird-impact resistant transparency (ADBIRT) windshield. Unserviceability has arisen due to cracks, crazes, delamination, optical distortions or scratches; the most critical are cracks and crazes. All failed first generation windshields (BIRT) examined showed crazing of the inner acrylic layer, while 60% of them had serious crazing of the outer acrylic layer, and in 35% this layer was cracked. With ADBIRT windshields all failures examined were crazed, while some were cracked or showed delamination. The shapes of the crazes seen on these windshields show that the stresses involved in their formation and growth are complex. GRA

N84-26627# Civil Aviation Authority, Redhill (England).
Airworthiness Div.

CIVIL AIRCRAFT WINDSCREEN DAMAGE DUE TO BIRDSTRIKES

J. THORPE *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 658-676 Dec. 1983
(AD-P003214) Avail: NTIS HC A08/MF A01 CSCL 01C

Brief details are presented of all known cases world wide of penetration of civil aircraft windshields. The information is divided into: (1) transport aircraft (piston engine aircraft are excluded), (2) twin engined general aviation aeroplanes, (3) single engined aeroplanes, and (4) helicopters. Windshield design requirement criteria are summarized. Examination of the data shows that penetration of transport aircraft windshields is extremely rare and damage to the outer pane is very rare (in Europe one per 1.5 million flying hours). There would appear to be little justification for a change in the current 1.8 Kg (4 lb) bird design requirement. There have been three fatal windshield penetrations on twin engined general aviation aircraft and six cases of injury. Many of the birds were large. The trend towards single pilot operations carrying a significant number of passengers (up to 22) may suggest a need for windshield design requirements, even though the rate of penetration is not high. GRA

N84-26628# Air Force Engineering and Services Center, Tyndall AFB, Fla.

USAF AIRCRAFT WINDSHIELD/CANOPY BIRD STRIKES

R. C. KULL *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 677-689 Dec. 1983
(AD-P003215) Avail: NTIS HC A08/MF A01 CSCL 01C

The United States Air Force loses millions of dollars due to bird strikes each year. The most serious damage to the aircraft and injury to the pilot occurs when birds penetrate the windshield/canopy system. The Air Force Bird/Aircraft Strike Hazard (BASH) Team has recorded over 1000 bird strikes on windshields and canopies since 1975. With this extensive amount of data, trends have been found relating to the types of aircraft, phases of flight, and types of birds most vulnerable to being involved in a serious windshield/canopy strike. This report discusses these trends, as well as the types of birds encountered and focuses on F-4 and F-16 weapon systems. GRA

N84-26629# Royal Netherlands Air Force, Volkel.
INCREASING BIRDSTRIKE RATES AND IMPROVED BIRDSTRIKE ANALYSIS OF THE ROYAL NETHERLANDS AIR FORCE

L. S. BUURMA *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 690-715 Dec. 1983
(AD-P003216) Avail: NTIS HC A08/MF A01 CSCL 01C

An increasing concern about the birdstrike risk did not prevent some Western European countries, like The Netherlands, from being faced with an increasing birdstrike problem. The primary aim of the paper is to show why birdstrike statistics to a varying extent fail to produce a realistic picture of the birdstrike risk. Several type of biases will be described. The problems can be reduced by improving reporting standard and, especially, by taking microscopic examination of minuscule bird remains as a routine procedure. The most important result is a substantial growth of data on the species and weight distribution of birds struck en route. In the case of high but normal jet fighter cruising speeds 80% of all two-pound birds involved in birdstrikes appear to have caused damage. GRA

N84-26630# Saab-Scania, Linkoping (Sweden). Aerospace Div.
INVESTIGATIONS CONCERNING IMPROVEMENTS OF THE SAAB 37 WINDSHIELD BIRDSTRIKE RESISTANCE

B. P. FONDEN and K. I. PERSSON *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 717-729 Dec. 1983
(AD-P003217) Avail: NTIS HC A08/MF A01 CSCL 01C

In 1980 some tests at Holloman AFB indicated that the windshield had less resistance than previously anticipated. Further birdgun tests were started in Sweden. A method for accurate

measuring of windshield deflections using high speed cameras was also developed. Beside establishing the protection level given by the serial windshield, the tests also made clear that the windshield might rupture below its undisturbed strength, if the bird impact made it deflect to contact with underlaying equipment. The head-up display was the main but not the only such equipment. Also birdspray entering the cockpit between the deflected windshield and the canopy was a major problem. The study now concentrated on establishing the probabilities of aircraft losses due to birdstrikes. Calculations were performed both regarding overall loss rates and risk levels for individual aircraft versus speed. The calculations specially dealt with the improvements that could be gained by a number of proposed modifications and the safety levels achieved. GRA

N84-26631# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

BIRD IMPACT EVALUATION OF THE F/RF-4 TRANSPARENCY SYSTEM

R. SIMMONS and G. J. STENGER *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 730-755 Dec. 1983
(AD-P003218) Avail: NTIS HC A08/MF A01 CSCL 01C

Birdstrikes to the crew enclosures of USAF F/RF-4 aircraft have resulted in major aircraft damages coupled with severe/fatal pilot injuries. Analysis of operational bird impact statistical data indicates that the trend of damaging bird impacts on the F-4 is continuing to rise. Impacts to the F-4 transparency system also continue to rise resulting in a continued flight safety risk to the aircraft and the aircrew. The Air Force Wright Aeronautical Laboratory, Improved Windshield Protection Office has initiated a program to develop a transparency system for the F-4 aircraft which has four pound, 500 knot bird impact capability. The first step in this program was to experimentally determine the existing transparency system capability by bird impact testing full scale flight hardware. Eight impact locations on the windshield and forward canopy were tested to failure with four pound birds. Tests on experimental, laminated windshield side panels were also conducted to investigate the capability of the windshield frame. The baseline birdstrike test results are presented through the use of post test photographs and an impact capability diagram. GRA

N84-26648# IFM Akustibyran A.B., Stockholm (Sweden).
THEORETICAL EVALUATION OF THE STRUCTURAL PERFORMANCE OF SWEDISH FIGHTER AIRCRAFT WINDSHIELDS SUBJECTED TO BIRD IMPACT

L. A. SAMUELSON, F. NILSSON, and L. SORNAS *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 1096-1131 Dec. 1983
(AD-P003235) Avail: NTIS HC A08/MF A01 CSCL 01C

High velocity bird impact characteristics were studied theoretically and the critical velocity, windshield deflection, birdraulics and associated phenomena in Swedish fighter aircraft were predicted. The investigation was carried out for the Swedish Air Force in close cooperation with the Saab Scania Aerospace Co. and the results were used to optimize the test program and to propose design improvements for existing crew enclosures. GRA

N84-26676 British Aerospace Aircraft Group, Kingston-upon-Thames (England).

VORTEX LIFTED STONE INGESTION: THE INFLUENCE OF STONE DIAMETER

C. L. BORE 19 Apr. 1983 6 p refs
(BAE-KRS-N-GEN-276) Avail: Issuing Activity

Stone ingestion during aircraft engine run up is discussed. Mathematical relationships devised for experimental scaling rules are extended to cover the variations in height of stone trajectory with varying diameter. According to the formulas smaller stones can be thrown higher than large stones, but the variation is not very sensitive. Results accord with experiments. Author (ESA)

03 AIR TRANSPORTATION AND SAFETY

N84-26677 Royal Aircraft Establishment, Farnborough (England).
NOTE ON AN ACCIDENT TO THE BOULTON PAUL 120 VT 951 DELTA AIRCRAFT
W. BRAUN Mar. 1953 12 p
(RAE-STRUCT-ACC-248; RAE-STRUCTS-A4/11183/WB) Avail: NTIS HC A02

The port elevon of the Prototype Boulton Paul Delta Aircraft 120, VT 951 broke off in flight. The cause of the detachment was flutter involving the elevon-tab or the wing-elevon-tab. Examination of the wreckage shows a lack of stiffness in the tab control mechanism. Author (ESA)

N84-26678 Royal Aircraft Establishment, Farnborough (England).
NOTE ON THE STRUCTURAL FAILURE OF HANDLEY PAGE 88 (E6/48) VX.330
A. J. ALMOND Jul. 1952 22 p
(RAE-STRUCT-ACC-245; RAE-STRUCTS-A4/11129/AJA/109) Avail: NTIS HC A02

The Handley Page 88 prototype (E6/48) crashed following structural failure in the air. The aircraft disintegrated in level, or shallow diving, flight at low altitude and subsonic speed. Examination of the wreckage suggests that primary failure occurred in the fuselage. This failure is attributed to pitching oscillations. Author (ESA)

N84-26679*# Battelle Columbus Labs., Mountain View, Calif.
CLEARED FOR THE VISUAL APPROACH: HUMAN FACTOR PROBLEMS IN AIR CARRIER OPERATIONS
W. P. MONAN Sep. 1983 39 p refs
(Contract NAS2-10060)
(NASA-CR-166573; NAS 1.26:166573) Avail: NTIS HC A03/MF A01 CSCL 01C

The study described herein, a set of 353 ASRS reports of unique aviation occurrences significantly involving visual approaches was examined to identify hazards and pitfalls embedded in the visual approach procedure and to consider operational practices that might help avoid future mishaps. Analysis of the report set identified nine aspects of the visual approach procedure that appeared to be predisposing conditions for inducing or exacerbating the effects of operational errors by flight crew members or controllers. Predisposing conditions, errors, and operational consequences of the errors are discussed. In a summary, operational policies that might mitigate the problems are examined. Author

N84-26680# Federal Aviation Agency, Atlantic City, N.J.
EVALUATION OF AN IMPROVED FLAME RESISTANT AIRCRAFT WINDOW SYSTEM Final Report
G. B. GEYER and C. H. URBAN May 1984 62 p refs
(FAA-CT-83-10) Avail: NTIS HC A04/MF A01

A series of representative fire modeling experiments of aircraft cabin window systems are conducted employing salvaged segments of a McDonnell Douglas DC 10 aircraft. Experiments are performed in which a thermally improved window system is installed adjacent to a standard window configuration and exposed to flame impingement. The thermally improved DC 10 window configuration, employing the stretched acrylic pressure pane and the EX 112 fail safe pane, provides an overall improvement in flame resistivity over the standard all acrylic window system of 79 seconds. The silicone rubber window gasket provides adequate thermal and mechanical stability toward preventing flame penetration into the cabin through the improved window system for 225 seconds. An improvement in fire resistivity of 51 seconds is obtained by the improved window configuration over the standard stretched acrylic window system. Comparative tests performed with representative DC 10 fuselage components employing the cabin interior honeycomb panel and the aluminum panel configurations, show that the honeycomb panel provides a minimum improvement in flame resistivity of 67 seconds over the aluminum interior panel. M.A.C.

N84-26681# Electra Mfg. Co., Independence, Kans.
AIRCRAFT SEAT FIRE BLOCKING LAYERS. EFFECTIVENESS AND BENEFITS UNDER VARIOUS SCENARIOS Final Report
R. G. HILL, L. J. BROWN, L. SPEITEL, G. R. JOHNSON, and C. SARKOS Feb. 1984 165 p
(AD-A140796; FAA-CT-83-43) Avail: NTIS HC A08/MF A01 CSCL 01B

Full-scale tests were conducted utilizing the C133 test article located in the Full-Scale Fire Test Facility to determine the benefits that could be derived from fire blocking aircraft passenger seats. Various fire scenarios were selected and tests conducted to evaluate the effectiveness of various blocking materials. The scenarios selected fell into three broad classifications, post-crash, inflight, and ramp type fires. Test results indicate that the use of a fire-blocking material could increase survivable evacuation time during a post-crash fire that enters a fuselage through a break in the cabin, by as much as 50 percent. Tests also indicate that in-flight and ramp type fires that could destroy the aircraft with present seating materials, could be controlled with the use of a fire-blocking material. Author (GRA)

N84-26682# Aeronautical Research Labs., Melbourne (Australia).
PROPOSED CRASHWORTHINESS REQUIREMENTS FOR THE AUSTRALIAN BASIC TRAINER
S. R. SARRAILHE Oct. 1983 41 p
(AD-A140850; ARL-STRUC-TM-366) Avail: NTIS HC A03/MF A01 CSCL 01C

A proposal for the crashworthiness requirements for the Basic Trainer was prepared by ARL in response to a request from the RAAF. The requirements, which are based on existing standards, together with some subsequent interpretations and recommendations are collated in this technical memorandum. Author (GRA)

N84-27673 Joint Publications Research Service, Arlington, Va.
IL-76 USED SUCCESSFULLY FOR ARCTIC CARGO AIR DROPS
V. TAMARIN *In its* USSR Rept.: Transportation (JPRS-UTR-84-005) p 20-24 2 Mar. 1984 Transl. into ENGLISH from Vozdushnyy Transport (Moscow), 15 Dec. 1983 p 4
Avail: NTIS HC A05

The feasibility of using the soviet IL 76 transport aircraft for cargo air drops was examined. Air drops were successfully carried out at low altitudes in the arctic region. The IL 76 aircraft was found to be well suited for air drops in the polar regions. B.W.

N84-27702# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
MCCAULEY AVIATION, INC. MITSUBISHI MU-2B, N72B NEAR JEFFERSONVILLE, GEORGIA, MARCH 24, 1983 AIRCRAFT ACCIDENT REPORT
21 Feb. 1984 18 p refs
(PB84-910401; NTSB/AAR-84/01) Avail: NTIS HC A02/MF A01

At 0236 eastern standard time on March 24, 1983, McCauley Flight 354, a Mitsubishi MU-2B, N72B, operated as a scheduled air taxi cargo flight from Jacksonville, Florida, to Atlanta, Georgia, by McCauley Aviation, Inc., Pine Bluff, Arkansas, crashed into a wooded area 5 nautical miles south of Jeffersonville, Georgia, killing the pilot and his three nonrevenue passengers. In the area of the crash there were light rain showers with ceilings of 2,000 feet and the surface visibility was 5 miles. The clouds extended to above 17,000 feet. The National Transportation Safety Board determines that the probable cause of this accident was the uncontrolled descent of the airplane for undetermined reasons and the overstress and breakup of the airplane during an attempted recovery by the pilot. Author

N84-27705# Service Techniques des Programmes Aeronautiques, Paris (France).

PROTECTION EQUIPMENT AGAINST HIGH VELOCITY EJECTIONS [EQUIPEMENTS DE PROTECTION CONTRE LES EJECTIONS A GRANDES VITESSES]

M. PONSAR 4 Apr. 1984 55 p refs In FRENCH (STPA/CIN-6) Avail: NTIS HC A04/MF A01

The forces acting on the pilot when ejected from a high velocity aircraft and the accidents which may result are analyzed. A program of protection equipment development is defined. The possible evolution of the ejection system and of the protection devices are discussed. Author (ESA)

N84-27706# Research Inst. of National Defence, Stockholm (Sweden). Dept. 3.

ANALYSIS OF INCIDENTS DURING HELICOPTER MISSIONS

A. CARLSTROEM Apr. 1984 29 p refs (FOA-C-53016-H2; ISSN-0347-7665) Avail: NTIS HC A03/MF A01

In order to identify critical situations during helicopter missions, incident reports from army pilots for a 5 yr period were analyzed. An empirical study in which helicopter pilots reported incidents with regard to causes and degree of risk was carried out. Results show errors to be most common during preflight procedures, tactical missions, and landing. The most common errors are procedure errors, faulty judgements of observations, and shortcomings in exterior supervision. The dominating main cause is disturbance of the pilot. Author (ESA)

N84-27707# Research Inst. of National Defence, Stockholm (Sweden). Dept. 5.

CORRELATIONS BETWEEN INCIDENTS DURING HELICOPTER MISSIONS AND BACKGROUND VARIABLES AND MOODS

A. CARLSTROEM Apr. 1984 30 p refs (FOA-C-53017-H2; ISSN-0347-7665) Avail: NTIS HC A03/MF A01

Correlations between background variables (e.g., flight experience and age, and moods and ambition before flight) and incidents during flight missions were assessed during 180 helicopter missions. Results show that one group of pilots with relatively short and one group with very long flight experience were affected by significantly more incidents than the group with medium flight experience. Relaxation shows a positive and activity a negative correlation with incidents. No correlation between age and incidents is found. Author (ESA)

N84-27708# Research Inst. of National Defence, Stockholm (Sweden). Dept. 5.

PARACHUTING IN NIGHT CONDITIONS

C. SPANGBERG, O. TILLHAGEN, and C. BJURQVIST Apr. 1984 12 p refs In SWEDISH; ENGLISH summary (FOA-C-59010-H1; ISSN-0347-7665) Avail: NTIS HC A02/MF A01

Parachute jumps in night conditions in very cold weather were made by three parachutists from an altitude of 2000 m, falling to 600 m using a drag chute. Night parachuting is comparable with parachuting in poor visibility. The main problems in night conditions are lack of exterior references and the difficulty estimating present altitude. Author (ESA)

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A84-36914

ANALYSIS AND DESIGN CONSIDERATIONS OF HARD LIMITERS FOR LF AND VLF NAVIAID RECEIVERS

C. JOOSSE (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands) and D. VAN WILLIGEN (Delft, Technische Hogeschool, Delft, Netherlands) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 267-278. refs

Hard limiters, followed by a D-type flip-flop as a digital-signal-polarity detector, are very effective receiver/phase detectors for low frequency (LF) and very low frequency (VLF) navigation receivers. However, the performance not only depends on the signal quality, but also on the specifications of the hard limiter and the flip-flop. Analysis of the tracking accuracy is given as a function of the dc offsets of the limiter and the flip-flop, the linear gain of the limiter, the signal-to-noise ratios of one or more input signals, and the power consumption of the limiter. The results are presented in formulas and graphs for application by circuit designers. A design example of a low-power, high-gain limiter is given. Author

A84-36915

THE DEVELOPMENT OF AIRBORNE PULSE DOPPLER RADAR

L. C. PERKINS (Boeing Co., Seattle, WA), H. B. SMITH, and D. H. MOONEY (Westinghouse Electric Corp., Baltimore, MD) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 292-303. refs

A development history is presented for pulse Doppler radar devices, whose invention dates back to the Bomarc missile seeker-radar project, launched in 1949. Attention is given to the principles of pulse Doppler operation, as well as to the design features and operational capabilities of such systems as 'airborne intercept' X-band and C-band radars employing the pulse Doppler effect. Both the U.S. Navy and Air Force were instrumental in the development of these radars, one of whose most recent examples is the F-16 fighter's AN/APG-66. O.C.

A84-37037

FROM 1950 TO THE YEAR 2000 - THE DYNAMICS OF AERONAUTICAL INERTIAL NAVIGATION SYSTEMS [DES ANNEES 1950 AL'AN 2000 - LA DYNAMIQUE DE L'INERTIE EN AERONAUTIQUE]

M. LLORET (Societed'Applications Generales d'Electriciteet de Mecanique, Paris, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 143, 144, 147, 148. In French.

Milestones in the development and utilization of inertial navigation systems for aircraft are traced and projections made of near-term technology advances. The most modern systems are laser gyros used on the 757 and 767 aircraft. Dynamic suspension gyroscopes currently experience the most widespread use due to 1 m/s accuracy with little noise. Improvements in accuracy by factors of 2.5-3 are foreseen with new manufacturing techniques. Increased vibration resistance and reduction of size by one-half will encourage military acceptance of laser gyros. Electric suspension gyroscopes, used on the B-52 bomber, are already accurate to 0.1 Nm/hr and 0.3 m/s, tolerances that are design goals for laser gyros. M.S.K.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

A84-37038

VOICE CONTROL ON MILITARY AIRCRAFT [LA COMMANDE VOCALE SUR AVION D'ARMES]

J.-M. MELOCCO (Crouzet, S.A., Valence, Drome, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 151-154, 158. In French.

Progress in introducing voice controls and annunciators in military aircraft to reduce the pilot workload is explored. French work in cockpit voice capability began in 1978 and concentrated initially on calling up data displays. The Mirage III was equipped with a voice annunciator that alerted the pilot to abnormal system functions. The voice was produced completely artificially. Pilot voices were then investigated in simulated conditions of altitudes, vibrations, and accelerations to encode sufficient recognizance programs for on-board computers to understand 100-200 pilot spoken word commands. In the most current system, the pilot must pronounce each command word before flying so that the computer will recognize his voice. Commands can then call up flight status data, select radio frequencies, and engage or disengage the autopilot. M.S.K.

A84-38123* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

BROAD-BAND HALF-WAVE DIPOLE

M. C. BAILEY (NASA, Langley Research Center, Hampton, VA) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-32, April 1984, p. 410-412.

A fan-dipole or bowtie element operating over a ground plane has been empirically designed to maximize the impedance bandwidth near the half-wavelength resonance. It is shown that a bandwidth of 37 percent can be achieved with a simple bowtie element less than a half-wavelength at the center frequency. This design could be useful as a radiating element in a wide-band phased array application or as a wide-band reflector feed or cavity-backed dipole. C.D.

A84-38124#

A COMPACT FLUSH-MOUNTING ANTENNA WITH DIRECTION FINDING AND STEERABLE CARDIOID PATTERN CAPABILITY

H. P. COLEMAN and B. D. WRIGHT (U.S. Navy, Naval Research Laboratory, Washington, DC) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-32, April 1984, p. 412-414. refs

A flush-mounting antenna is described which could be used, in lieu of present antennas, to provide direction finding and steerable directional pattern capability in airborne beacon transponder systems. The antenna is comparable in size to the existing, omni-directional antennas presently used for air-traffic control and military identification, friend or foe (IFF) functions. The design and performance of an experimental model of the antenna are discussed. Author

A84-38756

COMPLEX RADIO DIRECTION FINDER WITH ELECTRONIC STABILIZATION OF THE DIRECTIVITY DIAGRAM [KOMPLEKSNIY RADIOPELENGATOR S ELEKTRONNOI STABILIZATSIEI DIAGRAMMY NAPRAVLENNOSTI]

A. S. BOGACHEV Radiotekhnika (ISSN 0033-8486), May 1984, p. 37-41. In Russian. refs

The Markov theory of optimal nonlinear filtering in the first-order Gaussian approximation is used to synthesize, in analog and digital versions, a quasi-optimal complex onboard radio direction finder with electronic stabilization of the antenna-array directivity diagram. It is shown that the application of the proposed processing algorithm is most suitable for direction finders with arrays having a narrow diagram, since in many cases it is impossible to implement the tracking mode without additional information about the angular position of the flight vehicle. B.J.

A84-39282*# Honeywell Systems and Research Center, Minneapolis, Minn.

APPLICATION OF SPEECH RECOGNITION AND SYNTHESIS IN THE GENERAL AVIATION COCKPIT

R. A. NORTH, S. J. MOUNTFORD (Honeywell Systems and Research Center, Minneapolis, MN), and H. BERGERON (NASA, Langley Research Center, Hampton, VA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 49-54. refs (AIAA PAPER 84-2239)

Interactive speech recognition/synthesis technology is assessed as a method for the alleviation of single-pilot IFR flight workloads. Attention was given during this series of evaluations to the conditions typical of general aviation twin-engine aircraft cockpits, covering several commonly encountered IFR flight condition scenarios. The most beneficial speech command tasks are noted to be in the data retrieval domain, which would allow the pilot access to uplinked data, checklists, and performance charts. Data entry tasks also appear to benefit from this technology. O.C.

A84-39288#

STATUS REPORT ON THE MODERNIZATION OF THE ATC SYSTEM

H. A. VERSTYNEN, JR. (FAA, Hampton, VA) American Institute of Aeronautics and Astronautics and NASA, General Aviation Technology Conference, Hampton, VA, July 10-12, 1984. 7 p. (AIAA PAPER 84-2235)

A development status assessment is made of the U.S. National Airspace System (NAS) modernization program undertaken by the FAA. This program entails the consolidation of terminal and en route facilities into Area Control Facilities, and the networking of radar data from multiple sensors, in order to give the best representation to individual controllers and improve controller access to centralized, real time weather data. The implementation of the Advanced Automation System in 1989 will provide new controller work stations and additional capacity for the accommodation of much higher levels of ATC automation. Attention is given to the status of the Mode S/Data Link, Flight Service Station Automation, and Microwave Landing System elements of the improved NAS. O.C.

N84-26685*# Research Triangle Inst., Research Triangle Park, N.C. Center for Systems Engineering.

EFFECTS OF AIRCRAFT AND FLIGHT PARAMETERS ON ENERGY-EFFICIENT PROFILE DESCENTS IN TIME-BASED METERED TRAFFIC

F. R. DEJARNETTE Jun. 1984 72 p refs

(Contract NAS1-17023)

(NASA-CR-172338; NAS 1.26:172338; RTI/2467) Avail: NTIS HC A04/MF A01 CSCL 17G

Concepts to save fuel while preserving airport capacity by combining time based metering with profile descent procedures were developed. A computer algorithm is developed to provide the flight crew with the information needed to fly from an entry fix to a metering fix and arrive there at a predetermined time, altitude, and airspeed. The flight from the metering fix to an aim point near the airport was calculated. The flight path is divided into several descent and deceleration segments. Descents are performed at constant Mach numbers or calibrated airspeed, whereas decelerations occur at constant altitude. The time and distance associated with each segment are calculated from point mass equations of motion for a clean configuration with idle thrust. Wind and nonstandard atmospheric properties have a large effect on the flight path. It is found that uncertainty in the descent Mach number has a large effect on the predicted flight time. Of the possible combinations of Mach number and calibrated airspeed for a descent, only small changes were observed in the fuel consumed. E.A.K.

N84-26689# Arinc Research Corp., Annapolis, Md.
EVALUATION OF STRATEGIES TO ENHANCE DEPARTURE SEQUENCING Final Report
 D. TILLOTSON and K. MARKIN Mar. 1984 53 p
 (Contract DTFA01-80-C-10030)
 (AD-A140710; REPT-1378-11-9-3244; DOT/FAA/ES-84/1) Avail:
 NTIS HC A04/MF A01 CSCL 17G

This report assesses a departure enhancement strategy that will reduce the delays caused by the departure sequence of a series of aircraft. Data were collected at three airports to characterize the existing delays caused by the first come, first served departure sequencing strategy. The data were then used to define a simple alternative departure sequencing strategy. The alternative strategy was evaluated to determine the benefits available from departure resequencing. The evaluations indicate that possible reductions in fuel usage and possible increases in airport capacity could be achieved. However, the estimated benefits are not of sufficient magnitude to recommend implementation of the proposed strategy. Author (GRA)

N84-26690# Electronic Systems Div., Hanscom AFB, Mass.
AN/TPN-19 IMPROVEMENTS PROGRAM MANAGEMENT PLAN
 Feb. 1984 60 p
 (AD-A140728) Avail: NTIS HC A04/MF A01 CSCL 17G

The purpose of the AN/TPN-19 Landing Control Central (LCC) is to provide a modern, reliable, air transportable terminal area radar air traffic control system to perform effectively under conditions of heavy precipitation and high traffic density in support of world wide tactical operations. The AN/TPN-19 program resulted in the procurement of 11 systems: two prototypes refurbished to production configuration, and nine production units. The present program directs Air Force Systems Command (AFSC) to initiate a program to improve the operational effectiveness of the AN/TPN-19 LCC. Air Force logistics command (AFLC) is designated supporting command, Air Force communications command (AFCC) the operating command and Air Force operational test and evaluation center (AFOTEC) and Air training command (ATC) the participating commands. GRA

N84-26692# National Oceanic and Atmospheric Administration, Miami, Fla. Office of Aircraft Operations.
STUDY OF NOAA (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION) WP-3D TERMINAL NAVIGATION ERRORS BASED ON NAVIGATORS LOGBOOKS: 1977-1983
 F. J. MERCERET Dec. 1983 68 p refs
 (PB84-155738; NOAA/TM/OAO-2; NOAA-84020701) Avail:
 NTIS HC A04/MF A01 CSCL 17G

Terminal errors in position and ground speed as recorded in navigator's logbooks from the NOAA WP-3D aircraft are examined statistically. The effects of Omega aiding of the Inertial Navigation Equipment (INE) and the effects of mission length are determined. The behavior of particular units identified by serial number is examined along with secular trends in navigation accuracy. Author (GRA)

N84-27716# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Kreiselgetraete und Traegheitsnavigation.
REGRESSION ANALYSIS TECHNIQUE FOR AIR DATA SENSOR CALIBRATION WITH AN INERTIAL NAVIGATION SYSTEM
 H. J. HOTOP Jan. 1984 72 p refs In DUTCH; ENGLISH summary Original will also be announced as translation (ESA-TT-886)
 (DFVLR-MITT-84-03; ESA-TT-886) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 25

Error models for the calculation of air data sensor errors and of the wind using a pitot static system or a flight log for the true airspeed are described. Ground speed was based on an inertial navigation system. The different models were evaluated by regression analysis methods. Flight tests produce an estimated airspeed error of 3%. A comparison with external data from a weather bureau results in a mean difference of + or - 2 m/sec

and the 2 chosen flight tests produce an air speed error of 5%.
 Author (ESA)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A84-36524
WIND TUNNEL TEST OF A SOFT/STIFF INPLANE BEARINGLESS ROTOR

D. BANERJEE, R. A. JOHNSTON, and R. H. MESSINGER (Hughes Helicopters, Inc., Culver City, CA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, April 1984, p. 52-60. refs

A unique Composite Flexbeam Tail Rotor (CFTR) has been developed at Hughes Helicopters, Inc. for the AH-64, Advanced Attack Helicopter. The full scale rotor has been successfully tested in the wind tunnel over the full steady sideslip envelope of the AH-64. The test program has defined the performance, loads, and dynamic characteristics of the CFTR for rotor speeds up to 100 percent N(R) and airspeeds up to 197 knots. The complete impressed pitch range, as limited by test stand capabilities or rotor structural requirements, has been investigated in hover, low and high speed forward flight and sideslip conditions. Static sideslip limits as defined in the AH-64 System Specification have been investigated at airspeeds of 139, 164, and 197 knots. The wind tunnel tests have confirmed that the CFTR is aeroelastically stable, has excellent dynamic characteristics, and exhibits acceptable loads. Author

A84-36554#
SUPERSONIC MISSILE AERODYNAMIC AND PERFORMANCE RELATIONSHIPS FOR LONG-RANGE MISSION PROFILES

R. J. KRIEGER (McDonnell Douglas Astronautics Co., St. Louis, MO) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, May-June 1984, p. 234-240. refs

Previously cited in issue 19, p. 2977, Accession no. A82-39085

A84-36793#
EJECTION LAUNCHERS KICK MISSILES AWAY SAFELY

R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 36-38.

The conformal carriage of missiles and bombs promises significant stores drag reductions for tactical aircraft, but requires the use of an ejection launcher to push a missile away from the aircraft before its ignition. Safe separation may call for translational velocities of 25 ft/s and pitch rates of 80 deg/s, which require 30-40 g accelerations. The LAU-92 ejection launcher that is to be used for the AMRAAM missile uses a shotgun-like cartridge, loaded into a breech that feeds ejector pistons through tubes, to achieve these performance levels. Attention is given to the possibility of aircraft upper surface ejectors. O.C.

A84-36796#
B-1B - DESIGNING FOR SUPPORTABILITY

R. H. GULCHER (Rockwell International Corp., El Segundo, CA) Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 54-56.

Supportability, defined as the ability to maintain an aircraft at maximum readiness, was emphasized during the B-1B development program because this aircraft is to operate from austere bases with limited ground support and minimum maintenance manhours/flight hours. The B-1B's Central Integrated Test System (CITS) continually monitors the health of all essential aircraft systems, supplying equipment failure data to the crew during flight. The CITS can also be used for ground maintenance operations,

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such as the management of operation tests' equipment cooling. Attention is given to the supportability of aircraft software. O.C.

A84-36797*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPOSITES FOR LARGE TRANSPORTS - FACING THE CHALLENGE

H. L. BOHON and J. G. DAVIS, JR. (NASA, Langley Research Center, Hampton, VA) Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 58-62. refs

NASA has undertaken development and test programs in collaboration with the large transport aircraft construction industry, in order to remove existing barriers to the use of composite material primary structures and to assess their advantages in terms of both acquisition cost and mission performance. These programs are expected to reach design technology readiness for wing and fuselage structures by 1988, paving the way for the validation of design and manufacturing methods in the early 1990s. While composites promise a reduction in fuselage manufacturing costs, it is judged that the relative cost of a metallic wing will be more difficult to surpass. Nevertheless, a 40 percent wing weight saving may more than compensate for increased wing structure cost.

O.C.

A84-36906

THE EVOLVING REVOLUTIONARY ALL-ELECTRIC AIRPLANE

J. D. ENGELLAND (General Dynamics Corp., Fort Worth, TX) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 217-220.

The 'all-electric airplane' is described as it would apply to a military fighter. Emphasis is placed on implementation issues, on the mutual influence between all-electric and airframe design, and on the cost of ownership. It finishes with a projection of what an all-electric airplane might actually be like. Author

A84-36907

DIGITAL ELECTRONIC FLIGHT DECKS - THE OUTLOOK FOR COMMERCIAL AVIATION

C. W. CLAY (Boeing Commercial Airplane Co., Seattle, WA) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 221-226.

Digital avionics are increasingly able to reduce overall commercial airliner costs through their great reliability and flexibility of operation. Attention is presently given to the development of modular control units for fly-by-wire and power-by-wire directional controls and engine throttle controls, as well as the design features of a network of multisystem digital data buses which can be developed to manage the complex interchange of data among interrelated digital systems throughout an aircraft. O.C.

A84-36908#

FLIGHT SAFETY ISSUES OF AN ALL-ELECTRIC AIRCRAFT

J. J. TREACY (FAA, Seattle, WA) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 227-233.

In an 'all-electric' aircraft, components that were formerly mechanical, hydraulic and pneumatic will be replaced by electrical and electronic systems that will raise flight safety questions regarding flight control system reliability, protection from EM interference and lightning, and the ability to resist the effects of design errors and of system failures in flight. The most frequently expected design errors are in computer system software; system failures during flight are exacerbated by design practices assuming active electronic control of aircraft which dispense with traditional aerodynamic stability safety margins. O.C.

A84-36909

THE ALL-ELECTRIC FIGHTER AIRPLANE FLIGHT CONTROL ISSUES, CAPABILITIES, AND PROJECTIONS

J. B. LEONARD (Grumman Aerospace Corp., Bethpage, NY) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 234-242. Navy-supported research. refs

All-electric aircraft must possess an electrical power system as reliable as the hydraulic power system it supplants, together with electromechanical flight control actuators that are as effective as hydraulic ones. It is also required that redundant electromechanical actuation systems (EMASs) be designed to equal the flight safety reliability of dual tandem hydraulic actuators, and that satisfactory solutions be found for the problem posed by the need to dissipate the heat generated in electromechanical actuators and controllers. All-electric aircraft will be equipped with fly-by-wire control systems for which reliable power sources have already been developed. EMAS performance is demonstrably superior to that of hydraulic actuators. Heat dissipation system development is currently underway. O.C.

A84-36910#

ELECTROMECHANICAL ACTUATION TECHNOLOGY FOR THE ALL-ELECTRIC AIRCRAFT

D. P. RUBERTUS, L. D. HUNTER, and G. J. CECERE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 243-249.

Attention is given to the results of electromechanical actuation system developmental tests conducted to verify the performance and reliability of a 'hingeline' type electromechanical actuator. This actuator's design, fabrication and laboratory testing are described. Also presented is the development history of a linear electromechanical actuator for the aileron of a C-141 cargo aircraft, and the design and development of yet another linear type actuator for missiles with severe performance, temperature, and volumetric requirements. O.C.

A84-36911

'ELECTRIC AIRPLANE' ENVIRONMENTAL CONTROL SYSTEMS ENERGY REQUIREMENTS

L. B. BUSS (AiResearch Manufacturing Co., Torrance, CA) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 250-256.

The 'electric airplane' environmental control system (ECS) design drivers is discussed for an electric airplane from two aspects. The first aspect considered is the type of aircraft. The three examples selected are the 150-passenger commercial airline transport, the military on-station electronic-surveillance patrol aircraft, and the air-defense interceptor fighter. These vehicle examples illustrate the effect of both mission and mission profile on the design requirements of the ECS and the differences that the requirements make on the resulting advantages and disadvantages of electrification. For the commercial transport, the selection of the air source for ventilation will be featured. For the patrol aircraft, the cooling unit will be evaluated. For the fighter, emphasis will be placed on the need for systems integration. The second and more important consideration is the definition of the environmental control system requirements for both energy supply and heat sink thermal management integration from the power plant (engine) that make an electric ECS viable for each type of vehicle. Author

A84-36912#

ELECTRICALLY DRIVEN ENVIRONMENTAL CONTROL SYSTEM

J. E. MCNAMARA (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 257-260.

An environmental control system (ECS) being developed under the title of energy efficient environmental control system is described. The ECS is a closed-loop, electrically driven, vapor cycle system. The vapor cycle will have a compressor driven by a variable speed, high-voltage dc motor. The reasons for selecting this type of system are discussed here. Breadboard testing of a variable speed compressor to demonstrate the feasibility of such an approach has been completed. The testing results were used to develop a preliminary design of a prototype compressor. In future phases of the program, the prototype compressor will be developed; a prototype system will be constructed and laboratory tested; and finally the prototype system will be flight demonstrated. Author

A84-37026

RESEARCH AND THE FUTURE EVOLUTION OF AIRCRAFT [LA RECHERCHE ET L'EVOLUTION FUTURE DES AVIONS]

PH. POISSON-QUINTON Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 6-16. In French.

Nearly every problem area of flight through the atmosphere and into and back from space has been identified in the past 40 years. Work continues on improving flight efficiency, aircraft aerodynamics and structures, integrating the control systems and upgrading and automating wind tunnel trials. The usage of composite materials for aircraft structures will increase, as will computer-aided design and aerodynamics studies. Mach 0.8 cruise speeds for commercial aircraft are being explored for commercial aircraft, in conjunction with hypersustentator mechanisms to assure maximized lift. Optimization of the flow around the wing-nacelle area is being pursued, as are propan systems and laminar flow designs. Innovative designs such as the flying wing with supercritical wings, recirculating airfoil and tilt rotor aircraft and all-digital control fighters with canards are under investigation. Finally, Mach 6-capable commercial aircraft using LH2 fuel in turbojets are being considered. M.S.K.

A84-37027

PASSENGER AIRCRAFT IN THE YEAR 2000 [LES AVIONS DE TRANSPORT CIVILS AL'HORIZON 2000]

R. BETEILLE and T. SZLENKIER (Airbus Industrie, Blagnac, Haute-Garonne, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 18, 19, 21 (11 ff.). In French.

Possible designs for passenger aircraft at the turn of the century are described. Areas of progress will be in comfort (seating), flight economy, durability, and reliability of the aircraft components, propulsion systems, and structural materials. A trend to develop flight-ready, light composites is noted, as is computer-aided flight management to optimize flight efficiency. No move to supersonic aircraft or short or vertical take-off and landing aircraft is foreseen. Propfans, mounted on the rear fuselage to reduce noise, are under development and are prime candidates to replace turbojets and still attain Mach 0.8 cruise speeds. Canards and semicanards are being introduced into business aircraft designs, together with pusher props. M.S.K.

A84-37028

THE COMMERCIAL AIRCRAFT COCKPIT IN THE YEAR 2000 [LE POSTE DE PILOTAGE D'UN AVION DE TRANSPORT DE L'AN 2000]

J.-P. LABORIE (SocieteNationale Industrielle Aerospatiale, Paris, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 42-45, 47, 48. In French.

Controls, displays, and cockpit layouts are projected for commercial aircraft at the end of the century. Active, computer-aided controls will produce wind loading, buffeting and

flutter control, lift modulation, and active landing gear damping. A controversy surrounds the number of cockpit personnel, which will depend on the degree of control automation. Only long range flights would of necessity require two pilots. An interactive situation will arise between the control and the pilot, with the control system issuing alerts regarding malfunctions and the associated probability of failure. Data displays will be on flat screens on the console and holographic projections overhead. Laser guidance and detector systems, optical memories, and turbulence and cloud activity detectors will be installed, along with automated air routes, air traffic, and flight economy controls. Voice control will probably be used for calling up data displays, with incoming data all carried by optical fibers. M.S.K.

A84-37030

TOWARD A SUPERSONIC VERTICAL TAKE-OFF AND LANDING AIRCRAFT [VERS L'AVION DE COMBAT SUPERSONIQUE ADECOLLAGE ET ATERRISSAGE VERTICAL]

W. J. LEWIS (Rolls Royce, Ltd., London, England) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 62-65, 67, 68, 70. In French.

Possible designs and design solutions for a supersonic V/STOL fighters are explored. The need for V/STOL capabilities is driven by missions that require operation from degraded airfield and interception courses at short notice. A substantial data base already exists for vertical thrust sustentators and vectored thrust turbojets. The Mirage III-V is a VTOL aircraft that can reach Mach 2. A substantial mass penalty, and thereby increased operational costs, is inherent in V/STOL designs. Design problems include thrust axis control, stability in turbulent atmosphere and the reingestion of hot gases. Possible solutions are thrust augmentation, lower temperature and pressure operation and common motors for V/STOL and normal aircraft. Functional features at plenum chambers for vectored thrust such as featured on the Harrier Pegasus engine are outlined, as are capabilities of the 279-3, E7 and TF 120 VTOL experimental aircraft. An enormous market is foreseen if the concept can be made operational at acceptable costs. M.S.K.

A84-37031

THE STATUS OF HELICOPTER TECHNOLOGY IN FRANCE [OUEN EST LA TECHNIQUE HELICOPTERE EN FRANCE?]

R. MOUILLE (SocieteNationale Industrielle Aerospatiale, Paris, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 72-75, 77, 79, 80, 85, 87. In French.

Research directions and realizable goals in French helicopter technologies before the turn of the century are examined. Improvements in electronic controls will ease the pilot workload and extend the mission capabilities. Rotor research will involve blade strength upgrades, rotational speed increases (instead of wider diameters), composite materials blades, and vibration dampers to ameliorate the transmission of resonance from the flapping blade tips to the main shaft. Drag reduction is pursued through better fuselage aerodynamics. A 15 percent increase in the attainable velocities, a 10 percent enhancement in the relative payload capability, and a 50 percent decrease in the cost of carriage per kg of payload are predicted for the year 2000. M.S.K.

A84-37032

FLIGHT TESTING IN THE YEAR 2000 [LES ESSAIS EN VOL DE L'AN 2000]

J. MONFORT (Centre d'Essais en Vol, Bretigny-sur-Orge, Essonne, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 88-92. In French.

Recent rapid advances in computerized modeling and control systems and landing approach systems have had major impacts on aircraft flight testing. Computers permit flight data analyses while the trials are occurring. The flight tests then have a second function of testing the designed flight control programs. Flight simulators are used in the development of the flight control systems and are upgraded with real world data. Flight data also confirm and aid in modifying engine performance, flight stability, and performance in transient conditions. Telemetered data reception is slowly being upgraded to Gbit/s levels. The large data handling

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capability will take telemetered data from real-time use and will require data reduction procedures before applications. Automated approach control has progressed to the verge of automatic Category III landings. Flight tests will continue to be required to validate approach algorithms for each new aircraft. Ergonomic studies are necessary to reduce the approach variables to the level of a single decision normally made by an accomplished pilot. M.S.K.

A84-37033

FIGHTER AIRCRAFT IN THE YEAR 2000 [L'AVION DE COMBAT DE L'AN 2000]

B. REVELLIN-FALCOZ (Avions Marcel Dassault-Breguet Aviation, Vaucresson, Hauts-de-Seine, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 94-97, 99, 101, 102. In French.

Fighter aircraft will increasingly be upgraded to encounter enemy aircraft that are also high performance. The threat of ground-to-air missiles will increase in number and capability. Improvements to meet the dangers will be made in the areas of aerodynamics, propulsion, structures, on-board systems, and armaments systems. Ergonomically designed, computer-based cockpits will allow the pilot to focus on the mission in the role of prime decision maker. The fighter will have dual engines and be lightweight and capable of carrying a variety of weaponry. Because of the dangers inherent in a massive enemy air assault, the costs of fighters must be minimized and the reliability maximized to maintain an efficient and sufficient force in the sky. M.S.K.

A84-37635#

REQUIREMENTS, DEFINITION AND PRELIMINARY DESIGN FOR AN AXISYMMETRIC VECTORING NOZZLE, TO ENHANCE AIRCRAFT MANEUVERABILITY

E. HIENZ (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) and R. VEDOVA (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs (AIAA PAPER 84-1212)

With a view to the requirements of an advanced fighter for the late Nineties, MBB investigated various ways of raising combat effectiveness through improvements in aircraft maneuverability. After many manned combat simulations it was found that supermaneuverability produced the desired advantage but required aircraft controllability beyond the stall limit. Thus, it was determined that thrust-deflection within small angles, in both the pitch and yaw axis, was the most feasible way of reaching this goal. Requirements for such a vectoring nozzle system were derived and a design study was conducted by MTU which came up with a fairly light system meeting all requirements postulated. Author

A84-37638#

EFFECT OF AIRCRAFT PERFORMANCE REQUIREMENTS ON ENGINE TRADES

E. J. REED (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p. refs (AIAA PAPER 84-1258)

The influence of mission and aircraft requirements such as thrust loading (F/W) and wing loading (W/S) on maneuver levels and the subsequent impact on engine trade studies during the design process are discussed. A life cycle cost (LCC) methodology has been defined for evaluating engine characteristics that are interactive with aircraft size, cost, and performance. A mission analysis program simulates flying the design mission. The customized LCC program EAGLE features a modular LCC model to predict airframe/avionics and base operating system costs. Continuous updating of the engine costs keeps EAGLE current for new designs. Sample results of F/W and W/S effects on engine LCC estimation with the EAGLE code are provided for a 40,000 lb TOGW-class fighter configured for supersonic cruise. The importance of retaining engine technologies that reduce weight is stressed. M.S.K.

A84-37646#

SIGNIFICANT DRAG REDUCTION RESULTS FOR TWINPACK TURBOFAN NACELLE INSTALLATIONS USING COMBINATION OF WIND TUNNEL FORCE BALANCE, FLOW VISUALIZATION, AND THREE DIMENSIONAL COMPUTATIONAL METHODS

J. T. KUTNEY (General Electric Co., Cincinnati, OH) and D. R. CLARK (Analytical Methods Inc., Redmond, WA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs (AIAA PAPER 84-1328)

This paper deals with the application and demonstration of nacelle design methods for a subsonic aircraft 4 engine aft-fuselage mounted nacelle installation. Nacelles were initially designed for optimum installed performance on an isolated nacelle basis. The configuration was installed on a semi-span model twin pack (2 nacelles) configuration and high speed wind tunnel test results revealed the presence of a very significant and destructive drag penalty. This paper is concerned with the logic path followed to understand the nature of the problem and the details of the flow mechanism and to provide a basis for lessons learned to prevent future drag problems of this type. The contribution and timing of the various design and test methods in the design process are reviewed and recommendations made for cost effective implementation. Author

A84-37948

FINITE ELEMENT ANALYSIS OF NATURAL, LONGITUDINAL VIBRATIONS OF A DEFORMABLE AEROPLANE WITH SUSPENDED MASSES

J. BLASZCZYK Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 2, 1983, p. 191-208. refs

An aircraft with a symmetry plane for mass and rigidity is analyzed. Equations of dynamic equilibrium of the deformable subassemblies of the aircraft are derived as well as those of motion of the rigid parts of the fuselage; the latter equations constitute dynamic coupling conditions between deformable superelements of the system. By taking into consideration the compatibility conditions for translation and rotation of the rigid and deformable subassemblies and the conditions at the free and fixed ends, a set of equations is obtained the solution of which gives the required frequencies and relevant longitudinal vibration modes of the aircraft. An algorithm and computer program are used to analyze a hypothetical aircraft with uniform mass and rigidity distribution along the deformable subassemblies as well as an existing jet trainer. The results show that the method is suitable for practical application. C.D.

A84-38403

TRENDS IN MODERN HIGH PERFORMANCE AIRCRAFT

R. C. BARLOW and G. K. RICHEY (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. 2.1-2.11.

The present investigation is concerned with needs and trends for military aircraft, giving particular attention to fighters and large strategic or transport aircraft. One of the areas of technology felt to be important in the case of fighters is related to runway independence, short takeoff and landing (STOL). A second area involves force multiplier technology to improve lethality and survivability. For strategic and large transport aircraft objectives are expressed in terms of fuel economy, range-payload characteristics, and survivability. A description is given of a few examples of technology integration in the areas of aerodynamics, control, and structure in order to improve strategic aircraft effectiveness. G.R.

A84-38404

THE X-29A FORWARD SWEEP WING ADVANCED TECHNOLOGY DEMONSTRATOR PROGRAM

T. M. WEEKS and L. H. LEET (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.1.1-1.1.8. refs

The X-29A has the objective to demonstrate the viability of the Forward Swept Wing (FSW) concept in a manned flight class aircraft. The program was initiated in 1981. Basic elements concerning the transonic aerodynamic characteristics of the X-29A are related to reduced wave drag and increased leading edge suction. The increased leading edge suction capability of FSW is lift dependent and is a result of reduced leading edge sweep. As a result of the configuration evolution of the X-29A, the airframe has become statically unstable in the pitch axis. A digital fly-by-wire system has been selected to control the airframe and to provide the augmentation necessary to achieve acceptable flying qualities. It is pointed out that the X-29A Advanced Technology Demonstrator will significantly advance the state-of-the-art in structures, aerodynamic, and flight control technologies. G.R.

A84-38405

FORWARD SWEEP WINGS AT BRITISH AEROSPACE WARTON - AN OVERVIEW

J. FLETCHER (British Aerospace, PLC, Warton Div., Preston, Lancs., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.2.1-1.2.7.

Developments regarding the design of light single-engined combat aircraft at a British aerospace company are discussed. In connection with the achievement of combat agility, the employment of swept forward wings (SFW) was considered. However, design objectives related to short field length and supersonic performance had to be given priority. Studies conducted to explore the possibilities for satisfying the three requirements are discussed. It was found that certain aspects would favor the adoption of a SFW arrangement, in particular, the need for high subsonic maneuver performance. Attention is also given to the benefits which may be obtained on the basis of the additional configurational freedom which SFW allows. G.R.

A84-38406

EXPERIMENTAL INVESTIGATION INTO FORWARD SWEEP WINGS FOR A LIGHT-WEIGHT COMBAT AIRCRAFT

D. E. SHAW (British Aerospace, PLC, Warton Div., Preston, Lancs., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.3.1-1.3.10.

A summary is provided of experimental results obtained by a British aerospace company as part of a comprehensive feasibility study regarding the design of a light weight combat aircraft. The study was undertaken in 1980. The results provided proof for the feasibility of the forward swept wing concept (FSW). Major advantages and disadvantages of the FSW compared with more conventional configurations could be identified. It could be established that the forward swept wing, canard layout, is a viable option when project layout optimization and selection studies are undertaken. Attention is given to a low speed model, a high speed model, model planform outlines, wing characteristics, and the lift/drag ratio as a function of Mach number. G.R.

A84-38407

DESIGN OF A FORWARD SWEEP WING FIGHTER AIRCRAFT

J. SCHWEIGER, G. SCHNEIDER, O. SENSBURG, and G. LOEBERT (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.4.1-1.4.13. refs

This paper presents the results of theoretical investigations of a fighter aircraft with a forward swept carbon fiber composite wing. The aim was to find the optimum wing planform for a fighter with

superior maneuver performance at high subsonic speeds. Special attention was given to the aeroelastic divergence problem. For this purpose, preliminary investigations on the optimal fiber-directions of carbon fiber composites were made by means of parametrical studies. Using an automatic structural design computer program, the so-called ASAT-program, the wing structure was designed for minimum weight. The divergence speed was obtained with two different methods: divergence prediction by finding the eigenvalues and lift efficiency calculations. The optimum wing twist for the design point was established, and the necessary jig twist, considering aeroelastic deformation, was obtained by only two steps of iteration. It should be mentioned that all results are derived analytically and that an experimental proof would be very desirable. Author

A84-38408

FORWARD SWEEP WINGS AND COMMUTER AIRPLANES

J. ROSKAM (Kansas, University, Lawrence, KS) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.5.1-1.5.11. refs

The paper presents an outline of a commuter airplane configuration design philosophy which leads logically to a forward swept wing configuration employing also a canard and a horizontal tail (three-surface configuration). Results are based on a number of trade-studies which use a Quasi-Vortex-Lattice method to predict the trimmed lift, stability and induced drag behavior of multiple-surface configurations. The effects of aeroelasticity were accounted for by using an elastic beam model. Although the paper addresses specifically an airplane designed for 30 passengers and a typical U.S. commuter mission, they are believed to be more generally applicable. Author

A84-38409

A COMPARISON BETWEEN FORWARD AND AFT SWEEP WINGS ON V/STOL COMBAT AIRCRAFT

D. HOWE (Cranfield Institute of Technology, Cranfield, Beds., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.8.1-1.8.10. refs

It is pointed out that the most significant of several difficulties associated with the application of forward swept wings is the tendency towards torsional divergence. Krone (1975) has demonstrated that this problem may be overcome without substantial weight penalty by employing a suitably anisotropic wing construction, preferably in reinforced plastic materials. It is, therefore, now feasible to examine the circumstances in which forward sweep may confer an advantage relative to more conventional sweepback. It is found that the incorporation of a forward swept wing on a direct derivative of a Harrier type VTOL aircraft makes it possible to design the fuselage so that the powerplant may be removed without prior removal of the wing. A swept forward wing-canard layout provides the opportunity for a compact configuration having a relatively good transonic area distribution. G.R.

A84-38410

ASPECTS OF FORWARD SWEEP WING RESEARCH AT THE UNIVERSITY OF BRISTOL

R. K. NANGIA (Bristol, University, Bristol, England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.9.1-1.9.24. Research supported by the Science and Engineering Research Council. refs

Some of the benefits of forward swept wings (FSW) are related to lower lift induced drag and improved high angle of attack performance. Although these benefits have been appreciated for a number of years, a lack of adequate structural technology has in the past prevented their full exploitation. However, the general technological situation has now changed with recent advances, notably in composite materials and an improved understanding of flight dynamics. Howe (1982) has considered possible application of FSW to V/STOL type aircraft and indicates the possibility of a

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compact layout. Truckenbrodt (1980) has presented a case for high aspect ratio FSW designs. In this paper, a description is presented of results from a broadly based continuing aerodynamic research program. This program has been mainly concerned with the differences between forward and aft swept wings. G.R.

A84-38411

THEORETICAL INVESTIGATION INTO FORWARD SWEEP WINGS

R. K. NANGIA (Bristol, University, Bristol, England) and D. E. SHAW (British Aerospace, PLC, Warton Div., Preston, Lancs., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.10.1-I.10.8. Research supported by the Science and Engineering Research Council. refs

Two theoretical aspects of Forward Swept Wing (FSW) research have been considered. The first topic relates to examination of the subsonic canard-wing aerodynamics with the trailing wakes allowed to relax. The emphasis is on highlighting the major differences between forward- and aft-swept wings. The approach provides an indication of the flowfield in the vicinity of the vertical fin at the higher angles of attack and sideslip. It is also shown that loadings with relaxed wake are significantly different from those without relaxation. The second topic relates to an examination of the effectiveness of trailing edge flaps. It is concluded that the outer controls provide roll without pitch coupling thus enabling a simplification of the aircraft control system. Author

A84-38416

CONFIGURATION DEVELOPMENT OF A HIGHLY-MANOEUVRABLE RESEARCH AIRCRAFT WITH FORWARD SWEEP SURFACES

S. RANSOM (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. I.16.1-I.16.14. Research sponsored by the Bundesministerium der Verteidigung. refs

The configuration development of a small, highly-maneuvrable research aircraft is described. The aircraft, of delta-canard layout, is designed specifically to investigate the subsonic unconventional manoeuvre flight envelope, which includes direct-force and post-stall flight modes. Results from a low-speed wind tunnel investigation are presented and their analysis shows that the inclusion in the layout of twin, wing-mounted, forward swept vertical tail surfaces confers significant control and aerodynamic advantages. A forward swept-winged variant is considered for comparative purposes. Author

A84-38421

ASPECTS OF THE STRUCTURAL DESIGN OF A THIN, CARBON FIBRE COMPOSITE F.S.W. FOR A LIGHT COMBAT AIRCRAFT

T. MARKHAM (British Aerospace, PLC, Filton, Glos., England) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. II.3.1-II.3.8.

A description is presented of an exercise carried out by a British aerospace company in 1980. The exercise involved the preliminary design of a lightweight wing box in around 2500 manhours. The project included also the updating of computer programs and the selection of ideas on carbon fiber/forward sweep. The wing box was to be designed for a lightweight fighter. The initial approach was to investigate a series of designs with the cover material carbon fiber, taking into account three directions of ply. The theoretical tools are discussed, giving attention to loads, cover design, structural influence coefficients, divergence speed, and panel thickness increases. The obtained results are considered along with developments leading to an improved understanding, and details regarding the design of the final wing box. G.R.

A84-38422

WEIGHT COMPARISON OF DIVERGENCE-FREE TAILORED METAL AND COMPOSITE FORWARD SWEEP WINGS FOR AN EXECUTIVE AIRCRAFT

E. L. COOK and M. ABLA (Gates Learjet Corp., Wichita, KS) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. II.4.1-II.4.9. refs

It is pointed out that the forward swept wing (FSW) has a number of features which could also improve the performance of executive jets. These features include lower trim drag and lower stall speeds, with better lateral control at high lift coefficients. The major benefit, however, is related to the possibility of having the wing carry through structure aft of the passenger compartment. Such a development would lead to significant reductions in fuselage weight by allowing a more efficient design of the pressurized section of the aircraft. The present study includes an investigation of both metal and composite wings designed to prevent divergence. It is believed, however, that the uncertainties of composite technology may inhibit their use for business aircraft in the near future. Attention is given to wing geometry, an aerodynamic model, a structural model, divergence speed, and wing optimization. G.R.

A84-38423*

Purdue Univ., Lafayette, Ind. AEROELASTIC STABILITY OF FORWARD SWEEP COMPOSITE WINGED AIRCRAFT

T. A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. II.5.1-II.5.13. DARPA-supported research. refs

(Contract NAG1-157)

This paper reviews the author's past and present aeroelastic stability and performance studies related to forward swept, composite wing aircraft. The influence of laminate elastic bend/twist coupling upon wing divergence, lateral control, and lift effectiveness will be illustrated by means of closed-form solutions, numerical analysis and simple wind-tunnel experiments. In addition, results of analyses of a freely flying flexible FSW aircraft are discussed to indicate the possible effects of the flexible forward swept wing on aircraft dynamic stability. These studies show, both theoretically and experimentally, that, if the aircraft is not carefully designed, a phenomenon referred to as body freedom flutter may appear. Author

A84-38424

DIVERGENCE OF FORWARD SWEEP WINGS

R. CHEN and R. J. BUTLER IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1984, p. II.6.1-II.6.9. refs

A computational program to analyse divergence of low and moderate aspect ratio lifting surfaces is described. The F. A. Woodward aerodynamic method and the finite element method of structural analysis are used. Several examples of forward swept wings which are made of aluminium alloy or composite materials are presented. Author

A84-38463

V-530 V/STOL CONCEPT UPDATE

Aerospace Engineering (ISSN 0736-2536), vol. 4, Jan.-Feb. 1984, p. 2-6.

Recent tests on the V-530 aircraft propulsion systems have shown that performance goals can be met or exceeded. A core engine, two common-shaft fixed pitch fans with variable inlet guide vanes, and associated inlets and nozzles are the basis of the V/STOL concept with the core engine located immediately behind the aft fan and supercharged by it. During normal flight, fan flows are vectored directly aft, while during vertical takeoff and landing, thrust is directed vertically. Roll, pitch and heave are controlled by variable inlet guide vanes. During single engine operation, thrust symmetry is maintained by a cross shaft. The location of small diameter fans reduces drag, aircraft size and weight and large

engine inlet design and aft inlet arrangement contribute to good takeoff and vertical mode performance. The nozzles provide high thrust coefficients and efficient flow at deflection angles from 0 to 110 deg. Excellent inlet performance and stable operation were verified for all operating conditions. The major configuration factors affecting nozzle performance were hub configuration, spacer distance, and nozzle exit area. J.P.

A84-38465
C-17 TRANSPORT EMPLOYS EXTERNALLY BLOWN FLAP SYSTEM

D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 4, Jan.-Feb. 1984, p. 26-30.

The C-17, a new high payload, long range performance military aircraft, uses an externally blown flap (EBF) for powered lift to achieve short landing. In the EBF system, the engines are located close and forward to the wing with a two-part flap which lowers into their slipstream. Jet exhaust passing between the segments and over the flap surface reduces positive pressure buildup on the lower surface of the flap, reduces lateral flow, and improves efficiency. Additional lift is derived from thrust deflection and wing circulation. The C-17 is a high wing, T-tailed aircraft with a maximum takeoff weight of 572,000 pounds. It must be capable of taking off from a 7600-foot runway, flying 2400 nautical miles, and landing on a rough runway 3,000 feet long. J.P.

A84-38486#
THE FLYING WING RECONSIDERED

J. V. FOA (George Washington University, Washington, DC) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, March 1984, p. 62-65.

A comparison is made of jet-propelled flying wings and wing-body combinations from the standpoint of aerodynamic performance, with particular attention to range and cruising-speed schedules for any given gross weight, payload, and usable volume. The aerodynamic superiority of appropriate wing-body configurations over the flying wing is found to be generally a good deal more impressive than suggested by earlier analyses. Author

A84-38574
FORWARD-SWEEP TECHNOLOGY

G. WARWICK Flight International (ISSN 0015-3710), vol. 125, June 16, 1984, p. 1563-1567.

Technological innovations incorporated in the design of the X-29 forward swept-wing aircraft are discussed. Attention is focused on the aircraft's integration of several diverse technologies into one airframe, including a thin supercritical aerofoil section, an aeroelastically tailored composite wing, a close-coupled variable-incidence canard, relaxed static stability, triplex digital fly-by-wire control, three surface control, and discrete variable camber. A cutaway drawing of the X-29 system lists the design features and describes the rotational ranges of the variable control surfaces. I.H.

A84-38841#
LIMIT CYCLE OSCILLATIONS OF A NONLINEAR ROTORCRAFT MODEL

B. H. TONGUE (Georgia Institute of Technology, Atlanta, GA) (Structures, Structural Dynamics and Materials Conference, 25th, Palm Springs, CA, May 14-16, 1984, and AIAA Dynamics Specialists Conference, Palm Springs, CA, May 17, 18, 1984, Technical Papers, Part 2, p. 102-111) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 967-974. refs
 (Contract NSF MEA-81-19883)

Previously cited in issue 13, p. 1835, Accession no. A84-31695

A84-38878#
PERFORMANCE OF FIGHTER AIRCRAFT RAMP TAKE-OFF

L. J. SCHAEFER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 2-2-1 to 2-2-5.

Ramp assisted take-off is of interest to the Air Force for use in case of a bomb damaged runway. Comparisons between the normal ground run and the ground run with a ramp for the F-4E, F-15, and F-16 aircraft show significant performance benefits. Data was produced for ramp angles varying from 5 to 15 degrees, using a 7.5 degree-per-second pitch angle rate, and four different weights for each aircraft. Reductions in ground run distance up to 65 percent were found to be possible. Aircraft with higher acceleration characteristics proved to benefit the most from the ramp. Author

A84-38896#
EXPERIMENTAL EVALUATION OF THE F-4 TRANSPARENCY SUPPORT STRUCTURE INTERFACE

J. R. BLUST (Dayton, University, Dayton, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 9-1-1 to 9-1-5. refs
 (Contract F33615-80-C-3401)

The transparency support structure interface is a primary design consideration when dealing with bird impacts near the edge of a transparency. The edge design tests were conducted to rank various edge attachment designs focusing on the energy absorption and structural integrity of the joint prior to failure. A total of eight edge attachment designs and three transparency cross-sections were evaluated in this program. The testing consisted of high rate three-point loaded beams with simulated F-4 edge fixity. Edge failure of the specimens was generally shear tearout or pull-through of the bolt. Author

A84-38902#
DYNAMIC STABILITY ANALYSIS OF HOSE/DROGUE REFUELING SYSTEM

R. L. MOORE, B. M. OBLESKI, and D. O. CORNOG (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 12-4-1 to 12-4-5. refs

Dynamic analysis of the KC-135 hose/drogue refueling system was done using a finite element code formulated to analyze cables subject to steady-state wind loading. The instability mechanism is a coupling of the hose first longitudinal stretch mode with the fourth transverse mode of vibration. Predictions are made for different values of drogue drag, with variations in hose length, hose longitudinal stiffness and wet (fuel full) vs dry (fuel empty) conditions throughout the KC-135 refueling envelope. Good correlation of analysis and flight test data exists. Results indicate that instability problems can best be eliminated by increasing longitudinal hose stiffness by a factor of two or greater. Author

A84-39030
FLIGHT SERVICE OF COMPOSITE STRUCTURE ON MCDONNELL DOUGLAS COMMERCIAL AIRPLANES

C. Y. KAM and J. GAIDULIS (Douglas Aircraft Co., Long Beach, CA) SAMPE Quarterly (ISSN 0036-0821), vol. 15, Oct. 1983; p. 36-44.

The development activities that led to the introduction of advanced composite materials in Douglas Aircraft Company's commercial airplanes are reviewed. The applications of carbon/epoxy structural components on the Super 80 and DC-10 airplanes are emphasized. The design, fabrication, certification testing, and flight service of selected components are discussed. The damage and repair experience of the flight service components

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is also reviewed. Future plans for the development and production of advanced composite structures are summarized. Author

A84-39277# **PERFORMANCE TRADES OF TWO-SURFACE AND THREE-SURFACE CONFIGURATIONS**

E. R. KENDALL (Gates Learjet Corp., Wichita, KS) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 1-4. refs (AIAA PAPER 84-2221)

The paper reviews potential flow induced drag solutions for two-surface and three-surface airplane configurations. It is shown that 'ideal' minimum induced drag can be achieved with a three-surface airplane if equal and opposite vertical loads are applied by the forward and aft trimming surfaces. The minimum induced drag trim condition can be attained at any cg location because the two trim surface loads can be of any size and sign so long as their sum is zero. Author

A84-39278*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

WING DESIGN FOR SPIN RESISTANCE

H. P. STOUGH, III, D. J. DICARLO, K. E. GLOVER, and E. C. STEWART (NASA, Langley Research Center, Hampton, VA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 5-14. refs (AIAA PAPER 84-2223)

Use of a discontinuous outboard wing leading edge to improve stall/spin characteristics has been evaluated through wind-tunnel and flight tests. Addition of such a discontinuous outboard wing leading-edge droop design to three light airplanes having NACA 6-series airfoil sections produced significant improvements in stall characteristics and spin resistance. The increased spin resistance of the modified airplanes has been related to the difference in angle of attack between the outer wing panel stall and the maximum attainable angle of attack. Author

A84-39279*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PERFORMANCE OF TWO LOAD-LIMITING SUBFLOOR CONCEPTS IN FULL-SCALE GENERAL AVIATION AIRPLANE CRASH TESTS

H. D. CARDEN (NASA, Langley Research Center, Structures and Dynamics Div., Hampton, VA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 15-25. refs (AIAA PAPER 84-2225)

Three six-place, low wing, twin-engine general aviation airplane test specimens were crash tested at the Langley Impact Dynamics research Facility under controlled free-flight conditions. One structurally unmodified airplane was the baseline airplane specimen for the test series. The other airplanes were structurally modified to incorporate load-limiting (energy-absorbing) subfloor concepts into the structure for full scale crash test evaluation and comparison to the unmodified airplane test results. Typically, the lowest floor accelerations and anthropomorphic dummy occupant responses, and the least seat crushing of standard and load-limiting seats, occurred in the modified load-limiting subfloor airplanes wherein the greatest structural crushing of the subfloor took place. The better performing of the two load-limiting subfloor concepts reduced the peak airplane floor accelerations at the pilot and four seat/occupant locations to -25 to -30 g's as compared to approximately -50 to -55 g's acceleration magnitude for the unmodified airplane structure. Author

A84-39703

DESIGN AND LIMITATIONS OF HELICOPTER FLOTATION SYSTEMS

D. L. WILLIAMS International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 23-28.

Elements of the British Joint Airworthiness Committee paper recommending new design standards for helicopter flotation are considered. A series of line graphs describes the severity of ocean conditions for several Sea States (One to Seven), with corresponding predictions of helicopter performance following ditching maneuvers. Among the flotation performance criteria considered are: stability; vertical and horizontal deceleration after ditching; vertical acceleration with and without floats inflated; and accelerations measured in the cockpit, under the rotor and the rear of the cabin. It is recommended that improvements in the flotation capabilities of helicopters take advantage of existing design configurations. I.H.

N84-26598# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

BATTLE DAMAGE REPAIR OF BIRDSRIKE RESISTANT LAMINATED TRANSPARENCIES

D. A. CROCKER /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 25-45 Dec. 1983 (AD-P003185) Avail: NTIS HC A08/MF A01 CSCL 01C

Aircraft battle damage repair is a growing area of concern in today's Air Force. Methods of quickly repairing battle damaged aircraft in the field are currently being developed to provide increased sortie generation rates in a wartime environment. A battle damage repair program for bird impact resistant laminated transparencies is currently underway. This program is designed to evaluate experimental battle damage repair techniques for bird impact resistant laminated transparencies. Representative laminated transparencies have been ballistically damaged to simulate various anticipated threats. The experimental battle damage repair procedures have been applied to the damaged transparencies. The final portion of this program will consist of pressure and thermal fatigue testing of the repaired transparencies to determine the structural integrity of the repairs. The results of this program will be used to define additional development efforts and to determine the applicability of the repair techniques to other aircraft transparency systems. GRA

N84-26599# McDonnell Aircraft Co., St. Louis, Mo.

WINDSHIELD WEIGHT REDUCTION THROUGH THE USE OF HIGH STRENGTH GLASS AND POLYURETHANE INTERLAYERS

J. H. LAWRENCE, JR. /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 46-56 Dec. 1983 (AD-P003186) Avail: NTIS HC A08/MF A01 CSCL 01C

Polyurethane interlayers were developed during the 1970s and are a potential replacement material for the polyvinyl butyral interlayer, specified in MIL-G-25871, for laminated glass. In addition to the interlayer, higher strength glass has become available through the advancement of manufacturing techniques for thermally tempering glass that appears to be an improvement over thermally tempered glass, specified in MIL-G-25667. Through minor modifications, current laminated glass windshields could be redesigned to utilize these new materials. Potentially, the resultant effect could be a weight reduction or an improvement for aircraft cold dispatch capabilities. To fully qualify a redesigned windshield for commercial aircraft, testing and analysis is required to meet FAA requirements for bird impact, fail-safe, environmental (anti-ice and defog), and optical qualities. To utilize these new materials, full-size windshield specimens interchangeable with the DC-10/KC-10 were tested successfully to the FAR 25 requirements. The weight difference between the production windshields versus the lighter weight windshields was 17.5 pounds nominal. GRA

N84-26601# Sierracin Corp., Sylmar, Calif.
A NEW AND UNIQUE CONDUCTIVE ELEMENT FOR AIRCRAFT TRANSPARENCIES

J. B. OLSON and D. M. TREBES /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 72-107 Dec. 1983

(AD-P003188) Avail: NTIS HC A08/MF A01 CSCL 01C

A significant breakthrough in transparent conductive elements has been achieved by extending and modifying sophisticated microcircuitry technology to the scale and materials used in aircraft windshields. The resultant conductive element possesses more potential for versatility than any contemporary transparent element type. Like conventional wiggle-wire elements, this new element is comprised of myriad thin filaments which are too small to be individually visible from normal distances. Based on a photolithographic technology and lacking mechanical constraints, however, this unique element produces infinitely more design flexibility than the conventional wire elements. Design parameter such as wave form, pitch, amplitude, filament width and spacing can be varied at will, even on the run; i.e., within a given filament. The technique lends itself to computerization, and general programs have been developed to provide design solutions in minutes.

GRA

N84-26603# PPG Industries, Inc., Pittsburgh, Pa. Glass Research Center.

DEVELOPMENT OF LIGHTWEIGHT COMMERCIAL AIRCRAFT WINDSHIELDS WITH NEW HIGH STRENGTH GLASSES

W. E. GOURLEY and H. E. LITTELL, JR. /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 134-157 Dec. 1983

(AD-P003190) Avail: NTIS HC A08/MF A01 CSCL 01C

To evaluate the effect of increased surface compression on failure resistance, it was necessary to test instrumented windshields and measure surface stress versus velocity for different designs. A resulting test program included 164 bird impacts against 28 full-size, flat windshields incorporating different interlayers and glass plies of varying thicknesses at varying locations and temperature conditions. This paper presents the results of the program in the form of stress-velocity curves and pass-fail results for different designs. It also shows the evolution of a design which features a thick high strength thermally tempered core for load carrying and a thin chemically strengthened inboard ply to enhance fail-safe yet survive the stresses which occur during impact. The thick/thin high strength glass windshield met all bird impact qualification tests at Boeing and subsequent thermal-pressure certification. This design concept was also employed for lighter weight retrofit applications for other commercial aircraft windshields.

GRA

N84-26604# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

TRANSPARENCY TECHNOLOGY NEEDS FOR MILITARY AIRCRAFT

R. H. WALKER /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 158-172 Dec. 1983

(AD-P003191) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper attempts to identify transparent enclosure technology needs and separates the needs by technology areas such as design, testing, system, etc. As there are numerous technology needs identified, some condensing and/or combining of specific needs is necessary; although as many needs as possible are discussed in sufficient detail to provide the reader a clear understanding of the problem area and what technology is needed to fill a particular void. It is expected that the entire transparency technical community can find within this description of needed technologies, areas of work which fall within their individual interest and capabilities as a company or government agency and to which they may address some future effort, thus helping to solve the many problems facing transparency systems of the future.

GRA

N84-26612# Allied Chemical Corp., Morristown, N.J.
NEW HIGH PERFORMANCE WINDSHIELD/CANOPY MATERIALS

B. T. DEBONA and D. C. PREVORSEK /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 339-381 Dec. 1983

(Contract F33615-78-C-5077)

(AD-P003199) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper covers a three year program to develop new, thermally stable, transparent plastics for use high performance aircraft windshields and/or canopies. Forty-seven new materials were prepared during this period, each with a glass transition temperature exceeding those of currently used acrylic and polycarbonate plastics, and possessing varying degrees of transparency, color and impact strength. Substitution of thermally stable, aromatic diols and diacids by appropriate techniques for bisphenol-A in modified preparatory procedures for polycarbonates and polyesters has resulted in more thermally stable materials. Depending upon the reactants involved, new polyesters, polycarbonates, polyester-carbonates, copolyesters and copolyester-carbonates were prepared. Concepts governing the choice of monomers and their effects on final polymer properties is presented along with a brief discussion on the importance of molecular chain entanglement in the glassy state.

GRA

N84-26625# Dayton Univ., Ohio.
SIMULATION OF EXPOSURE OF AIRCRAFT TRANSPARENCIES TO FLIGHT LINE ENVIRONMENT

A. PIEKUTOWSKI /in its Conf. on Aerospace Transparent Mater. and Enclosures p 619-634 Dec. 1983

(AD-P003212) Avail: NTIS HC A08/MF A01 CSCL 01C

During the major portion of their lifetime, aircraft transparencies are subjected to the flight line environment. Processes initiated or aggravated by exposure to the elements usually reduce the useful life of the transparency. A procedure for developing an accelerated flight line environment test is presented. Determination of the acceleration rate of weathering simulated in the test cycle is based on the definition of a so-called worst case day for exposure to ultraviolet radiation. Acceleration rate for the simulated flight line environment test was determined by dividing the total dosage of ultraviolet radiation produced by a constant laboratory source in the test environment by the total amount of ultraviolet radiation which would have been absorbed during a year of worst case days. In the combined flight and flight line environment test facility, the test article was exposed to ultraviolet radiation produced by fluorescent sunlamps and black lights. A year of normal exposure to ultraviolet radiation was simulated in two months of testing.

GRA

N84-26626# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

AIRCRAFT TRANSPARENCY TESTING METHODOLOGY

M. E. KELLY /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 635-655 Dec. 1983

(AD-P003213) Avail: NTIS HC A08/MF A01 CSCL 01C

Accurately predicting in-service durability of aircraft transparencies is beyond the present state-of-the-art. There are, however, approaches to testing and evaluating candidate designs and materials that may provide more useful test results than some of the more commonly used test methods. A testing methodology has been derived that uses a logical combination of exposure conditions and test methods to evaluate the durability of plastic aircraft transparency materials. While most testing naturally involves coupons, durability testing of full scale transparencies is also recommended. A large, complex facility has been constructed which can impose combinations of temperatures, pressure differentials, and exposure conditions that represent both the in-flight and flight line environments. This paper describes the tests and exposures recommended in the methodology, plus describes the preliminary conclusions and lessons learned from using the full scale testing equipment.

GRA

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

N84-26632# Dayton Univ., Ohio.

ALTERNATE T-38 TRANSPARENCY DEVELOPMENT

B. S. WEST and K. I. CLAYTON *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 756-775 Dec. 1983

(AD-P003219) Avail: NTIS HC A08/MF A01 CSCL 01C

The T-38 missions at speeds above the existing crew enclosure damage threshold will result in flight safety risk to aircraft and crew. This paper summarizes the design/development of alternate T-38 transparencies having the capability of defeating the impact of a four pound bird at aircraft speeds up to 400 knots. A preliminary design and evaluation defined the guidelines and constraints governing the modifications, defined and assessed candidate transparency configurations, and conducted a birdstrike risk assessment. Edge attachment screening tests were conducted fracture mechanism, and energy absorption potential. A parametric finite element analysis examined the effects of transparency and support structure stiffness versus peak load and deflection. A full-scale flight hardware test program established the failure threshold for the existing T-38 forward windshield and forward canopy for a four pound birdstrike at six impact locations. GRA

N84-26639# Lufthansa German Airlines, Frankfurt (West Germany). Structures Group.

LUFTHANSA GERMAN AIRLINES EXPERIENCE WITH CABIN AND COCKPIT WINDOWS OF BOEING 707, 727, 737, 747, DOUGLAS DC10 AND AIRBUS A300

K. W. EWALD *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 874-891 Dec. 1983

(AD-P003226) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper highlights the experience as related to the various types of windows installed on all types of aircraft operated within Lufthansa, which are 15 B747, 14 DC10, 11 A300, 7 B707, 34 B727, 42 B737. After great improvements during 1970 to 1977 a remarkable deterioration in performance of cabin and cockpit windows is realized. The most important problems encountered are: crazing, inplane cracking, deformation on acrylic windows, vinyl cracks, arcing, heating system failures, chips, cracks and distorted vision on multilayer windows, mainly glass windows. GRA

N84-26641# Civil Aviation Authority, Redhill (England). Airworthiness Div.

WINDSHIELD PROBLEMS ON UK OPERATED TRANSPORT SIZED JET AIRCRAFT 1976 TO 1982

J. THORPE *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 910-919 Dec. 1983

(AD-P003228) Avail: NTIS HC A08/MF A01 CSCL 01C

The paper reviews windshield problems reported between 1976 and 1982 on UK operated sized jet aircraft. The paper shows that external causes such as hail (four cases) and birds or lightning (one case each) are out weighted by problems with the windshield itself (157 cases). GRA

N84-26693*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN ANALYSIS OF ROTOR BLADE TWIST VARIABLES ASSOCIATED WITH DIFFERENT EULER SEQUENCES AND PRETWIST TREATMENTS

K. ALKIRE May 1984 41 p refs

(NASA-TM-84394; A-9507; NAS 1.15:84394) Avail: NTIS HC A03/MF A01 CSCL 01C

A nonlinear analysis which is necessary to adequately model elastic helicopter rotor blades experiencing moderately large deformations was examined. The analysis must be based on an appropriate description of the blade's deformation geometry including elastic bending and twist. Built-in pretwist angles complicate the deformation process and its definition. Relationships between the twist variables associated with different rotation sequences and corresponding forms of the transformation matrix are listed. Relationships between the twist variables associated with first, the pretwist combined with the deformation twist are included. Many of the corresponding forms of the transformation

matrix for the two cases are listed. It is shown that twist variables connected with the combined twist treatment are related to those where the pretwist is applied initially. A method to determine the relationships and some results are outlined. A procedure to evaluate the transformation matrix that eliminates the Eulerlike sequence altogether is demonstrated. The resulting form of the transformation matrix is unaffected by rotation sequence or pretwist treatment. E.A.K.

N84-26695# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

PRELIMINARY AIRWORTHINESS EVALUATION OF THE RUTAN AIRCRAFT FACTORY (RAF), INCORPORATED LONG-EZ AIRPLANE Final Report, 14 Jan. - 1 Apr. 1983

V. L. DIEKMANN, D. L. UNDERWOOD, R. N. WARD, and M. GRAHAM Jun. 1983 162 p

(AD-A140765; USAAEFA-82-18) Avail: NTIS HC A08/MF A01 CSCL 01C

The U.S. Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation of the Rutan Aircraft Factory, Inc. designed LONG-EZ airplane at Edwards AFB, Calif. During the test program 34 flights were conducted for a total of 32.0 hours, of which 24.5 were productive. The objectives of the evaluation were to assess the performance and handling qualities of the LONG-EZ so that the US Army Aviation Research and Development Command could issue an airworthiness release for concept feasibility evaluation of the aircraft. The test aircraft exhibited excellent potential for the light observation/reconnaissance mission and is satisfactory for the intended concept feasibility evaluation. The high availability and minimal maintenance down time due to ease of repair of composite structures during flight testing of the LONG-EZ were noteworthy. One deficiency and fifteen shortcomings were identified. The loss of directional control due to single point brake failure during take-off/landing and ground handling was identified as a deficiency and is a safety-of-flight hazard. The major shortcomings affecting mission versatility and pilot effectiveness were: decrease in engine power during low g maneuvers; limited directional control; excessive throttle freeplay; limited longitudinal trimmability; and inaccessibility of the lateral trim system. The deficiency should be corrected if development continues. The shortcomings should be corrected prior to production. GRA

N84-26696# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

PRELIMINARY AIRWORTHINESS EVALUATION OF THE UH-60 HELICOPTER WITH T700-GE-701A ENGINES INSTALLED Final Report, 24 - 25 Jun. 1983

J. I. NAGATA, J. MIESS, and L. A. HAWORTH Aug. 1983 45 p

(AD-A140882; AD-E500637; USAAEFA-83-17-F) Avail: NTIS HC A03/MF A01 CSCL 01C

This limited preliminary evaluation, conducted 24-25 June 1983, consisted of three flights for a total of 4.8 productive flight hours. The significant increase in power available for single engine contingencies (262 shaft horsepower (22%) at 4000 ft pressure altitude, 95 F) is an enhancing characteristic. The excellent torque matching engine stability and rotor speed control with one engine in electrical control unit lockout and the power lever set for level flight at 80 knots indicated airspeed is also an enhancing characteristic for both the T700-GE-701A engine and T700-GE-700 engine. The UH-60A acceleration, deceleration, and normal maneuvering response characteristics are essentially the same with either the T700-GE-700 engine or T700-GE-701A engine installed. Two shortcomings were identified: (1) slow engine acceleration during collective pulls from approximately zero torque to 50% or greater torque; and (2) rotor droop to less than 95% rotor speed during collective pulls from zero torque and during aggressive maneuvers such as a quick stop from the maximum airspeed in level flight. During the evaluation a popping sound was noted during collective pulls to approximately 80% and greater torque settings. This popping sound was subsequently identified as oil

canning on the fuselage skin between the pilot's station and gunner/crew chief's window. GRA

N84-26697# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

OPERATIONAL LOADS ON B-747 AIRCRAFT: DESIGN ASSUMPTIONS, ACTUAL EXPERIENCE AND MAINTENANCE ASPECTS

D. J. SPIEKHOUT and C. W. J. VANLUMMEL 21 Aug. 1983 35 p refs Presented at 12th AIDS Symp., Brunswick, 20-22 Sep. 1983

(NLR-MP-83051-U) Avail: NTIS HC A03/MF A01

Usage and loading environment data relevant for fatigue were selected from the standard AIDS recordings of B-747 aircraft. The data are stored in a data base (16,000 flights). Groups of flights can be selected from this data base for statistical analysis. By comparing experience with design assumptions, adjustments to the maintenance program (inspection intervals) are possible.

Author (ESA)

N84-27662*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

F-111 TACT NATURAL LAMINAR FLOW GLOVE FLIGHT RESULTS

L. C. MONTOYA, L. L. STEERS, and B. TRUJILLO *In* NASA. Langley Research Center Advan. Aerodyn.: Selected NASA Res. p 11-20 Dec. 1981

Avail: NTIS HC A05/MF A01 CSCL 01C

Improvements in cruise efficiency on the order of 15 to 40% are obtained by increasing the extent of laminar flow over lifting surfaces. Two methods of achieving laminar flow are being considered, natural laminar flow and laminar flow control. Natural laminar flow (NLF) relies primarily on airfoil shape while laminar flow control involves boundary layer suction or blowing with mechanical devices. The extent of natural laminar flow that could be achieved with consistency in a real flight environment at chord Reynolds numbers in the range of 30×10^6 power was evaluated. Nineteen flights were conducted on the F-111 TACT airplane having a NLF airfoil glove section. The section consists of a supercritical airfoil providing favorable pressure gradients over extensive portions of the upper and lower surfaces of the wing. Boundary layer measurements were obtained over a range of wing leading edge sweep angles at Mach numbers from 0.80 to 0.85. Data were obtained for natural transition and for a range of forced transition locations over the test airfoil. Author

N84-27666*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EET THEORETICAL DESIGN TECHNIQUES

D. L. DWOYER *In its* Advan. Aerodyn.: Selected NASA Res. p 79-94 Dec. 1981 refs

Avail: NTIS HC A05/MF A01 CSCL 01C

As a part of the EET aerodynamics program an out-of-house program was developed and monitored to provide theoretical procedures useful in the design of transport aircraft. The focus of the effort was to provide tools valid in the nonlinear transonic speed range. The effort was divided into two basic areas, inviscid configuration analysis and design procedures and viscous correction procedures. B.G.

N84-27670 Joint Publications Research Service, Arlington, Va. **HUNGARIAN OFFICIALS COMMENT ON PERFORMANCE OF SOVIET-BUILT AIRCRAFT**

A. ANDRYUSCHENKO *In its* USSR Rept.: Transportation (JPRS-UTR-84-005) p 11-14 2 Mar. 1984 Transl. into ENGLISH from Sov. Export (Moscow), no. 6(147), Nov.-Dec. 1983 p 18-22

Avail: NTIS HC A05

Soviet-built aircraft and helicopters are rated on their performance and reliability. Factors such as the amount of air traffic, engine performance and personnel training are discussed.

B.W.

N84-27671 Joint Publications Research Service, Arlington, Va. **SUCCESSFUL ARCTIC TESTING OF KA-32 HELICOPTER**

A. DYATLOV *In its* USSR Rept.: Transportation (JPRS-UTR-84-005) p 15-17 2 Mar. 1984 Transl. into ENGLISH from Kosmolskaya Pravda (Moscow), 5 Oct. 1983 p 4

Avail: NTIS HC A05

The feasibility of using the KA-32 helicopter to unload freight from cargo ships is discussed. Performance tests were carried out on the shore of the arctic ocean. The KA-32 helicopter proved to be exceptional in this area. B.W.

N84-27672 Joint Publications Research Service, Arlington, Va.

NEW WORLD RECORDS SET BY AN-72 TRANSPORT

O. GUSEV *In its* USSR Rept.: Transportation (JPRS-UTR-84-005) p 18-19 2 Mar. 1984 Transl. into ENGLISH from Pravda (Moscow), 16 Nov. 1983 p 6

Avail: NTIS HC A05

The flight characteristics of the AN-72 transport aircraft are described. New world records in civil aviation have been set by this aircraft. B.W.

N84-27690*# Boeing Military Airplane Development, Seattle, Wash.

MEASUREMENTS OF THE FUEL MILEAGE OF A KC-135 AIRCRAFT WITH AND WITHOUT WINGLETS

G. E. TEMANSON *In* NASA. Dryden Flight Research Facility KC-135 Winglet Program Rev. p 117-144 Jan. 1982 refs

Avail: NTIS HC A09/MF A01 CSCL 01C

The KC-135A Winglet Flight Research and Demonstration Program was a joint effort of the Air Force, NASA and the Boeing Military Airplane Company to flight test winglets on the KC-135A. The primary objective of the program was to verify the cruise performance improvements predicted by analysis and wind tunnel tests. Flight test data were obtained for winglets positioned at 15 deg cant/-2 deg incidence, 0 deg cant/-4 deg incidence, 15 deg cant/-4 deg incidence and for winglets off (baseline). Both fuel mileage and drag measurements were obtained. The 15 deg cant/-4 deg incidence winglet configuration provided the greatest performance improvement. The flight test measured fuel mileage improvement for a 0.78 Mach number was 3.1 percent at 8×10^5 pounds W/delta and 5.5 percent at 1.05×10^6 pounds W/delta. Correcting the flight measured data for surface pressure differences between wind tunnel and flight resulted in a fuel mileage improvement of 4.4 percent at 8×10^5 pounds W/delta and 7.2 percent at 1.05×10^6 pounds W/delta. The agreement between the fuel mileage and drag data was excellent. Author

N84-27710# Joint Publications Research Service, Arlington, Va. **ANTONOV BUREAU DEVELOPING NEW STOL TURBOFAN FOR USE IN FAR NORTH**

V. BELIKOV *In its* USSR Rept.: Transportation (JPRS-UTR-84-009) p 1-2 29 Mar. 1984 Transl. into ENGLISH from Izv. (Moscow), 2 Nov. 1983 p 6

Avail: NTIS HC A04/MF A01

Typical features of the OKB are inherent in the AN aircraft but are embodied at the most technical level. The jet turbines are removed from the zone where particles of soil, chunks of ice, and other solid objects may land in them. The streams of gases ejected from the turbine nozzle seems to stick to the upper surface of the wing, increasing its lift. The plane can develop a maximum speed of up to 720 kilometers per hour, climb to an altitude of up to 11 kilometers, and transport about 10 tons of cargo. An auxiliary power unit provides additional electric power and heat. The cargo hatch becomes a ramp and the cargo compartment is hermetically sealed. An electronic-computer navigation complex permits programming the flight ahead of time, considering all necessary maneuvers on a long map. A map plotting board indicates the location of the red-winged aircraft. A.R.H.

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N84-27717*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.
A FUNDAMENTAL APPROACH TO THE STICKING OF INSECT RESIDUES TO AIRCRAFT WINGS Annual Technical Report
N. S. EISS, JR., J. P. WIGHTMAN, D. R. GILLIAM, and E. J. SIOCHI Apr. 1984 24 p
(Contract NAG1-300)
(NASA-CR-173721; NAS 1.26:173721) Avail: NTIS HC A02/MF A01 CSCL 01C

A proposed testing scheme is described for obtaining data on the effects of surface roughness and surface energy on insect adhesion. The road test apparatus is discussed as well as surface preparation techniques. Uncoated and polymer coated metal substrates were analyzed by SEM/ESCA/IRS before and following collision with insects. Critical surface tensions of unexposed Nyabar and poly sulfone coatings were 10 and 33 dynes/cm, respectively, as determined from contact angles. A total of 95% of insect residues collected belong to order Diptera. Significantly less insect debris was detected on the coated plates as compared to the uncoated plates. Minimal contamination at the 5 nm level of both coated and uncoated plates occurs even after hours of exposure to road conditions as determined by ESCA analysis. The presence of nitrogen detected by ESCA on exposed plates is unequivocal evidence for insect residues left on plates. A.R.H.

N84-27718*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NUMERICAL OPTIMIZATION DESIGN OF ADVANCED TRANSONIC WING CONFIGURATIONS
G. B. COSENTINO (Colorado Univ., Boulder) and T. L. HOLST
May 1984 99 p refs
(NASA-TM-85950; A-9725; NAS 1.15:85950) Avail: NTIS HC A05/MF A01 CSCL 01C

A computationally efficient and versatile technique for use in the design of advanced transonic wing configurations has been developed. A reliable and fast transonic wing flow-field analysis program, TWING, has been coupled with a modified quasi-Newton method, unconstrained optimization algorithm, QNMDIF, to create a new design tool. Fully three-dimensional wing designs utilizing both specified wing pressure distributions and drag-to-lift ratio minimization as design objectives are demonstrated. Because of the high computational efficiency of each of the components of the design code, in particular the vectorization of TWING and the high speed of the Cray X-MP vector computer, the computer time required for a typical wing design is reduced by approximately an order of magnitude over previous methods. In the results presented here, this computed wave drag has been used as the quantity to be optimized (minimized) with great success, yielding wing designs with nearly shock-free (zero wave drag) pressure distributions and very reasonable wing section shapes. B.W.

N84-27719*# Kentron International, Inc., Hampton, Va. Aerospace Technologies Div.
APPLICATION OF SELECTED ADVANCED TECHNOLOGIES TO HIGH PERFORMANCE, SINGLE-ENGINE, BUSINESS AIRPLANES
C. S. DOMACK and G. L. MARTIN Jun. 1984 77 p refs
(Contract NAS1-16000)
(NASA-CR-172361; NAS 1.26:172361) Avail: NTIS HC A05/MF A01 CSCL 01C

Improvements in performance and fuel efficiency are evaluated for five new configurations of a six place, single turboprop, business airplane derived from a conventional, aluminum construction baseline aircraft. Results show the greatest performance gains for enhancements in natural laminar flow. A conceptual diesel engine provides greater fuel efficiency but reduced performance. Less significant effects are produced by the utilization of composite materials construction or by reconfiguration from tractor to pusher propeller installation. M.A.C.

N84-27720*# Boeing Commercial Airplane Co., Seattle, Wash.
INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT: WING PLANFORM STUDY AND FINAL CONFIGURATION SELECTION Summary Report, Jun. 1979 - Oct. 1980
Washington NASA Oct. 1981 43 p refs
(Contract NAS1-15325)
(NASA-CR-3468; NAS 1.26:3468; D6-48679) Avail: NTIS HC A03/MF A01 CSCL 01C

This report summarizes the Wing Planform Study Task and Final Configuration Selection of the Integrated Application of Active Controls (IAAC) Technology Project within the Energy Efficient Transport Program. Application of Active Controls Technology (ACT) in combination with increased wing span resulted in significant improvements over the Conventional Baseline Configuration (Baseline) and the Initial ACT Configuration previously established. The configurations use the same levels of technology (except for ACT), takeoff gross weight, and payload as the Baseline. The Final ACT Configuration (Model 768-107) incorporates pitch-augmented stability (which enabled an approximately 10% aft shift in cruise center of gravity and a 45% reduction in horizontal tail sizes), lateral/directional-augmented stability, an angle-of-attack limiter, and wing-load alleviation. Flutter-mode control was not beneficial for this configuration. This resulted in an 890 kg (1960 lb) reduction in airplane takeoff gross weight and a 9.8% improvement in cruise lift/drag. At the Baseline mission range (3590 km) (1938 nmi), this amounts to 10% block fuel reduction. Good takeoff performance at high-altitude airports on a hot day was also achieved. Results of this task strongly indicate that the IAAC Project should proceed with the Final ACT evaluation and begin the required control system development and testing. Author

N84-27721*# Douglas Aircraft Co., Inc., Long Beach, Calif. Avionics Engineering.
EXPERIMENTAL INVESTIGATION OF ELASTIC MODE CONTROL ON A MODEL OF A TRANSPORT AIRCRAFT Final Report
M. ABRAMOVITZ, R. M. HEIMBAUGH, J. K. NOMURA, R. M. PEARSON, W. A. SHIRLEY, R. H. STRINGHAM, E. L. TESCHER, and I. E. ZOOCK Washington NASA Nov. 1981 212 p refs
(Contract NAS1-15327)
(NASA-CR-3472; NAS 1.26:3472) Avail: NTIS HC A10/MF A01 CSCL 01C

A 4.5 percent DC-10 derivative flexible model with active controls is fabricated, developed, and tested to investigate the ability to suppress flutter and reduce gust loads with active controlled surfaces. The model is analyzed and tested in both semispan and complete model configuration. Analytical methods are refined and control laws are developed and successfully tested on both versions of the model. A 15 to 25 percent increase in flutter speed due to the active system is demonstrated. The capability of an active control system to significantly reduce wing bending moments due to turbulence is demonstrated. Good correlation is obtained between test and analytical prediction. M.A.C.

N84-27722*# Boeing Commercial Airplane Co., Seattle, Wash.
ADVANCED COMPOSITE ELEVATOR FOR BOEING 727 AIRCRAFT. VOLUME 1: TECHNICAL SUMMARY Contractor Report, May 1977 - Dec. 1979
D. V. CHOUIL, S. T. HARVEY, J. E. MCCARTY, O. E. DESPER, E. S. JAMISON, and H. SYDER Washington NASA Nov. 1981 88 p refs 2 Vol.
(Contract NAS1-14952)
(NASA-CR-3290; NAS 1.26:3290) Avail: NTIS HC A05/MF A01 CSCL 01C

The design, development, analysis, and testing activities and results that were required to produce five and one-half shipsets of advanced composite elevators for Boeing 727 aircraft are summarized. During the preliminary design period, alternative

concepts were developed. After selection of the best design, detail design and basic configuration improvements were evaluated. Five and one-half shipsets were manufactured. All program goals (except competitive cost demonstration) were accomplished when our design met or exceeded all requirements, criteria, and objectives. Author

N84-27723*# Boeing Commercial Airplane Co., Seattle, Wash. Preliminary Design Dept.
INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT: FINAL ACT CONFIGURATION EVALUATION Final Report, Oct. 1980 - Apr. 1981
 Feb. 1982 86 p refs
 (Contract NAS1-15325)
 (NASA-CR-3519; NAS 1.26:3519; D6-49356) Avail: NTIS HC A05/MF A01 CSCL 01C

The Final ACT Configuration Evaluation Task of the Integrated Application of Active Controls (IAAC) technology project within the energy efficient transport program is summarized. The Final ACT Configuration, through application of Active Controls Technology (ACT) in combination with increased wing span, exhibits significant performance improvements over the conventional baseline configuration. At the design range for these configurations, 3590 km, the block fuel used is 10% less for the Final ACT Configuration, with significant reductions in fuel usage at all operational ranges. Results of this improved fuel usage and additional system and airframe costs and the complexity required to achieve it were analyzed to determine its economic effects. For a 926 km mission, the incremental return on investment is nearly 25% at 1980 fuel prices. For longer range missions or increased fuel prices, the return is greater. The technical risks encountered in the Final ACT Configuration design and the research and development effort required to reduce these risks to levels acceptable for commercial airplane design are identified. E.A.K.

N84-27724*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
DEVELOPMENT AND EVALUATION OF A PERFORMANCE MODELING FLIGHT TEST APPROACH BASED ON QUASI STEADY-STATE MANEUVERS Final Report
 T. R. YECHOUT and K. B. BRAMAN Apr. 1984 421 p refs
 (Contract NSG-4028)
 (NASA-CR-170414; NAS 1.26:170414) Avail: NTIS HC A18/MF A01 CSCL 01C

The development, implementation and flight test evaluation of a performance modeling technique which required a limited amount of quasisteady state flight test data to predict the overall one g performance characteristics of an aircraft. The concept definition phase of the program include development of: (1) the relationship for defining aerodynamic characteristics from quasi steady state maneuvers; (2) a simplified in flight thrust and airflow prediction technique; (3) a flight test maneuvering sequence which efficiently provided definition of baseline aerodynamic and engine characteristics including power effects on lift and drag; and (4) the algorithms necessary for cruise and flight trajectory predictions. Implementation of the concept include design of the overall flight test data flow, definition of instrumentation system and ground test requirements, development and verification of all applicable software and consolidation of the overall requirements in a flight test plan. E.A.K.

N84-27725# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
JUH-1H PNEUMATIC BOOT DEICING SYSTEM FLIGHT TEST EVALUATION Final Report, 16 Nov. 1981 - 30 May 1983
 L. A. HAWORTH, R. G. OLIVER, and R. WORATSCHEK May 1983 103 p
 (AD-A140986; USAAEFA-81-11) Avail: NTIS HC A06/MF A01 CSCL 01C

The concept of operation of the Pneumatic Boot Deicing System as a deice system is feasible under the conditions tested when installed on the test UH-1H helicopter. A cooperative effort between

NASA and the B.F. Goodrich Company led to the development of a prototype pneumatic boot deicing system designed for use on a helicopter main rotor system. Flight tests were conducted to establish an operational envelope and evaluate the feasibility of the pneumatic deicing concept. Phase 1 consisted of a ground and inflight structural loads survey which established an operational envelope. Phase 2 was a limited aircraft performance and handling qualities evaluation, and Phase 3 involved artificial icing tests. Thirteen problem areas were identified with the prototype Pneumatic Boot Deicing System installation, two of which were corrected during the evaluation. Major problem areas included excessive increases in power required for flight and deicer material erosion and breakdown. GRA

N84-27726# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN ANALYSIS OF THE IMPLEMENTATION PLAN FOR THE CONVERSION FROM THE T-37 TO THE T-46 AIRCRAFT IN UNDERGRADUATE PILOT TRAINING M.S. Thesis
 J. R. DICKINSON, JR. and G. E. MOSES Mar. 1984 229 p
 (AD-A141199; AFIT/GST/OS/84M-8) Avail: NTIS HC A11/MF A01 CSCL 05I

This research provided insight and identified statistically significant factors affecting the ability of Air Training Command (ATC) to continue to produce pilots while simultaneously converting from the T-37 to the T-46 jet trainer. To analyze the Undergraduate Pilot Training environment during the conversion, a model of the system was built using a SLAM network with FORTRAN inserts. Six factors of interest to ATC were varied from a low to high value using average days to graduate students, average sorties remaining for late classes, and days to complete the conversion as measures of effectiveness (MOE). Several factors and two-factor interactions were significant for each MOE; thus, analysis with this model is prudent whenever changes to the implementation plan are considered. The model has the inherent flexibility to model different scenarios, bases, and aircraft by changing input variables and distribution parameters to fit the environment being studied. The model can be used as a general production model which transforms periodic inputs (students) into outputs (pilots) using limited resources (instructors, aircraft, daylight, simulators) on a prescribed schedule (syllabus) which random variations (weather and maintenance cancels, et al.). Author (GRA)

N84-27727# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
EVALUATION OF UH-1H HOVER PERFORMANCE DEGRADATION CAUSED BY ROTOR ICING Final Report, 28 Jan. - 4 Mar. 1983
 W. Y. ABBOTT, D. BELTE, R. A. WILLIAMS, and F. W. STELLAR Aug. 1983 69 p
 (AD-A141252) Avail: NTIS HC A04/MF A01 CSCL 01B

Hover icing tests were conducted with a UH-1H helicopter. The rotor blade ice shapes obtained in the Canadian National Research Council Icing Spray Rig were documented using stereoscopic photography, silicone molds, and cross-section tracings. Power required data were also obtained in an attempt to define the rotor performance degradation caused by icing. A summary of the test effort and ice shape documentation is presented in this report. Additional low-speed performance tests were performed and the results presented. GRA

N84-27728# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A SIMULATION MODEL TO EVALUATE AIRCRAFT SURVIVABILITY AND TARGET DAMAGE DURING OFFENSIVE COUNTERAIR OPERATIONS M.S. Thesis
 M. J. FOLEY and S. G. GRESS, JR. Mar. 1984 263 p
 (AD-A141324; AFIT/GST/OS/84M-10) Avail: NTIS HC A12/MF A01 CSCL 09B

Offensive counterair missions are essential to insure air supremacy. Effective allocation of aircraft for these missions requires consideration of the likely benefits and costs. The purpose of this thesis was to develop a methodology which could be used

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to assess the likely target damage and the resulting attrition of friendly aircraft during offensive counterair missions. The specific problem addressed was a mission of two aircraft attacking an area target at an enemy airfield. The area of operations was contained within a ten mile radius circle centered on the airfield's runway. Located within this area were the target and ground based defenses. A simulation model based on the SLAM language was built, but extensive use of FORTRAN was also made in the model. The continuous system capabilities of SLAM were used to investigate three-dimensional aircraft movements, threat engagements, and pilot reactions. The extensive use of the FORTRAN logic simplifies the understanding of the SLAM language required to use the model. Included in this FORTRAN logic is an analytical routine used to assess target damage due to weapons effects. This routine is based on a methodology contained in the Joint Munitions Effectiveness Manual. Author (GRA)

N84-27729# Centre d'Essais Aeronautique Toulouse (France). Lab. d'Etudes de Materiaux Metalliques.

CHARACTERIZATION OF A SAMPLE OF ALUMINUM ALLOY LONGERON IN 7050 T73652 OF ALCOA ORIGIN. SUMMARY OF TEST NUMBER MO 570300 [CARACTERIZATION D'UNE EBAUCHE DE LONGERON EN 7050 T73652 D'ORIGINE ALCOA. PROCES-VERBAL DE L'ESSAI NO. MO 570300]

M. LORENDEAUX 13 Dec. 1982 50 p refs In FRENCH
Avail: NTIS HC A03/MF A01

The static, fatigue and fracture mechanics characteristics of an aluminum alloy longeron used as a construction material of the A310 aircraft are presented. The microstructure analysis shows a low rate of corrosion. The tensile and fatigue characteristics are rather poorer than results available on similar materials.

Author (ESA)

N84-27730# Naples Univ. (Italy). Ist. di Progetto Velivoli.
PRELIMINARY EXPERIMENTAL AND THEORETICAL RESULTS ON CANTILEVER VIBRATION ABSORBERS APPLIED FOR AIRCRAFT CABIN VIBRATION [ALCUNI RISULTATI TEORICI E SPERIMENTALI SULL'ASSORBITORE DI VIBRAZIONI DI TIPO TRAVIFORME PER LA RIDUZIONE DEL RUMORE IN CABINA DI VELIVOLI TURBOELICA]

L. LECCE, F. MARULO, and E. FERRANTE 1983 77 p refs In ITALIAN
(SPER-8390) Avail: NTIS HC A05/MF A01

The design and calculation of vibrating beam dampers, for application to aircraft cabin noise reduction, are investigated. A calculation method to evaluate the efficiency of these dampers applied to panels of simple shape and boundary conditions is presented. Results of experiments in which cantilever dampers were adapted to aluminum alloy panels are presented. The resonant frequency estimation errors vary from 5% to 15% for different types of vibrating beams. A theoretical approach of the computation of the dynamic response of pressurized cabins equipped with a number of dampers tuned to the fundamental aircraft propeller frequency is proposed.

Author (ESA)

N84-27731# Naples Univ. (Italy). Ist. di Progetto Velivoli.
THEORETICAL AND EXPERIMENTAL RESULTS OF DYNAMIC BEHAVIOR OF PERIODICALLY STIFFENED CYLINDRICAL SHELL

L. LECCE, F. MARULO, A. CARBONE (Aeritalia S.p.A., Naples), and A. PAONESSA (Aeritalia S.p.A., Naples) 1982 15 p refs In ITALIAN; ENGLISH summary Presented at 10th Convegno Nazl. dell'Assoc. Ital. per l'Anal. delle Sollecitazioni, Cosenza, Italy, 22-25 Sep. 1982

Avail: NTIS HC A02/MF A01

Within the scope of cabin noise reduction in turboprop commuter aircraft, the dynamic behavior of cylindrical skin-frame shell structures when subjected to acoustic excitation at low and middle frequencies is explored. Work is concentrated in developing a computing procedure combining the transfer matrix method with the wave transmission approach. Depending on the frequency of excitation, one of two models is used: the skin-stringer model, a periodic succession of flat panels and stringers between two rigid

frames, or the cylinder-frame model, a periodic succession of cylindrical shells and frames. The measured transfer functions of fuselage structures are compared to theoretical predictions. The results are encouraging and show the need to improve the experimental techniques.

Author (ESA)

N84-27732# Aeritalia S.p.A., Naples (Italy).
EXPERIMENTAL MODAL ANALYSIS OF A PARTIAL FULL-SCALE FUSELAGE OF TURBOPROP AIRCRAFT [ANALISI MODALE SPERIMENTALE DI UN TRONCO DI FUSOLIERA DI UN VELIVOLO TURBOPROP]

A. PAONESSA, S. MANDARINI, L. LECCE (Naples Univ.), and F. MARULO (Naples Univ.) 1983 17 p refs In ITALIAN; ENGLISH summary Presented at 7th Assoc. Ital. di Aeron. e Astron. Congr. Nazl. sulla Base dell'Esame del Solo Sommario, Naples, 25-28 Oct. 1983

Avail: NTIS HC A02/MF A01

Within the context of a vibro-acoustic test program to study cabin noise reduction technology in a twin-engine turboprop commuter aircraft, results of a modal analysis are presented. A single input frequency response function method is used to perform the analysis in a ATR-42 aircraft. The test program includes three different measurement configurations for a total of 182 pick-ups, different frequency ranges of analysis up to 500 Hz, with and without a 5 PSI pressurization. The principal modes related either to the global structure or to its parts (frame, stringer and skin-panel) are identified.

Author (ESA)

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A84-37796
ESTIMATING THE PRESSURE ALTITUDE OF AIRCRAFT BY RADAR

S. NAGAOKA (Electronic Navigation Research Institute, Tokyo, Japan) Journal of Navigation (ISSN 0020-3009), vol. 37, May 1984, p. 209-216. refs

A method for estimating the pressure altitude is developed to facilitate correlating navigation accuracy measurement system (NAMS) data with flight progress strips. NAMS is a simple height-finding radar. A function for estimating the pressure altitude automatically was added on NAMS. In this way, the monthly variation of the height of a flight level and the accuracy of the estimation for the pressure altitude were studied on the basis of NAMS data collected over a year. Statistical results on estimated pressure altitudes are compared with the measured heights; averages of estimation errors are within 500 ft. A seasonal variation between the measured heights and the assigned flight levels was observed, with a maximum difference reaching 1500 ft for FL310 and 2000 ft for FL350. The difference is comparatively large in both summer and winter.

J.N.

A84-37797
THE DEVELOPMENT OF FLIGHT DECK DISPLAYS

F. S. STRINGER (Royal Aircraft Establishment, Farnborough, Hants., England) Journal of Navigation (ISSN 0020-3009), vol. 37, May 1984, p. 217-231.

The evolution of controls and displays in military and civil fixed-wing aircraft is reviewed, and the development of flight instruments up to the present high degree of automation is traced. Topics covered include blind-flying and all-weather instruments, vhf communications, flight automation, and the total civil flight deck. A consideration of military aircraft includes color CRT head-up displays, voice control and voice warning, and navigation systems.

J.N.

A84-38751

OPTIMIZATION OF ALGORITHMS FOR DATA PROCESSING IN A COMPLEX RADIO ALTIMETER [OPTIMIZATSIIA ALGORITMOV OBRABOTKI INFORMATSII V KOMPLEKSNOM RADIOVYSOTOMERE]

M. S. IARLYKOV, M. A. MIRONOV, and I. U. N. MOISEENKO
Radiotekhnika (ISSN 0033-8486), May 1984, p. 4-11. In Russian.
refs

Methods of the theory of conditional Markov processes are used to optimize algorithms for the primary processing of signals from a system incorporating a radio altimeter for making measurements at low altitudes as well as a baroaltimeter and accelerometer of the vertical channel of an inertial navigation system. It is noted that this complex processing approach makes possible a substantial improvement in the accuracy and noise immunity of the measurements. B.J.

A84-39283#

CONTROL AND DISPLAY REQUIREMENTS FOR SINGLE PILOT IFR

R. H. HOH (Systems Technology, Inc., Hawthorne, CA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 55-64. refs
(AIAA PAPER 84-2240)

This paper represents a first step in developing the criteria for pilot interaction with advanced controls and displays in a single pilot IFR (SPIFR) environment. The research program presented herein is comprised of an analytical phase and an experimental phase. The analytical phase consisted of a review of fundamental considerations for pilot workload taking into account existing data, and using that data to develop a SPIFR pilot workload model. The rationale behind developing such a model was based on the concept that it is necessary to identify and quantify the most important components of pilot workload to guide the experimental phase of the research which consisted of an abbreviated flight test program. The purpose of the flight tests was to evaluate the workload associated with certain combinations of controls and displays in a flight environment. This was accomplished as a first step in building a data base for single pilot IFR controls and displays. Author

A84-39706

COCKPIT VOICE RECORDERS - WHICH MICROPHONE?

R. A. DAVIS (Department of Transport, Accidents Investigation Branch, London, England) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 40-42.

The problems inherent in collecting usable information from the four channels of the standard cockpit voice recorder (CVR) system are discussed, and system improvements are suggested. The poor quality of the recording from the free-area microphone is identified as a critical factor, since no sound is recorded on the three crew channels unless intercom or radio communication is taking place. The 'hot-microphone' approach adopted in the UK since 1974 is shown to provide better information because all sound picked up by the boom-mounted microphones (regardless of source) is recorded continuously. This system also permits the use of the free-area channel for technical analyses. Adoption of the hot-microphone system is recommended along with increases in the frequency response and duration of recording and the addition of a time base to the record. T.K.

N84-26567# Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany).

ACCESS TO MAINTENANCE VIA AIRCRAFT INTEGRATED DATA SYSTEM (AIDS): FUTURE ASPECTS OF THE EXPANDED AIDS

H. KALBE In DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 25-50 Feb. 1984
Avail: NTIS HC A25/MF A01

An expanded A310 AIDS is introduced. The amount of available data is examined. Data which could be used for maintenance of the connected aircraft systems are discussed. The access to these

data and their use in maintenance is demonstrated. Future possibilities of AIDS are discussed. Author (ESA)

N84-26568# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

INTELLIGENT FLIGHT DATA RECORDER: A CONTRIBUTION TO ON-CONDITION MAINTENANCE AND OPTIMIZATION OF OPERATION

B. MUELLER and U. SCHULZ In DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 51-70 Feb. 1984
Avail: NTIS HC A25/MF A01

Starting from existing accident data recorder (ADR) systems and flight data acquisition units (FDAU) a design of an improved FDAU using standard microprocessor and memory technology is described. The range of applications in addition to the accident data recorder task leads to the on-condition maintenance concept and optimization of operations while reducing in parallel the amount of ground support equipment. The result is a remarkable increase of cost effectiveness. Author (ESA)

N84-26569# National Aerospace Lab., Amsterdam (Netherlands).

OPERATIONAL LOADS ON B-747 AIRCRAFT: DESIGN ASSUMPTIONS, ACTUAL EXPERIENCE AND MAINTENANCE ASPECTS

D. J. SPIEKHOUT and C. W. J. VANLUMMEL In DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 71-106 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

Usage and loading environment data relevant for fatigue were selected from the standard AIDS recordings of B-747 aircraft. The data are stored in a data base (16,000 flights). Groups of flights can be selected from this data base for statistical analysis. By comparing experience with design assumptions, adjustments to the maintenance program (inspection intervals) are possible. Author (ESA)

N84-26570# Rolls-Royce Ltd., Bristol (England).

THE DEVELOPMENT OF MILITARY AIRCRAFT ENGINE MONITORING SYSTEMS

C. M. OCONNOR and R. L. THOMPSON (Plessey Radio Systems, Havant, England) In DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 107-141 Feb. 1984
Avail: NTIS HC A25/MF A01

Digital engine monitoring development is summarized. Monitoring started with the analysis of basic engine parameters acquired using relatively simple data logging equipment. As the analysis of these data demonstrated that distinct benefits were practicable, the number of parameters monitored increased, permitting more comprehensive calculations. Commensurate with the progress in microelectronics, a second generation engine monitoring system for Harrier aircraft which provided the capability for on-board data reduction and recording was designed. This was fundamental to pioneering the development of the compact integrated systems now being introduced. Author (ESA)

N84-26571# Deutsche Lufthansa Aktiengesellschaft, Cologne (West Germany).

ENGINE CONDITION MONITORING WITH AIRCRAFT INTEGRATED DATA SYSTEMS ON LUFTHANSA A310

H. REILAENDER and H. SCHLUETER In DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 143-163 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

Experience gained during more than a decade in engine condition monitoring (ECM) was used to develop an advanced ECM concept for A310 aircraft engines in order to reduce engine operating cost. Mechanical and thermodynamic condition of the engine down to the modular level, and its control system are monitored. The aircraft integrated data system includes automatic data recording through expanded instrumentation, preprocessing and real time output using an onboard printer. The ground based

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parts of the system are designed around automated real time data processing and data analysis. Author (ESA)

N84-26572# Deutsche Lufthansa A.G., Hamburg (West Germany).

FIRST EXPERIENCE WITH ARINC 717 AIRCRAFT INTEGRATED DATA SYSTEMS (AIDS) ON AIRBUS 310 FOR MAINTENANCE SUPPORT

P. LADWIG *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 165-182 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

Logistics problems involved in operating the A-310 aircraft integrated data system are discussed. Real time print report, manual selection, and the return of the message to home base as fast as possible for engineering analysis are described. Data selection out of over 1000 available airplane parameters and identification on magnetic tape for automatic data processing at ground data stations are outlined. Aircraft system data readability on ground without the need of additional test equipment is treated. *Maintenance experience examples are provided.* Author (ESA)

N84-26573# Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).

FAILURE IDENTIFICATION MODULE (FIM) FOR DIGITAL CONTROL SYSTEMS

G. DAHL *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 183-202 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

It is argued that trouble shooting of avionic systems is too expensive. Defects reported to the maintenance crew or other failures indicated on the maintenance panel are often not confirmed in the following trouble shooting, because of incorrect or incomplete objections or because of unspecified or unconsidered disturbances to the unit. To make the trouble shooting easier and more reliable and to decrease the rate of unconfirmed defects a failure identification module (FIM) is proposed. During the preflight and the postflight test phase, as well as during the operation phase of the controller, this FIM records essential data of the controller and its safety systems. The data are stored in a non volatile memory, so are available despite a power failure. At the end of the mission the automatic analysis indicates the defective line replaceable unit on a failure display with high probability.

Author (ESA)

N84-26574# National Transportation Safety Board, Washington, D. C.

UPGRADED AIRCRAFT ACCIDENT RECORDER STANDARDS

C. A. ROBERTS *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 203-242 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

United States work in upgrading and redefining standards for flight data recorders (FDR) and cockpit voice recorders (CVR) is summarized. For CVRs, crash protection standards are lower than for FDRs, and CVR sound quality standards are low compared to the current state of the art, since they were written in the early 1960s. The United States needs an updated Technical Standard Order (TSO) for CVRs which upgrades standards for both electronic design and crash and fire protection. A new TSO for digital flight data recorders is also necessary. The TSO should not only set standards for digital recording, but should also set standards for crash and fire protection.

Author (ESA)

N84-26575# Ministry of Transport and Civil Aviation (England). Accidents Investigation Branch.

DEFICIENCIES OF CURRENT FLIGHT DATA RECORDERS IN ACCIDENTS INVESTIGATION

R. A. DAVIS *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 243-275 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

Remedial actions which would improve the value of digital flight data recorders (DFDR) as a investigative tool in aircraft accidents are proposed. The DFDR manufacturers need to develop better in-built test facilities and fault diagnosis. Operators should tighten

their maintenance requirements for flight recorder installations and should record and store calibration data. Regulatory authorities should legislate for additional parameters and sampling rates on large sophisticated aircraft. Author (ESA)

N84-26576# Fairchild Weston Systems, Inc., Sarasota, Fla. **THE FAIRCHILD DIGITAL FLIGHT RECORDER (DFR) F 800**

H. F. NAPFEL *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 277-312 Feb. 1984

Avail: NTIS HC A25/MF A01

The development and design of the Fairchild Digital Flight Recorder (DFR) are outlined. The DFR uses the Fairchild Cockpit Voice Recorder (CVR) data storage and protection package, and the majority of parts are common to both equipments. Recorder operation and its interface with simple business type computers or with more elaborate computer/data processing systems in use at major airlines are described. Examples of flight data presentation are provided. The use of small portable data recovery units on the aircraft are also described, along with data results and automatic testing capabilities. Author (ESA)

N84-26577# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.

ANALYSING REDUNDANT FLIGHT PATH DATA ON TWO AIRBUS A-300 AIRCRAFT

O. WEBER and G. ROSENAU *In its* Proc. of 12th Symp. on Aircraft Integrated Data Systems p 313-348 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

Reconstruction of aircraft flight paths from integrated data system recordings is discussed. Airbus A-300 takeoff and landing, and short segments of straight and level flight data were analyzed. Trajectory was determined by integration of the differential equation system for the longitudinal or three-dimensional motion using recorded acceleration, heading and attitude data. The parameters of the computed trajectories were compared with redundant data recorded on board or routinely on the ground. The analyses suggest that the aircraft integrated data systems (AIDS) designed according to ARINC 573 suffer a performance limitation in that the sampling rates of relevant parameters are relatively low and the body-angle rate is not primarily measured. These systems are suited for analyzing short flight paths before incidents or accidents, but they might be unsuitable for identifying flight-mechanical parameters of special aircraft. The AIDS on board the Airbus A-310 which complies with ARINC 717 provides for such applications through an additional special recorder. Author (ESA)

N84-26578# Lear Siegler, Inc., Grand Rapids, Mich. Instrument Div.

PERFORMANCE VALIDATION OF LEAR SIEGLER FLIGHT MANAGEMENT SYSTEMS

M. K. DEJONGE *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 349-368 Feb. 1984 refs

Avail: NTIS HC A25/MF A01

The Lear Siegler Flight Performance Data Computer System was evaluated by tests ranging from pilot recorded data at the end of each flight to the use of an airborne recording system. Data reduction and analysis techniques are described. The information is used in determining the number of aircraft and the evaluation period required for meaningful performance validation. Review of data gathered during the evaluations provides insight into practical limitations, and highlights several controls which should be placed on data-gathering flights in order to improve the quality of performance measurements. Author (ESA)

N84-26579# Delco Systems Operations, Milwaukee, Wis.

DELCO PERFORMANCE MANAGEMENT SYSTEM FLIGHT TEST EVALUATION

J. KAUFMAN *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 369-394 Feb. 1984

Avail: NTIS HC A25/MF A01

Flight tests of a performance management system (PMS) were conducted on a DC-10 and a Boeing 747 aircraft to determine

the fuel savings potential of a PMS through precise pitch and thrust control rather than changing the operating policy of the airlines. Digital recorders were installed on the aircraft. Approximately 40 variables from the PMS were recorded every 4 sec. The recorder operated on PMS-controlled flights and flights on which the PMS was inhibited. Ground-based programs reduced the data from 1000 flights, comparing fuel savings in climb, cruise, step-climb and descent. In all cases the results show significant fuel savings on PMS-coupled flights. Author (ESA)

N84-26580# Sperry Rand Corp., Phoenix, Ariz. Flight Systems Div.

PERFORMANCE VALIDATION OF SPERRY FLIGHT MANAGEMENT SYSTEMS (FMS)

R. KELLER *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 395-431 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

A fuel validation system was developed to determine the fuel savings achievable by using a digital flight management system (FMS) in normal aircraft operations. The system is designed to accumulate and statistically compare data from FMS-off flights, and determine fuel savings as a function of any preselected parameter. The fuel validation system is also designed to interface with a fast-time simulator in the FMS. The user can duplicate the actual flight and investigate fuel savings by introducing the flight environment, mode conditions, and aircraft conditions into the simulation. Author (ESA)

N84-26581# British Airways, Middlesex (England).

AIRLINE EXPERIENCE WITH AVIONIC SOFTWARE DEVELOPMENT FOR AIRCRAFT INTEGRATED DATA SYSTEMS

C. MURFET *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 433-457 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

The use of processor controlled aircraft integrated data systems (AIDS) by British Airways is discussed. Software accounts for an increasing proportion of the total cost, and in-service experience often reveals shortcomings in specification or implementation. British Airways undertook its own software development, starting with minor program changes and progressing to completely new software. For the nonmandatory part of its Boeing 757 system, the airline took complete software responsibility. Despite difficulties, the program is valuable in line service, and can be further developed at relatively low cost by the engineers who produced it.

Author (ESA)

N84-26583# Naval Air Test Center, Patuxent River, Md.

THE SILICON AIDS (AIRBORNE INTEGRATED DATA SYSTEMS)

D. M. WATTERS, J. A. ALFANO (NADC), and D. AMUNDSON (Sperry Corp.) *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 483-508 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

Airborne Integrated Data Systems (AIDS) in US military aircraft evolution from analog monitoring and recording systems to the first generation distributed microcomputer multiplex bus digital AIDS is traced. The development of high density nonvolatile memory chips (8K bits to 64K bits) is discussed. Digital sensor and audio data compression techniques enhance systems integration and hardware compression. Digital audio processing and compression techniques, and the integration of fiber optics multiplex busing, navigation ground proximity warning, and flight control systems are considered. Author (ESA)

N84-26584# Naval Air Test Center, Patuxent River, Md.
CRASH POSITION INDICATOR/CRASH SURVIVAL FLIGHT DATA RECORDER (CPI/CSFDR): EJECTABLE VERSUS NONEJECTABLE

D. M. WATTERS *In* DFVLR Proc. of 12th Symp. on Aircraft Integrated Data Systems p 509-534 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

The use by carrier aircraft of nonejectable, and by military aircraft of both ejectable and nonejectable crash position indicator/crash survival flight data recorder/crash survival cockpit voice recorder (CPI/CSFDR/CSCVR) systems is discussed. The relevance of aircraft mission, acquisition and maintenance costs, complexity, reliability, record survivability, weight, volume, and power are considered. Ejectable CPI/CSFDR/CSCVR systems should be used on aircraft that operate over water. All other aircraft could use either ejectable or nonejectable systems.

Author (ESA)

N84-26586# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Fluguehrung.

PILOT-AIRCRAFT INTERACTION CONCERNING A WIND SHEAR INDICATION SYSTEM

U. TEEGAN and M. MITTENDORF *In its* Proc. of 12th Symp. on Aircraft Integrated Data Systems p 555-577 Feb. 1984 refs
Avail: NTIS HC A25/MF A01

A wind shear indication system with an airborne sensor and filter concept resulting in an indicator control characteristic demanding thrust control was developed. Two different display versions were evaluated in a flight simulator experiment with 12 airline pilots. The results show differences in individual pilot performance. Preference of a higher integrated indication system can be stated from objective data as well as subjective pilot opinions. Modification of indicator intention resulting in a thrust command display with direct relation to thrust lever setting is an optimal system design. Author (ESA)

N84-26594# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.

PHYSICAL INTEGRATION OF THE HUD (HEAD-UP DISPLAY)
R. W. SCHWARTZ *In* Aerospace Medical Research Labs. Opt. and Human Performance Evaluation of HUD (Head-Up Display) Systems p 67-73 15 Dec. 1983
(AD-P003163) Avail: NTIS HC A05/MF A01 CSCL 01C

The physical integration of the HUD into the aircraft crew station used to be a relatively simple matter once the basic design parameters for the crew station were established, particularly the over-the-nose vision angles and the location of the design eye. The HUD was then mounted in the upper portion of the instrument panel and integrated into the surface of the glare shield, along the over-the-nose vision angle, with the optics oriented so that the center line of the collimating bundle passes through the design eye. There were minor problems with this method, the most notable being a tendency for pilots to sit higher than the design eye. The integration of the new LANTIRN HUD into the F-16, however, brought a whole new set of problems. GRA

N84-26698# National Oceanic and Atmospheric Administration, Washington, D. C. National Environmental Satellite, Data, and Information Service.

THE NESDIS-SEL LEAR AIRCRAFT INSTRUMENTS AND DATA RECORDING SYSTEM

G. F. SMITH, K. O. HAYES, J. S. KNOLL, and R. S. KOYANAGI
Jun. 1984 38 p refs
(NOAA-TR-NESDIS-9) Avail: NTIS HC A03/MF A01

Support of the NOAA-NESDIS Satellite Vicarious Calibration effort requires the use of aircraft mounted field instrumentation to conduct high altitude measurements of radiance from White Sands, New Mexico. Small laboratory spectrometers were adapted for aircraft environment and modified so that their visible wavelength dynamic range and their spectral and spatial characteristics would commensurate with specific satellite instruments. Author

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N84-26699# Arinc Research Corp., Annapolis, Md.
COCKPIT DATA MANAGEMENT REQUIREMENTS (CURRENT TECHNOLOGY AIRCRAFT) Final Report

T. P. BERRY Oct. 1983 304 p
(Contract DTFA01-80-C-10030)
(AD-A140643; REPT-1378-03-8-3150; DOT/FAA/PM-83/25)
Avail: NTIS HC A14/MF A01 CSCL 01C

This study describes a technique for estimating the effect of the data management tasks imposed on flight crews by new systems. It presents the development of a data base of data management tasks in current technology aircraft and examines the effect of four proposed new systems on the data management tasks of a flight crew in these aircraft. The annexes to the appendix represent data items and times for various emergency situations. Annex A shows the effect of hydraulic and flight control malfunction and Annex B presents the effect of engine failure due to fire. Times and data items for these conditions were developed in a United Airlines DC-10 flight simulator. GRA

N84-27733* National Aeronautics and Space Administration.
Langley Research Center, Hampton, Va.

HEADS UP DISPLAY Patent

H. D. GARNER and W. E. HOWELL, inventors (to NASA) 5 Jun. 1984 6 p Filed 28 May 1982 Supersedes N82-29319 (20 - 20, p 2789)

(NASA-CASE-LAR-12630-1; US-PATENT-4,453,163;
US-PATENT-APPL-SN-383384; US-PATENT-CLASS-340-980;
US-PATENT-CLASS-73-178R; US-PATENT-CLASS-340-971;
US-PATENT-CLASS-340-975; US-PATENT-CLASS-340-978;
US-PATENT-CLASS-340-705) Avail: US Patent and Trademark Office CSCL 01D

A heads up aircraft display which allows the pilot to view the display without diverting his attention from the scene ahead is disclosed. The display is designed for use on propeller driven aircraft comprised of a radially disposed row of lamps embedded in the rear surface of a propeller. Measurements of flight data are made by conventional means and converted into digital signals. These digital signals are applied to graphic generators which control lamp drivers which in turn control lamps through slip rings. The lamps are lit at the appropriate times during each revolution of the propeller to display the flight data in graphic form to the pilot. The combination of graphic generators and radially disposed lamps embedded in an aircraft propeller enables the pilot to view the display without diverting his attention from the scene ahead.

Official Gazette of the U.S. Patent and Trademark Office

N84-27734*# SRI International Corp., Menlo Park, Calif.
FAULT TOLERANT ARCHITECTURES FOR INTEGRATED AIRCRAFT ELECTRONICS SYSTEMS, TASK 2 Final Report

K. N. LEVITT, P. M. MELLIAR-SMITH, and R. L. SCHWARTZ
Jun. 1984 96 p refs
(Contract NAS1-17067)
(NASA-CR-172282; NAS 1.26:172282) Avail: NTIS HC A05/MF A01 CSCL 01D

The architectural basis for an advanced fault tolerant on-board computer to succeed the current generation of fault tolerant computers is examined. The network error tolerant system architecture is studied with particular attention to intercluster configurations and communication protocols, and to refined reliability estimates. The diagnosis of faults, so that appropriate choices for reconfiguration can be made is discussed. The analysis relates particularly to the recognition of transient faults in a system with tasks at many levels of priority. The demand driven data-flow architecture, which appears to have possible application in fault tolerant systems is described and work investigating the feasibility of automatic generation of aircraft flight control programs from abstract specifications is reported. A.R.H.

N84-27735# Arinc Research Corp., Annapolis, Md.
COST ANALYSIS OF MODE S DATA LINK AVIONICS SYSTEM FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY Final Report

D. A. SWANN, P. N. YOUNG, and A. P. SCHUST Feb. 1984 115 p refs
(Contract DTFA01-82-C-10027)
(DOT/FAA/PM-83/382; ARINC-1481-11-1-3216) Avail: NTIS HC A06/MF A01

This report presents the results of a cost analysis of five Mode Select (Mode S) data link avionics configurations that may be implemented for the low-performance general aviation aircraft community. ARINC Research Corporation developed the Mode S data link avionics designs considered in this analysis using state-of-the-art technology. Author

N84-27736# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

B-1B AVIONICS/AUTOMATIC TEST EQUIPMENT: MAINTENANCE QUEUEING ANALYSIS M.S. Thesis

L. M. ROARK Dec. 1983 158 p
(AD-A141175; AFIT/GOR/OS/83D-11) Avail: NTIS HC A08/MF A01 CSCL 15E

The purpose of this research effort was to develop a technique to determine B-1B automatic test equipment station quantities required to support the B-1B avionics components at base level. As part of this effort, both simulation and analytical solutions were developed. A detailed and complex simulation model was developed in the Q-GERT simulation language. In addition, an analytical model was developed based on the theory of open queueing networks and other queueing techniques. However, the analytical model required many crude and simplifying assumptions, and the analytical results were not entirely satisfactory. The Q-GERT simulation model was selected as the best choice for the remainder of the research effort. Two techniques were developed to determine test station quantities based on the model output. The first technique was to buy sufficient test stations to achieve a four day maximum base repair cycle time for the avionics components. The second technique was to conduct a cost-benefit analysis by comparing the costs of additional test stations (and the benefits of shorter repair cycle times) to the benefits of fewer test stations (and the costs of longer repair cycle times). Considerable sensitivity analysis was performed with the simulation model, and the research effort concludes with a range of management options for consideration by the B-1B System Program Office. Author (GRA)

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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.

A84-36829#
VECTORED EXHAUST NOZZLE TECHNOLOGY

G. R. BARNES (Rolls-Royce, Inc., Atlanta, GA), S. G. CURRY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and A. C. WOOD (Rolls-Royce, Ltd., Bristol, England) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p. refs
(AIAA PAPER 84-1175)

A range of vectored exhaust nozzle concepts which have the potential of enhancing the short take off and landing performance of future tactical aircraft have been investigated. The concepts studied are derivatives of nozzles developed for a range of conventional and vertical take off and landing projects. The concepts, which include both side and rear exhaust thrust vectoring systems with axisymmetric and non-axisymmetric nozzles, were

developed to produce advanced tactical aircraft capable of operating with either a 700 ft or 1000 ft field length. Subscale models of each nozzle concept have been tested at NASA Langley to validate internal performance predictions and develop test techniques for STOL exhaust systems. Transonic wind tunnel tests are scheduled, mid-84, to investigate installed performance with the nozzles in the conventional flight mode. Low speed wind tunnel testing will follow to assess the vectored nozzle and aircraft characteristics during the transition, approach, touchdown and rollout of a STOL landing. Author

A84-36832#
NAVY STUDY OF PROPULSION DEVELOPMENT AND ACQUISITION POLICY

R. PRINE, F. WILSON (U.S. Naval Air Systems Command, Washington, DC), and J. THALER (U.S. Naval Air Propulsion Test Center, Trenton, NJ) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 6 p. (AIAA PAPER 84-1255)

U.S. Department of Defense initiatives to reduce full scale engineering engine development costs have led to a Naval Air Systems Command review and formal documentation of turbine engine acquisitions policy. In this process, attention is given to technology development, program requirement definition, full scale engineering development, and operational support. General guidelines and specifications are expected to promote consistency and conformance to U.S. Navy policy for propulsion development. O.C.

A84-36905#
ADVANCED AIRCRAFT ELECTRIC SYSTEM

J. D. SEGREST (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 213-216.

In the advanced aircraft electric system presently discussed, energy efficiency is secured by means of both efficient power generation and lightweight power management and distribution techniques. Also impacting energy use are the avionic power conditioning and utilization equipment and the environmental control system which will maintain operational temperatures consistent with high reliability. Attention is given to the characteristics of the solid state electric logic system which will furnish digital multiplex power management and built-in testing. O.C.

A84-36913*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THE ALL-ELECTRIC AIRCRAFT - A SYSTEMS VIEW AND PROPOSED NASA RESEARCH PROGRAMS

C. R. SPITZER (NASA, Langley Research Center, Hampton, VA) (Institute of Electrical and Electronics Engineers, Annual Symposium, 5th, Dayton, OH, Nov. 30, 1983) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-20, May 1984, p. 261-266. refs

It is expected that all-electric aircraft, whether military or commercial, will exhibit reduced weight, acquisition cost and fuel consumption, an expanded flight envelope and improved survivability and reliability, simpler maintenance, and reduced support equipment. Also noteworthy are dramatic improvements in mission adaptability, based on the degree to which control system performance relies on easily exchanged software. Flight-critical secondary power and control systems whose malfunction would mean loss of an aircraft pose failure detection and design methodology problems, however, that have only begun to be addressed. NASA-sponsored research activities concerned with these problems and prospective benefits are presently discussed. O.C.

A84-36951*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PRELIMINARY INVESTIGATION OF A TWO-ZONE SWIRL FLOW COMBUSTOR

J. A. BIAGLOW, S. M. JOHNSON, and J. M. SMITH (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p. refs (AIAA PAPER 84-1169)

The effect of full-annular swirling-flow on a flow-zone combustor design is investigated. Swirl flow angles of 25, 35, and 45 degrees were investigated in a combustor design envelope typical of those used in modern engines. The two-zone combustor had 24 pilot-zone fuel injectors and 24 main-fuel injectors located in the centerbody between the pilot and swirl passage. Combustor performance was determined at idle, and two parametric 589 K inlet temperature conditions. Combustor performance was highest with the 45 degree swirl vane design; at the idle condition, combustion efficiency was 99.5 percent. The 45 degree swirl vane also produced the lowest pattern factor of the three angles and showed a combustor lean blowout limit below a 0.001 fuel-air ratio. Combustor total pressure drop varied from a low of 4.6 percent for the 25 degree swirl to a high of 4.9 percent for the 45 degree swirl. Previously announced in STAR as N84-22565 M.A.C.

A84-36952*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL INVESTIGATION OF THE LOW NOX VORTEX AIRBLAST ANNULAR COMBUSTOR

S. M. JOHNSON, J. A. BIAGLOW, and J. M. SMITH (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p. refs (AIAA PAPER 84-1170)

A low oxides of nitrogen vortex airblast annular combustor was evaluated which has attained the goal of 1 gm NO₂/kg fuel or less during operation. The experimental combustor test conditions were a nominal inlet-air temperature of 703 K, inlet total pressures between 0.52 to 0.83 MPa, and a constant inlet Mach number of 0.26. Exit temperature pattern factors for all test points were between 0.16 and 0.20 and exit swirl flow angles were 47 degrees at isothermal conditions and 23 degrees during combustion. Oxides of nitrogen did not exceed 1.05 gm NO₂/kg fuel at the highest inlet pressure and exhaust temperature tested. Previous correlations have related NO_x proportionally to the combustor inlet pressure raised to some exponent. In this experiment, a band of exponents between 0.5 and 1.0 resulted for fuel-air ratios from 0.023 to 0.027 and inlet pressures from 0.52 to 0.83 MPa. Previously announced in STAR as N84-22567 S.L.

A84-36953#
DESIGN AND PERFORMANCE EVALUATION OF A TWO-POSITION VARIABLE GEOMETRY TURBOFAN COMBUSTOR

J. W. SANBORN, P. E. SCHEIHING, E. B. COLEMAN, K. P. JOHNSON, and F. G. DAVIS (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. (AIAA PAPER 84-1171)

A series of tests has been conducted with a variable geometry combustor configuration which can potentially reduce weight and blowout fuel-air ratios required for expanded aircraft operation envelopes, while maintaining acceptable levels of combustion efficiency and pattern factor at high temperature rise operating conditions. The tests included ground level ignition, altitude ignition, stability, combustion efficiency, and discharge temperature quality as functions of JP-4, JP-5R, and JP-5R-DF2 blend fuel use. O.C.

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A84-36954# AERODYNAMIC PERFORMANCE OF ACOUSTICALLY SUPPRESSED EXHAUST NOZZLES

C. D. WAGENKNECHT and E. BEDI AKO (General Electric Co., Cincinnati, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. (AIAA PAPER 84-1173)

The present investigation of exhaust system noise abatement schemes for an Advanced Supersonic Transport aircraft has identified a system which incorporates three distinct techniques to achieve an FAR 36 specification stage 2 noise level of 104 EPNdB, for realistic aircraft scalings. The design has a potential for further improvements in performance through nozzle area ratio optimization, structural design innovation, and nozzle/weight performance trades. O.C.

A84-36955# AXISYMMETRIC APPROACH AND LANDING THRUST REVERSER CONCEPTS HOT FLOW TEST RESULTS

R. C. OBYE (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) and A. D. HAKIM (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 10 p. refs (AIAA PAPER 84-1176)

The effects of gas turbine engine internal flows on the flow coefficient characteristics of three axisymmetric nozzle design concepts applicable to augmented turbofan engine approach and landing thrust reversal (ALTR) have been studied in hot flow model tests. Two of the reverser designs deflect engine flow downstream of the primary nozzle throat, while the third deflects the flow upstream of the throat through reverser ports located in the engine's augmentor duct. The hot flow increment representing the correction that must be applied to cold flow model data in order to render it useful for full-scale engine calculations is found to be related to the temperature and pressure of the internal streams. Such increments are also noted to be sensitive to ALTR design concept, reverser geometry, and exit vane angle. O.C.

A84-36956# PERFORMANCE INVESTIGATION OF A FAN THRUST REVERSER FOR A HIGH BY-PASS TURBOFAN ENGINE

B. M. ROMINE, JR. (General Electric Co., Cincinnati, OH) and W. A. JOHNSON (Rohr Industries, Inc., Chula Vista, CA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 10 p. (AIAA PAPER 84-1178)

A parametric test program has been conducted to investigate turbofan thrust reverser cascade design alternatives which are compatible with the nacelle envelope of mid-to-late-1980s aircraft configurations. These tests were conducted on a two-dimensional, 35-percent scale simulator model of the CF6 fan duct with reverser vanes in fully deployed position. Attention was given to the effects of changes in vane profile, spacing, and skew angle, together with changes in cascade entrance and exit flow streamline orientation, cascade exit total pressure profile, and internal pressure loading in the fully deployed position. O.C.

A84-36957*# ADVANCED PROPFAN DRIVE SYSTEM CHARACTERISTICS AND TECHNOLOGY NEEDS

R. D. ANDERSON, D. A. WAGNER, R. E. DEVLIN, and A. S. NOVICK (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 9 p. refs (Contract NAS3-23046) (AIAA PAPER 84-1194)

Characteristics of a single-rotation drive system for an advanced turboprop engine are described. The gearbox is designed for a 10,000 shp three-spool, free-turbine engine and is installed in a wing-mounted nacelle. An offset gearbox from an earlier APET study provided the background for the preliminary design and benefit analysis for a 1990s advanced technology versus 1980s

state-of-the-art gearbox. High efficiencies were achieved for both designs with inherently high life goals. Increases in design allowables for gears, bearings, and lubricants resulted in improvements for the 1990s design. Author

A84-36959*# DETERMINATION OF COMPRESSOR IN-STALL CHARACTERISTICS FROM ENGINE SURGE TRANSIENTS

C. F. LORENZO, F. P. CHIARAMONTE, and C. M. MEHALIC (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 19 p. refs (AIAA PAPER 84-1206)

A technique for extracting the in-stall pumping characteristics for an axial flow compressor operating in an engine system environment is developed. The technique utilizes a Hybrid computer simulation of the compressor momentum equation in which actual transient data are used to provide all terms but the desired compressor characteristic. The compressor force characteristic as a function of corrected flow and speed results from the computation. The critical problem of data filtering is addressed. Results for a compressor operating in a turbofan engine are presented and comparison is made with the conventional compressor map. The relationship of the compressor surge characteristic with its rotating stall characteristic is explored. Initial interpretation of the measured results is presented. Previously announced in STAR as N84-22566 Author

A84-36961# NASA-GENERAL ELECTRIC ENERGY EFFICIENT ENGINE HIGH LOAD SQUEEZE FILM DAMPER-SYSTEM ANALYSIS AND TEST RESULTS

A. F. STORAGE and S. J. CLINE (General Electric Co., Cincinnati, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 10 p. refs (AIAA PAPER 84-1217)

The superior system vibration characteristics predicted for the NASA-GE Energy Efficient Engine (E3), were verified during the recently completed test program. The high pressure rotor for the E3 engine is soft mounted by means of squirrel cage springs at the forward and aft bearings. A sealed multi-film high load squeeze film damper is added in parallel with the forward squirrel cage to dampen the rigid body modes. A modal subsystem method was developed and used to analytically examine the damper-system dynamic response characteristics and to determine the damper and suspension properties needed to meet the design objectives. Author

A84-36972*# COMPARISON BETWEEN MEASURED TURBINE STAGE PERFORMANCE AND THE PREDICTED PERFORMANCE USING QUASI-3D FLOW AND BOUNDARY LAYER ANALYSES

R. J. BOYLE, T. KATSANIS (NASA, Lewis Research Center, Cleveland, OH), and J. E. HAAS (U.S. Army, Propulsion Laboratory, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 18 p. refs (AIAA PAPER 84-1299)

A method for calculating turbine stage performance is described. The usefulness of the method is demonstrated by comparing measured and predicted efficiencies for nine different stages. Comparisons are made over a range of turbine pressure ratios and rotor speeds. A quasi-3D flow analysis is used to account for complex passage geometries. Boundary layer analyses are done to account for losses due to friction. Empirical loss models are used to account for incidence, secondary flow, disc windage, and clearance losses. Previously announced in STAR as N84-22564 Author

A84-36975#**EFFECT OF VARIABLE INLET GUIDE VANES ON OPERATING CHARACTERISTICS OF A TILT NACELLE INLET/POWERED FAN MODEL**

H. C. POTONIDES and M. J. MEBES (Grumman Aerospace Corp., Bethpage, NY) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 11 p. refs (AIAA PAPER 84-1398)

Wind tunnel tests have been conducted to determine the effects of a Variable Inlet Guide Vane (VIGV) assembly on the operating characteristics of a V/STOL inlet and on the performance of a 20-in. fan engine. The results indicate that VIGV's are effective thrust modulators over a wide range of freestream velocities, nacelle angles-of-attack and fan speeds. The thrust modulation ranges, including the choking, the fan stall and the inlet separation boundaries, are presented. The installation of the VIGV assembly and diffuser modification with its compromised inlet area distribution caused significant losses of inlet angle-of-attack capability and produced increased levels of fan blade stress (in some cases at engine orders previously absent of all flight conditions of low and moderate angles-of-attack). Reducing the fan nozzle exit area limits the positive VIGV actuation range and consequently decreases the range of thrust modulation. The reverse occurs for increased fan exit nozzle area. Thus it is possible to maximize the VIGV useful range of thrust modulation by coupling vane actuation to a variable fan exit nozzle. Author

A84-36976#**CF6-80 CONDITION MONITORING - THE ENGINE MANUFACTURER'S INVOLVEMENT IN DATA ACQUISITION AND ANALYSIS**

R. J. E. DYSON and D. L. DOEL (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p.

(AIAA PAPER 84-1412)

Attention is given to the design features and implementation of the A310 airliner's CF6-80A3 engine Condition Monitoring System, whose data acquisition function centers on an on-engine Propulsion Multiplexer (PMUX). Also noted are the characteristics of the ground-based software used. The PMUX incorporates instrumentation sensors that in turn employ a variety of transducers. Software functions extend to a Turbine Engine Module Performance Estimation Routine. O.C.

A84-36987#**SUPERCritical SHAFTING FOR ADVANCED MODEL 250-C34 ENGINE**

W. H. PARKER, M. J. GRITTON, S. A. KLUSMAN, and M. J. ORELUP (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p.

(AIAA PAPER 84-1501)

The model 250-C34 is an advanced version of the Allison Model 250 series of engines. A new shaft arrangement, featuring a squeeze film damped, supercritical gas generator shaft, has been designed for increased reliability and durability, reduced complexity and part count, less maintenance, and decreased operating costs. A comprehensive analytical and experimental program has been conducted to evaluate the Model 250-C34 supercritical shaft concept and to optimize the damper design. The ranges of potential mechanical and damper variations were determined by production and field experience. The result of the evaluation is a Model 250-C34 gas generator shaft design that combines low sensitivity to shaft and turbine unbalance, damper tolerances, and damper oil temperature and pressure with the ability to withstand shocks from hard landings or blade loss. Author

A84-37029**THE M.88 - A FIGHTER AIRCRAFT ENGINE IN THE YEAR 2000 [LE M.88 - MOTEUR POUR AVION DE COMBAT DE L'AN 2000]**

M. GENSE (SNECMA, Paris, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 53, 55, 57, 59, 60. In French.

The M.88 is intended as the standard fighter aircraft engine in the year 2000. Designed using the existing Mach 2 flight speed data base, the M.88 will serve as varying altitudes on interceptor, air superiority, tactical, and penetration missions. Operational parameters include an intake temperature of 1850 K, a 25:1 compression ratio, 0.5 dilution rate, and 2100 K output temperature. A recirculating double body configuration has been selected, with nine compression stages and fewer compressor blades than on previous turbines. The air-recooled blades will be monocrystalline metal, although examinations of eutectics and ceramics are proceeding. The engine will be equipped with a variety of electronic controls to assure performance and economy. Testing is scheduled for 1984. M.S.K.

A84-37035**THOUGHTS ON THE EVOLUTION OF SMALL GAS TURBINES TO THE YEAR 2000 [REFLEXION SUR L'EVOLUTION DES PETITES TURBINES AGAZ VERS L'AN 2000]**

R. DEBLACHE (Turbomeca, S.A., Bizanos, Pyrenees-Atlantiques, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 113-117, 119, 120. In French.

Predictions of the improvements in small gas turbines for powering aircraft, engines, and missiles before the year 2000 are presented. Research and development will continue on improving overall efficiency to rotational speed, blade shapes, and materials. Numerical models will be developed in parallel to theoretically evaluate the overall and component performances. Technologies investigated will include variable geometries, new architectures, higher temperature-tolerant casings, recooling, and environmental control. Particular attention will be devoted to ceramic and composite materials and heat exchanger designs. A complete revolution in gas turbine design and construction is expected before the turn of the century. M.S.K.

A84-37627#**INTERNAL FLOW FIELD CALCULATIONS FOR ANNULAR COMBUSTION CONFIGURATIONS**

M. J. KENWORTHY and D. L. BURRUS (General Electric Co., Cincinnati, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p.

(AIAA PAPER 84-1168)

Internal flow field calculations of a contoured combustor with fuel injection and heat release were performed using a 3-D elliptic, turbulent, and reacting aerothermal model. Three grid configurations representing progressively more complex utilization of a stairstep boundary within a common rectangular grid mesh were evaluated. The calculations serve to demonstrate the capabilities and deficiencies of using a stairstep boundary in the context of modeling certain annular combustor geometries with significant contour. The use of body fitted coordinates is postulated to be a superior approach to the 'stairstep' technique. Author

A84-37628*# General Electric Co., Cincinnati, Ohio.**STATIC INTERNAL PERFORMANCE EVALUATION OF SEVERAL THRUST REVERSING CONCEPTS FOR 2D-CD NOZZLES**

R. K. ROWE, D. J. DUSS (General Electric Co., Cincinnati, OH), and L. D. LEAVITT (NASA, Langley Research Center, Hampton, VA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p.

(AIAA PAPER 84-1174)

Recent performance testing of the two-dimensional convergent-divergent (2D-CD) nozzle has established the concept as a viable alternative to the axisymmetric nozzle for advanced technology aircraft. This type of exhaust system also offers potential integration and performance advantages in the areas of thrust reversing and vectoring over axis-symmetric nozzles. These

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advantages include the practical integration of thrust reversers which operate not only to reduce landing roll but also operate in-flight for enhanced maneuvering and thrust spoiling. To date there is a very limited data base available from which criteria can be developed for the design and evaluation of this type of thrust reverser system. For this reason, a static scale model test was conducted in which five different thrust reverser designs were evaluated. Each of the five models had varying performance/integration requirements which dictated the five different designs. Some of the parameters investigated in this test included; variable angle external cascade vanes, fixed angle internal cascade vanes, variable position inner doors, external slider doors and internal slider valves. In addition, normal force and yawing moment generation was investigated using the thrust reverser system. Selected results from this test will be presented and discussed in this paper. Author

A84-37632#

A TRANSMISSION FOR THE CONTRA-ROTATING PROP-FAN POWERPLANT

J. DOMINY and R. A. MIDGLEY (Rolls-Royce, Ltd., Derby, England) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs (AIAA PAPER 84-1196)

Recent developments in propeller technology have introduced the possibility of modern, turbo-prop powerplants capable of driving 80 - 200 seat airliners at Mach numbers approaching 0.8. Studies suggest that reductions in fuel burn of up to 30 percent are possible with a contra-rotating propfan. This paper describes the concept of the transmission necessary to drive such a propeller, considers a possible design and discusses its performance and areas of future development. Author

A84-37633#

ADVANCED GEARBOXES FOR A MODERN SINGLE ROTATION TURBOPROP ENGINE

C. M. TORAASON and C. L. BROMAN (General Electric Co., Evendale, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 11 p. refs (AIAA PAPER 84-1197)

This paper presents an approach for the selection of a modern turboprop speed decreasing gearbox (SDG) for a commercial transport powered by twin tractor engines. The horsepower level is 12,500 HP per engine, more than twice that of any production aircraft engine in the Western world. Included is a discussion of how the parameters of a modern propfan lead to significant departures from past practice in SDG parameters. The sensitivity of SDG parameters on direct operating cost and its influence on design is also presented. Seven candidate configurations were screened and two promising ones were further evaluated. Information is given on the two designs and one is identified for further refinement. Author

A84-37639*# ISTAR, Inc., Santa Monica, Calif.

DETONATION WAVE AUGMENTATION OF GAS TURBINES

A. WORTMAN (ISTAR, Inc., Santa Monica; California State University, Fullerton, CA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 10 p. refs (Contract NAS3-24098) (AIAA PAPER 84-1266)

The results of a feasibility study that examined the effects of using detonation waves to augment the performance of gas turbines are reported. The central ideas were to reduce compressor requirements and to maintain high performance in jet engines. Gasdynamic equations were used to model the flows associated with shock waves generated by the detonation of fuel in detonator tubes. Shock wave attenuation to the level of Mach waves was found possible, thus eliminating interference with the compressor and the necessity of valves and seals. A preliminary parametric study of the performance of a compressor working at a 4:1 ratio in a conceptual design of a detonation wave augmented jet engine in subsonic flight indicated a clear superiority over conventional designs in terms of fuel efficiency and thrust. M.S.K.

A84-37640*# Beltran Associates, Inc., Syosset, N.Y.

HEAT PIPE APPLICATIONS IN AIRCRAFT PROPULSION

M. R. BELTRAN, D. L. ANDERSON, and P. J. MARTO (Beltran Associates, Inc., Syosset, NY) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 24 p. refs

(Contract NAS3-24095)

(AIAA PAPER 84-1269)

Heat pipes for improving the cycle efficiency and/or thrust-to-weight ratio of aircraft gas turbines are examined. A heat pipe employs a capillary structure, a wick, and an evacuated chamber to transfer heat between condenser and evaporator ends. Heat absorbed at the evaporator is transported to the condenser. In an aircraft, the heat pipe can be stationary or rotating, can be used for cooling stators and rotors, and is amenable to shapes such as cylinders, cones, and flat plates. Heat pipes in aircraft gas turbines can be applied for intercooling between stages, regeneration, reheat, and blade cooling. Improvements are projected in the cycle efficiency, thrust and thrust specific fuel consumption in the fanjet by using heat pipes. Consideration is also given to heat pipe heat exchangers with high axial heat transfer for stationary heat pipes and high heat transport for rotating heat pipes. M.S.K.

A84-37650#

POWER REDUCTION GEAR DEVELOPMENT FOR LYCOMING T53 TURBOPROP ENGINES

A. G. MEYER (Avco Corp., Avco Lycoming Div., Stratford, CT) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs (AIAA PAPER 84-1382)

The history of the reduction gearbox development for the T53 series of turboprop engines is presented in this paper. The engine family includes four different models the first of which went into production in 1960. The gear design point horsepower for the different models has increased from 960 to 1800 with a constant reduction ratio of 12.4:1. Author

A84-37652#

SURFACE LAYER ACTIVATION TECHNIQUE FOR MONITORING AND IN-SITU WEAR MEASUREMENT OF TURBINE COMPONENTS

P. SIOHANSI and C. C. BLATCHEY (Spire Corp., Bedford, MA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 7 p. refs (AIAA PAPER 84-1410)

Surface layer activation (SLA) is an advanced radionuclide approach for monitoring and measuring material loss due to wear, erosion and corrosion. In this technique a minute quantity of radionuclides is induced on the surface of the wearing part. The part can be installed in its normal position or in a test configuration. The gamma ray intensity of this activated component penetrates the surrounding material and can be monitored externally, in-situ, and on-line while the system is functioning under normal operating conditions. The decrease in gamma ray intensity after correction for natural decay half-life is a direct measure of the wear. The detection system is capable of measuring a 1 percent decrease in activity. For a depth of activity of 10 micrometers, a sensitivity of 0.1 micrometers or about 5 micrograms/per sq cm weight loss is typically observed. Three recent applications of the SLA technique, two in turbine engines and one in material testing which is potentially applicable to turbine engines, are presented. Author

A84-37657#

EVALUATION OF RELIABILITY GROWTH MODELS FOR ELECTRONIC ENGINE CONTROL SYSTEMS

J. A. TERRELL and M. E. MCGLONE (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. USAF-supported research. refs (AIAA PAPER 84-1454)

A reliability growth model (RGM) evaluation program (GAPCEEC) was devised to quantify the capability of RGMs for assessing, predicting, and controlling the reliability of aircraft electronic control systems. The effort was driven by the need for high reliability in fully automated engine control systems. GAPCEEC tested the abilities of the RGMs to generate 12 month forecasts, predict reliability at maturity from developmental data, relate model parameters to reliability engineering concepts, produce graphic displays, be adaptable to changing data trends and engine components, perform evaluations on the basis of real-world data, and produce realistic reliability estimates. Reviews were carried out on the Army AMSAA/Duane, the Endless Burn-in (EBI), the modified Duane, the Cox-Lewis, and the Box Jenkins (ARIMA) models. The results commend AMSAA to general use and ARIMA and EBI as viable alternatives for short-term forecasts. M.S.K.

A84-37928*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FLIGHT EFFECTS ON FAN NOISE WITH STATIC AND WIND-TUNNEL COMPARISONS

J. S. PREISSER and D. CHESTNUTT (NASA, Langley Research Center, Acoustic Noise Reduction Div., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 453-461. refs

Previously cited in issue 10, p. 1377, Accession no. A83-25910

A84-37929#

MONTE CARLO SIMULATION OF THE ENGINE DEVELOPMENT PROCESS

D. G. CULY and J. J. GOSSEN (Garrett Turbine Engine Co., Phoenix, AZ) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 462-468. Navy-sponsored research.

Previously cited in issue 16, p. 2310, Accession no. A83-36394

A84-37930#

EFFECTS OF COMPRESSOR HUB TREATMENT ON STATOR STALL AND PRESSURE RISE

P. CHENG, M. E. PRELL, E. M. GREITZER, and C. S. TAN (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 469-475. refs (Contract F49620-82-K-0002)

Previously cited in issue 16, p. 2362, Accession no. A83-36354

A84-37933*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

DESIGN AND FLIGHT TEST OF A KEVLAR ACOUSTIC LINER

H. C. LESTER, J. S. PREISSER, and T. L. PARROTT (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 491-497. refs

Previously cited in issue 10, p. 1378, Accession no. A83-25963

A84-37937#

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF BIRD IMPACT ON FAN AND COMPRESSOR BLADING

A. F. STORACE, R. P. NIMMER, and R. RAVENHALL (General Electric Co., Cincinnati, OH) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 457-465) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 520-527. refs (Contract F33615-77-C-5221)

Previously cited in issue 12, p. 1704, Accession no. A83-29856

A84-38482#

DESIGN AND TEST OF TWO 8:1 PRESSURE RATIO SINGLE STAGE CENTRIFUGAL COMPRESSORS OF DIFFERENT FLOW SIZE

R. W. CHEVIS (Noel Penny Turbines, Ltd., Coventry, England) (International Symposium on Centrifugal Compressor Design, Toronto, Canada, May 5, 1982) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, March 1984, p. 16-33. refs

Design and test data are presented for two high performance, wide flow range, 8:1 pressure ratio transonic centrifugal compressors of differing flow volume, whose test program was intended to validate both the design variables and the methodology by which they were chosen. The compressor design process used was entirely computer-based, and its final stages were iterative. Attention is given to the design features of the inlet duct, impeller, and diffuser, with respect to both aerodynamics and mechanical features. Test apparatus details are also given. O.C.

A84-38625

A RANGE OF CIVIL POWERPLANTS

T. E. FORD Aircraft Engineering (ISSN 0002-2594), vol. 56, May 1984, p. 2-4, 22.

Recent design advances in the RTM 322, Tay and V2500 aircraft engines are reviewed, noting rapid improvements made possible by a sharing of data among major engine manufacturers. The RTM 322 engines produce from 1800-3000 shp and 2200-2750 lb thrust and may improve helicopter fuel efficiency by 30 percent. Compressor ratios approaching 23:1 are used. The Tay turbofan has an increased low pressure flow and bypass ratio when compared with earlier Spey engines. Fan blades are wide to reduce noise and lower the specific fuel consumption. The V2500, producing 23,100 lb thrust, has electronic controls, a 20:1 ten-stage compressor, single crystal turbine airfoils and a powder metallurgy turbine disk. It will be installed on commercial transport aircraft. M.S.K.

A84-38721

GAS TURBINE COMBUSTION

A. H. LEFEBVRE (Purdue University, West Lafayette, IN) New York, McGraw-Hill Book Co., 1983, 549 p. refs

The present text addresses the basic physical, chemical, and aerothermodynamic processes occurring in gas turbine combustion, demonstrating their relevance to combustor design and performance. Attention is given to typical combustor configurations, laminar and turbulent flames, global reaction rates and stoichiometry, conical and annular diffuser characteristics, and mixing-, evaporation-, and reaction-rate controlled systems. Also noted are flame stability for various fuel types and operating conditions, theories and practices in spark ignition, heat transfer processes governing combustor wall temperatures, and fuel types and fuel injection systems. O.C.

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A84-39286*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACOUSTIC PREDICTION METHODS FOR THE NASA GENERALIZED ADVANCED PROPELLER ANALYSIS SYSTEM (GAPAS)

S. L. PADULA and P. J. W. BLOCK (NASA, Langley Research Center, Hampton, VA) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 82-90. refs

(Contract AIAA PAPER 84-2243)

Classical methods of propeller performance analysis are coupled with state-of-the-art Aircraft Noise Prediction Program (ANOPP) techniques to yield a versatile design tool, the NASA Generalized Advanced Propeller Analysis System (GAPAS) for the novel quiet and efficient propellers. ANOPP is a collection of modular specialized programs. GAPAS as a whole addresses blade geometry and aerodynamics, rotor performance and loading, and subsonic propeller noise. O.C.

A84-39299

RB199 TO XG-40 - STRETCH STOPS BUT TECHNOLOGY TRANSFERS

B. WANSTALL Interavia (ISSN 0020-5168), vol. 39, June 1984, p. 557-559.

Programs underway to modify the RB199 turbojet engine (currently used in the Tornado) to meet the probable demands of the proposed European Fighter Aircraft (EFA) in the 1990s are reviewed. The improvements already introduced in upgrading the RB199 from the original Mk 101 design to the Mk 104 (with 15 percent greater thrust at Mach 0.9 and 30,000 ft) are summarized; the EFA requirements (thrust/weight ratio 10:1, turbine entry temperature 1800 K, and fan pressure ratio above 4:1) are discussed; and technologies proposed by the participants in the Turbo-Union are briefly characterized and illustrated (including the MTU 1992 and the R-R XG-40). While SNECMA has bench tested a new design, the M88, the Turbo-Union partners (MTU, Fiat, and R-R) are continuing the RB199-based approach, and further difficult negotiations will be required if SNECMA is to be brought into the cooperative development program for the EFA engine. T.K.

A84-39423#

LESSONS LEARNED DEVELOPING A DERIVATIVE ENGINE UNDER CURRENT AIR FORCE PROCEDURES

D. B. EDMUNDS (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) and W. J. MCANALLY, III (United Technologies Corp., Engineering Div., West Palm Beach, FL) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p.
(AIAA PAPER 84-1338)

The component development program to produce an enhanced version of the F101 jet engine, the F100, is used to illustrate effective techniques to improve an operational system. The engine currently powers the F-15 and F-16 fighters. Various configurations of the digital electronic engine control, single crystal turbine blades, an increased airflow/pressure ratio fan and an augmentor and the automatic flight management system were examined in bench and simulated altitude tests. The 4 yr program included more than 2200 hr of sea level and altitude tests. The enhanced engine has a 4000 hr inspection interval, a \$260/flight hr support cost, 27,410 lb thrust, a 0.65 bypass ratio, weighs 3335 lb (an increase), has centerline fuel spraying and a restart that is 75 kt better than the previous configuration. The testing program was a joint effort of NASA, the USAF, and the manufacturer. M.S.K.

N84-26701 Carnegie-Mellon Univ., Pittsburgh, Pa.

FRICTION DAMPING OF FLUTTER IN GAS TURBINE ENGINES Ph.D. Thesis

A. SINHA 1983 121 p

Avail: Univ. Microfilms Order No. DA8406453

The feasibility of using friction dampers to control flutter in gas turbine engine rotor stages is investigated. The stabilizing effects to blade to ground dampers are studied on the basis of a single

degree of freedom model of an isolated blade. The range of initial conditions over which the response is stable, the maximum negative damping that can be stabilized, the effect of external excitation, and the determination of optimum damper parameters are each examined. The physical concepts and mathematical techniques required to analyze and understand the effects of friction dampers on aerodynamically unstable rotor stages are developed. The influence of friction on the torsional blade flutter is examined. On the basis of the results of three, six, nine, and twelve bladed disks, the use of friction dampers in controlling flutter appears promising. Dissert. Abstr.

N84-26702*# Garrett Turbine Engine Co., Phoenix, Ariz.

DILUTION JET MIXING PROGRAM

R. SRINIVASAN, E. COLEMAN, and K. JOHNSON Jun. 1984 354 p refs

(Contract NAS3-22110)

(NASA-CR-174624; NAS 1.26:174624; GARRETT-21-4804)

Avail: NTIS HC A16/MF A01 CSCL 21E

Parametric tests were conducted to quantify the mixing of opposed rows of jets (two-sided injection) in a confined cross flow. Results show that jet penetrations for two sided injections are less than that for single-sided injections, but the jet spreading rates are faster for a given momentum ratio and orifice plate. Flow area convergence generally enhances mixing. Mixing characteristics with asymmetric and symmetric convergence are similar. For constant momentum ratio, the optimum S/H(0) with in-line injections is one half the optimum value for single sided injections. For staggered injections, the optimum S/H(0) is twice the optimum value for single-sided injection. The correlations developed predicted the temperature distributions within first order accuracy and provide a useful tool for predicting jet trajectory and temperature profiles in the dilution zone with two-sided injections. A.R.H.

N84-26703# Draper (Charles Stark) Lab., Inc., Boston, Mass. Aviation and Surface Effects Dept.

OPTIMIZING THE THRUST DEFLECTING SURFACE FOR THE PNEUMATIC THRUST DEFLECTOR Final Report

M. J. HARRIS Mar. 1984 36 p

(Contract MIPR-FY1456-83-N-0026)

(AD-A140612; DTNSRDC/ASED-84/02) Avail: NTIS HC

A03/MF A01 CSCL 21E

A pneumatic thrust deflector has been developed in which the thick slipstream from a turbojet is deflected by blowing a thin jet sheet tangentially over a deflecting surface adjacent to the slipstream. In developing this concept, three geometries have been evaluated for the thrust deflecting surface. The three deflecting surfaces are cylindrical with a semicircular, a quarter-circular, or a semielliptical cross section. The range of thrust deflection achievable with each deflecting surface was determined by using each surface to deflect the slipstream of a small turbojet simulator. In the cold gas investigation, a thrust deflection of 20 deg or more was achieved with this mechanically simple system. The cold gas performance is compared to the range of thrust deflection achieved by pneumatically deflecting the hot gas of a small turbojet. Results of the hot gas investigation are also presented.

Author (GRA)

N84-26704# Air Force Academy, Colo.

TURBOFAN ENGINE TECHNOLOGY EVALUATION SYSTEM, USER'S GUIDE Final Technical Report, Jan. 1983 - Mar. 1984

V. J. VILLHARD Apr. 1984 138 p

(Contract AF PROJ. 2307)

(AD-A140781; FJSRL-TR-84-0002) Avail: NTIS HC A07/MF

A01 CSCL 21E

The user guide includes a description of the general layout of the system, the general approach used in calculating gas properties throughout the engine simulation model, the recommended limitations and suggested constraints of the system, how the performance calculated by TRBOFN, the engine simulation program in this system, compares to SMOTE, an accepted standard turbofan engine simulation program, and discussion of the general

conventions followed in developing the system. The Turbofan Engine Technology Evaluation System is intended to be a computer age back-of-the-envelope calculation tool for use in evaluating the relative payoffs of competing gas turbine engine technologies. The system consists of four programs: SETUP - an interactive graphics program used to select and input design cycle parameters for the engine and the flight conditions at which performance is to be calculated. TRBOFN - the turbofan engine performance simulation program; ENCOM - an interactive engine sizing and comparison program that also allows selection of performance parameters for graphs and comparison of up to five engines' performance powering an airplane through an eleven leg fighter/ground attack mission. The bottom line output in this comparison is the minimum fraction of take-off gross weight that must be fuel for the airplane to complete the mission using each engine under consideration; and GRAPH - an interactive graphics program for the creation of publication quality graphs of almost any calculated parameter versus any other. GRA

N84-26906# Joint Publications Research Service, Arlington, Va.
ESTIMATING THERMAL FATIGUE STRENGTH OF PROTOTYPE BLADES IN GAS TURBINE ENGINE Abstract Only
 M. Y. KOLOTNIKOV and S. Y. STRILETS *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 13 13 Apr. 1984
 Transl. into ENGLISH from Probl. Proch. (Kiev), no. 7, Jul. 1983 p 15-17
 Avail: NTIS HC A04/MF A01

The fatigue strength of gas turbine blades under cyclic thermal loads with cooling was investigated. Blades of prototype sizes made of ZhS6F heat-resistant alloy were heated over the 523-1373 K temperature range in sawtooth cycles and cooled at rate reaching 25 C/s at the hottest blade section. The test data on stress and strain at rupture were correlated with calculations of deformation according to the theory of beams, with the boundary conditions established thermometrically on a special blade specimen and the corresponding equations then solved numerically on a YeS-1033 unified system computer. The results yield the necessary corrections for estimating the thermal fatigue strength and indicate a dependence not only on the temperature swing but also on the peak temperature, the magnitude of alternating stresses being more critical than that of alternating strains. Author

N84-27737*# Pratt and Whitney Aircraft Group, East Hartford, Conn.
ENERGY EFFICIENT ENGINE FAN COMPONENT DETAILED DESIGN REPORT
 J. E. HALLE and C. J. MICHAEL Sep. 1981 141 p refs
 (Contract NAS3-20646)
 (NASA-CR-165466; NAS 1.26:165466; PWA-5594-165) Avail:
 NTIS HC A07/MF A01 CSCL 21E

The fan component which was designed for the energy efficient engine is an advanced high performance, single stage system and is based on technology advancements in aerodynamics and structure mechanics. Two fan components were designed, both meeting the integrated core/low spool engine efficiency goal of 84.5%. The primary configuration, envisioned for a future flight propulsion system, features a shroudless, hollow blade and offers a predicted efficiency of 87.3%. A more conventional blade was designed, as a back up, for the integrated core/low spool demonstrator engine. The alternate blade configuration has a predicted efficiency of 86.3% for the future flight propulsion system. Both fan configurations meet goals established for efficiency surge margin, structural integrity and durability. E.A.K.

N84-27738*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.
ENERGY EFFICIENT ENGINE: LOW-PRESSURE TURBINE SUBSONIC CASCADE COMPONENT DEVELOPMENT AND INTEGRATION PROGRAM
 O. P. SHARMA, F. C. KOPPER, L. K. KNUDSEN, and J. B. YUSTINICH Jan. 1982 98 p refs
 (Contract NAS3-20646)
 (NASA-CR-165592; NAS 1.26:165592; PWA-5594-167) Avail:
 NTIS HC A05/MF A01 CSCL 21E

A subsonic cascade test program was conducted to provide technical data for optimizing the blade and vane airfoil designs for the Energy Efficient Engine Low-Pressure Turbine component. The program consisted of three parts. The first involved an evaluation of the low-chamber inlet guide vane. The second, was an evaluation of two candidate aerodynamic loading philosophies for the fourth blade root section. The third part consisted of an evaluation of three candidate airfoil geometries for the fourth blade mean section. The performance of each candidate airfoil was evaluated in a linear cascade configuration. The overall results of this study indicate that the aft-loaded airfoil designs resulted in lower losses which substantiated Pratt & Whitney Aircraft's design philosophy for the Energy Efficient Engine low-pressure turbine component. Author

N84-27739*# United Technologies Corp., East Hartford, Conn. Aircraft Group.
ENERGY EFFICIENT ENGINE HIGH-PRESSURE TURBINE SUPERSONIC CASCADE TECHNOLOGY REPORT
 F. C. KOPPER, R. MILANO, R. L. DAVIS, R. P. DRING, and R. C. STOEFLER Nov. 1981 155 p refs
 (Contract NAS3-20646)
 (NASA-CR-165567; NAS 1.26:165567; PWA-5594-152) Avail:
 NTIS HC A08/MF A01 CSCL 21E

The performance of two vane endwall geometries and three blade sections for the high-pressure turbine was evaluated in terms of the efficiency requirements of the Energy Efficient Engine high-pressure turbine component. The vane endwall designs featured a straight wall and S-wall configuration. The blade designs included a base blade, straightback blade, and overcambered blade. Test results indicated that the S-wall vane configuration and the base blade configuration offered the most promising performance characteristics for the Energy Efficient Engine high-pressure turbine component. Author

N84-27740# Naval Postgraduate School, Monterey, Calif.
SENSITIVITY ANALYSIS OF PREDICTED REACTING FLOW CHARACTERISTICS IN SOLID FUEL RAMJET COMBUSTORS
M.S. Thesis
 A. S. PILOS Dec. 1983 74 p
 (AD-A141279) Avail: NTIS HC A04/MF A01 CSCL 21B

This study was a sensitivity analysis of a computer code (based upon CHAMPION/2/E/FIX), used at the Naval Postgraduate School mainly to model the flow within Solid Fuel Ramjets. The purpose of the study was to make the code simpler and more accurate by reducing the required CPUs time and/or improving the accuracy of predictions. Author (GRA)

N84-27741# Flight Dynamics Research Corp., Van Nuys, Calif.
HIGH SPEED EJECTORS Annual Report, 22 Mar. 1982 - 31 Mar. 1984
 M. ALPERIN 4 Apr. 1984 29 p
 (Contract F49620-81-C-0043; AF PROJ. 2307)
 (AD-A141562; AFOSR-84-0430TR) Avail: NTIS HC A03/MF A01 CSCL 21E

A description of the test apparatus and some major experimental results are presented. The test apparatus is a pressurized test cell for simulation of translational motion by pressurization of the inlet flow to the corresponding stagnation pressure. The experiment consisted of measurement of the pressure distribution along the ejector surfaces and of the pressure, temperature and forces required to evaluate the mass flow, total forces and the ram drag. In addition, Schlieren photographs were taken at each test to

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observe the flow and in particular to illustrate the shock wave patterns. Combination of the pressure distribution and Schlieren photographs illustrate the successful achievement of second solution flows. Further tests are to be performed to illustrate the optimization of second solution performance and for comparison between theory and experiment. Author (GRA)

N84-27742# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Abteilung Korrosion.

HOT CORROSION IN AIRCRAFT ENGINES

H. J. RAETZER-SCHIEBE Jan. 1984 239 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-887) (DFVLR-MITT-84-04; ESA-TT-887) Avail: NTIS HC A11/MF A01; DFVLR, Cologne DM 67

Hot corrosion behavior of high temperature materials, in particular heat resistant alloys used in aircraft gas turbines is reviewed. Corrosion phenomena of Ni-base and Co-base alloys were examined by burner rig tests, and protective coating systems were studied. It is found that the alloying constituents Cr, Ti, and Y improve the hot corrosion resistance while Al, Mo, and W deteriorate the sulphurization resistance. Author (ESA)

08

AIRCRAFT STABILITY AND CONTROL

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

A84-36567#

A SIMPLE ESTIMATION PROCEDURE OF ROLL-RATE DERIVATIVES FOR FINNED VEHICLES

D. D. KHURANA (Indian Space Research Organization, Vikram Sarabhai Space Centre, Trivandrum, India) and S. PRAKASH Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, May-June 1984, p. 318-320. refs

A generalized formulation is proposed for computing the roll-rate derivatives for finned vehicles, and an adaptation of proper fin-body and fin-fin interference effects is discussed. The calculations based on the method proposed are generally found to be in good agreement with experimental data. However, in certain cases at subsonic speeds, the present approach gives C_{lp} values that are too high. V.L.

A84-36574

FLIGHT MANAGEMENT SYSTEMS - WANTED BUT ONLY WHEN THEY WORK

P. CONDOM Interavia (ISSN 0020-5168), vol. 39, May 1984, p. 437, 439-441.

Technological innovations in computerized flight-management systems (FMS) are discussed. Following a brief review of the history and distinctive features of FMS technology, attention is given to the experience of several airlines in reducing costs and flight-deck workloads by using FMS. Among the functions performed by FMS are performance management, navigation, flight guidance, and display of the data for different flight modes. The FMS to be installed in the A320 aircraft is viewed as attaining a high degree of integration with other flight systems. All outer loop modes and cruise control settings on the A320 will be governed by the FMS computer. This degree of integration is expected to make it possible to eliminate the duplicated elements not required specifically for safety reasons, to reduce the weight of the system as a whole and to further, simplify the flight deck. Photographs of two different FMS systems are provided. I.H.

A84-37233

PROBLEMS CONCERNING THE STABILITY OF A FLIGHT VEHICLE AT A GIVEN ALTITUDE [VOPROSY USTOICHIVOSTI LETATELINOGO APPARATA NA ZADANNOI VYSOTE]

V. I. NESHCHERET IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 133-144. In Russian.

The paper generalizes Panchenkov's differential equations of motion of a lifting system near a support system obtained on the basis of asymptotic quadrupole wing theory. Raus-Gurvitz conditions are used to analyze the influence of cruising-flight parameters and the geometric parameters of the flight vehicle on its motion stability. The static stability is investigated, and the possibility of dynamic-stability breakdown is shown. B.J.

A84-37234

PROBLEMS IN THE LONGITUDINAL DYNAMICS OF A FLIGHT VEHICLE IN A BOUNDED FLOW [VOPROSY PRODOL'NOI DINAMIKI LETATEL'NOGO APPARATA V OGRANICHENNOM POTOKE]

V. A. ODAREEV IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 145-165. In Russian. refs

The results of Odareev (1979, 1981) concerning the motion of a flight vehicle of canard configuration near a support surface in the case of the periodic modulation of the angle of attack of the lifting complex are reviewed. Particular attention is given to the parametric resonance of the vehicle near a screen. B.J.

A84-37923#

FLY-BY-LIGHT CONTROLS

A. W. L. NAYLER Airship, Dec. 1983, p. 4, 5.

The development of a system of 'fly-by-light' controls for the SK-600 airship is discussed. The system moves each of the airship's four control surfaces by electric actuators mounted on the hinge-line between the control surface and the airframe, so that their rotational power is used directly. Signals are passed between the actuators and an onboard flight control computer by single-fiber, light-carrying cables protected by a buffer material, a plastic sheath, a Kevlar coating, and another plastic layer. The fiber-optic cables reduce the negative effects on control response caused by distortions of the flight envelope and eliminate the airship's vulnerability to lightning strikes. The use of fiber-optic cables will be accompanied by the introduction of autopilots, and it is expected that these will improve the viability of airships in the near future. Diagrams of the system's design are provided. I.H.

A84-37934*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PARAMETER IDENTIFICATION APPLIED TO THE OSCILLATORY MOTION OF AN AIRPLANE NEAR STALL

J. G. BATTERSON (NASA, Langley Research Center, Hampton, VA) and V. KLEIN (Joint Institute for Advancement of Flight Sciences, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 498-504. refs

Previously cited in issue 19, p. 2804, Accession no. A83-41905

A84-37947

DYNAMICS OF SPATIAL MOTION OF AN AEROPLANE WITH FIXED CONTROLS

Z. DZYGADLO and R. BOLDAK Journal of Technical Physics (ISSN 0324-8313), vol. 24, no. 2, 1983, p. 177-189. refs

The dynamics of the spatial motion of an aircraft perturbed by certain initial conditions has been studied. It was assumed that all the aircraft controls are indeformable and fixed. The complete nonlinear system of equations of motion was used in a body-fixed reference frame. The analytic method was applied to aerodynamic and other data of a TS-11 Iskra trainer. The initial perturbation of the steady motion of the aircraft was a transient increase in the angle of attack and that of sideslip. The variation of the parameters of perturbed motion was determined assuming no action of the pilot or autopilot. Couplings were detected between the longitudinal

and lateral motion of the aircraft; their variation depended on the flight conditions and the initial perturbations. C.D.

A84-38417

COMPARATIVE STABILITY ANALYSIS OF A CONVENTIONAL AND SWEEP FORWARD WING AIRCRAFT AT HIGH ANGLES OF ATTACK AND SIDESLIP

R. A. CALICO, JR. (USAF, Institute of Technology, Wright-Patterson AFB, OH) and S. G. FULLER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. 1.17.1-1.17.6. refs

The stability of an aircraft with a swept forward wing at high angles of attack and sideslip is determined analytically via two methods. The first of these considers an eigenvalue analysis of high angle of attack and sideslip trim conditions, and a stability envelope is determined. These results are compared with an approximate analysis which uncouples the translation and rotational motion of the aircraft and analyzes the stability of the latter. This method only requires the knowledge of static derivatives. This second approach reduces to the familiar $C_n(\text{dyn})$ criteria for symmetric flight. The results of the two methods are shown to yield good agreement. These results are also compared with the stability envelope for a conventional aircraft. Author

A84-38419

VALIDATION OF DATCOM METHODS FOR SWEEP FORWARD WINGS

D. G. SHARPES (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. 1.19.1-1.19.9. refs

The USAF Stability and Control Datcom has been available for over twenty years to aid in the determination of forces and moments acting on flight vehicles. The Datcom has been regularly updated since its inception to present more accurate methods or reduce configurational limitations. Among those limits were forward swept wings which were not considered practical design options until recently. As a result of in-house research at the Flight Dynamics Laboratory forward swept wing boundaries have been removed in the following areas: Wing Zero-Lift Angle of Attack at Subsonic Speeds; Wing and Wing-Body Linear Lift Curve Slope at Subsonic, Transonic and Supersonic Speeds; and Wing and Wing-Body Sideslip Derivatives at Subsonic Speeds. Datcom methodology for the above coefficients was evaluated by comparing wind tunnel data with calculated values. Datcom relations were found to give good overall agreement with the tunnel data. A better zero-lift angle of attack relation was developed and charts used to determine the effect of twist on the zero-lift angle were expanded to include sweptforward wings. Also, charts for use in the determination of rolling moment due to sideslip were reconciled to negative sweep angles. Author

A84-38425

PASSIVE DIVERGENCE CONTROL WITH FREE-FLOATING WING TIPS

G. LOEBERT (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) IN: Forward swept wing aircraft; Proceedings of the International Conference, Bristol, England, March 24-26, 1982. Bristol, University of Bristol, 1983, p. III.2.1-III.2.3.

An exploitation of the aerodynamic and configurational benefits of the forward swept wing (FSW) is only possible if either a stiffness weight penalty or the relatively high cost of a carbon fiber composite wing structure is accepted. On the other hand, a costly and failure-prone active control system is needed to achieve the performance, weight, and operational benefits of relaxed static stability, maneuver load control, and gust alleviation. The present investigation is concerned with an aircraft configuration which makes it possible to overcome both difficulties. This configuration is characterized by the combination of an aft tail with a forward swept wing with free-floating wing tips. This combination makes it

feasible to exploit the advantages of the FSW and the benefits of the CCV technology without the employment of costly aeroelastic tailoring and active control methods. G.R.

A84-38883#

REAL TIME STUDY OF A MICROPROCESSOR BASED FLIGHT CONTROL SYSTEM

A. SARWAL and K. S. RATTAN (Wright State University, Dayton, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 4-1-1 to 4-1-4. refs (Contract F33615-82-K-3603)

This paper presents a microprocessor based control system for controlling the longitudinal axis of the YF-16 aircraft. The longitudinal axis of the aircraft was simulated on the analog computer which was interfaced to a microprocessor. The existing continuous controllers were digitized and a software package was developed to implement these digital controllers and to carry out other control functions. Pulse and frequency responses were obtained and the results were compared to the theoretical results. Comparison of different methods of digitization were also carried out in this study. Author

A84-38884#

ESTIMATOR SYNTHESIS FOR FLUTTER CONTROL USING POSITIVITY OF TRANSFER MATRICES

G. L. SLATER (Cincinnati, University, Cincinnati, OH) and M. D. TAKAHASHI IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 4-3-1 to 4-3-6. refs

Positivity of both the feedforward and feedback block is a condition, which, if met, guarantees the stability of the entire system. A linear five mode wing flutter model with lag terms is used to formulate various reduced order models. These models are used to formulate estimator blocks to control the full model with and without actuator dynamics. The estimator gains are selected to guarantee the positive realness of the feedback block. Using this process, estimators can easily be designed that increase the dynamic pressure limit of instability by 45 percent. Author

A84-39285#

SIDESTICK CONTROLLERS FOR GENERAL AVIATION AIRCRAFT - A FEASIBILITY STUDY

A. HERRERA, D. DOWNWING, and J. ROSKAM (Kansas, University, Lawrence, KS) IN: General Aviation Technology Conference, Hampton, VA, July 10-12, 1984, Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1984, p. 73-81. refs (AIAA PAPER 84-2242)

This paper presents the results of a feasibility study on the use of sidestick controllers in general aviation airplanes. The study was limited to airplanes with reversible flight control systems only. The sets of equations that relate the vehicle motion to the controller parameters were documented in the form of the general longitudinal and lateral-directional trim problems. These equations were then implemented into computer programs, and the control stick force requirements were investigated for three typical general aviation airplanes: Cessna 172, C-303, and C-402. The paper includes the identification of the relevant FAR requirements, a discussion of the force limits for sidestick controllers, and the identification of the important design parameters. It is shown that, with minor redesign of the control surfaces and control system, present-day general aviation airplanes of the type investigated could be flown with a sidestick controller. Author

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A84-39716

SOME THOUGHTS ON MATHEMATICAL MODELS FOR FLIGHT DYNAMICS

H. H. B. M. THOMAS Aeronautical Journal (ISSN 0001-9240), vol. 88, May 1984, p. 169-178. refs

Changes introduced in a mathematical model of the aerodynamic behavior of whole aircraft by historical alterations in the performance demands, are discussed. Generally, two sets of equations are necessary: the aircraft parameters and the elastic equations for the deformation of components resulting from loading. Greater detail has been required to cover the past history of the aircraft motion to determine the instantaneous aerodynamic forces and moments. Consideration has to cover slip, roll at low and high speeds, spin entry and spin. All formulations require definitions of initial conditions that simulate the actual aerodynamic state. Commonly accepted terminology has been defined for spin model. It is suggested that various states of flight conditions may be segmented analytically and characterized sufficiently so that iterative calculations may be performed that involve a minimum number of submodels, to obtain the required solution. M.S.K.

A84-39740

DISTRIBUTED PARAMETER SYSTEM THEORY OF AUTOPILOT DESIGN OF SLENDER VEHICLE

J. SONG, J. YU (Beijing Institute of Control and Information, Beijing, People's Republic of China), G. ZHU, and D. BI (Chinese Academy of Sciences, Institute of Systems Science, Beijing, People's Republic of China) IN: Control of distributed parameter systems; Symposium, 3rd, Toulouse, France, June 29-July 2, 1982, Preprints . Oxford, Pergamon Press, Ltd., 1982, p. XVII.15-XVII.21. refs

The effect of structural elasticity in the autopilot design of a slender vehicle is addressed. The spectrum of aerodynamical elasticity, the spectrum perturbation of the gain and compensator feedback, the evolution equations and the critical stability, and the pole assignment of the gain feedback system are discussed. C.D.

N84-26706# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung fuer Flugmechanik.

IN-FLIGHT INVESTIGATION OF LANDING APPROACH FLYING QUALITIES OF TRANSPORT AIRCRAFT WITH RELAXED STATIC STABILITY

K. WILHELM and D. SCHAFRANEK Jan. 1984 86 p refs (DFVLR-FB-84-11) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 29

An in-flight simulator was used to investigate the influence of longitudinal static stability reduction on the landing approach flying qualities of transport aircraft. The static margin was varied from 14% MAC to -10% MAC by rearward center of gravity translation. No clear tendency of Cooper-Harper pilot ratings to deteriorate with decreasing stability is detectable until inherent instability, corresponding to 6 sec time-to-double amplitude, is reached. Mean Cooper-Harper ratings for all pilots show a slight improvement when the static margin is changed from 14% to 5% MAC. The effect of turbulence on the configuration is relatively low until time-to-double amplitude reaches 6 sec. For configurations with a time-to-double amplitude of 6 sec, turbulence intensity becomes greater and determines the gradient of deterioration. Pilot effort ratings and comments confirm the Cooper-Harper rating tendency. After an initial drop their effort to fulfill the task with the same accuracy in all cases increases with increasing instability.

Author (ESA)

N84-27743*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EVALUATION OF HIMAT AIRCRAFT LANDING APPROACH LATERAL CONTROL GEARING USING SIMULATION AND A VISUAL DISPLAY

S. K. SARRAFIAN May 1984 23 p refs (NASA-TM-84916; H-1205; NAS 1.15:84916) Avail: NTIS HC A02/MF A01 CSCL 01C

The utility of a visual display when studying the influence of changes in lateral stick gearing gains on the Highly Maneuverable Aircraft Technology (HiMAT) vehicle handling qualities during simulated approaches and landings is investigated. The visual display improved the validity of the simulation and provided improved roll response cues for the HiMAT aircraft landing approach. A range of acceptable constant lateral stick gearing gains is found that provides adequate maneuverability and allows for precision moments. M.A.C.

N84-27744*# Boeing Commercial Airplane Co., Seattle, Wash. **INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT: CURRENT AND ADVANCED ACT CONTROL SYSTEM DEFINITION STUDY** Summary Report, Jul. 1978 - Oct. 1980

Washington NASA Apr. 1982 82 p refs (Contract NAS1-14742; NAS1-15325) (NASA-CR-3545; NAS 1.26:3545; D6-49352) Avail: NTIS HC A05/MF A01 CSCL 01C

The Current and Advanced Technology ACT control system definition tasks of the Integrated Application of Active Controls (IAAC) Technology project within the Energy Efficient Transport Program are summarized. The systems mechanize six active control functions: (1) pitch augmented stability; (2) angle of attack limiting; (3) lateral/directional augmented stability; (4) gust load alleviation; (5) maneuver load control; and (6) flutter mode control. The redundant digital control systems meet all function requirements with required reliability and declining weight and cost as advanced technology is introduced. M.A.C.

N84-27745# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

MULTIVARIABLE DIGITAL FLIGHT CONTROL DESIGN OF THE X-29A M.S. Thesis

R. S. FELDMANN Mar. 1984 321 p (AD-A140983; AFIT/GE/EE/84M-3) Avail: NTIS HC A14/MF A01 CSCL 01C

Multivariable design techniques developed by Professor Brian Porter of the University of Salford, England are applied to the X-29A forward swept-wing demonstrator. The aircraft model is in a linearized state-space form at a number of different flight conditions. The computer aided design program MULTI is used to develop the control laws. Separate longitudinal and lateral controllers are developed for each of eight maneuvers of five different flight conditions: 0.4 Mach, 0k ft; 0.9 Mach, 50k ft; 1.2 Mach, 15k ft; 0.7 Mach, 15k ft; and 0.9 Mach, 0k ft. A universal lateral controller that is effective for all maneuvers at all flight conditions is developed. Finally, a universal lateral controller requiring only three distinct gains is developed. This minimum gain universal lateral controller produces minimal degradation of response, while permitting the elimination of gain scheduling usually required of digital flight controllers. In addition, maximum possible maneuvers are performed without exceeding control input limitations. Suggestions for improving MULTI to allow artificial intelligence algorithms are discussed. These would enable the designer to determine the number of point designs required to satisfactorily cover the flight envelope, and at the same time provide the designer with the capability of designing for many points with minimal effort. Author (GRA)

N84-27746# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

MULTIVARIABLE DIGITAL CONTROL LAWS FOR THE UH-60A BLACK HAWK HELICOPTER M.S. Thesis

B. H. MAYHEW Mar. 1984 261 p
(AD-A141046; AFIT/GE/EE/84M-6) Avail: NTIS HC A12/MF A01 CSCL 01C

This thesis investigates the application of multivariable design techniques developed by Professor Brian Porter of the University of Salford, England to design digital control laws for the UH-60A Black Hawk helicopter. In the study, designs were developed for five longitudinally and laterally, strongly coupled plants with control inputs of cyclic roll control, cyclic pitch control, collective lift control, and tail rotor yaw control. An improved computer-aided design packaged called MULTI was used in refining the control laws. Separate controllers were developed to perform three flight maneuvers. The maneuvers performed were a coordinated turn, a yaw rate response, and a vertical rate response. Since each maneuver is flown at a different airspeed, a uniquely specified linearized plant model was required. The methods employed to obtain a design are presented along with the evaluations of the final control laws. After successful designs of the individual control laws for the three maneuvers were developed, tests were performed to find a single controller to perform each maneuver for its applicable flight conditions. Finally, the evaluation of the robustness of the single controllers is presented. Author (GRA)

N84-27747# Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Torrejon de Ardoz (Spain). Seccion de Guiado.
DEVELOPMENT SITUATION FOR GUIDING SYSTEMS [SIMULADORES DE DESARROLLO PARA SISTEMAS DE GUIADO]

C. M. RICO 1983 14 p refs In SPANISH
Avail: NTIS HC A02/MF A01

The design of computerized simulation of guiding systems applied to remote controlled atmospheric vehicles is discussed. The problems found in the mathematical model complexity and nonlinearity and the limited speed of the available digital computers for real time operation are analyzed. General rules for the design of a simulator are proposed, and a system based on the Gould Sel 32/7780 32 bit minicomputer is described. Author (ESA)

N84-27748# Naples Univ. (Italy). Ist. di Progetto Velivoli.
ON THE STICK-FREE LONGITUDINAL DYNAMIC STABILITY OF A GENERAL AVIATION AIRCRAFT EQUIPPED WITH AN ALL-MOVABLE HORIZONTAL TAIL [SULLA STABILITA DINAMICA LONGITUDINALE A COMANDI LIBERI DI UN VELIVOLO DELL AVIAZIONE GENERALE CON PIANO DI CODA TUTTO MOBILE]

L. PASCALE (Partenavia), C. DAMATO (Partenavia), G. VERDE (Partenavia), E. CAVATORTA (Caeritalia Spa., Naples), O. CARROZZO (Aeritalia Spa., Naples), L. LECCE, and F. MARULO 1983 15 p refs In ITALIAN; ENGLISH summary Presented at 7th Assoc. Ital. di Aeron. e Astron. Cong. Nazl. sulla Base dell'Esame del Solo Sommaro, Naples, 26-28 Oct. 1983
Avail: NTIS HC A02/MF A01

Theoretical and experimental results for short period stick-free dynamic stability (porpoising) are compared. Classical dynamic equations of motion were used to describe the longitudinal stability of a turboprop aircraft equipped with an all-movable servotab longitudinal control system. Flight test evidence of dynamic stick-free instability does not agree with the theoretical analysis. The effect of an additional parameter, the torsional rigidity of the servotab plane, included in the model explains the difference between theoretical and flight-test results. Author (ESA)

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A84-36552#

TEST OF A PROBE USED TO SENSE ALTITUDE THROUGH MEASUREMENT OF PRESSURE

A. E. FUHS (U.S. Naval Postgraduate School, Monterey, CA) and K. D. TILLOTSON (General Dynamics Corp., Pomona, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, May-June 1984, p. 225, 226. Navy-supported research.

Previously cited in issue 19, p. 2984, Accession no. A82-39128

A84-36986#

HIGH PRESSURE RATIO TESTING WITH A NOZZLE DRIVEN EJECTOR

R. A. CONLEY (McDonnell Douglas Astronautics Co., St. Louis, MO) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 6 p. Research supported by the McDonnell Douglas Astronautics Co. (AIAA PAPER 84-1488)

This paper describes selected features of a cold flow static test facility for nozzle performance evaluations. An ejector assembly which uses the test nozzle exhaust to provide a tenfold increase in pressure ratio capability is also described. Thrust measurement accuracy assessments for standard and conical nozzles are discussed. Comparisons of ejector operating characteristics to theoretical predictions are also presented. Author

A84-37521

AIRCRAFT ARRESTING SYSTEMS [AERODROMNYE SISTEMY TORMOZHENIIA SAMOLETOV]

G. A. KHACHATUROV, A. M. MATVEENKO, D. E. KOPEV, and IA. I. KATS Moscow, Izdatel'stvo Mashinostroenie, 1984, 200 p. In Russian. refs

The use of aircraft arresting systems provides a relatively simple and efficient way to improve runway safety and to reduce the length of runways. Recent developments in aircraft arresting systems are reviewed, with particular attention given to the basic requirements that must be met by such systems, their classification, principal components, and design criteria. The discussion also covers a brief characterization of the existing types of aircraft arresting gear, the dynamics of the interaction between the arresting system and the aircraft, and optimization of the arresting system parameters. V.L.

A84-37995#

LOW SPEED CLOSED CIRCUIT HIGH PRESSURE TUNNEL FOR GAS FLOW SPARK GAP STUDIES

E. G. RUF and J. M. KUHLMAN (Old Dominion University, Norfolk, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. refs
(Contract N60921-81-C-A221)
(AIAA PAPER 84-1596)

The design and performance of a closed circuit, low speed, high pressure wind tunnel constructed to investigate the relationships among spark gap parameters are reviewed. The tunnel features control of the gas species, pressure, and temperature and is equipped to handle a variety of two-dimensional electrode geometries and materials. The flow velocity and turbulence levels can be varied at the interelectrode level. Optical windows in the tunnel permit flow visualization with schlieren photography and image converter cameras. Uniform velocities have been confirmed in the interelectrode region. Examples of measured spark gap performance are provided. M.S.K.

09 RESEARCH AND SUPPORT FACILITIES (AIR)

A84-38017*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NOZZLE OPTIMIZATION STUDY FOR QUIET SUPERSONIC WIND TUNNELS

I. E. BECKWITH (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA), M. R. MALIK, and F.-J. CHEN (NASA, Langley Research Center; High Technology Corp., Hampton, VA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 24 p. refs (AIAA PAPER 84-1628)

In the present study of the effects of operational factors and nozzle design parameters on the size of the quiet test section in several Mach 3.5 wind tunnel nozzles, the test results from a rapid expansion pilot nozzle with boundary layer removal slots upstream of the throat have shown that the low stream noise levels required for transition research are only obtainable with laminar nozzle wall boundary layers. Six different nozzles were evaluated, including a flat wall radial flow nozzle and a novel rod-wall nozzle. Attention is given to rms surface finish effects on quiet test region length. O.C.

A84-38618# TESTING STRUCTURAL INTEGRITY AND SERVICE LIFE

U. VAN ENDERT Dornier-Post (English Edition) (ISSN 0012-5563), no. 2, 1984, p. 13-15.

The Dornier 228 airframe is a combination of integral construction and fiber technology. The wing incorporates only single-slotted flaps, does not have edge slats, combines the latest aerodynamics, low weight, low maintenance costs and improved lift ratio. Static tests on the 228 airframe were performed on three major assemblies: the complete fuselage including vertical tail surfaces, the starboard outer wing with the inner wing and one flap, and the horizontal tail surface. Stress tests on the wing showed the structure to rupture at a 19 percent overload. Tests on the fuselage were conducted to simulate a five percent overload. Two load tests were conducted successfully on the horizontal tail surfaces. The design objective for the airframe is a no-repair service life of at least 30,000 flights or 24,000 hours, but as a result of experience gained from fatigue tests, the airframe structure has been specified for 62,500 flights or 50,000 flying hours under normal operating conditions. J.P.

A84-38619# THE DORNIER FLIGHT TEST CENTRE

U. V. MEIER and R. TAUCHMAN Dornier-Post (English Edition) (ISSN 0012-5563), no. 2, 1984, p. 46-52.

The large variety of testing tasks undertaken in the Dornier GmbH flight test center at Oberpfaffenhofen, FRG, has compelled the development of novel integrated measurement system concepts for both airborne and ground-based activities. The aircraft for which these facilities have been successfully used include the Do 228 and Alpha Jet. Test apparatus are capable of (1) pressure distribution and atmospheric measurements across wing sections under conditions that include icing; (2) flight attitude parameter measurements; (3) structural loading measurements; and (4) antenna and avionics measurements. Extensive use is made of telemetry and test data processing, and the monitoring of test sensors, by computers. O.C.

A84-38891# TRAINING EFFECTIVENESS EVALUATION OF THE C-130 WEAPON SYSTEM TRAINER WIDE-ANGLE VISUAL SYSTEM

M. R. ROCKWAY (Dayton, University, Dayton, OH) and R. T. NULLMEYER (USAF, Human Resources Laboratory, Williams AFB, AZ) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 6-2-1 to 6-2-5. refs

The purpose of this effort was to determine the effectiveness of the C-130 Weapon System Trainer (WST) visual system for training visually-oriented tactical airlift operational tasks. Several experiments were conducted using aircrew personnel from

populations being trained for initial qualification, mission qualification, and continuation training. Most of these studies compared the in-flight performance of personnel who had received prior training in the WST to performance of those who had not. Instructor ratings of student proficiency revealed positive transfer from the WST to the C-130 aircraft for most tasks. Recommendations are made concerning the actions required to optimize the value of the C-130 WST within the context of an integrated aircrew training program. Author

A84-39303# AN ASYMPTOTIC THEORY OF WIND TUNNEL WALL INTERFERENCE ON SUBSONIC SLENDER BODIES

N. D. MALMUTH (Rockwell International Science Center, Thousand Oaks, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 12 p. refs (AIAA PAPER 84-1625)

An asymptotic theory of solid cylindrical wind tunnel wall interference about subsonic slender bodies has been developed. The basic approximation used is of one of large wall radius to body length ratio. Matched asymptotic expansions show that in contrast to the analogous two-dimensional problem of a confined airfoil, three regions exist. Besides the incompressible cross flow and nearly axisymmetric zones, a wall layer exists where reflection in the wall of the line source representing the body becomes of dominant importance. From the theory, the interference pressures are shown to be approximately constant for closed bodies. Also demonstrated is that D'Alembert's paradox holds for interference drag of such shapes. Numerical studies comparing the exact theory to the asymptotic model, which provides drastic simplifications, show that the latter can be used with reasonable accuracy to describe flows, even where the characteristic tunnel radius body length ratio is as low as 1.5. Author

N84-26707# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

DESIGN STUDY FOR A LOW DENSITY WIND TUNNEL M.S. Thesis - 6 Dec. 1983 [ANTE-PROJETO DE TUNEL AERODINAMICO DE BAIXA DENSIDADE]

R. B. ABRAO Apr. 1984 167 p refs In PORTUGUESE; ENGLISH summary (INPE-3072-TDL/160) Avail: NTIS HC A08/MF A01

A basic study of the design of a low density wind tunnel is presented. The various components of the tunnel are described and the principal design parameters are analyzed. A detailed analysis of nozzle flow is made for designing supersonic nozzle for low density flows. The tunnel instrumentation, the principal difficulties involved in the theoretical and the experimental investigation of aerodynamics of satellites, as well as other aspects of interest are discussed. M.A.C.

N84-26708*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SUPPORT INTERFERENCE OF WIND TUNNEL MODELS: A SELECTIVE ANNOTATED BIBLIOGRAPHY

M. H. TUTTLE and P. L. LAWING May 1984 13 p Supplement to NASA-TM-81909: See N81-20084 (NASA-TM-81909; NAS 1.15:81909) Avail: NTIS HC A02/MF A01 CSCL 14B

This bibliography, with abstracts, consists of 143 citations arranged in chronological order by dates of publication. Selection of the citations was made for their relevance to the problems involved in understanding or avoiding support interference in wind tunnel testing throughout the Mach number range. An author index is included. E.A.K.

N84-26709# Army Armament Research and Development Command, Aberdeen Proving Ground, Md. Ballistic Research Lab.

A THREE-DEGREE-OF-FREEDOM FLIGHT SIMULATOR FOR SPIN-STABILIZED PROJECTILES Final Report

W. P. DAMICO, JR. Mar. 1984 23 p
(Contract DA PROJ. 1L1-62618-AH-80)
(AD-A140657; AD-F300411; ARBRL-MR-03341) Avail: NTIS HC A02/MF A01 CSCL 19A

A three-degree-of-freedom flight simulator has been constructed to model the free-flight angular motion of spin-stabilized projectiles. Hydraulic actuators are used to drive a conventional gimbal system producing pitch and yaw, while an electric motor yields steady roll rates as fast as 200 Hz. GRA

N84-26711# Systems Associates, Inc., Long Beach, Calif.

COMMAND FLIGHT PATH DISPLAY, PHASE 1 AND 2 Final Technical Report, 20 Apr. 1982 - 29 Sep. 1983

G. W. HOOVER, V. T. CRONAUER, S. SHELLEY (Intermetrics, Inc.), J. N. DITTENHAUSER (Calspan Corp.), B. J. EULRICH, and P. A. REYNOLDS (Calspan Corp.) Sep. 1983 94 p Prepared in cooperation with Calspan Corp.

(Contract F33615-79-C-3618)
(AD-A140870; CALSPAN-6645-F-12; R83-49-APP-A-E; S82-03-APP-A-E; SAI-83-01-APP-A-E) Avail: NTIS HC A05/MF A01 CSCL 09B

This report covers the development of the Command Flight Path Display System and the actual Flight Test Operation of the System including the evaluation of the CFPD concept by analysis of flight test recorded data. It proves the validity of the CFPD concept which consists of a totally integrated pictorial presentation of the fundamental information necessary to effectively perform all of the normal basic flight operations with and without reference to the real world. The actual flight test: (1) Demonstrated that the CFPD was in fact a truly integrated display which provided the pilot with adequate information to execute take-off, climb, cruise/navigation, approach and landing, without reference to conventional parametric displays, or the real world. (2) Established that pilot performance with the CFPD was enhanced, demanding minimal concentration on the display, minimizing inadvertent departures, and requiring minimal training time, both initially and for maintaining flight proficiency, as compared to performance utilizing standard symbolic displays. (3) Proved that the electronic system required to generate the CFPD can be achieved by modifying current aircraft display and control systems through the utilization of computer graphics picture processing techniques.

Author (GRA)

N84-26712# Systems Associates, Inc., Long Beach, Calif.

COMMAND FLIGHT PATH DISPLAY, PHASE 1 AND 2. APPENDICES A - E Final Technical Report

Sep. 1983 131 p Prepared in cooperation with Calspan Corp.
(Contract F33615-79-C-3618)
(AD-A140871; CALSPAN-6645-F-12-APP-A-E; R83-49-APP-A-E; S82-03-APP-A-E; SAI-83-01-APP-A-E) Avail: NTIS HC A07/MF A01 CSCL 09B

Ground simulation of the Command Flight Path Display System commenced on January 27, 1983, and continued through April 20, 1983. Approximately ninety-one hours of simulation were accumulated during this timeframe. The simulation flights involved display parameter changes and adjustments, introduction and preparation of pilots for the actual flight test, and demonstration flights. A breakdown of the simulation is presented in this report.

Author (GRA)

N84-26713# Battelle Columbus Labs., Ohio.

HEAT: INITIATED FURAN RESIN FOR RAPID RUNWAY REPAIR Final Report, Mar. - Sep. 1982

J. P. PFAU, F. A. FORSTER, R. L. HUGGINS, and M. J. SNYDER Tyndall AFB, Fla. Air Force Engineering and Services Center. Aug. 1983 31 p
(Contract F08635-82-C-0187; AF PROJ. 2673)
(AD-A140902; AFESC/ESL-TR-82-37) Avail: NTIS HC A03/MF A01 CSCL 11I

This project established the feasibility of a furan polymer concrete composition utilizing an inorganic latent catalyst which achieves a longer working time; has reduced mixing complexity, and possesses less sensitivity to variations in material temperature than previous compositions. This composition can be heat initiated to begin polymerization at any time up to the end of the working time and attains a minimum average flexural strength of greater than 500 psi 1 hour after placement. Several promising concepts were briefly explored in addition to the inorganic latent catalyst approach. The inorganic latent catalyst approach was unable to achieve cure through exotherm propagation at the lower temperatures using a flame-point initiation. Flame-point initiation consists of heating a portion of the repair surface with an open flame and allowing the exotherm to carry the polymerization (cure) throughout the polymer concrete. Due to the failure of this approach, a more conventional active acid blend with a freezing point below 5 deg F was used as a catalyst at the lower temperatures. GRA

N84-26714# Air Force Engineering and Services Center, Tyndall AFB, Fla. Engineering and Services Lab.

EVALUATION OF SELECTED COMMERCIAL CONSTRUCTION EQUIPMENT FOR BOMB DAMAGE REPAIR Final Report, Jan. - Jun. 1980

E. F. ALEXANDER and R. W. GRAHN Mar. 1984 54 p
(Contract DA PROJ. 2054)
(AD-A140907; AFESC/ESL-TR-81-49) Avail: NTIS HC A04/MF A01 CSCL 13C

Three pieces of commercial equipment, a loader, an excavator, and a combination loader/backhoe, were evaluated for use in rapid repair of damaged airfields. The equipment was evaluated for their ability to remove damaged, upheaved concrete from around bomb craters. The actual force required to remove damaged concrete was also measured on an explosively formed crater. The force required was found to be in the 20,000-25,000 lb range. Of the three pieces of equipment evaluated the most capable was the large front-end loader; however, it was found to be too large for the smaller craters. The hydraulic excavator would be the best machine for the job if it had at least 25,000 pounds of breakout force. GRA

N84-26715# Federal Aviation Administration, Washington, D.C. Program Engineering and Maintenance Service.

AIRFIELD DELAY SIMULATION MODEL (ADSIM) USERS GUIDE

H. MONK and R. HOLLADAY Jan. 1984 116 p
(PB84-171552; DOT/FAA/PM-84/2; FAA-DF-84-001A) Avail: NTIS HC A06/MF A01 CSCL 01E

ADSIM is a discrete event simulation model which can be used to study airport capacity and delay. The model calculates travel time, delay, and flow rate data to analyze components of an airport, airport operations, and operations in the adjacent airspace. This document provides the information necessary to use the ADSIM appropriately. It describes the modeling methodology and contains instructions for preparing the input data, applying the model, and interpreting the output. Author (GRA)

09 RESEARCH AND SUPPORT FACILITIES (AIR)

N84-26716# Ducharme (Robert G.), Inc., Deerfield, Ill.
AIRPORT NOISE AND LAND USE COMPATIBILITY AT DOWNSTATE ILLINOIS AIRPORTS
R. G. DUCHARME Aug. 1983 80 p refs Sponsored by the Illinois Dept. of Energy and Natural Resources (Contract PROJ. 83/5002)
(PB84-177377; IL-ENR/RE-83/27) Avail: NTIS HC A05/MF A01 CSCL 01E

This report represents the second and final phase of an airport noise demonstration project at the Decatur Airport that was launched in 1982. The objective of this project was to show how an airport and its neighboring community can develop and implement a program to correct and prevent airport noise exposure problems. GRA

N84-27749* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DIFFUSER/EJECTOR SYSTEM FOR A VERY HIGH VACUUM ENVIRONMENT Patent

K. E. RIGGS (Lockheed Missiles and Space Co., Huntsville, Ala.) and C. J. WOJCIECHOWSKI, inventors (to NASA) (Lockheed Missiles and Space Co., Huntsville, Ala.) 19 Jun. 1984 10 p Filed 19 Aug. 1982 Supersedes N82-33712 (20 - 24, p 3441) Sponsored by NASA
(NASA-CASE-MRS-25791-1; US-PATENT-4,454,753; US-PATENT-APPL-SN-409678; US-PATENT-CLASS-73-117.1; US-PATENT-CLASS-417-159) Avail: US Patent and Trademark Office CSCL 14B

Turbo jet engines are used to furnish the necessary high temperature, high volume, medium pressure gas to provide a high vacuum test environment at comparatively low cost for space engines at sea level. Moreover, the invention provides a unique way by use of the variable area ratio ejectors with a pair of meshing cones are used. The outer cone is arranged to translate fore and aft, and the inner cone is interchangeable with other cones having varying angles of taper.

Official Gazette of the U.S. Patent and Trademark Office

N84-27751# Federal Aviation Administration, Atlantic City, N.J.
MARKING AND LIGHTING OF UNPAVED RUNWAYS - INSERVICE TESTING

V. F. DOSCH and G. S. BROWN Mar. 1984 46 p
(AD-A140958; FAA-CT-84-11) Avail: NTIS HC A03/MF A01 CSCL 01E

This document describes the results of inservice testing of an FAA developed unpaved runway airport marking and lighting system. Inservice testing of the prototype unpaved runway marking and lighting system was conducted at separate utility airports having essentially different environmental conditions. User participating pilots were, in general, favorably impressed with the standardized system concept. They did, however, indicate several aspects of the system that could be improved or modified. This report details results of this inservice evaluation, and provides conclusions as to desirable changes that might enhance system effectiveness. GRA

N84-27752# Pennsylvania Transportation Inst., University Park.
ANALYTICAL AND EXPERIMENTAL STUDY OF GROOVED PAVEMENT RUNOFF Final Report, May 1981 - Aug. 1983

J. R. REED, D. F. KIBLER, and M. L. PROCTOR Aug. 1983 72 p Original contains color illustrations
(Contract DTFA01-81-C-10037)
(AD-A141021; PTI-8318; DOT/FAA/PM-83/34) Avail: NTIS HC A04/MF A01 CSCL 01E

Drainage characteristics of grooved runways were investigated. An analytical model, developed from unsteady flow theory, was solved on a computer in order to predict runoff depths for various rainfall rates on a 100-ft-wide runway sloping transversely at 1.5%. The hydraulic roughness used by the model was predicted from pavement macrotecture. Experiments to check the validity of the model were conducted using artificial rain indoors on a 30-ft-by-15-ft portland cement concrete slab sloping at 1.5% along the 30-ft side. Rainfall rates of 1.15 and 2.45 in./hr were applied to the

slab with rectangular grooves parallel to the 30-ft side and spaced at infinity, 5, 2.5, and 1.25 in. Data on the slab surface showed that water depths were smaller, and the hydraulic roughness was larger, than expected. The model was adjusted accordingly, and used to generate curves of water depths and their reductions versus distance out to 100 ft for a rainfall of 3 in./hr and a hydraulic roughness of 0.056. Predicted reductions in water depths ranged from 100% through 39 ft to 27% at 100 ft for the 1.25-in. spacing; from 100% through 19 ft to 14% at 100 ft for the 2.5-in. spacing; and from 100% through 9 ft to 7% at 100 ft for the 5-in. spacing. GRA

N84-27753# Canyon Research Group, Inc., Westlake Village, Calif.

SIMULATOR DESIGN FEATURES FOR AIR-TO-GROUND BOMBING. PART 1: PERFORMANCE EXPERIMENT 1 Interim Final Report, 1 Sep. 1981 - 31 Aug. 1984

D. P. WESTRA Sep. 1983 70 p
(Contract N61339-81-C-0105)
(AD-A141190; NAVTRAEQUIPC-81-C-0105-4) Avail: NTIS HC A04/MF A01 CSCL 05I

The Visual Technology Research Simulator (VTRS) at the Naval Training Equipment Center was used to study the effects of six factors on air-to-ground bombing performance. The purpose of the experiment was to obtain information relevant to the design of simulators used for skill maintenance and transition training and to obtain information for making decisions about future transfer-of-training studies. The task was 30-degree cone pattern manual dive bombing initialized at 8000 feet altitude. Pilots who participated in the experiment were navy fleet pilots experienced in air-to-ground bombing. Factors studied were system lag (117 msec vs. 217 msec), background offset (-40 degrees vs. no offset), edge segmentation (up to 16 per modelled edge vs. no-edge segmentation), motion (platform motion vs. none), and g-seat (operational g-seat vs. none). Scene type was also included as a factor with four scenes ranging in type and content from a skeletal grid pattern to a relatively complex scene with mountain ranges and a river valley. Results indicated small to null effects for all factors but scene type. Scene type affected a number of performance measures, suggesting that further study to determine transfer of training effects is warranted. Author (GRA)

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ASTRONAUTICS

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

A84-36965#
DEVELOPMENT OF A FAST RESPONSE JI CONTROL SYSTEM GUIDED BY ANALYTICAL TRANSIENT RESPONSE COMPUTER MODELING

T. J. FANCIULLO (Aerojet TechSystems Co., Sacramento, CA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. refs
(AIAA PAPER 84-1252)

Hypersonic interceptors countering the threat posed by hostile reentry vehicles endoatmospherically can incorporate Jet Interaction (JI) control systems which provide faster maneuvering response with less aerodynamic drag. A validation program has demonstrated the transient and frequency response in pitch, yaw and roll control for JI thrusters exhibiting thrust modulation and durability suitable for hypersonic missiles. A fluid dynamics computer model was used to mechanistically model the dynamic behavior of the pressurization, propellant tankage, and propellant

distribution subsystems, together with a 12-degree-of-freedom engine response model. O.C.

A84-36967#
STUDIES OF CONVERTIBLE TURBOSHAFT-TURBOFAN ENGINES FOR HIGH SPEED ROTORCRAFT

R. E. NEITZEL, R. HIRSCHKRON, and P. W. VINSON (General Electric Co., Lynn, MA) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 10 p. refs (AIAA PAPER 84-1268)

Rotary wing aircraft require auxiliary thrust to fly at speeds higher than current helicopters. One approach is to use the turboshaft engine to drive both the vehicle rotor and a variable geometry fan which allows independent variation of SHP and thrust. Various convertible engine configurations including variable pitch (VP) fans, variable inlet guide vane (VIGV) fans, and clutched fans are described and their suitability for two types of aircraft is examined. One is a 225 knot U.S. Army combat rotorcraft in which the rotor operates in high speed flight. The variable IGV fan with or without a clutch is shown to be a viable approach. The second aircraft is a 400 knot X-wing commercial transport in which the rotor is stopped in flight. The variable IGV fan and prop/shaft systems are shown to be competitive. Author

A84-36984#
DEVELOPMENT OF A SUPERSONIC TURBINE STAGE FOR THE HM60 ENGINE

L. ERIKSSON (Volvo Flygmotor AB, Trollhattan, Sweden) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 6 p. (AIAA PAPER 84-1464)

The HM60 liquid propellant engine currently under development incorporates a supersonic flow turbine, in order to satisfy the high pressure requirement of the first stage of a two-stage liquid hydrogen turbine and the single stage of a liquid oxygen turbine. Attention is given to the results of laboratory tests conducted for this configuration with hot compressed air rather than cryogenic fluids in order to obtain realistic conditions at low cost. It is noted that boundary layer stability is critical on the turbine blades' convex side, so that the blade airfoil profile design must carefully avoid separation. O.C.

A84-37663#
REUSABLE SINGLE-STATE-TO-ORBIT VEHICLE CONCEPT UTILIZING COMPOSITE ENGINES

A. D. BARNARD, M. W. BERUBE, S. Q. ELDRID, M. V. POWERS, and E. T. WHITE AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 13 p. Research supported by the Rensselaer Polytechnic Institute. refs (AIAA PAPER 84-1498)

A study has been conducted of a single-stage-to-orbit vehicle concept utilizing composite (multi-mode) propulsion. Particular emphasis has been placed on the conceptual design and thermodynamic analysis of air turborocket engines used during the initial segment of the launch trajectory. Four separate propulsion modes were selected for sequential application along the flight trajectory. The modes (in order) are: air turborocket, ramjet (integral with air turborocket), scramjet, and, finally, liquid propellant rocket. Whenever possible, existing technology was utilized in the engine and vehicle design. The principle characteristics of the air turborocket engine are: sea level static thrust of 74,000 lb with a specific impulse of 2375 sec. The vehicle was designed to carry a payload of 500 kg to low earth orbit, and then reenter as a glider. The principle vehicle characteristics are: length of 50.9 ft (15.5 m), maximum width (without control surfaces) of 16.7 ft (5.1 m) and gross lift-off weight of 29,060 lbs (13,200 kg). The primary mission envisioned for this vehicle is personnel resupply for space stations. Author

A84-38150
RESIDUAL THRUST DUE TO DECOMPOSITION OF INSULATOR MATERIALS

T. MITANI and T. NIIOKA (National Aerospace Laboratory, Kakuda, Miyagi, Japan) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 191-197.

After the solid propellant has burned out, the insulator continues to decompose and to generate a very small residual thrust. The residual thrust causes fatal troubles in the vehicles flying at a high altitude. The present work presents a theoretical treatment for the small thrust originated from the decomposed gases. The phenomena were formulated to be an unsteady heat conduction problem with a decomposition reaction driven by time-dependent radiative heat transfer. The problem was analytically solved using an asymptotic expansion method for a large activation energy of the decomposition reaction. The results were applied to an evaluation of the residual thrust of a 90 cm diameter spherical motor. Author

A84-38151
THE INVESTIGATION OF ENGINES FEED SYSTEMS DYNAMIC CHARACTERISTICS BY HYDRODYNAMIC MODELLING METHOD

V. A. SHERSTIANNIKOV and V. M. KALNIN (Akademii Nauk SSSR, Moscow, USSR) IN: International Symposium on Space Technology and Science, 13th, Tokyo, Japan, June 28-July 3, 1982, Proceedings. Tokyo, AGNE Publishing, Inc., 1982, p. 199-203.

A hydrodynamic model was devised for transient processes in jet engine feed systems. The nonsteady processes considered include hydraulic shock, a high gradient in the gas flow rate, and the turbine rotational speed. The model was used to simulate the performance of an aircraft gas turbine, and predictions were compared with measurements from five different engines. Little effect on turbine efficiency was observed over a wide range of dynamic rotor acceleration. Good agreement was obtained between test data and the model predictions. M.S.K.

A84-39715
THE VON KARMAN INSTITUTE FOR FLUID DYNAMICS - TEACHING AND RESEARCH

J. J. GINOUX (Bruxelles, Universite Libre, Brussels; Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) Aeronautical Journal (ISSN 0001-9240), vol. 88, May 1984, p. 160-168.

The organization, curriculum, degrees offered, and general goals of the von Karman Institute for Fluid Dynamics (VKI) are summarized. VKI is internationally funded to further expertise in aerodynamics. Many small research contracts are fulfilled each year, forming a significant part of the support for the Institute. Total enrollment, postgraduate and undergraduate, is over 150 regular students and hundreds of short-term participants. Degree programs are currently offered in aeronautics/aerospace, environmental and applied fluid dynamics and turbomachinery, with emphasis placed on individual research projects. Doctoral degrees are awarded by an affiliated Belgian university. Details of the engineering facilities are provided. M.S.K.

CHEMISTRY AND MATERIALS

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

A84-36521**FLIGHT SERVICE EVALUATION OF COMPOSITE COMPONENTS ON BELL 206L AND SIKORSKY S-76 HELICOPTERS**

D. J. BAKER (U.S. Army, Structures Laboratory, Hampton, VA) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, April 1984, p. 3-11.

Progress on two programs to evaluate composite structural components in flight service on commercial helicopters is described. Thirty-six ship sets of composite components that include the litter door, baggage door, forward fairing, and vertical fin were installed on Bell Model 206L helicopters that are operating in widely different climatic areas. Four horizontal stabilizers and ten tail rotor spars that are production components on the S-76 helicopter were tested after prescribed periods of service to determine the effects of the operating environment on their performance. Concurrent with the flight evaluation, specimens from materials used to fabricate the components were exposed in ground racks and tested at specified intervals to determine the effects of outdoor environments. Results achieved from 14,000 hours of accumulated service on the 206L components, tests on a S-76 horizontal stabilizer after 1600 hours of service, tests on a S-76 tail rotor spar after 2300 hours service, and two years of ground based exposure of material coupons are reported. Previously announced in STAR as N83-19815 Author

A84-36522**INFLUENCE OF HYGROTHERMAL CONDITIONING ON THE COMPRESSIVE BUCKLING OF GRAPHITE/EPOXY COMPOSITE STRUCTURES**

L. W. REHFELD, J. PRUCZ (Georgia Institute of Technology, Atlanta, GA), and P. L. N. MURTHY American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, April 1984, p. 12-15. refs (Contract AF-AFOSR-82-0080; DAAG29-82-K-0094)

Considerable research activity on composite materials has been directed towards the study of hygrothermal effects. These effects are consequences of combined exposure to moisture and elevated temperature environments. Their influence on compressive buckling of graphite/epoxy structures has been studied analytically. Two primary mechanisms are identified which control behavioral changes. The first is associated with transverse shear deformations; it dominates the behavioral changes in a simple unidirectional column, but appears to be a minor influence on practical configurations. The second is the reduction of the primary bending stiffness with hygrothermal conditioning; it is the dominant influence on the behavior of the wide column structure of practical construction. Buckling resistance reductions of over twenty percent in extreme situations are predicted, but, apparently, normal operating environments do not cause significant reductions. Author

A84-36800#**LIGHTWEIGHT ALUMINUM-LITHIUM ALLOYS POISED FOR TAKEOFF**

V. WIGOTSKY Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 74-77.

Low density aluminum-lithium alloy replacements for the current 2000 and 7000 series aircraft alloys will offer significant improvements in such design properties as ultimate and yield tensile strengths, compressive yield strength, elongation, and fracture toughness. This is due to the ability of lithium to decrease aluminum's density while increasing its stiffness. The specific elasticity/weight modulus of an alloy with 2.8 percent lithium by

weight is 21 percent higher than that of the alloy 2024-T351, and 26 percent higher than that of 7075-T651. The higher specific modulus reduces the rate of fatigue crack growth. Studies have established that material density reductions have greater aircraft structure weight saving influence than increased material strength, stiffness, and durability and damage tolerance. O.C.

A84-37040**MATERIALS IN AERONAUTICAL RESEARCH (LES MATERIAUX DANS LA RECHERCHE AERONAUTIQUE)**

P. COSTA (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) Air et Cosmos (ISSN 0044-6971), May 5, 1984, p. 171, 172, 174-180 (4ff). In French.

Research and applications being studied in the development of lighter alloys and composite structures for aircraft power plants are discussed. Aluminum alloys, some with Li additives, superalloys, and ceramics are being investigated for use in engines. The metal parts are formed with powder metallurgy and hot isostatic pressure (HIP) techniques. Ceramic casings provide heat resistant, strong turbine casings. The elements Ta, Re, W, and Mo are candidates for turbine blade materials that can withstand high rotation speeds and temperatures above 1500 C. Continued tests to validate lifetimes, durability, damage resistance, nondestructive testing and maintenance procedures are still necessary. Particular efforts are being expended to introduce materials which do not originate in countries experiencing political instability. M.S.K.

A84-38500#**SIMPLE METHOD FOR ANALYSIS OF BENZO(A)PYRENE IN EXHAUST PARTICLES FROM JET ENGINE BY HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY USING EXTRELUT EXTRACTION**

Y. MIYAMOTO and A. KOBAYASHI (Japan Air Self-Defense Force, Aeromedical Laboratory, Tachikawa, Tokyo, Japan) Japan Air Self Defense Force, Aeromedical Laboratory, Reports (ISSN 0023-2858), vol. 24, Dec. 1983, p. 203-208. In Japanese, with abstract in English. refs

A84-38808**HOT ISOSTATIC PRESSING FOR THE REPAIR OF HOT SECTION TURBINE PARTS**

H. KOVEN (Chromalloy American Corp., Midwest City, OK) and D. G. ATTWOOD (Chromalloy Aeroservices, Ltd., Nottingham, England) IN: International Conference on Isostatic Pressing, 2nd, Stratford-upon-Avon, W. Midlands, England, September 21-23, 1982, Proceedings. Volume 1. Shrewsbury, Worcs., England, MPR Publishing Services, Ltd., 1982, p. 18-1 to 18-20. refs

Some results of the use of hot isostatic pressing (HIP) to reduce microporosity in turbine components are discussed. For stress rupture type applications, HIP processing can improve mean property levels and decrease scatter bands. Data showing that fatigue properties can be improved by HIP processing are presented. Actual examples of the use of HIP in these applications are described. The equipment requirements for these HIP tasks are summarized. C.D.

A84-38889#**THE STUDY OF GRAPHITE/EPOXY REPAIR VARIABLES USING A DOUBLE LAP SHEAR SPECIMEN**

F. S. SANDOW and E. STEPHEN (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 5-8-1 to 5-8-5.

There are many variables which affect the strength and reliability of the repairs to graphite/epoxy structure. This program uses a double lap shear joint representing a simulated repair to isolate the effects of (1) moisture content prior to repair, (2) moisture removing procedures, (3) co-curing procedures, (4) surface treatment, (5) loading conditions and (6) joint design. Author

N84-39212

FRACTURE TOUGHNESS ACCEPTANCE TESTING OF ALUMINUM ALLOYS FOR AIRCRAFT APPLICATIONS

K. R. BROWN (Kaiser Aluminum and Chemical Corp., Center for Technology, Pleasanton, CA) IN: Fracture mechanics technology applied to material evaluation and structure design; Proceedings of the International Conference, Melbourne, Australia, August 10-13, 1982. The Hague, Martinus Nijhoff Publishers, 1983, p. 257-270. refs

It is pointed out that the aerospace industry is concerned with the prevention of both plane strain fractures, which involve little plastic deformation near the crack tip, and plane stress fracture which may be associated with extensive plasticity. The employed test methods are discussed, taking into account plane strain tests, plane strain screening tests, mixed mode tests, mixed mode screening tests, plane stress tests, and plane stress screening tests. A summary is presented regarding the general approaches taken, and the different fracture toughness tests favored in different specifications issued by ten major aircraft manufacturers. It is concluded that there is a clear need for standardization in test methods and data interpretation, and for cooperation in data collection throughout the industry. G.R.

N84-39488

THE EFFECT OF CYCLIC OVERLOADS ON THE LONG-TERM STRENGTH OF A GAS-TURBINE DISK ALLOY [VLIANIE TSIKLICHESKIKH PEREGRUZOK NA DLITEL'NIUI PROCHNOST' DLIA DISKOV GTD]

E. R. GOLUBOVSKII, G. P. MELNIKOVA, I. P. BULYGIN, F. V. IUSHAKOVA, and L. P. SOROKINA Problemy Prochnosti (ISSN 0556-171X), June 1984, p. 10-14. In Russian. refs

Long-term strength data are presented for a gas-turbine disk alloy, EI698VD, which has been tested at 650 C with overloads. By using an experimental design, an expression is obtained which relates the time to failure to the magnitude of the overload, its duration, and the number of overload cycles. It is shown that the linear law of summation of relative lives is not valid in the case studied due to differences in the mechanisms of creep strain accumulation. V.L.

N84-39497

A STUDY OF THE FATIGUE STRENGTH OF HEAT-RESISTANT NICKEL ALLOYS WITH COATINGS [ISSLEDOVANIE SOPROTVIENIYA USTALOSTI ZHAROPROCHNYKH NIKELEVYKH SPLAVOV S POKRYTIAMI]

V. N. PAVLOV, E. IA. PALIENKO, and A. D. POGREBNIAK (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), June 1984, p. 117-121. In Russian. refs

Experiments have been carried out to investigate the effect of calorizing and aluminosiliconizing on the long-term strength and fatigue resistance of the nickel-base heat-resistant alloys ZhS6K and EI867. It is shown that an increase in the coating thickness from 20 to 70 microns leads to a reduction in the fatigue strength of the alloys studied. This result is ascribed to structural changes in the alloys that are induced by interdiffusion between the coating and the substrate. V.L.

N84-26600# PPG Industries, Inc., Pittsburgh, Pa. Glass Research Center.

NEW AIRCRAFT WINDSHIELD APPLICATIONS USING ION EXCHANGE GLASS

W. W. HORNSEY and W. F. ROTHE In Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 57-70 Dec. 1983

(AD-P003187) Avail: NTIS HC A08/MF A01 CSCL 01C

The primary goal of the test program was to develop stress versus velocity curves for each of seven cross sections. To minimize the effect of other variables, the samples were 26 inches square with radius corners and were fabricated with outboard glass thickness and interlayer thicknesses held constant while the internal and inboard glass ply thicknesses were varied. Each sample was instrumented with a minimum of one 2-element rosette strain gage

on the inboard glass surface opposite the impact point. Prior testing had confirmed that the maximum stress would always be at the inboard surface of the inner glass ply on two structural ply laminates. Some samples had additional element gages above and below the impact point to determine the peak stress location. To determine the effect of test frame stiffness, curves were developed at a 37 degree angle to the bird path in two different test frames. GRA

N84-26605# Texstar Corp., Grand Prairie, Tex.

TESTING POLYCARBONATE FOR UTILIZATION IN THE PRODUCTION OF TRANSPARENT ENCLOSURES

A. J. BONJE and J. IRION In Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 174-182 Dec. 1983 (AD-P003192) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper looks at the polycarbonate now being utilized in the fabrication of high performance aircraft enclosures. Polycarbonate is now being utilized both in a monolithic form and in conjunction with traditional enclosure materials; such as acrylic, and glass. It is the intent of this paper to look at the testing and evaluation of polycarbonate prior to processing into acceptable enclosure hardware. The present procurement specifications such as MIL-P-83310 or L-P-393 are inadequate in addressing materials properties that are critical in the processing and fabrication of acceptable hardware. Since material properties can determine acceptable hardware and therefore the yield from any given lot of material, this can dramatically effect the price of finished goods. In addition, these material properties can ultimately impact the quality and life of the finished enclosures. GRA

N84-26606# National Research Council of Canada, Ottawa (Ontario).

DEGRADATION OF THE BIRD IMPACT RESISTANCE OF POLYCARBONATE

J. B. R. HEATH and R. W. GOULD In Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 183-211 Dec. 1983

(AD-P003193) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper describes a program, comparing the bird impact resistance of new as-extruded polycarbonate with polycarbonate that has undergone natural aging, artificial heat aging, fabrication heat treatments, and fabrication heat treatments with subsequent artificial heat aging. The two pound bird impacts were carried out on flat 24 inch by inch monolithic specimens mounted 45 degrees to the horizontal. A rigid test frame incorporating a clamped specimen edge design was utilized. Bird impacts on the modified material resulted in a significant decrease of penetration velocity, with a corresponding change from a ductile to a brittle type failure mode. GRA

N84-26607# Dayton Univ., Ohio.

THE EFFECT OF ACCELERATED ULTRA VIOLET WEATHERING ON THE RAIN EROSION RESISTANCE OF COATED AIRCRAFT TRANSPARENCIES

C. J. HURLEY and G. F. SCHMITT In its Conf. on Aerospace Transparent Mater. and Enclosures p 213-236 Dec. 1983 (AD-P003194) Avail: NTIS HC A08/MF A01 CSCL 01C

Three proprietary coatings on monolithic polycarbonate transparency material were examined. The coated polycarbonate materials were exposed to one and three years of accelerated ultra violet exposure. The specimens were then exposed at a 30 degrees impact angle to a simulated one inch/hour rainfall at 500 mph in the AFWAL Mach 1.2 Rain Erosion Test Apparatus. Percent coating removal as a function of rainfield exposure was determined. Accelerated UV weathering exposure did not directly affect the coatings' behavior under rainfield exposure conditions but did have an indirect effect on the adhesion of the coatings to the polycarbonate substrate materials. SEM techniques are the most effective in assessing the role of mechanistic processes in rain erosion phenomena. GRA

11 CHEMISTRY AND MATERIALS

N84-26609# British Airways, Middlesex (England).

SOME CRAZING EXPERIMENTS ON AS-CAST ACRYLIC TO MIL-P-8184

K. B. ARMSTRONG *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 260-274 Dec. 1983 (AD-P003196) Avail: NTIS HC A08/MF A01 CSCL 01C

A first set of experiments was done to provide threshold crazing stress data on As-cast acrylic to MIL-P-8184 using a variety of fluids likely to be found in an airline environment. A second set of experiments was done to study the effect of water soluble cutting oils on acrylic. The oils were for potential use as corrosion inhibitors on a machine for sanding acrylics. A third and smallest experiment was to study the effect of de-icing fluid (propylene glycol) on cast acrylic following the discovery of de-icing fluid between the inner and outer panes on Trident passenger windows. The results of these experiments led to the measurement of a crazing stress of water and also cast doubt upon using threshold crazing stresses after 30 minutes testing. It would appear that some fluids do not reach their threshold in 30 minutes and need to be tested for a longer time. GRA

N84-26614# Naval Research Lab., Washington, D. C.

FLUROEPOXY AND FLUROACRYLIC TRANSPARENCIES

J. R. GRIFFITH *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 407-414 Dec. 1983 (AD-P003201) Avail: NTIS HC A08/MF A01 CSCL 01C

Heavily fluorinated epoxy resins and acrylic polymers which have been synthesized and developed at NRL during the last fifteen years are transparent, nearly colorless plastics of low refractive index which seem to be prime candidates for aerospace transparency applications. The presence of 50% or more fluorocarbon in these classes of well-known polymers impart some properties which are uncommon and may be of special benefit in selected instances. For example, a helicopter with a fluoropolymer canopy could be expected to have better visibility in a rain storm than one with a conventional type because the unusual hydrophobicity of the fluorinated material would prevent wetting and consequent shimmering on the surfaces. Also, the refractive indices of the fluoropolymers are quite low compared to those of the common materials and this should result in less optical distortion of transmitted light. GRA

N84-26615# Coors Porcelain Co., Golden, Colo.

POLYCRYSTALLINE MGAL2O4 SPINEL FOR HIGH PERFORMANCE WINDOWS

D. W. ROY and J. L. HASTERT *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 415-426 Dec. 1983 (AD-P003202) Avail: NTIS HC A08/MF A01 CSCL 01C

There is a need for optical materials which are highly transparent at wavelengths from the ultraviolet to the infrared, hard enough to resist high speed rain erosion, strong enough to resist mechanically or thermally induced fracturing and are inexpensive to fabricate. Magnesium aluminate spinel possesses an unusual combination of optical, dielectric, physical and mechanical properties that make it an attractive candidate for windows on EP systems that are moving at very high speeds, and is cost effective when compared with sapphire. Spinel is cubic and optically isotropic; thus polycrystalline shapes may be fabricated without the severe scattering problems inherent in noncubic materials. In the microwave region the isotropy of spinel prevents localized absorption and heating that occurs in noncubic materials because of differing grain boundary orientation and anisotropic dielectric loss index. Spinel undergoes no polymorphic transformations and is thus free of problems due to thermally induced phase changes. GRA

N84-26616# Swedlow, Inc., Garden Grove, Calif.

AN IMPROVED ACRYLIC SHEET MATERIAL WITH ENHANCED CRAZE RESISTANCE

M. V. MONCUR and W. F. FISHER *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 428-450 Dec. 1983 (AD-P003203) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper describes a new acrylic material developed by Swedlow, Inc., Acrivue 351, which has been designed to provide improved resistance to water-induced crazing when compared to current acrylic materials. Acrivue 351 combines the high inherent craze resistance of MIL-P-8184 acrylic plastic with the low moisture uptake characteristic of MIL-P-5425. Stretching of Acrivue 351 further enhances its inherent craze resistance. Results of lab craze studies are presented, comparing as-cast Acrivue 351 to MIL-P-8184 and MIL-P-5425 acrylic materials. Standard solvent stress crazing tests were used to determine craze resistance of these materials as a function of water content. The crazing stress advantage of Acrivue 351 over the other cast acrylic materials increases upon exposure to moisture. Other properties of Active 351 are very similar to MIL-P-8184 acrylic sheet. GRA

N84-26617# PPG Industries, Inc., Pittsburgh, Pa. Glass Research Center.

PROTECTIVE LINEAR MATERIALS FOR TRANSPARENT PLASTICS

J. E. MAHAFFEY and T. G. RUKAVINA *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 451-467 Dec. 1983 (AD-P003204) Avail: NTIS HC A08/MF A01 CSCL 01C

Parasitic plies such as acrylic used to protect polycarbonate from the environment in aircraft transparencies and undesirable weight and are subject to crazing. PPG Industries has recently developed a family of elastomeric liner materials specifically formulated to provide complete isolation of the substrate to which it is substrate. This paper describes two specific liner materials. The first was designed to withstand the relatively severe environments encountered on the exterior surface of an aircraft transparency. The second was developed for use on the inboard surface where environmental considerations are not as demanding. Comprehensive testing and evaluation of these liners have been performed by PPG over the past two years. Environmental-resistance testing has included humidity exposure, ultraviolet radiation, chemical resistance, rain erosion resistance, accelerated and natural weathering, and abrasion resistance. The results of these tests have been very encouraging and the liners are currently being tested on full-scale transparencies. In addition, the outboard liner has been flight-tested for over a year with excellent results. The complete testing program for these liners, including field service performance, will be reviewed. GRA

N84-26618# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

HEAT RESISTANT COPOLYESTER-CARBONATE TRANSPARENT PLASTICS

T. J. REINHART *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 468-495 Dec. 1983 (AD-P003205) Avail: NTIS HC A08/MF A01 CSCL 01C

Air Force service experience with state-of-the-art transparent plastics has demonstrated the need for improved materials. A project was started to evaluate research samples of copolyester-carbonate (PEC) plastics received from the Allied Corporation as a result of a research and development contract funded by the Materials Laboratory of the Air Force Wright Aeronautical Laboratories. Mechanical, physical and chemical properties of the PEC materials were evaluated in order to assess the potential to the material for use in aircraft transparencies. It was found that the PEC materials possess several advantages over the state-of-the-art polycarbonate plastics and that the materials showed promise for use in high performance transparencies. GRA

N84-26619# Swedlow, Inc., Garden Grove, Calif.
SPECIALTY COATINGS FOR INCREASED SERVICE LIFE OF ACRYLIC AIRCRAFT TRANSPARENCIES, PART 2

W. C. HARBISON *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 496-525 Dec. 1983
 (AD-P003206) Avail: NTIS HC A08/MF A01 CSCL 01C

Swedlow's abrasion resistant coatings on acrylic windows have now provided up to eight years serviceability against the harsh environments of people abuse and automated cleaning procedures. The superior performance of the Swedlow coatings over that of all other commercially available coatings has been confirmed by many independent facilities. General Motors Corp., for example, has recently approved only two coatings, Swedlow's SS-6590 and SS-6712, for use on the formed acrylic sunroofs for their 1984 Corvette. This represents the first significant entry for plastics into automotive transparencies in this country. In aircraft applications, the SS-6590 and SS-6712 coatings are undergoing extensive laboratory and flight testing. Coated as-cast acrylic windshields have demonstrated excellent abrasion and chemical resistance in non-pressurized general purpose and agricultural spray aircraft. On stretched acrylic material, the coatings conform to CAR 3.27(a) and 3.396(a) pressurization testing and have successfully achieved over 5000 flight hours on cabin windows in a TWA operated 727 aircraft. GRA

N84-26623# Ministry of Defence, London (England).
ARTIFICIAL AGING OF TRANSPARENT AEROSPACE MATERIALS

A. DAVIS *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 582-596 Dec. 1983
 (AD-P003210) Avail: NTIS HC A08/MF A01 CSCL 01C

The AECMA working party which is drawing up a standard for the artificial weathering of aircraft transparencies has through a collaborative experimental program shown the importance of measuring the output of ultraviolet radiation of the various lamps used in weathering chambers. A simple method of monitoring radiation below 320 nm, based on the use of polysulphone film, is described. The manufacture and properties of the film are presented along with details of its use. Variability in the output of a Xenon-arc source as a result of lamp and filter aging is demonstrated and data on the ultraviolet intensity of different types of lamp are compared with measurements made outdoors at Dhahran, Innisfail and London. GRA

N84-26640# Royal Aircraft Establishment, Farnborough (England).

THE WIPER ABRASION AND RAIN EROSION RESISTANCE OF TRANSPARENT MATERIALS AND COATINGS FOR AIRCRAFT GLAZING

N. S. CORNEY and R. J. KING *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 892-909 Dec. 1983

(AD-P003227) Avail: NTIS HC A08/MF A01 CSCL 01C

The requirements for improved abrasion and rain erosion resistance of transparent materials for helicopters and aircraft glazing have led to the development and application at NPL of a laboratory-scale wiper abrasion apparatus, and also to an investigation using the RAE rain erosion rig. The NPL apparatus employs the linear motion of a short windscreen wiper blade across a 50 mm diameter specimen. The characteristics of the blade, chose to produce even and reproducible abrasion over the rubber area. Surface condition is assessed in detail by Nomarski interference microscopy with a quantitative estimation of abrasion damage from profilometry, light scatter and transmittance measurements. The RAE rain erosion rig enables specimens to be exposed in a simulated rain field under conditions of known velocity and impact angle. Detailed examinations have been made of the progressive effects of rain erosion by weight loss and transmittance measurements. The in-service degradation of glazing materials as simulated by these techniques are compared. GRA

N84-26785*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

P/M SUPERALLOYS: A TROUBLED ADOLESCENT?

R. L. DRESHFIELD and H. R. GRAY 1984 23 p refs
 Presented at P/M 1984, Toronto, 17-22 Jun. 1984; sponsored by Metal Powder Industries Federation
 (NASA-TM-83623; E-2057; NAS 1.15:83623) Avail: NTIS HC A02/MF A01 CSCL 11F

The history of powder metallurgy P/M superalloy technology is reviewed with a comment on the state of the art, and speculates on the technology's future potential growth and maturity. M.A.C.

N84-26797# Rockwell International Science Center, Thousand Oaks, Calif.

PROCESSING AND PROPERTIES OF AIRFRAME MATERIALS Annual Report, 1 Jan. - 31 Dec. 1983

J. A. WERT, A. K. GHOSH, J. C. CHESNUTT, and C. G. RHODES Feb. 1984 51 p
 (Contract F49620-83-C-0055; AF PROJ. 2306)
 (AD-A140832; SC5358.2AR; AFOSR-84-0250TR) Avail: NTIS HC A04/MF A01 CSCL 11F

This annual report describes progress during the first year of the three year research program to study the relationship between microstructure and processing conditions, and the effect of processing conditions on the performance of structural airframe materials. Part 1 of this program is examining the influence of beta processing methods on the interaction of fatigue cracks with the microstructural elements. Three beta phase processing methods have been chosen to provide variations in beta phase continuity and alpha phase plate size. The microstructure of the beta processed materials has been quantitatively characterized using SEM, TEM and STEM. Fatigue crack propagation results are also presented for each of the beta annealing treatments. In Part 2, the micromechanics of superplastic deformation behavior. Experiments have been performed with 7475 Al having various grain sizes. The flow stress vs strain rate behavior for the mixed grain size materials is best described using the iso-strain rate concept. Observations of dynamic grain growth and dynamic recrystallization have led to new perceptions of how these processes may alter the mechanical response of the materials during superplastic deformation. Based on these observations, the new model of the superplastic deformation process is outlined.

Author (GRA)

N84-26807# General Electric Co., Schenectady, N. Y.
DEVELOPMENT OF SINTERED Si3N4 FOR HIGH PERFORMANCE THERMOMECHANICAL APPLICATIONS Final Report, 30 Aug. 1982 - 30 Aug. 1983

W. D. PASCO DOE Jan. 1984 66 p
 (Contract DAAG46-82-C-0053)
 (AD-A140795; DOC-84SRD026; AMMRC-TR-84-4) Avail: NTIS HC A04/MF A01 CSCL 13H

The sintering of Si3N4 containing BeSiN2 and YO3 was examined and found to yield densities greater than 99% on a routine basis. A composition containing 2.5 wt% BeSiN2 and 3.0 Y2O3 displayed a room temperature strength of greater than 690 MPa and a fracture toughness K_{IC} of about 6 MNm^{-3/2} power, a creep rate of .00004/h at 1300 C under a 69 MPa load, and a parabolic rate constant for oxidation at 1350 1.7 x 10 to the -11 power sq. kg/m to the -4 power/s. This composition has adequate properties for high temperature structural applications except for the high creep rate, which is of the same order as Nc-132. The sintering of Si3N4 containing 5 wt% LiAlO8 and 3 wt% YF3 was examined and found to yield densities of greater than 96%. The creep rate of this composition was 5 x .005/h at 1300 C under a 69 MPa load. The high creep rate, in conjunction with a moderately high oxidation rate, precludes the use of this composition for high temperature structural applications. A new source of Si3N4 powder, made by Ube Industries, was qualified as an alternative powder source of this program. The addition of 7 wt% BeSiN2 in conjunction with a total oxygen content of 3.5 wt% yielded sintered densities of greater than 98.5%. GRA

11 CHEMISTRY AND MATERIALS

N84-27835*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

INTERLAMINAR FRACTURE OF COMPOSITES

T. K. OBRIEN Jun. 1984 39 p refs Prepared in cooperation with Army Aviation Research and Development Command, Hampton, Va.

(Contract DA PROJ. 1L1-61102-AH-45)

(NASA-TM-85768; NAS 1.15:85768; USAAVSCOM-TR-84-B-2)

Avail: NTIS HC A03/MF A01 CSCL 11D

Fracture mechanics has been found to be a useful tool for understanding composite delamination. Analyses for calculating strain energy release rates associated with delamination growth have been developed. These analyses successfully characterized delamination onset and growth for particular sources of delamination. Low velocity impact has been found to be the most severe source of composite delamination. A variety of test methods for measuring interlaminar fracture toughness are being developed to identify new composite materials with enhanced delamination resistance. Author

N84-27836*# Lockheed-California Co., Burbank.

DEVELOPMENT OF AN ADVANCED COMPOSITE AILERON FOR THE L-1011 TRANSPORT AIRCRAFT Final Report, Apr. 1977 - Oct. 1980

C. F. GRIFFIN and E. G. DUNNING (Avco Corp.) Feb. 1982 42 p refs

(Contract NAS1-15069)

(NASA-CR-3517; NAS 1.26:3517; LR-29911) Avail: NTIS HC A03/MF A01 CSCL 11D

Significant improvements in structural efficiency can be achieved by the utilization of advanced composites for construction of aircraft secondary structures. Careful evaluation of alternate designs and materials for the L-1011 advanced composite inboard aileron has led to the selection of several unique material combinations and easily manufactured structural configurations. The advanced composite aileron is a direct replacement for the metal aileron with a weight savings of 23 percent. Due to the configurational simplicity of the components within the composite aileron, and because it contains 50 percent fewer parts and fasteners than the metal aileron, it is predicted that the composite aileron will be cost competitive with the metal aileron in a production environment. Structural analysis of the composite aileron, in conjunction with the design data, concept verification, and ground tests, indicates that the composite aileron design meets or exceeds structural requirements. Author

N84-27837# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.

HYGROTHERMAL EFFECTS IN CONTINUOUS FIBRE REINFORCED COMPOSITES. PART 1: THERMAL AND MOISTURE DIFFUSION IN COMPOSITE MATERIALS

J. P. KOMOROWSKI Jan. 1983 59 p refs

(AD-A128228; NAE-AN-4; NRC-20974) Avail: NTIS HC A04/MF A01 CSCL 11D

This report is the first in a series of literature reviews in which hygrothermal effects on aerospace composite materials (CM) are examined. This first report (Part 1) deals primarily with fundamental aspects of the diffusion of moisture into, and from, composite materials. The effects of temperature under both steady state and transient conditions are also examined. GRA

N84-27855* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COATING WITH OVERLAY METALLIC-CERMET ALLOY SYSTEMS Patent

M. A. GEDWILL, S. R. LEVINE, and T. K. GLASGOW, inventors (to NASA) 29 May 1984 7 p Filed 7 Jan. 1983 Supersedes N83-17683 (21 - 08, p 1158) Division of US-Patent-Appl-SN-403378, US-Patent-4,446,199, filed 30 Jul. 1982

(NASA-CASE-LEW-13639-2; US-PATENT-4,451,496;

US-PATENT-APPL-SN-456460; US-PATENT-CLASS-427-34;

US-PATENT-CLASS-427-405; US-PATENT-CLASS-427-419.2;

US-PATENT-CLASS-428-632) Avail: US Patent and Trademark Office CSCL 11F

A base layer of an oxide dispersed, metallic alloy (cermet) is arc plasma sprayed onto a substrate, such as a turbine blade, vane, or the like, which is subjected to high temperature use. A top layer of an oxidation, hot corrosion, erosion resistant alloy of nickel, cobalt, or iron is then arc plasma sprayed onto the base layer. A heat treatment is used to improve the bonding. The base layer serves as an inhibitor to interdiffusion between the protective top layer and the substrate. Otherwise, the 10 protective top layer would rapidly interact detrimentally with the substrate and degrade by spalling of the protective oxides formed on the outer surface at elevated temperatures.

Official Gazette of the U.S. Patent and Trademark Office

N84-27860*# Rockwell International Corp., Los Angeles, Calif. Aircraft Operations Office.

SPF/DB PRIMARY STRUCTURE FOR SUPERSONIC AIRCRAFT (T-38 HORIZONTAL STABILIZER) Final Report

A. R. DELMUNDO, F. T. MCQUILKIN, and R. R. RIVAS Dec. 1981 131 p

(Contract NAS4-2651)

(NASA-CR-163114; NAS 1.26:163114; NA-81-649) Avail: NTIS HC A07/MF A01 CSCL 11F

The structural integrity and potential cost savings of superplastic forming/diffusion bonding (SPF/DB) titanium structure for future Supersonic Cruise Research (SCR) and military aircraft primary structure applications was demonstrated. Using the horizontal stabilizer of the T-38 aircraft as a baseline, the structure was redesigned to the existing criteria and loads, using SPF/DB titanium technology. The general concept of using a full-depth sandwich structure which is attached to a steel spindle, was retained. Trade studies demonstrated that the optimum design should employ double-truss, sinewave core in the deepest section of the surface, making a transition to single-truss core in the thinner areas at the leading and trailing edges and at the tip. At the extreme thin edges of the surface, the single-truss core was changed to dot core to provide for gas passages during the SPF/DB process. The selected SPF/DB horizontal stabilizer design consisted of a one-piece SPF/DB sinewave truss core panel, a trunnion fitting, and reinforcing straps. The fitting and the straps were mechanically fastened to the SPF/DB panel. Author

N84-27878# Centre d'Essais Aeronautique Toulouse (France). Lab. d'Etudes de Materiaux Metalliques.

MATERIAL CHARACTERIZATION BY STRAIN RATE CONTROLLED LOW CYCLE FATIGUE TESTS AND BY CRACK PROPAGATION VELOCITY: SUMMARY OF TEST NUMBER M3 430300 [CARACTERISATION EN FATIGUE OLIGOCYCLIQUE A DEFORMATION IMPOSEE ET EN VITESSE DE PROPAGATION DE FISSURE]

9 Apr. 1984 35 p In FRENCH

(IMI-679) Avail: NTIS HC A03/MF A01

The titanium zirconium alloy TE11Zr (IMI 679) was characterized in order to consider its application to Turbomeca TM 322 engine design. Sample preparation is described. Tensile, crack propagation and fatigue tests were carried out at temperatures up to 600 C. The static characteristics are superior to those of the IMI 685 alloy. The fatigue results are scattered although the averages are normal for this type of alloy. The microstructure analysis shows

that cracks are induced by the surface defects produced by sample machining. Author (ESA)

N84-27908*# ICF, Inc., Washington, D. C.
COMPUTER ANALYSIS OF EFFECTS OF ALTERING JET FUEL PROPERTIES ON REFINERY COSTS AND YIELDS Final Report

T. BRETON and D. DUNBAR Jun. 1984 134 p
 (Contract NAS3-22780)
 (NASA-CR-174642; NAS 1.26:174642) Avail: NTIS HC A07/MF A01 CSCL 21D

This study was undertaken to evaluate the adequacy of future U.S. jet fuel supplies, the potential for large increases in the cost of jet fuel, and to what extent a relaxation in jet fuel properties would remedy these potential problems. The results of the study indicate that refiners should be able to meet jet fuel output requirements in all regions of the country within the current Jet A specifications during the 1990-2010 period. The results also indicate that it will be more difficult to meet Jet A specifications on the West Coast, because the feedstock quality is worse and the required jet fuel yield (jet fuel/crude refined) is higher than in the East. The results show that jet fuel production costs could be reduced by relaxing fuel properties. Potential cost savings in the East (PADDs I-IV) through property relaxation were found to be about 1.3 cents/liter (5 cents/gallon) in January 1, 1981 dollars between 1990 and 2010. However, the savings from property relaxation were all obtained within the range of current Jet A specifications, so there is no financial incentive to relax Jet A fuel specifications in the East. In the West (PADD V) the potential cost savings from lowering fuel quality were considerably greater than in the East. Cost savings from 2.7 to 3.7 cents/liter (10-14 cents/gallon) were found. In contrast to the East, on the West Coast a significant part of the savings was obtained through relaxation of the current Jet A fuel specifications. B.W.

N84-27910# Federal Aviation Administration, Washington, D.C.
US ENERGY: AVIATION PERSPECTIVE
 C. L. BLAKE Nov. 1983 187 p
 (AD-A137766; FAA-EE-83-10) Avail: NTIS HC A09/MF A01 CSCL 21D

This report is a sequel/update of the IMPACT OF PETROLEUM, SYNTHETIC AND CRYOGENIC FUELS ON CIVIL AVIATION, DOT/FAA/EM-82/29, June, 1982. Where the earlier report is more concerned with energy resources and availability, this report is more concerned with energy supply/demand balance and with prices. The report reviews world and U.S. energy, U.S. transportation energy, aviation fuel, natural gas, alternative fuels and energy sources, synthetic fuels, aviation fuel conservation, and petroleum price vulnerability. It draws heavily on THE NATIONAL ENERGY POLICY PLAN OF 1983 and its supporting documents. World oil production and prices should remain generally steady for thirty to fifty years, growing slightly faster than the world economy. Near-term prices should be softer. OPEC can raise prices whenever demand for its production exceeds 80% of OPEC production capacity. The U.S. could delay or reverse future price rises by encouraging, or at least reducing restrictions against, domestic production. All future energy forecasts are risky. A disruption in crude production at any time until at least year 2000, can easily increase fuel prices by 100%. GRA

N84-27911# Ohio State Univ., Columbus.
KINETIC-ELASTIC APPROACH FOR TIME-DEPENDENT RHEOLOGICAL DATA ON SLURRY FUELS AND POLYMERS Final Technical Report, 24 Mar. 1980 - 30 Sep. 1982

R. S. BRODKEY, K. PARK, S. WENG, A. OUIBRAHIM, and S. F. LIN Wright-Patterson AFB, Ohio AFWAL Jan. 1984 222 p
 (Contract F33615-80-C-2021; AF PROJ. 3048)
 (AD-A141210; OSURF-762084/712747; AFWAL-TR-83-2085)
 Avail: NTIS HC A10/MF A01 CSCL 20D

At The Ohio State University, we have been developing our kinetic interpretation of non-Newtonian fluid behavior under support from the Aero Propulsion Laboratory with materials of interest to the Air Force. Specifically, we have considered slurry fuel systems

and a reference, high-viscosity lubricant (5P4E). In addition, we continued to obtain data on a polymeric system previously studied by us so as to ascertain the adequacy of our measurements and of our theory. The kinetic theory is a phenomenological rate concept used to describe the time rate of change of a material structure. We call this part of the development "the kinetic model for thixotropic change," corresponding to "thixotropic fluid structure" is a thixotropic structural viscosity and a corresponding thixotropic stress. The real stress in the system is different from the thixotropic stress because of the elastic properties of the material. Our 'elastic model for viscoelasticity' utilizes a modified version of Oldroyd's development in convected coordinates. A combination of the two models allows the representation of rheological data with what we call 'the kinetic-elastic model'. To date we have shown conclusively that much of the older data could not be used because of instrumentation problems. We have obtained new polymer data (polymethylmethacrylate in DEP, PMMA/DEP) with our improved instrumentation and data acquisition system. GRA

N84-27912# AeroChem Research Labs., Inc., Princeton, N. J.
FUEL EFFECTS ON SOOT FORMATION IN TURBOJET ENGINES Progress Report, 15 Sep. 1983 - 14 Mar. 1984

D. B. OLSON and R. J. GILL 4 May 1984 20 p
 (Contract N00014-83-C-2311)
 (AD-A141287; AEROCHEM-TN-238) Avail: NTIS HC A02/MF A01 CSCL 21D

The sooting tendencies of sixteen Navy jet fuels and eight fuel blending components have been studied in laboratory flames to compare with results obtained in other programs using these fuels in turbojet engines and combustors. The average molecular weight, density, ASTM smoke point, and diffusion flame and premixed flame threshold sooting index of each fuel have been measured. An apparatus has been assembled to measure premixed flame soot yields using a multi-wavelength laser extinction technique. Experiments have been performed on a six-component test fuel blended using pure hydrocarbon components. The diffusion flame soot threshold of this fuel can be predicted using the pure component values but the predicted premixed flame soot threshold is larger than measured. Experiments are planned to measure soot yields of the jet fuels and to correlate the laboratory measurements with engine test results. Author (GRA)

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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.

A84-36492*# Bell Aerospace Co., Buffalo, N. Y.
FLUTTER ANALYSIS OF ADVANCED TURBOPROPELLERS
 V. ELCHURI and G. C. C. SMITH (Bell Aerospace Textron, Buffalo, NY) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 2, p. 160-165) AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 801, 802. refs
 (Contract NAS3-22533)

Previously cited in issue 12, p. 1742, Accession no. A83-29824

A84-36499#
INJECTION INTO A TURBULENT BOUNDARY LAYER THROUGH DIFFERENT POROUS SURFACES

F. S. COLLIER, JR. and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg, VA) AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 839-841. refs

Previously cited in issue 05, p. 634, Accession no. A83-16635

12 ENGINEERING

A84-36525

STATIC AND FATIGUE POST-BUCKLED BEHAVIOR OF COMPOSITE SHEAR PANELS IN THE ACAP DESIGN

F. CAMARATTA and J. GOLDBERG (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) American Helicopter Society, Journal (ISSN 0002-8711), vol. 29, April 1984, p. 61-64.

The postbuckling behavior of laminated Kevlar/epoxy composite panels is investigated as part of the Advanced Composite Airframe Program (ACAP). An assortment of stiffener designs is considered, and the effects of curvature of the skin are included. Test panels were subjected to loads of 2100, 4275, 3000, 5900, and 7970 lbs at room temperature in a pin-connected 'picture-frame' attached to two strain gages. The ultimate strength of the panels was a factor of 3 or more higher than the initial buckling load. Catastrophic panel failure was precipitated by stiffener delamination or crippling rather than skin tearing. Curvature of the skin is found to stiffen the structure, resulting in higher initial buckling loads. Postbuckling strength was reduced as the added curvature accentuated lateral deflections. The panels also showed high fatigue resistance (with a relatively high limit when compared to the static ultimate strength), and the fatigue life curve appeared to be flat compared to metallic skin structure. I.H.

A84-36555#

TRANSIENT ABLATION OF BLUNT BODIES AT ANGLES OF ATTACK

N. ARAI, T. TANI (Tokyo University of Agriculture and Technology, Tokyo, Japan), and K. SATO (Tokyo, University, Tokyo, Japan) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 21, May-June 1984, p. 241-245. refs

Previously cited in issue 05, p. 637, Accession no. A83-16803

A84-36600

TRENDS IN THE DEVELOPMENT OF EDDY CURRENT EQUIPMENT FOR AIRCRAFT MAINTENANCE

G. SCHROEDER (Institut Dr. Foerster GmbH & Co., Reutlingen, West Germany) Materialpruefung (ISSN 0025-5300), vol. 26, May 1984, p. 148-150.

Two new instruments for eddy current inspection in aircraft maintenance are briefly described. Their application to the monitoring of crack growth and the detection of fatigue cracks at rivet holes as well as surface defects in aircraft is described. C.D.

A84-36794#

VHSIC IN MIDCOURSE

J. C. TOOMAY Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 41-46.

Attention is given to the achievements of the U.S. Department of Defense VHSIC development program, whose first phase ends this year with the delivery of system component brassboards. Phase I technologies emphasize bipolar and MOS devices with the smallest pattern geometries and the greatest radiation hardness yet achieved, in keeping with military requirements. Dimensional reductions have led to throughput increases of a factor of 18, and power reductions of a factor of 25. The novel architectures used integrate 15,000-25,000 gates on a single chip. Electronics of this type will make possible antijam voice communications, optimized electronic warfare, practical tactical data gathering systems fusion, all-weather global surveillance and reconnaissance, integrated avionics, high performance RPVs, and 'Star Wars' ABM defenses. O.C.

A84-36795#

ELECTRON DEVICE TECHNOLOGY - FROM PAC MAN TO COMBAT AVIONICS

J. M. BORKY (USAF, Washington, DC) Aerospace America (ISSN 0740-722X), vol. 22, June 1984, p. 48-52.

The category of 'electron devices' encompasses discrete semiconductors, digital and analog microelectronics, microwave and mm-wave devices, and such electrooptical devices as lasers and detectors. Attention is given to the state-of-the-art in these various technologies, with a view to the impact of the performance

levels they facilitate on the military capabilities of highly integrated avionics suites. Such avionics are characterized by increasing digitalization, functional integration of diverse types of information, piloting function automation, and increasing reliability and maintainability. O.C.

A84-36991

VIBRATIONAL BEHAVIOR OF COUPLED BLADE SYSTEMS [BEITRAG ZUM SCHWINGUNGSVERHALTEN GEKOPPELTER SCHAUFELSYSTEME]

J. JAROSCH Stuttgart, Universitaet, Fakultaeat Energietechnik, Dr.-Ing. Dissertation, 1983, 133 p. In German. refs

It is shown that concepts developed in the design of aircraft gas turbines which describe the vibrational behavior of blades with elastic disks are applicable to blade systems coupled with a stiff rotor. Starting from the vibrational characteristics of the circular disk, a continuum is established between bladed elastic disks and coupled blades on a stiff rotor. A free-standing blade represents the minimum coupling. This concept permits vibrational phenomena to be ordered in a few groups with specific characteristics and to be qualitatively predicted to an extent. The applicability of terminology derived from the bladed elastic plate to the description of a bound industrial turbine end stage is shown. C.D.

A84-37067

A METHOD FOR SOLVING THE UNSTEADY HEAT TRANSFER AND ABLATION PROBLEM FOR A BODY [OB ODNOM METODE RESENIIA ZADACHI NESTATSIONARNOGO TEPLOBMENA TELA I EGO ABLIATSII]

A. F. POLIANSKII and L. T. SKURIN Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), April 1984, p. 62-66. In Russian.

A method for calculating the unsteady heating and ablation of a solid is proposed which is a modification of the straight line method wherein a cubic spline is used to approximate the temperature field in its principal change direction. The method is tested on a one-dimensional model by comparing it with an exact solution. It is shown that by introducing few bands in the main temperature change direction, satisfactory results can be obtained for heat transfer problems typical for hypersonic flows. V.L.

A84-37077

THE EFFECT OF HYDRODYNAMICS ON THE THERMAL DIFFUSION PROCESS OF GAS MIXTURE SEPARATION [VLIIANIE GIDRODINAMIKI NA TERMODIFFUZIONNYI PROTSSESS RAZDELENIIA GAZOVYKH SMESEI]

V. N. GUSEV and V. P. PROVOTOROV PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki (ISSN 0044-4626), Mar.-Apr. 1984, p. 15-22. In Russian. refs

The effect of hydrodynamic phenomena on the thermal diffusion separation of gas mixtures can be investigated on the basis of exact solutions to a system of complete Navier-Stokes equations. Such solutions, however, are very difficult to obtain in the case of the arbitrary motion of gas mixtures. It is proposed that various asymptotic representations of the Navier-Stokes equations be used instead. The approach is demonstrated here for thin shock and boundary layers. V.L.

A84-37149

EVOLUTION OF TEST METHODS FOR STRUCTURAL VIBRATIONS [EVOLUTION DES METHODES D'ESSAI DE VIBRATION DES STRUCTURES]

R. DAT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) Revue Francaise de Mecanique (ISSN 0373-6601), no. 4, 1983, p. 37-46. In French. refs

Current test techniques for determining the modal characteristics of aircraft and spacecraft structures are reviewed and illustrated. The emphasis is on frequency or impulse responses to harmonic, impulsional, or white-noise excitation and on the mathematical methods used to reduce the data, usually involving the use of microcomputers. The significant reductions in test time achievable with these methods are indicated. Some problems occurring in the analysis of structures with small nonlinearities are

examined, and techniques for reducing the adverse effects of these nonlinearities are suggested. T.K.

A84-37161

SEQUENTIAL QUADRATIC PROGRAMMING AND DYNAMIC OPTIMAL DESIGN OF ROTATING BLADES

K. CHENG and Y. GU (Dalian Institute of Technology, Dalian, People's Republic of China) (Euromech, Colloquium on Optimization Methods in Structural Design, 164th, Universitaet Siegen, Siegen, West Germany, Oct. 12-14, 1982) Journal of Structural Mechanics (ISSN 0360-1218), vol. 11, no. 4, 1983-1984, p. 451-464. refs

By studying the Kuhn-Tucker conditions for a structural optimal design problem with multifrequency constraints, it is shown that the optimality criterion (OC) approach and mathematical programming (MP) can be unified. This unification leads to a new approach, sequential quadratic programming (SQP), which is combined with a technique of temporary relaxation of constraints and application of rational move-limits based on deviations due to linearization of nonlinear constraints. The SQP algorithm is applied to solve the dynamic optimal design problem of rotating blades with prescribed multifrequency constraints on both flapping and chordwise vibration. A computer program based on the finite element method and explicit design sensitivities is developed and a set of examples is tested. Numerical results for a variety of cross-sectional shapes are presented. Author

A84-37230

INVESTIGATION OF TWO EXTREMAL PROBLEMS OF QUADROPOLE WING THEORY [ISSLEDOVANIE DVUKH EKSTREMAL'NYKH ZADACH KVADROPOL'NOI TEORII KRYLA]

L. E. SIDUNOVA IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 82-92. In Russian. refs

Two extremum problems concerning wings are analyzed on the basis of Panchenkov's quadrople theory. Particular emphasis is placed on the problem of optimizing the geometry of a low-aspect-ratio wing near a screen. B.J.

A84-37298

SWIRL FLOWS

A. K. GUPTA (Maryland, University, College Park, MD), D. G. LILLEY (Oklahoma State University, Stillwater, OK), and N. SYRED (University College, Cardiff, Wales) Tunbridge Wells, Kent, England, Abacus Press, 1984, 488 p. refs

Attention is given to the range of swirl phenomena occurring in both the atmosphere and man-made devices which may involve combustion-generated reacting flows. Experimental studies have established that swirl has large scale favorable effects on various aspects of flowfields, such as jet growth, entrainment and decay in inert flows and flame size, shape and stability in reacting flows. Mathematical modeling and numerical prediction for swirling flows combine experimental and theoretical combustion aerodynamics with sophisticated computational fluid dynamics to reduce development program costs and duration. Attention is given to practical combustor design in gas turbine engines, industrial furnaces, and waste incinerators, as well as to the effects of combustor swirl flow on the pollutant content of exhaust gases. O.C.

A84-37369

ESTIMATION OF DEFORMATION KINETICS OF GTE BLADES IN CONDITIONS OF LOW-FREQUENCY TEMPERATURE AND HIGH-FREQUENCY MECHANICAL LOADS [RASHCHET KINETIKI DEFORMIROVANIYA LOPATOK GTD V USLOVIAKH NIZKO-CHASTOTNYKH TEMPERATURNYKH I VYSOKOCHASTOTNYKH MEKHANICHESKIKH NAGRUZOK]

L. A. ZASLOTSKAIA (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), May 1984, p. 106-110. In Russian.

A computer-aided technique for calculating the kinetics of variations in the elastoplastic deformation of GTE blades is presented. A rod model is proposed for the blade in order to

follow the kinetics of variations in the stress-strained state over a period of long-term loading. Step-by-step computation of the equation of state of the material is selected because of the temperature variation of several hundred degrees per cycle. The rod model and flow theory with increments are combined, and the increments of plastic deformation at each stage of loading are calculated by the approximation method of additional deformations. Calculation results show that the redistribution of the stress-strained state from cycle to cycle is mainly dependent on the mechanical properties of the material: the modulus of elasticity, the coefficient of linear expansion, and the strain curves for the entire temperature range (430-840 C). J.N.

A84-37379

THE SOLUTION OF LARGE FLUTTER PROBLEMS ON SMALL COMPUTERS

A. SIMPSON (Bristol, University, Bristol, England) Aeronautical Journal (ISSN 0001-9240), vol. 88, April 1984, p. 128-140. refs

The Duncan et al. (1936) inverse method for the calculation of flutter boundaries is restated in a form suited both to methods of dynamical and numerical analysis and programming on a 32K RAM microcomputer. The method, which has been extended to provide information on subcritical and supercritical eigenvalues, can solve flutter problems of orders up to 35 with suitable accuracy. O.C.

A84-37523

AUTOMATION OF SMALL-SCALE MACHINE-SHOP PRODUCTION AND THE PRODUCT QUALITY [AVTOMATIZATSIIA MELKOSERIINOGO MASHINOSTROITEL'NOGO PROIZVODSTVA I KACHESTVO PRODUKTSII]

R. I. ADGAMOV, ED. Moscow, Izdatel'stvo Mashinostroenie, 1983, 280 p. In Russian.

Various approaches to the automation of small-scale machine-shop production are analyzed, with the production of aircraft engines used as an example. Particular attention is given to the development of methods for estimating the effect of automation on the product quality and production efficiency. The discussion also covers automatic testing, quality control on the basis of service statistics, service life prediction, cost efficiency, and social aspects of the automation of small-scale production. No individual items are abstracted in this volume V.L.

A84-37532#

RESPONSE OF AN AXIAL COMPRESSOR TO DISTORTED INLET FLOW

G. BILLET, P. LAVAL, and P. CHEVALIER (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) (Conference on Computational Methods in Turbomachinery, University of Birmingham, Birmingham, England, Apr. 10-12, 1984) ONERA, TP, no. 1984-13, 1984, 10 p. refs (ONERA, TP NO. 1984-13)

A model representing rotating or fixed blade rows, which is similar to a pseudo-two-dimensional semiactuator disk model, is coupled to a fully unsteady nonlinear numerical method. It has been developed for the computation of three-dimensional compressible inviscid nonuniform flows in the turbomachines. Numerical results, which have been obtained on the vector processor CRAY 1, are presented in the case of a low speed single stage compressor with an inlet steady total pressure distortion. They show that this numerical approach is able to foresee the place and the time where strong decelerations occur from which rotating stalls could originate. Author

A84-37642#

IMPROVED ACCURACY MAGNETOSTRICTIVE TORQUEMETER

F. E. SCOPPE and K. S. COLLINGE (Avco Corp., Avco Lycoming Div., Stratford, CT) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984. 8 p. (AIAA PAPER 84-1280)

Details of recent improvements that have produced a magnetostriuctive torquemeter system with 1 percent accuracy are

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described. The torque meter utilizes the effect of changing magnetic permeability in a ferromagnetic material experiencing mechanically induced torsional shear stress. A transformer produces an electric signal with a voltage proportional to the magnetic permeability of the transformer core, which is integral to the engine power shaft. The magnetostriction effect dictates that the shear stress as a function of torque is transduced to the shaft material magnetic reluctance, which decreases with increasing torque. The electric behavior of the transformer, the sensor element configuration, the head assembly and factors influencing the system accuracy are explored. System upgrades, including a self-test circuit, an overtorque indicator, a microprocessor-based look-up table, a prestressing procedure for the magnetostrictive material and a change to SAE 3910 carburizing steel as the magnetostrictive material are outlined. M.S.K.

A84-37702 NUMERICAL SIMULATION OF COMPRESSIBLE, VISCOUS FLOW USING AN IMPLICIT, BI-DIAGONAL METHOD

E. VON LAVANTE (Texas A & M University, College Station, TX)
IN: Computational and asymptotic methods for boundary and interior layers; Proceedings of the Second BAIL Conference, Dublin, Ireland, June 16-18, 1982. Dublin, Boole Press, 1982, p. 311-316. refs

The numerical simulation of compressible viscous flow is investigated with an emphasis on proper boundary conditions for the implicit block bidiagonal method developed by MacCormack (1981). The nature of the predictor-corrector method makes the development of stable implicit boundary conditions difficult. Various boundary conditions were tested on a supersonic diffuser which included shock generation by compression corner, boundary layer shock interaction with separation and reattachment, and termination of shock by expansion corner. A supersonic inflow boundary condition was correct; there were no problems at the supersonic upstream boundary. Solid wall boundary conditions were applied resulting in varying degrees of stability. The type of boundary conditions at the outflow had no influence on the overall convergence and only a limited local effect on the flow variables at the downstream boundary. J.N.

A84-37724 THE THEORETICAL DETERMINATION OF THE DAMPING COEFFICIENTS OF THE SURROUNDING MEDIUM BY MEANS OF THE AERODYNAMICAL BOUNDARY-LAYER THEORY [ZUR THEORETISCHEN BESTIMMUNG DER DAEMPUNGSKOEFFIZIENTEN DES UMGEBENDEN MEDIUMS MITTELS DER AERODYNAMISCHEN GRENZSCHICHTTHEORIE]

S. KATSAITIS (Ministerium fuer Forschung Technologie, Athens, Greece) Forschung im Ingenieurwesen (ISSN 0015-7899), vol. 50, no. 3, 1984, p. 69-80. In German. refs

In problems involving the occurrence of mechanical vibrations, it is generally assumed that the damping coefficients related to the surrounding medium, gas or liquid, are constant. The present investigation aims to demonstrate that the assumption of a constancy of the damping coefficients is incorrect. The case of a rigid orthogonal parallelepiped is considered. This case involves a vibratory system with six degrees of freedom. The vibration can take place in a compressible or incompressible liquid. The damping coefficients are determined on the basis of the aerodynamical theory of the boundary layer and the mechanical principle of the energetic equilibrium. It is found that the damping coefficients depend on the density and the kinematic viscosity of the surrounding medium. The values of the two medium parameters are a function of pressure and temperature. In addition, the damping coefficients depend also on the volume of the vibrating body, and the frequency and the maximum amplitude of the vibrations.

G.R.

A84-37728 MATHEMATICAL DEVELOPMENTS REGARDING BOUNDARY LAYER THEORY DURING THE LAST 25 YEARS [MATHEMATISCHE ENTWICKLUNGEN IN DER GRENZSCHICHTTHEORIE WAEREND DER LETZTEN 25 JAHRE]

K. NICKEL (Freiburg, Universitaet, Freiburg im Breisgau, West Germany) (Gesellschaft fuer angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Hamburg, West Germany, Mar. 28-31, 1983) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 64, no. 4, 1984, p. T18-T33. In German. refs

The advances in boundary layer theory made within the last 25 years are considered in the context of the general development of this theory, taking into account also aspects of expected future developments. The characteristics of a boundary layer are examined and boundary layer flows are discussed. A description is given of the boundary layer theory, as first conceived by Prandtl (1904). In a review of the results obtained during the last 25 years, attention is given to the method of differential inequalities, the external boundary condition, questions concerning the existence of a solution for the boundary layer equations under the given boundary conditions, aspects of uniqueness and continuous dependence on the data, asymptotic considerations for disappearing viscosity, approaches for obtaining approximate solutions for the Prandtl boundary value problem, and a priori estimates. A number of problems which have not yet been solved are also discussed. G.R.

A84-37903# CALCULATION OF THE BOUNDARY LAYER GROWTH BEHIND AN UNSTEADY EXPANSION WAVE IN A TUBE

S. WANG (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 20-28. In Chinese, with abstract in English.

The problem of the boundary layer growth in the charge tube is discussed. Based on Becker's (1957) work and Sivells' (1975) modification, in the axisymmetric case, a theoretical treatment of the boundary layer growth in the expansion wave is given; the movement velocity of the equivalent unsteady expansion wave of zero width is derived; an analytical solution is obtained and has been reduced to an algebraical expression. The result contains various factors which affect boundary layer growth: axisymmetry, velocity profile, skin-friction coefficient law and expansion wave thickness effect. The calculation is simple and the results coincide with experiments. Author

A84-37909# THE APPLICATION OF SURFACE HOT FILM IN AERODYNAMIC TESTING

T. WANG (Nanjing Aeronautical Institute, Nanjing, People's Republic of China) Acta Aerodynamica Sinica, no. 1, 1984, p. 77-84. In Chinese, with abstract in English. refs

A84-37956*# A VECTORIZED SOLUTION FOR INCOMPRESSIBLE FLOW

N. R. PATEL and J. F. THOMPSON (Mississippi State University, Mississippi State, MS) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs (Contract NGR-25-001-055) (AIAA PAPER 84-1534)

An algorithm is developed to obtain solutions to the unsteady Reynolds-averaged incompressible Navier-Stokes equations in general curvilinear coordinates on a vector processor. The governing equations are in nonconservative form with the velocity and pressure as dependent variables. Two momentum equations and the Poisson equation for pressure form a set of three governing equations for three flow field unknowns: u , v , and p . The governing equations and boundary conditions are expressed in terms of boundary-conforming curvilinear coordinates, and a checkerboard SOR iteration is used to solve the governing equations. Several possible sequences for a checkerboard SOR iteration are

investigated for finding the best overall convergence rate. The efficiency and capability of the present algorithm was assessed using the example of an 18 percent thick NACA 66(3)018 airfoil at zero degree angle of attack for chord Reynolds number range 1000-40,000. J.N.

A84-37964#
BREAKDOWN PHENOMENON OF THE KARMAN VORTEX STREET DUE TO THE NATURAL CONVECTION
 K. NOTO, H. ISHIDA, and R. MATSUMOTO (Kobe University, Kobe, Japan) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. refs (AIAA PAPER 84-1547)

The breakdown phenomenon of the Karman vortex street is made clear from the viewpoints of flow visualizations by the smoke wire method, power spectra, and the Strouhal number. In the positively buoyant wake behind both a heated horizontal circular cylinder and a heated horizontal triangular one, the Karman vortex street breaks down due to the natural convection. By adding the natural convection to the neutrally buoyant wake, the Strouhal number increases gradually, and then decreases abruptly. In the wake with large Froude number, the swaying motion of the natural convection plume occurs because the natural convection effect is rather dominant. As causes of the breakdown, an acceleration of velocity in the wake is more dominant than a shift of the separation points. Author

A84-37966#
AN ASSESSMENT OF NUMERICAL SOLUTIONS OF THE COMPRESSIBLE NAVIER-STOKES EQUATIONS
 J. S. SHANG (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 25 p. refs (AIAA PAPER 84-1549)

A brief survey of the literature on numerical solutions of the compressible Navier-Stokes equations is presented. This paper attempts to address the need for an alternative to experimental efforts for establishing or supplementing the data base for aerospace vehicle design at the outer limits of the flight envelope. Topics covered include the Reynolds-averaged Navier-Stokes equations, forebody, airfoils and wings, wing-fuselage, afterbody and near-wake, propulsion systems and combustion, inviscid-viscous interactions, and time-dependent problems. An assessment of numerical procedures for efficiency and accuracy includes the multigrid technique, spectral methods, implicit finite-difference algorithms, hybrid procedures, and computer adaptation. The coupled five conservative Navier-Stokes equations of mass, continuum, and energy are considered with respect to well posed and stable boundary conditions. Attention is also given to the development of turbulence models, grid generation and data structures, and post processing of data and data display. J.N.

A84-38028#
THREE-DIMENSIONAL SIMULATION OF MUZZLE BRAKE FLOWFIELDS
 J. C. BUELL and G. F. WIDHOPF (Aerospace Corp., Fluid Mechanics Dept., El Segundo, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 13 p. refs (Contract F04701-83-C-0084) (AIAA PAPER 84-1641)

A three-dimensional numerical inviscid model of the time-dependent near field of multi-element muzzle brakes has been developed. The model includes the effect of the free air blast, the exhaust of the barrel air ahead of the shell, shell ejection and flight, and the exhausting of the propellant gases. Detailed calculations of this flow sequence are compared with pressure measurements on the frontal surfaces and top plate of a 20 mm cannon double baffle muzzle brake tested by Gion and Faller.

Relative agreement between the calculated and measured peak overpressure on these surfaces is shown. Author

A84-38030*# Massachusetts Inst. of Tech., Cambridge.
CONSERVATIVE STREAMTUBE SOLUTION OF STEADY-STATE EULER EQUATIONS
 M. DRELA, M. GILES, and W. T. THOMPSON, JR. (MIT, Cambridge, MA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 8 p. refs (Contract F49620-78-C-0084; NAG3-9) (AIAA PAPER 84-1643)

This paper presents a new method for solving the steady state Euler equations. The method is similar to streamline curvature methods but has a conservative finite volume formulation which ensures correct shock capturing. Either wall position or wall pressure may be prescribed as boundary conditions, permitting both direct and inverse calculations. In supersonic applications the solution is obtained by space-marching while in subsonic and transonic applications iterative relaxation methods are used. Numerical results are given for: (1) supersonic diffuser with oblique shocks (direct calculation); (2) supersonic jet entering still reservoir (inverse calculation); (3) subsonic bump in a channel with 25 percent blockage (direct and inverse); (4) subsonic high-work turbine cascade (direct); and (5) transonic bump in a channel with 12 percent blockage (direct calculation). Author

A84-38034#
EFFICIENT METHODS FOR PREDICTING COMPRESSIBLE INVISCID FLOWS
 J. TREVINO and E. VON LAVANTE (Texas A&M University, College Station, TX) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 9 p. refs (AIAA PAPER 84-1648)

Two efficient implicit finite difference methods for predicting the compressible inviscid flow were developed. These numerical schemes were: (1) Simplified block-bidiagonal predictor-corrector scheme, and (2) Diagonal form of flux-vector splitting algorithm. The methods were compared with each other and with an existing diagonalized approximate factorization scheme using several test problems, including supersonic diffuser and nozzle. A method that gives the best compromise between performance and computational efficiency is finally selected. Author

A84-38039*# Texas A&M Univ., College Station.
FREQUENCY DEPENDENCE OF COHERENT STRUCTURES IN A MACH NUMBER 0.6 JET
 G. L. MORRISON (Texas A&M University, College Station, TX) and S. EMAMI American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 16 p. refs (Contract NAG1-112) (AIAA PAPER 84-1657)

The existence of a large scale structure in a Mach number 0.6, axisymmetric jet of cold air has been proven by previous work. In order to further characterize the coherent structure, phase averaged measurements of the axial mass velocity, radial velocity, and one component of the Reynolds stress tensor were made. These measured values were compared to the total fluctuation levels for each quantity and the result expressed as a percent of the total fluctuation level contained in the organized structure at Strouhal numbers of 0.16, 0.32, 0.474, 0.95, and 1.26. All of the phase averaged measurements required that the jet be artificially excited. The fluctuation profiles showed that the axial mass velocity fluctuations maximized when excited at a Strouhal number of 0.474. The radial velocity fluctuations possessed a lower amplitude for both the full wave and phase averaged fluctuations than the axial mass velocity fluctuation. The Reynolds stress decayed faster than the other two quantities past the end of the potential core for both the full wave and phase averaged components. The coherence contours showed that the radial velocity fluctuations possessed

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higher levels of coherence than the axial mass velocity fluctuation and the Reynolds stress. Author

A84-38095#

BLADE BENDING FLUTTER IN STARTED SUPERSONIC FLOW
J. P. GIRAULT (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France) La Recherche Aeronautique (English Edition) (ISSN 0379-380X), no. 1, 1984, p. 57-66. refs

Compressor blade bending flutter in started supersonic flow is studied in a straight cascade wind tunnel at an inlet flow Mach number = 1.4 and at frequencies up to 200 Hz. Conditions for instability are reached at high pressure ratios and are mainly due to the unsteady pressures generated on the blade suction side by the impact of the leading edge shock wave from the neighboring blade. Author

A84-38110

THIN-WALLED STRUCTURES IN AEROSPACE DESIGN

R. C. TENNYSON (Toronto, University, Toronto, Canada) IN: Developments in thin-walled structures - 2. London and New York, Elsevier Applied Science Publishers, 1984, p. 173-210. refs

In the present assessment of the development status of thin-walled structures in aerospace applications, emphasis is given to the buckling and postbuckling behavior of composite shells and methods for both structural optimization and buckling mode interaction determination. Attention is also given to the related issue of aircraft and helicopter fuselage crashworthiness design criteria, using lumped mass and finite element models. O.C.

A84-38111

DEVELOPMENT AND APPLICATIONS OF FAST-SENSITIVE MAGNETIC RUBBER INSPECTION FORMULATIONS

H. J. WELTMAN, W. T. KAARLELA, J. D. REYNOLDS, and J. E. HALKIAS (General Dynamics Corp., Fort Worth, TX) (Symposium on Nondestructive Evaluation, 14th, San Antonio, TX, Apr. 1983) Materials Evaluation (ISSN 0025-5327), vol. 42, June 1984, p. 917-921.

Faster curing materials have been developed for magnetic rubber inspection (MRI), a nondestructive technique used to inspect for cracks in small holes, complex parts, and relatively inaccessible areas encountered in high-performance aircraft. By modifying the initial viscosity and the catalyst system, a formulation has been obtained that cures in 10-20 min, compared with about 1 hr for the original compound. The low viscosity of this material makes it even more sensitive than the original rubber. Another new formulation has been developed in which the color of the base rubber has been changed from gray to yellow, so that cracks are displayed as black lines against a yellow background. Still another new product is an MRI paint formulation for the inspection of upside-down surfaces in aircraft wing structures. V.L.

A84-38361#

REVIEW - TURBOMACHINERY PERFORMANCE DETERIORATION EXPOSED TO SOLID PARTICULATES ENVIRONMENT

W. TABAKOFF (Cincinnati, University, Cincinnati, OH) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 106, June 1984, p. 125-134. refs
(Contract DAAG29-82-K-0029)

The objective of this paper is to review experimental and analytical investigations concerning the effect of the presence of solid particles on the performance of turbomachines. Experimental data on the effect of solid particles on turbine and compressor performance are examined. Some basic data have been reinterpreted to provide guidance for future design. The equations that govern the dynamics of the three-dimensional motion of solid particles suspended in compressible gas flow through a rotating cascade of a turbine are discussed. The results obtained from the solution of these equations are presented to indicate the location on the turbine blade subjected to erosion damage. Some erosion data relevant to gas turbine engines are discussed. The concluding remarks include a global view of the state of the art of particulate flow problems in turbomachinery. Author

A84-38368#

LAMINAR-TO-TURBULENT TRANSITION ON A BODY OF REVOLUTION WITH AN EXTENDED FAVORABLE PRESSURE GRADIENT FOREBODY

R. J. HANSEN (U.S. Navy, Naval Research Laboratory, Washington, DC) and J. G. HOYT (U.S. Naval Academy, Annapolis, MD) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 106, June 1984, p. 202-210. Navy-supported research. refs

An experimental study of the laminar-to-turbulent transition and resulting hydrodynamic forces on a body of revolution with a long, favorable pressure gradient forebody (i.e., where pressure is dropping and the flow accelerating) is reported. Over a substantial range of body velocity and angle of attack the favorable pressure gradient is shown to postpone transition to the point of laminar separation, and this extended laminar region results in a much lower hydrodynamic drag than is characteristic of an all-turbulent body. The intermittency of the boundary layer and the propagation characteristics of turbulent spots in the extended favorable pressure gradient region are quantified by hot film probes mounted flush with the body surface. The sensitivity of the boundary layer transition to three-dimensional surface roughness elements located in tandem (along a streamline) is also quantified. A number of such elements in tandem causes transition at a lower Reynolds number than would a single element of the same size, this effect becoming more pronounced with increasing number of roughness elements and decreasing space between them. Author

A84-38484#

STATIC PRESSURE RECOVERY CHARACTERISTICS OF SOME RADIAL VANELESS DIFFUSERS

C. RODGERS (Solar Turbines International, Turbomach Div., San Diego, CA) (International Symposium on Centrifugal Compressor Design, Toronto, Canada, May 5, 1982) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, March 1984, p. 42-54. refs

A test program has been conducted for single stage centrifugal compressors with backswept impellers that discharge into vaneless, parallel wall diffusers whose width/diameter ratios range from 0.035 to 0.117. Attention is given to the formulation of important criteria influencing vaneless diffuser performance and stability, on the basis of test results. The major concern is unstable static pressure recovery, which precipitates stage stall, rather than the first occurrence of rotating stall, or reverse flows into the impeller. At optimum and lower specific speeds, vaneless diffuser losses at DeLaval numbers lower than 1.2 are essentially due to internal friction. Decreasing specific speed with commensurately lower diffuser width/diameter ratios increases loss, decreases static pressure recovery, and reduces compressor stability. O.C.

A84-38493

THE ROLE OF MAGNETIC FLUID SEALS IN MODERN MACHINERY

S. GRAY (Mechanical Technology, Inc., Latham, NY) and D. F. WILCOCK Lubrication Engineering (ISSN 0024-7154), vol. 40, June 1984, p. 331-334. refs

In magnetic fluid seals, the fluid is held in the gap to be sealed by a nonuniform magnetic field. Seals of this type have become common in low-speed shaft penetrations where near-absolute sealing and generous clearances with no mechanical contact are highly desirable. The technology is now advancing to the point where sealing at very high speeds can be seriously contemplated, and where pressure differences greater than one atmosphere can be contemplated. Future applications are foreseen in centrifugal compressors, reciprocating compressors, and many types of refrigeration and energy-recovery machinery. Author

A84-38671

A CALCULATION OF INTERNAL FLOWS IN A ROTATING FLUID WITH CURVED STREAMLINES OF RELATIVE MOTION [K RASCHETU VNU TRENNIKH TECHENII VRASHCHAIUSHCHEISIA ZHIDKOSTI S ISKRIVLENNYMI LINIAMI TOKA OTNOSITEL'NOGO DVIZHENIIA]

E. M. SMIRNOV and S. V. IURKIN (Leningradskii Politekhnikeskii Institut, Leningrad, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriiia Tekhnicheskikh Nauk (ISSN 0002-3434), March 1984, p. 39-46. In Russian. refs

The motion of a fluid in a rotating annular region, that is caused either by a differential angular rotational velocity of the bounding surfaces or by a nonzero circumferential component of the pressure gradient, is analyzed using a nonlinear formulation. The characteristics of a possible non-self-similar class of solutions for the nonlinear Ekman layer are calculated and used for the closure of the problem concerned with the determination of the velocity field in the flow kernel. A solution is then presented for flow in a curved rotating duct, with allowance for the curvature of the streamlines. The calculated drag coefficients are found to be in good agreement with experimental data over a wide range of the governing criteria. V.L.

A84-38674

FLOW PAST ROTATING AND STATIONARY CIRCULAR CYLINDERS NEAR A PLANE SCREEN. II - CHARACTERISTICS OF FLOW PAST A STATIONARY CYLINDER [OBTEKANIE VRASHCHAIUSHEHEGOSIA I NEPODVIZHNOGO KRUGOVOGO TSILINDRA VBLIZI PLOSKOGO EKRANA. II - KHARAKTERISTIKI OBTEKANIIA NEPODVIZHNOGO TSILINDRA]

V. M. KOVALENKO, N. M. BYEHKOV, G. A. KISEL, and N. D. DIKOVSKAIA (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriiia Tekhnicheskikh Nauk (ISSN 0002-3434), March 1984, p. 78-88. In Russian. refs

Measurements have been made of pressure distributions and pulsations in a cross flow past a circular cylinder placed near a plane screen of finite length. The experiments reported here have been carried out under low turbulence conditions over a range of Reynolds numbers that includes the critical values. The boundary layer separation points and the evolution of the front critical point and other characteristic zones with the distance to the screen are determined. The components of the aerodynamic force acting on the cylinder and the Strouhal number are calculated on the basis of the predominant pulsation frequencies on the cylinder. V.L.

A84-38720

AEROTHERMODYNAMICS OF GAS TURBINE AND ROCKET PROPULSION

G. C. OATES (Washington, University, Seattle, WA) New York, American Institute of Aeronautics and Astronautics, Inc., 1984, 421 p. refs

The present book is intended to serve as a text for both graduate and under-graduate courses in aerospace propulsion. After introducing fundamental concepts of thermodynamics and quasi-one-dimensional flows, these are applied to rocket nozzle behavior prediction. Airbreathing engines are considered within the framework of ideal cycle analysis at first, and then real engine effects are introduced through definition of component measures. Selected examples of nonideal cycles are considered in detail, design concepts are extended to off-design estimation, and the restrictive effects of fixed geometry engines are revealed. Attention is also given to the elementary aerodynamics of turbomachinery. O.C.

A84-38838*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FORMATION AND DESTRUCTION OF VORTICES IN A MOTORED FOUR-STROKE PISTON-CYLINDER CONFIGURATION

H. J. SCHOCK, D. J. SOSOKA (NASA, Lewis Research Center, Cleveland, OH), and J. I. RAMOS (Carnegie-Mellon University, Pittsburgh, PA) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 948, 949; Abridged.

Previously cited in issue 05, p. 652, Accession no. A83-16749

A84-38846#

A FLUTTER EIGENVALUE PROGRAM BASED ON THE NEWTON-RAPHSON METHOD

V. J. E. STARK (Saab-Scania AB, Linkoping, Sweden) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 993-995. Research supported by the Swedish Defense Material Administration. refs

A tool-locus method based on the Newton-Raphson method and on a new expression for approximating aerodynamic transfer functions is described. The determinant of the Laplace transformed equations of motion and its derivative are calculated using efficient numerical methods. Results from test on low-order systems and incompressible flows are promising. C.D.

A84-38853#

APPLICATION OF RIEMANN PROBLEM SOLVERS TO WAVE MACHINE DESIGN

S. EIDELMAN, A. MATHUR (U.S. Naval Postgraduate School, Monterey, CA), R. SHREEVE (Exotech, Inc., Campbell, CA), and J. ERWIN AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 1010-1012. refs

(Contract N00014-82-SR-20232)

Unsteady wave phenomena (involving shock waves, reflected and hammer shocks, rarefaction waves, and their interactions) appearing in wave rotors with direct gas-to-gas energy transfer are investigated analytically. The Riemann problem of the system is derived and solved using a computer code (written in FORTRAN or PASCAL) based on the approach of Courant and Friedrichs (1948). A step-by-step analysis of a turbine-mode experiment is presented and illustrated with a diagram, and numerical results are given in a table. The computation of a typical Riemann step requires about 20 msec of CPU time on an IBM 370-3033AP. T.K.

A84-39218

CRACK CLOSURE AND OVERLOAD EFFECTS IN FATIGUE

J. Q. CLAYTON (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: Fracture mechanics technology applied to material evaluation and structure design; Proceedings of the International Conference, Melbourne, Australia, August 10-13, 1982. The Hague, Martinus Nijhoff Publishers, 1983, p. 491-503. refs

Observations of crack closure occurring during crack propagation in thin sheet materials under variable amplitude cyclic loading are discussed. The studies show that closure in the region immediately adjacent to the crack tip is important in controlling crack growth. From this basis, the Dugdale model and a simple fracture mechanics analysis is used to investigate the closure stresses produced by an overload during fatigue. The results suggest that this is a promising approach to fatigue crack growth prediction under varying load amplitude. Author

A84-39267

USE OF 'MARKER BLOCKS' AS AN AID IN QUANTITATIVE FRACTOGRAPHY IN FULL-SCALE AIRCRAFT FATIGUE TESTING - A CASE STUDY

R. V. DAINTY (National Aeronautical Establishment, Structures and Materials Laboratory, Ottawa, Canada) IN: Fractography of ceramic and metal failures; Proceedings of the Symposium, Philadelphia, PA, April 29, 30, 1982. Philadelphia, PA, American Society for Testing and Materials, 1984, p. 285-308. refs

With a view to the development of means for acquiring accurate fatigue crack growth data from fracture surface analysis, a

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technique was formulated which used a 64-cycle, constant amplitude 'marker block' in an otherwise random load spectrum of 4469 cycles to derive fatigue crack growth data from an aluminum alloy spar cap and two wing skin rivets. An undetected incipient crack in the spar cap from a previous full scale aircraft structure test allowed the accounting for the entire random loading crack growth history in terms of the 'marker band' spacings. Marker bands at the relatively short crack lengths of 2.6 mm for the spar cap and 0.5 mm for the rivets were identified by SEM. O.C.

A84-39302#

MODERN DEVELOPMENTS IN FLOW VISUALIZATION

G. S. SETTLES (Pennsylvania State University, University Park, PA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 17 p. refs (AIAA PAPER 84-1599)

This review paper covers a number of developments of the past few years which concern the visualization of fluid flows. Some of the subjects covered include laser holography, holographic interferometry, light-screen illumination, laser-induced fluorescence, surface flow visualization and topology, infrared thermography, tomography, large-field flow visualization, high-speed photography and videography, computer graphics, digital and optical image processing, and flow visualization techniques for practical aerodynamic testing. The review covers a broad range but is by no means exhaustive; instead an attempt has been made to draw connections among related disciplines, point out significant trends, and guide the reader to resources for further study. A commentary on the state-of-the-art of flow visualization and a list of future needs is also included. Author

A84-39309*# Aerometrics, Inc., Mountain View, Calif.

A REAL-TIME INTERFEROMETER TECHNIQUE FOR COMPRESSIBLE FLOW RESEARCH

W. D. BACHALO and M. J. HOUSER (Aerometrics, Inc., Mountain View, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 14 p. NASA-supported research. refs (AIAA PAPER 84-1600)

Strengths and shortcomings in the application of interferometric techniques to transonic flow fields are examined and an improved method is elaborated. Such applications have demonstrated the value of interferometry in obtaining data for compressible flow research. With holographic techniques, interferometry may be applied in large scale facilities without the use of expensive optics or elaborate vibration isolation equipment. Results obtained using holographic interferometry and other methods demonstrate that reliable qualitative and quantitative data can be acquired. Nevertheless, the conventional method can be difficult to set up and apply, and it cannot produce real-time data. A new interferometry technique is investigated that promises to be easier to apply and can provide real-time information. This single-beam technique has the necessary insensitivity to vibration for large scale wind tunnel operations. Capabilities of the method and preliminary tests on some laboratory scale flow fluids are described. D.H.

A84-39316#

VISCOUS FLOW CALCULATIONS OF SHOCK DIFFRACTION AND DRAG LOADS ON ARCHED STRUCTURES

J. KURYLO, S. HANCOCK, and Y. KIVITY (Physics International Co., San Leandro, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 10 p. refs (AIAA PAPER 84-1680)

The goal of this work is to develop a numerical method for computing both the shock diffraction phase and viscous drag phase of airblast loading on structures. Calculations of single Mach reflection and double Mach reflection demonstrate the accuracy of the numerical method for oblique shock reflections. A long-term calculation of blast loading on a structure demonstrates that the

drag coefficient becomes zero if viscosity is neglected. When the calculation is repeated with viscous effects included, the flow separates and a finite drag coefficient is obtained. We conclude that meaningful long-duration blast loading calculations are possible. Author

A84-39368#

PROTUBERANCE INTERFERENCE HEATING IN HIGH-SPEED FLOW

F. T. HUNG (Aerospace Corp., Thermal Control Dept., El Segundo, CA) and D. K. PATEL (Rockwell International Corp., Aerothermodynamics Dept., Downey, CA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 19th, Snowmass, CO, June 25-28, 1984. 13 p. refs (AIAA PAPER 84-1724)

Extensive experimental study was conducted on interference heating caused by protuberances protruding from a flat plate. Heating measurements were made on both the flat plate and the protuberances. The parametric study includes variation of protuberance dimensions, unit Reynolds number, flow length, and, consequently, boundary layer thickness. The protuberance can be either two- or three-dimensional, and the three-dimensional protuberance can either be submerged in the boundary layer or be infinitely long, with the flow on the flat plate either laminar or turbulent. The heating data were correlated in such a way that generalized heating prediction methods were developed for thermal design purposes. Based on heating characteristics, criteria were derived in this study for categorizing short, long, small, and large protuberances. The effect of protuberance interference on the flat plate boundary layer transition was also discussed. Author

A84-39498

PROBLEMS OF FAILURE ANALYSIS, TAKING INTO ACCOUNT THE EXAMPLE OF A DESTROYED AXIAL-FLOW COMPRESSOR [PROBLEME DER SCHADENSANALYSE - DARGESTELLT AM BEISPIEL EINES ZERSTOERTEN AXIALVERDICHTERS]

G. LANGE (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Metallkunde (ISSN 0044-3093), vol. 75, June 1984, p. 401-406. In German. refs

Failure analysis has mainly the objective to determine the causes for the failure of a structural element. In addition, it is to provide the information for taking suitable steps to prevent further damage. Problems of failure analysis are discussed, giving attention to the importance of representative samples, advantages of a use of the scanning microscope, macroscopic and microscopic studies, the importance of a uniform technology for damage assessment, and damage produced as a consequence of the violation of basic rules regarding the employment of metallic materials. The selected example for a failure analysis is related to a helicopter which was employed over the North Sea. The helicopter had to make an emergency landing on water because of engine failure. The failure was connected with damage involving the two-stage axial-flow compressor. Nine out of eleven blades in the first compressor stage had been severed. Details of the analysis procedure are described along with the evaluation of the results. G.R.

A84-39738

OPTIMUM DESIGN IN DISTRIBUTED PARAMETER SYSTEMS

M. KODA (Tokyo, University, Tokyo, Japan) IN: Control of distributed parameter systems; Symposium, 3rd, Toulouse, France, June 29-July 2, 1982, Preprints. Oxford, Pergamon Press, Ltd., 1982, p. XIV.1-XIV.6. refs

A new numerical method for the computation of sensitivity of design performance functional with respect to boundary variations is used to study the optimum design problems in general distributed parameter systems. The method is based on a modification of schemes in functional derivative sensitivity analysis and includes a specialization of the optimal control algorithms in distributed parameter systems. A design sensitivity theorem is derived for the determination of the optimum boundary location that minimizes a design performance functional. Necessary conditions for minimum drag profiles in unsteady Navier-Stokes flows are obtained and a

numerical design algorithm based on the gradient method is formulated. Author

N84-26610# Naval Research Lab., Washington, D. C.
THE EFFECTS OF MOISTURE ON FRACTURE TOUGHNESS AND THERMAL RELAXATION OF STRETCHED ACRYLIC PLASTICS

J. TIROSH, S. A. SUTTON, P. W. MAST, R. W. THOMAS, and I. WOLOCK *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 275-295 Dec. 1983 (AD-P003197) Avail: NTIS HC A08/MF A01 CSCL 01C

Studies were conducted to determine the effects of absorbed moisture on the thermal relaxation behavior and fracture toughness of stretched acrylic plastic. Results indicated that the thermal relaxation behavior is affected significantly by the amount of absorbed moisture. Test results can be obtained on the same material that meet or do not meet the requirements of that specification, depending on the moisture content of the test specimens. Fracture toughness tests were conducted over a range of loading rates and for different moisture contents, using the compact tension specimen. The material with a high moisture content had a higher fracture toughness than dry material at lower rates of loading. At high loading rates, moisture content did not affect fracture toughness. Thus, if a specification stipulates a high loading rate for the fracture toughness test, control of moisture content is not necessary. Data previously obtained on polycarbonate plastic indicates that this material has a higher fracture toughness than stretched acrylic for lower moisture contents. However, at high moisture contents, there is little difference between the two materials for the thicknesses and loading rates studied. GRA

N84-26613# Boeing Commercial Airplane Co., Seattle, Wash.
AN INDUSTRY TEST PROGRAM FOR INTERLAYER EQUIVALENCY

P. H. BAIN *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 382-406 Dec. 1983 (AD-P003200) Avail: NTIS HC A08/MF A01 CSCL 01C

After the announcement in 1980 that Monsanto will have to discontinue production of their interlayer Salflex PT due to the non availability of 3 GH plasticizer, an Industry team, under the auspices of the Aerospace Industries Association (AIA), was formed to identify and obtain approval for a replacement interlayer. A test program was derived to examine the physical, mechanical and operational characteristics of candidate replacement materials and compare them to those of the current PVB/3GH. Typical production batches of material were procured and the test program was completed by an Industry cooperative effort. The program demonstrated a high degree of equivalency and finally resulted in FAA approval of an interlayer as a general direct replacement for all existing designs of glass windshields utilizing PVB/3GH interlayer in either a bird bouncing or bird bagging mode. It is believed that this is the first time a windshield material has received FAA approval without the usual expensive certification program normally required for each design. GRA

N84-26624# Boeing Commercial Airplane Co., Seattle, Wash.
THE NEED FOR APPLICATION OF DYNAMIC MECHANICAL ANALYSIS IN THE EVALUATION OF INTERLAYER MATERIALS

A. JAYARAJAN *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 597-618 Dec. 1983 (AD-P003211) Avail: NTIS HC A08/MF A01 CSCL 01C

Interlayer materials like Polyvinyl Butyral (PVB), Silicone and Urethane are viscoelastic in their mechanical behavior. Mechanical properties of a viscoelastic material are not only dependent on temperature, but also highly dependent on frequency or strain rate. Dynamics mechanical analysis provides an effective experimental tool to measure the viscoelastic properties over a wide range of temperatures and in the time range of a few seconds up to 10 to the minus 5th power seconds. It is especially suitable for studying the viscoelastic nature of interlayer materials since the temperature and strain rate conditions for windshield design

and service are within the measurement and analytical capabilities of DMA. GRA

N84-26633# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

A TRIANGULATION TECHNIQUE FOR OBTAINING DEFLECTIONS OF AIRCRAFT TRANSPARENCIES DURING BIRD IMPACT TESTING

W. R. PINNELL and D. A. CROCKER *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 776-791 Dec. 1983

(AD-P003220) Avail: NTIS HC A08/MF A01 CSCL 01C

A technique for determining a time history for the displacement in space of points on the inside surface of an aircraft transparency during and after the simulated impact of a bird has been developed. This method utilizes two high speed motion picture cameras located in a three dimensional space which also contains designated points on the transparency surface. The cameras are positioned so that a common field of view contains points for which deflection history is required. Displacements of the images of given points in the film frames from each camera are used to obtain positions in a three dimensional space. All optical magnifications and changes in point to camera distances are accounted for. In addition to obtaining deflection data for selected points, the films are also useful for describing the footprint of the bird on the transparency, an important improvement in the ability to model bird loading in computerized dynamic analysis efforts. As an example of the application of this process, data resulting from a bird impact on a T-38 windshield are included. GRA

N84-26642# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

VALIDATION OF THE MAGNA (MATERIALLY AND GEOMETRICALLY NONLINEAR ANALYSIS) COMPUTER PROGRAM FOR NONLINEAR FINITE ELEMENT ANALYSIS OF AIRCRAFT TRANSPARENCY BIRD IMPACT

R. E. MCCARTY and J. L. HART *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 921-972 Dec. 1983

(AD-P003229) Avail: NTIS HC A08/MF A01 CSCL 01C

The approach taken for validation of MAGNA is based on the simulation of full scale bird impact tests followed by a comparison of the experimental data with that computed by MAGNA. To date, five of these validation studies have been accomplished and several more remain to be conducted. This paper summarizes the results of the validation studies which have been completed to date and lists the user guidelines which have been established in the process. These first validation studies may be characterized as analyses of simple structures, i.e., only single transparent panels have been analyzed as opposed to complex systems of multiple panels joined by metallic edgemember support structure. These same studies may be further characterized as involving only simple definitions of boundary conditions and a somewhat arbitrary procedure for the explicit definition of bird impact pressure loading on the surface of the structure. The cases selected for study were a flat, laminated glass windshield panel; a curved, laminated glass windshield panel; a curved, laminated plastic windshield panel; a bubble-shaped monolithic plastic one-piece canopy; and a heated glass cylinder (which involved neither an aircraft transparency system per se nor bird impact loads). GRA

N84-26645# Dayton Univ., Ohio.

PARAMETRIC STUDIES OF THE T-38 STUDENT WINDSHIELD USING THE FINITE ELEMENT OF CODE MAGNA (MATERIALLY AND GEOMETRICALLY NONLINEAR ANALYSIS)

R. NASH *In its* Conf. on Aerospace Transparent Mater. and Enclosures p 1040-1055 Dec. 1983

(Contract F33615-76-C-3103; F33615-80-C-3401)

(AD-P003232) Avail: NTIS HC A08/MF A01 CSCL 01C

The parametric studies examine the effect of structural variations on the nonlinear dynamic response of the T-38 student windshield/support structure system to bird impact. The studies were conducted using the MAGNA (Materially and Geometrically

Nonlinear Analysis) finite element computer program. Both static and dynamic analyses were performed, examining the effects of changes to the transparency stiffness and intensity of the applied load, both coupled and uncoupled. Significant results of the finite element analysis include transparency deflection peak load versus transparency stiffness, and resultant force plots along the aft arch. A discussion of the application of the finite element method to the birdstrike problem is also presented. GRA

N84-26646# Dayton Univ., Ohio.

CURRENT PROBLEMS AND PROGRESS IN TRANSPARENCY IMPACT ANALYSIS

R. A. BROCKMAN *In its* Conf. on Aerospace Transparent Mater. and Enclosures p 1057-1082 Dec. 1983 (AD-P003233) Avail: NTIS HC A08/MF A01 CSCL 01C

The design of aircraft transparencies for impact resistance poses a number of difficult problems for the structural analyst. Prominent among these are the accurate modeling of the transparency and its dynamic response, characterization of the construction materials, and evaluation of the applied loadings resulting from soft-body impact. This paper reviews current practices for mathematical modeling of transparency impacts, discusses problem areas in current analysis capabilities, and summarizes some current research on methods for impact simulation. GRA

N84-26647# Goodyear Aerospace Corp., Litchfield Park, Ariz.

NASTRAN ANALYSIS OF NUCLEAR EFFECTS ON HELICOPTER TRANSPARENCIES

P. T. LIN and J. S. JORGENSON *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 1083-1095 Dec. 1983

(AD-P003234) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper deals with the linear and geometric nonlinear analysis of the gunner's window on the AH-1S Cobra helicopter in response to a nuclear overpressure environment. The work was sponsored by the Applied Technology Laboratory, U.S. Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, Virginia. Both monolithic stretched acrylic and multilayered transparency configurations are considered in this report. Comparison analyses using both the NASTRAN finite element program and classical Timoshenko plate theory show good agreement. Comparison of the analytical results with experimental observations made by other sources indicates that the geometric nonlinear mathematical models, rather than the linear models, are the more realistic and appropriate representation of transparency response to nuclear overpressure loading in the range considered. It is shown that the classical analysis of a simplified equivalent configuration serves as a useful checkpoint, while finite element programs, such as MSC/NASTRAN, are the necessary analytical tools to examine the complicated configurations and loading conditions. GRA

N84-26649# Sverdrup Technology, Inc., Arnold Air Force Station, Tenn.

STATUS OF NEW AEROTHERMODYNAMIC ANALYSIS TOOL FOR HIGH-TEMPERATURE RESISTANT TRANSPARENCIES

M. O. VARNER and C. A. BABISH *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 1132-1157 Dec. 1983

(Contract F33615-81-C-3412)

(AD-P003236) Avail: NTIS HC A08/MF A01 CSCL 01C

This paper summarizes the status of the definition, selection, modification, and development of a Specific Thermal Analyzer Program for Aircraft Transparencies (STAPAT). The code developed will merge state-of-the-art technology, code accuracy requirements, and the definition of code function requirements resulting in an aerothermodynamic analytical technique that is specifically applicable and limited to the study of high-temperature resistant transparencies for high-speed aircraft. The aerothermodynamic methodologies required for the definition of the convective heat-load requirements of the STAPAT are described. These include the identification of inviscid methodologies covering the subsonic-to-supersonic-speed flight regime complex

three-dimensional configurations consisting of real canopy geometries. The external forced convection methodology is described which includes complex three-dimensional effects resulting from the circumferential and streamwise variation of the local heating loads, the forced convection heat transfer as influenced by wall-temperature effects and transition location, and variable-edge entropy effects. GRA

N84-26895# Joint Publications Research Service, Arlington, Va. **USSR REPORT: ENGINEERING AND EQUIPMENT**

13 Apr. 1984 59 p refs Transl. into ENGLISH from various Russian articles

(JPRS-UEQ-84-003) Avail: NTIS HC A04/MF A01

The reduction of mass transfer during the friction of bronzes and other improvements in industrial technology are highlighted. Investigations in turbine and engine design, the development of navigation and guidance systems, fluid mechanics, and the mechanics of solids are also summarized.

N84-26916# Joint Publications Research Service, Arlington, Va. **MATHEMATICAL MODELING OF TRANSIENT SEPARATION FLOW AROUND CIRCULAR CYLINDER Abstract Only**

S. M. BELOTSEKOVSKIY, V. N. KOTOVSKIY, M. I. NISHT, and R. M. FEDOROV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 23-24 13 Apr. 1984 Transl. into ENGLISH from *Izv. Akad. Nauk SSSR: Mekh. Zhidk. i Gaza* (Moscow), no. 4, Apr. 1983 p 138-147

Avail: NTIS HC A04/MF A01

A numerical method is proposed for complete solution of the problem of transient separation flow of a viscous fluid around a cylinder. It is based on existing models of a boundary layer and on assuming an ideal medium, and it requires no additional empirical data. The potential flow outside the boundary layer is mathematically modeled by a system of $N+1$ dimensionless algebraic equations in series form describing the circulation of discrete vortices. At time zero N of these equations represent the condition of impermeability of the cylinder surface and one represents the condition of zero tangential velocity at the stagnation point. For subsequent instants of time the N equations are modified to represent the condition of impermeability at successive points on the surface and the one equation is modified to represent the Thomson theorem of constant circulation around a contour enclosing both the body and its trail. The boundary layer is simulated not only on the front from the stagnation point to the separation point on each side, but also on the rear side with backstreams within the zone between the two separation points there. Viscous flow in the boundary layer is described by the conventional system of differential equations of a nonsteady layer, with both kinematic and eddy viscosity as parameters. Author

N84-26930# Joint Publications Research Service, Arlington, Va. **IMMERSION OF DISK IN COMPRESSIBLE FLUID AT ANGLE TO FREE SURFACE Abstract Only**

V. A. YEROSHIN *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 32-33 13 Apr. 1984 Transl. into ENGLISH from *Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza* (Moscow), no. 2, Feb. 1983 p 142-144

Avail: NTIS HC A04/MF A01

Fast immersion of a disk in a compressible fluid was considered in the oblique mode. The dependence of the maximum impact drag coefficient and of the length of the transient period of impact load buildup on the Mach number of the disk prior to impact is established. The conventional expression for the maximum impact drag coefficient for immersion in an incompressible fluid such as water is modified to account for the compressibility of the fluid and remove the singularity $C_x \rightarrow \infty$ as the difference between angle of disk trajectory θ and angle of attack α approaches 90° . E.A.K.

N84-26936# Joint Publications Research Service, Arlington, Va.
THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS AT BIELLIPTICAL BODIES IN STREAM OF COMPRESSIBLE GAS AT SOME ANGLE OF ATTACK Abstract Only

V. A. ALEKSIN and Y. D. SHEVELEV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 36-37 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 2, Feb. 1983 p 39-47
 Avail: NTIS HC A04/MF A01

Three-differential turbulent boundary layers at conical bodies with bielliptical cross section in a stream of compressible gas are analyzed on the basis of a system of partial differential equations in a curvilinear system of coordinates. These equations, one equation of continuity and two equations of momentum, contain geometrical coefficients and semiempirical effective transfer coefficients. The semiempirical model of transfer is a direct extension of a two-dimensional model of turbulent transfer with fast changes in boundary conditions. The effective dynamic viscosity depends on the local Reynolds number and the local critical Reynolds number, the effective thermal conductivity depends on the two Reynolds numbers as well as on the local Prandtl number and the local eddy Prandtl number. The partial differential equations have been integrated numerically by the method of finite differences, with fourth-order accuracy in the normal coordinate. Pressure and velocity fields, including the separation zone and points of maximum thermal flux and maximum friction on the surface, have been determined in this way for a bielliptical conical body at angle of attack $\alpha = 20$ deg in a supersonic air stream with $M_\infty = 20$. B.W.

N84-26943# Joint Publications Research Service, Arlington, Va.
SUBHARMONIC VIBRATIONS OF ROTOR MOUNTED IN ROLLING BEARINGS Abstract Only

A. V. MOVCHAN and V. V. FILATOV *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 42 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Tverdogo Tela (Moscow), no. 4, Apr. 1983 p 77-80
 Avail: NTIS HC A04/MF A01

An experimental study of subharmonic vibrations of a rotor was made, with a gyromotor mounted in ball bearings so as to ensure very low friction. The electric gyromotor was a 3-phase synchronous one with voltage and frequency control. The rotor speed was measured with a stroboscopic tachometer for precise speed control and recording, its vibrations were measured by means of a piezoelectric accelerometer with the sensitivity axis in the radial plane of one bearing. The accelerometer readings, twice integrated and amplified, were fed to a digital computer for harmonic analysis. Each of the five such GMS-9 motors for this experiment was mounted in 1000095 ball bearings with stationary inner race and rotating outer race. The vibration spectra of all motors reveal two dominant frequencies, indicated by sharp amplitude peaks. These frequencies correspond respectively to the speed of the rotor w and to the speed of the bearing separator $w_{sub s}$, the ratio of these speeds remaining $w_{sub s}/w = D/(D + d) = 0.61$ in all tests (D and d diameters of outer and inner bearing race, respectively, at the contact line in the groove). Author

N84-26954# Joint Publications Research Service, Arlington, Va.
ORIENTATION AND CALIBRATION OF THREE-DIMENSIONAL TACHOMETER WITH AID OF AVAILABLE ANGLE DATA Abstract Only

A. I. TKACHENKO *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 49 13 Apr. 1984 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Tverdogo Tela (Moscow), no. 3, Mar. 1983 p 19-23
 Avail: NTIS HC A04/MF A01

The problem of determining the spatial orientation of an 'instrument' trihedron was investigated. An trihedron with its angular velocity measured continuously and its initial orientation known approximately was considered. The readings of angular velocity were assumed to contain a small additive error representable as a linear combination of a finite number of known functions with unknown coefficients, the latter to be determined along with the

parameters defining the orientation of the instrument. The components of the true velocity vector were assumed to be continuously differentiable of the true velocity vector were assumed to be continuously differentiable with respect to time throughout almost the entire measuring period. This problem was solved with the aid of available data on the angular motion of another trihedron with fixed but unknown orientation relative to the instrument. The solution was analyzed for accuracy, and a procedure for refining the orientation of the orthonormalized instrument vector basis was demonstrated. R.S.F.

N84-26964# Selenia S.p.A., Rome (Italy).

INTRODUCTION TO MULTIRADAR TRACKING SYSTEMS

A. FARINA and S. PARDINI *In its* Rivista Tec. Selenia, Vol. 8, No. 1 p 14-26 1982 refs
 Avail: NTIS HC A03/MF A01

Multiradar tracking (MRT) using distributed and centralized systems is discussed. Although MRT has advantages with respect to a monoradar system (e.g., a target may be tracked, with greater accuracy, over an area wider than the coverage of each radar) difficulties arise in organization and processing of measurement data. Unlike the monoradar case, the data organization according to azimuthal sectorization is not possible, because the measurements come from various spatial sectors in a nonuniform manner. In the overlapped area, the targets are detected by different radars which are asynchronously scanning and have different scan periods and accuracies. Author (ESA)

N84-26967# Naval Postgraduate School, Monterey, Calif.

SPECIALIZED COMMON CARRIERS: LONG DISTANCE ALTERNATIVES FOR MILITARY INSTALLATIONS M.S. Thesis

S. L. KLINGLER Mar. 1984 205 p
 (AD-A140596) Avail: NTIS HC A10/MF A01 CSCL 17B

Specialized Common Carriers, communications carriers which came into existence offering private line microwave service, are now significant competitors in the long distance telecommunications industry. This thesis provides military installation telecommunications managers with a basic knowledge of how Specialized Common Carriers entered the telecommunications market, what services Specialized Common Carriers offer, and how to obtain these services for a military installation. It includes a case study evaluation of the potential use of long distance services of two of these competing common carriers at Naval Air Station Moffett Field, California. A computer program used to calculate the costs of using these two alternative long distance carriers is included as part of the case study. GRA

N84-26973*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ALTERNATIVE VOICE SWITCHING AND CONTROL SYSTEM DISPLAY PANEL FORMAT SIMULATION AND EVALUATION Final Report

M. L. SLONSKI and J. G. STIPANUK Feb. 1984 34 p
 (NASA-CR-173644; JPL-D-1371; NAS 1.26:173644; AD-A140825; DOT/FAA/PM-84/6) Avail: NTIS HC A03/MF A01 CSCL 17B

This report documents Jet Propulsion Laboratories efforts in the simulation and evaluation of the three alternative displays proposed for the Voice Switching and Control System. It includes the identification of the initial display requirements, selection, simulation, and evaluation of the three proposed formats and also the definition and simulation of a final modified display format. Author (GRA)

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N84-26974# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

MULTISENSOR SPEECH INPUT Final Technical Report, Feb. 1982 - Jul. 1983

V. R. VISWANATHAN, K. F. KARNOFSKY, K. N. STEVENS, and M. N. ALAKEL Griffiss AFB, N.Y. RADC Dec. 1983 112 p (Contract F30602-82-C-0064; AF PROJ. LDFP) (AD-A140894; RADC-TR-83-274) Avail: NTIS HC A06/MF A01 CSCL 17A

The use of multiple sensors to transduce speech was investigated. A data base of speech and noise was collected from a number of transducers located on and around the head of the speaker. The transducers included pressure, first order gradient, second order gradient microphones and an accelerometer. The effort analyzed this data and evaluated the performance of a multiple sensor configuration. The conclusion was: multiple transducer configurations can provide a signal containing more useable speech information than that provided by a microphone.

Author (GRA)

N84-27002*# Scientific Research Associates, Inc., Glastonbury, Conn.

SOLUTION OF 3-DIMENSIONAL TIME-DEPENDENT VISCOUS FLOWS. PART 2: DEVELOPMENT OF THE COMPUTER CODE

B. C. WEINBERG and H. MCDONALD Dec. 1980 82 p refs 3 Vol.

(Contract NAS2-10016)

(NASA-CR-166565-PT-2; NAS 1.26:166565-PT-2) Avail: NTIS HC A05/MF A01 CSCL 20D

There is considerable interest in developing a numerical scheme for solving the time dependent viscous compressible three dimensional flow equations to aid in the design of helicopter rotors. The development of a computer code to solve a three dimensional unsteady approximate form of the Navier-Stokes equations employing a linearized block explicit technique in conjunction with a QR operator scheme is described. Results of calculations of several Cartesian test cases are presented. The computer code can be applied to more complex flow fields such as these encountered on rotating airfoils.

M.A.C.

N84-27003*# Scientific Research Associates, Inc., Glastonbury, Conn.

SOLUTION OF 3-DIMENSIONAL TIME-DEPENDENT VISCOUS FLOWS. PART 3: APPLICATION TO TURBULENT AND UNSTEADY FLOWS

B. C. WEINBERG and H. MCDONALD Sep. 1982 93 p refs 3 Vol.

(Contract NAS2-10016)

(NASA-CR-166565-PT-3; NAS 1.26:166565-PT-3) Avail: NTIS HC A05/MF A01 CSCL 20D

A numerical scheme is developed for solving the time dependent, three dimensional compressible viscous flow equations to be used as an aid in the design of helicopter rotors. In order to further investigate the numerical procedure, the computer code developed to solve an approximate form of the three dimensional unsteady Navier-Stokes equations employing a linearized block implicit technique in conjunction with a QR operator scheme is tested. Results of calculations are presented for several two dimensional boundary layer flows including steady turbulent and unsteady laminar cases. A comparison of fourth order and second order solutions indicate that increased accuracy can be obtained without any significant increases in cost (run time). The results of the computations also indicate that the computer code can be applied to more complex flows such as those encountered on rotating airfoils. The geometry of a symmetric NACA four digit airfoil is considered and the appropriate geometrical properties are computed.

M.A.C.

N84-27006# Aeronautical Research Inst. of Sweden, Stockholm.

A FUNDAMENTAL STUDY OF RELATION BETWEEN THE VELOCITY FIELDS FAR UPSTREAM OF, AT AND FAR DOWNSTREAM OF A ROTOR DISK IN A SHEAR FLOW

B. C. A. JOHANSSON Oct. 1983 98 p refs

(FFA-136) Avail: NTIS HC A05/MF A01

For the analysis of wind turbine low, it would be of great value to find a general relation between the local velocity fields far upstream, at the rotor disk and far downstream of a rotor inducing large perturbations in a shear flow. When the velocity perturbations of a parallel flow are small, the induced velocity at the obstacle causing the perturbation (disk or lifting line) is half the induced velocity far downstream at the same streamline. For a rotor in uniform flow, the mean induced velocity at the disk is also half the mean induced velocity far downstream, even if the perturbation velocities are not small. A first step was taken towards obtaining the desired general relation. A numerical example is calculated, which shows that the ratio one half has no general validity. Results are applicable not only to wind turbines, also to propellers, and helicopter rotors.

A.R.H.

N84-27007# Royal Aircraft Establishment, Farnborough (England).

THEORETICAL MODELLING OF THREE-DIMENSIONAL VORTEX FLOWS IN AERODYNAMICS

J. H. B. SMITH 1983 24 p refs Presented at the AGARD Fluid Dyn. Panel Symp. Aerodyn. of Vortical Type Flows in Three Dimensions, Rotterdam, 25-28 Apr. 1983

(AD-A134966; RAE-TM-AERO-1963; BR89099) Avail: NTIS HC A02/MF A01 CSCL 20D

A unified account is presented of the various inviscid models used to represent three-dimensional vortex flows in aerodynamics; essentially those relying on vortex sheets and line-vortices. Recent developments in extending the scope, accuracy, and stability of these models are described. An evaluation of their relative strengths and weaknesses suggests that the different models all have continuing roles to play. It is claimed that vortex modelling has come of age, in the sense that we can now learn about the real world from the behavior of models, after decades of trying to make the models conform with reality.

M.G.

N84-27024*# Pennsylvania State Univ., University Park. Dept. of Physics.

EXPERIMENTAL STUDY USING NEARFIELD ACOUSTICAL HOLOGRAPHY OF SOUND TRANSMISSION FUSELAGE SIDEWALL STRUCTURES Progress Report

J. D. MAYNARD 1983 84 p refs

(Contract NAG1-216)

(NASA-CR-173639; NAS 1.26:173639) Avail: NTIS HC A05/MF A01 CSCL 14E

This project involves the development of the Nearfield Acoustic Holography (NAH) technique (in particular its extension from single frequency to wideband noise measurement) and its application in a detailed study of the noise radiation characteristics of several samples of aircraft sidewall panels. With the extensive amount of information provided by the NAH technique, the properties of the sound field radiated by the panels may be correlated with their structure, mounting, and excitation (single frequency or wideband, spatially correlated or uncorrelated, structure-borne). The work accomplished at the beginning of this grant period included: (1) Calibration of the 256 microphone array and test of its accuracy. (2) extension of the facility to permit measurements on wideband noise sources. The extensions included the addition of high-speed data acquisition hardware and an array processor, and the development of new software. (3) Installation of motion picture graphics for correlating panel motion with structure, mounting, radiation, etc. (4) Development of new holographic data processing techniques.

B.W.

N84-27038 Wisconsin Univ., Madison.
DESIGN OF MECHANICAL JOINTS IN COMPOSITES Ph.D. Thesis

Y. J. CHIANG 1983 231 p
 Avail: Univ. Microfilms Order No. DA8400480

Stress and strength analyses of pin loaded holes in mechanical joints in composite materials are presented. The design of mechanical joints in composites depends on several parameters: materials, fastener details, geometry and environmental effects. The literature on the topic is reviewed and the relevant technical problems are outlined. Stress analysis of mechanically fastened joints in linear elastic anisotropic materials is discussed. Many practical problems exist in which nonlinear constitutive behavior supersedes simple linear elastic assumptions. The nonlinear material responses of mechanical joints in composite materials are treated. It is not uncommon for cracks to emanate from fastener holes in high-performance advanced composite structures such as aircrafts. The dependence of variation of stress intensity factors on the concerned parameters is utilized to determine the severity of flaws embedded in the composite at the beginning of service life. Diagrams for stress intensity factors which are useful for design are presented. Dissert. Abstr.

N84-27065*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, Va.

ANALYSIS OF LATERAL AND TORSIONAL VIBRATION CHARACTERISTICS OF BEAMS AND SHAFTS WITH END LOCATED ROTATIONAL MASSES

D. K. ROBERTSON May 1984 33 p refs
 (NASA-TM-84593; NAS 1.15:84593) Avail: NTIS HC A03/MF A01 CSCL 20K

Partial differential equations are derived for free lateral and torsional vibration of a uniform free-free beam with a rotational mass attached to each extremity. For appropriate boundary conditions, nonlinear algebraic equations are obtained using a symbolic manipulation computer program, the solutions of which enable the computation of the natural frequencies and mode-shapes. The mode-shapes are linear combinations of trigonometric and hyperbolic sine and cosine functions. A computer program is written for the numerical solution of the algebraic equations mentioned above, which can compute the natural frequencies, mode-shapes, and node points for any given set of parameters, for any given number of modes. Author

N84-27070# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

PRELIMINARY EVALUATION OF WAVEGUIDE VIBRATION ABSORBERS Final Report, May 1983 - Jan. 1984

E. E. UNGAR and L. G. KURZWEIL Wright-Patterson AFB, Ohio
 AFWAL Jan. 1984 58 p
 (Contract F33615-83-C-3217; AF PROJ. 2401)
 (AD-A140743; BBN-5527; AFWAL-TR-83-3125) Avail: NTIS HC A04/MF A01 CSCL 20K

The loss factor contribution provided to a vibrating structure by an attached energy-absorbing system is analyzed in terms of the mechanical impedances of the structure and attached system. The driving-point impedance of an exponentially tapered semi-infinite beam is derived and is used to determine the parameters that govern the energy-absorption characteristics of flexural waveguide absorbers. Impedances measured on several preliminary candidate absorber configurations are reported, together with the loss factor contributions they provided for an experimental plate. Although these configurations were found not to exhibit the desired waveguide behavior, their measured loss factor contributions were found to be in good agreement with those predicted from their measured impedances. It is concluded that flexural waveguide absorbers indeed have the potential for providing significant damping, but in order to achieve this effect, they must be impedance-matched to the structure that is to be damped, and absorber configurations need to be developed that exhibit the desired waveguide behavior in the frequency range of concern. Author (GRA)

N84-27074# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (West Germany).

GENERATION OF MARKER LINES BY MEANS OF MARKER LOADS

K. HOFFER and R. HILLBRECHT 1984 13 p
 Avail: NTIS HC A02/MF A01

Flight simulation crack propagation tests were run on flat specimens to show that it is possible to generate marker lines on the fatigue fracture surface. The marker lines are clearly visible. A comparison of results obtained from crack propagation tests shows the constant amplitude loads interspersed in the FALSTAFF flight-by-flight loads to be damage equivalent to the flights not simulated in the flight-by-flight sequence. Author (ESA)

N84-27914# Textron Bell Aerospace Co., Buffalo, N. Y.
DEVELOPMENT OF IMPROVED LACV-30 PROPELLER BLADE COATINGS FOR PROTECTION AGAINST SAND AND RAIN EROSION AND MARINE ENVIRONMENT CORROSION Final Report, 4 Jan. 1982 - 4 Mar. 1983

G. A. MALONE 10 May 1983 130 p refs
 (Contract DAAK70-82-C-0017)
 (AD-A132999; TBA-7467-927063) Avail: NTIS HC A07/MF A01 CSCL 11C

An investigation was conducted of candidate systems offering potential erosion and corrosion protection when applied as coatings to Aluminum 7075 alloy propeller blades used to propel air cushioned vehicles operating in severe environments such as offshore and marine beach logistics missions. Blade lifespans are significantly abbreviated by erosion from sand and water impingement. This work focused on special hard anodized and hard nickel electroplated coatings as candidate protective systems with sand/rain erosion testing to evaluate their merits. Results indicated that anodized coatings did not provide suitable erosion protection to Aluminum 7075 in sand/rain environments, even with dry film lubricant supplemental films. Electroplated hard nickel coatings, Vickers hardnesses in the range of 380 to 440, appeared better for combined sand/rain erosion resistance based on comparisons with prior work. Dilute phosphoric anodizing the aluminum substrates led to excellent bonds and improved corrosion resistance when subsequently plated with ductile nickel from a low pH bath, followed by hard nickel electroplate. Electrodeposited sacrificial corrosion coatings degraded the overall coating bond integrity. M.G.

N84-27951* National Aeronautics and Space Administration.
 Pasadena Office, Calif.

SYNTHETIC APERTURE RADAR TARGET SIMULATOR Patent
 H. A. ZEBKER (JPL, California Inst. of Tech., Pasadena), D. N. HELD (JPL, California Inst. of Tech., Pasadena), R. M. GOLDSTEIN (JPL, California Inst. of Tech., Pasadena), and T. C. BICKLER (JPL, California Inst. of Tech., Pasadena) 22 May 1984 8 p
 Filed 17 Jul. 1981 Supersedes N82-10286 (20 - 01, p 0043)
 Sponsored by NASA
 (NASA-CASE-NPO-15024-1; US-PATENT-4,450,447;
 US-PATENT-APPL-SN-284287; US-PATENT-CLASS-343-17.7;
 US-PATENT-CLASS-434-2) Avail: US Patent and Trademark Office CSCL 17B

A simulator for simulating the radar return, or echo, from a target seen by a SAR antenna mounted on a platform moving with respect to the target is described. It includes a first-in first-out memory which has digital information clocked in at a rate related to the frequency of a transmitted radar signal and digital information clocked out with a fixed delay defining range between the SAR and the simulated target, and at a rate related to the frequency of the return signal. An RF input signal having a frequency similar to that utilized by a synthetic aperture array radar is mixed with a local oscillator signal to provide a first baseband signal having a frequency considerably lower than that of the RF input signal.

T.M.

12 ENGINEERING

N84-27965# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.

VOICE COMMUNICATION AND POSITIVE PRESSURE BREATHING IN NOISE Technical Report

C. W. NIXON Jan. 1984 26 p

(Contract AF PROJ. 7231)

(AD-A141303; AFAMRL-TR-84-009) Avail: NTIS HC A03/MF

A01 CSCL 05E

The speech intelligibility of talkers and listeners using military voice communications equipment was measured in the laboratory under conditions of positive pressure breathing and tactical aircraft cockpit noise environments. Results indicated that positive pressure breathing did not significantly degrade speech intelligibility until the noise environment reached 115 dB. A trend suggesting that intelligibility decreased with increased pressure was observed across the other experimental conditions. Positive pressure breathing did contribute to changes in speech production which resulted in increased talker effort and decreased speech quality. A new respiration valve that could operate at lower mask pressures and would have lower internal noise levels might be highly desirable for aircrews. Speech intelligibility changes due to the cockpit noise conditions were typical of those seen in previous experiments where the percent correct responses decreased with increased levels of the noise. GRA

N84-27967# Rome Air Development Center, Griffiss AFB, N.Y.
NARROWBAND (LPC-10) VOCODER PERFORMANCE UNDER COMBINED EFFECTS OF RANDOM BIT ERRORS AND JET AIRCRAFT CABIN NOISE Inhouse Report, Jun. 1982 - Sep. 1983

C. P. SMITH Dec. 1983 12 p

(Contract AF PROJ. 1205)

(AD-A141333; RADC-TR-83-293) Avail: NTIS HC A02/MF A01

CSCL 17B

Speech intelligibility and voice quality tests were conducted to evaluate the performance of the DOD standard LPC-10 narrowband vocoder algorithm under degradation caused by the combined effects of random bit errors in the data path and background noise accompanying the input speech, as occurs in the acoustic environment in the cabins of an E4B aircraft during operational flight. Vocoder intelligibility scores and voice quality scores indicated that the in-flight acoustic noise environments of the E4B Briefing Room, Battlestaff Compartment, and NCA Compartment were alike in their effects on overall vocoder performance. Composite performance data pooled for the three compartments indicated that vocoder intelligibility averaged 80.2 (fair) with no bit errors, and fell 4-1/2 points with each percent of bit errors incurred in the data path. Thus, the average intelligibility fell to 77.9 (poor) at 1/2 percent error rate, to 73.4 (very poor) at 1-1/2 percent error rate, and to 68.9 (unacceptable) at 2-1/2 percent error rate. GRA

N84-27989# Boeing Aerospace Co., Seattle, Wash.

ADVANCED APPLICATION OF THE PRINTED CIRCUIT BOARD TESTABILITY DESIGN AND RATING SYSTEM Final Technical Report, 1 Nov. 1981 - 30 Nov. 1982

R. SPILLMAN and T. NICOLINO Griffiss AFB, N.Y. RADC Dec. 1983 115 p

(Contract F30602-81-C-0224; AF PROJ. 2338)

(AD-A141147; RADC-TR-83-291) Avail: NTIS HC A06/MF A01

CSCL 09E

The objectives of this study were to extend the present PCB testability design and rating system developed by Grumman to the module, rack, and subsystem levels and to generate an overall system level testability figure of merit (FOM). The FOM developed is based on the evaluation of a system, modelled as a node-valued weighted graph, (a node being each individual PCB in the system). This model requires as inputs the testability ratings of each individual PCB (outside the system) as a number between 0 and 1. This FOM was validated on 3 of Boeing Aerospace's own subsystems, each containing a various number of PCB's. The results of the validation and the development of the FOM model are presented. This model has been computerized in the PASCAL

computer language and is provided as part of this report.

Author (GRA)

N84-28002*# High Technology Corp., Hampton, Va.

COSAL: A BLACK-BOX COMPRESSIBLE STABILITY ANALYSIS CODE FOR TRANSITION PREDICTION IN THREE-DIMENSIONAL BOUNDARY LAYERS

M. R. MALIK May 1982 331 p refs

(Contract NAS1-16916)

(NASA-CR-165925; NAS 1.26:165925; HTC-1) Avail: NTIS HC

A15/MF A01 CSCL 20D

A fast computer code COSAL for transition prediction in three dimensional boundary layers using compressible stability analysis is described. The compressible stability eigenvalue problem is solved using a finite difference method, and the code is a black box in the sense that no guess of the eigenvalue is required from the user. Several optimization procedures were incorporated into COSAL to calculate integrated growth rates (N factor) for transition correlation for swept and tapered laminar flow control wings using the well known e to the Nth power method. A user's guide to the program is provided. R.S.F.

N84-28010# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Antriebsintegration.

ON THE EVALUATION OF BOUNDARY LAYER MEASUREMENTS ON BOATAILED BODIES OF REVOLUTION IN AXISYMMETRIC COMPRESSIBLE SUBSONIC FLOW

H. RIEDEL Mar. 1983 200 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-883)

(DFVLR-FB-84-09; ESA-TT-883) Avail: NTIS HC A09/MF A01;

DFVLR, Cologne DM 56,50

Turbulent boundary layer measurements of the boatailed afterbody of a single jet body of revolution are considered. An axisymmetric flow for Mach numbers 0.50 and 0.96 and for corresponding Reynolds numbers 860,000 and 1.96 million was employed. Only the jet-off flow case was considered. The reference flow (potential flow) required for the boundary layer evaluation can be derived from the real viscous flow without recourse to potential flow computational methods. Author (ESA)

N84-28081* National Aeronautics and Space Administration. Pasadena Office, Calif.

CENTRIFUGAL-RECIPROCATING COMPRESSOR

W. H. HIGA, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 22 May 1984 14 p Filed 23 Jul. 1982 Supersedes

N83-29708 (21 - 18, 2947) Continuation-in-part of US Patent

Application SN-037194, filed 8 May 1979 Sponsored by NASA

(NASA-CASE-NPO-14597-2; US-PATENT-4,449,894;

US-PATENT-APPL-SN-401288; US-PATENT-APPL-SN-037194;

US-PATENT-CLASS-417-328; US-PATENT-CLASS-417-392;

US-PATENT-CLASS-417-462) Avail: US Patent and Trademark

Office CSCL 13I

A centrifugal compressor is described which includes at least one pair of cylinders arranged in coaxial alignment and supported for angular displacement about a common axis of rotation normally dissecting a common longitudinal axis of symmetry for the cylinders. The cylinders are characterized by ported closures located at the mutually remote ends thereof through which the cylinders are charged and discharged, and a pair of piston heads seated within the cylinders and supported for floating displacement in compressive strokes in response to unidirectional angular displacement imparted to the cylinders.

Official Gazette of the U.S. Patent and Trademark Office

N84-28082* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPARATUS FOR AND METHOD OF COMPENSATING DYNAMIC UNBALANCE Patent

J. A. HRASTAR, inventor (to NASA) 10 Jul. 1984 13 p Filed 27 Feb. 1981 Supersedes N81-22358 (19 - 13, p 1762)
 (NASA-CASE-GSC-12550-1; US-PATENT-4,458,554;
 US-PATENT-APPL-SN-238888; US-PATENT-CLASS-74-573R;
 US-PATENT-CLASS-74-5.5; US-PATENT-CLASS-73-468) Avail:
 US Patent and Trademark Office CSCL 13I

An apparatus to stabilize a fine platform that carries a parabolic reflecting dish, utilized in connection with the large aperture, multichannel microwave radiometer, is discussed. It provides compensation for dynamic unbalance imparted to a fixed body by a shaft about which the rotating body rotates. Force components exerted on the fixed body by the rotating body in a plane at right angles to the axis are determined. In response to the determined force components, the rotational speed and effective direction of mass means mounted on the rotating body are controlled. The mass means has an effective axis of rotation in a plane at right angles to the longitudinal axis.

Official Gazette of the U.S. Patent and Trademark Office

N84-28085* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TUBING AND CABLE CUTTING TOOL Patent

D. D. MCSMITH and J. I. RICHARDSON, inventors (to NASA) 10 Jul. 1984 6 p Filed 6 Oct. 1981 Supersedes N82-20545 (20 - 11, p 1515)

(NASA-CASE-LAR-12786-1; US-PATENT-4,458,418;
 US-PATENT-APPL-SN-309292; US-PATENT-CLASS-30-228;
 US-PATENT-CLASS-30-180; US-PATENT-CLASS-30-188;
 US-PATENT-CLASS-30-272R; US-PATENT-CLASS-30-249)
 Avail: US Patent and Trademark Office CSCL 13I

A hand held hydraulic cutting tool was developed which is particularly useful in deactivating ejection seats in military aircraft rescue operations. The tool consists primarily of a hydraulic system composed of a fluid reservoir, a pumping piston, and an actuator piston. Mechanical cutting jaws are attached to the actuator piston rod. The hydraulic system is controlled by a pump handle. As the pump handle is operated the actuator piston rod is forced outward and thus the cutting jaws are forced together. The frame of the device is a flexible metal tubing which permits easy positioning of the tool cutting jaws in remote and normally inaccessible locations. Bifurcated cutting edges ensure removal of a section of the tubing or cable to thereby reduce the possibility of accidental reactivation of the tubing or cable being severed.

Official Gazette of the U.S. Patent and Trademark Office

N84-28089*# General Motors Corp., Indianapolis, Ind.
ADVANCED GAS TURBINE (AGT) TECHNOLOGY PROJECT Semiannual Report, 1 Jan. - 30 Jun. 1983

Jun. 1984 69 p
 (Contract DEN3-168; DE-AI01-77CS-51040)
 (NASA-CR-174629; DOE/NASA/0168-7; NAS 1.26:174629;
 EDR-11577; SAR-7) Avail: NTIS HC A04/MF A01 CSCL 21E

Technical work on the design and effort leading to the testing of a 74.5 kW (100 hp) automotive gas turbine engine is reviewed. Development of the engine compressor, gasifier turbine, power turbine, combustor, regenerator, and secondary system is discussed. Ceramic materials development and the application of such materials in the gas turbine engine components is described.

R.S.F.

N84-28104 National Maritime Inst., Teddington (England).
EVALUATION OF AERODYNAMIC ADMITTANCE OF A MODEL BRIDGE OSCILLATING WITH VERTICAL MOTION

D. E. WALSHE Apr. 1984 49 p refs
 (Contract TRRL-CON/9158/23; NMI-P/352029)
 (NMI-R-175) Avail: Issuing Activity

The aerodynamic admittance function of a model bridge was deduced from measurements of model response and turbulence spectra. The aerodynamic admittance values are higher than

anticipated. This is attributed to self excited random oscillations contributing to an appreciable extent to the measured response spectra thereby invalidating the analysis. It is also found that for the slender bridge model tested, the damping derivative is close to the theoretical value for a flat plate. Author (ESA)

N84-28105 National Maritime Inst., Teddington (England).
THE AERODYNAMIC ADMITTANCE OF MODEL BRIDGES
 D. E. WALSHE and A. M. ELLIOTT Apr. 1984 53 p refs
 (Contract DRG474/154; NMI-P/352045)
 (NMI-R-176; OT/R/176) Avail: Issuing Activity

The aerodynamic admittance function of a model slender box-girder bridge oscillating with a sinusoidal displacement mode shape was deduced from wind tunnel measurements of turbulence spectra and response spectra. The function was compared with that deduced from sectional model tests. Values deduced from the model with a sinusoidal mode shape are generally higher than those obtained with the sectional model, and both models give higher values than Sears' function. It is argued that correlation lengths over the model are longer than those measured in the turbulent free stream. The higher deduced admittance values therefore incorporate a correction factor which accounts for the longer correlation lengths. Author (ESA)

N84-28111*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN INVESTIGATION INTO THE PROBABILISTIC COMBINATION OF QUASI-STATIC AND RANDOM ACCELERATIONS
 R. W. SCHOCK and L. P. TUELL May 1984 13 p refs
 (NASA-TM-82584; NAS 1.15:82584) Avail: NTIS HC A02/MF A01 CSCL 20K

The development of design load factors are investigated for aerospace and aircraft components and experiment support structures, which are subject to a simultaneous vehicle dynamic vibration and acoustically generated random vibration. The characteristics of the combined acceleration probability density function is determined, and an appropriate percentile level for the combined acceleration is selected. This mechanism is developed and graphical data is provided to select combined accelerations for most popular percentile levels. M.A.C.

N84-28231*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OVERVIEW OF ADVANCED STIRLING AND GAS TURBINE ENGINE DEVELOPMENT PROGRAMS AND IMPLICATIONS FOR SOLAR THERMAL ELECTRICAL APPLICATIONS Abstract Only

D. ALGER *in* JPL Proc. of the 5th Parabolic Dish Solar Thermal Power Program p 49 1 Mar. 1984
 Avail: NTIS HC A15/MF A01 CSCL 10B

The DOE automotive advanced engine development projects managed by the NASA Lewis Research Center were described. These included one Stirling cycle engine development and two air Brayton cycle development. Other engine research activities included: (1) an air Brayton engine development sponsored by the Gas Research Institute, and (2) plans for development of a Stirling cycle engine for space use. Current and potential use of these various engines with solar parabolic dishes were discussed. Author

GEOSCIENCES

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

A84-37126#**THE EFFECTS OF UNBALANCED FLOW ON THE THERMAL PERFORMANCE OF COLLECTOR ARRAYS**

R. CULHAM and P. SAUER (Public Works Canada, Solar Programs Office, Canada) ASME, Transactions, Journal of Solar Energy Engineering (ISSN 0199-6231), vol. 106, May 1984, p. 165-170.

This paper details a mathematical model and a computer program that were developed to examine the effects of a flow imbalance on the total solar energy gain of a collector array. The model allows for variation in collector geometry, array geometry, collector flow rate, and collector inlet temperature, as well as fluctuations in ambient temperature and incident solar radiation. The program calculates the collector plate temperature, the heat removal factor, the collector heat loss coefficient, and the solar energy collected. The program is written in the BASIC language. It is iterative and uses the collector plate temperature as its test for convergence. The significance of a flow imbalance is explored by a systematic variation of the above parameters. Results indicate a relatively minor penalty for an unbalanced system, provided none of the rows in the array stagnate. Author

A84-37127#**ON THE DESIGN OF HORIZONTAL AXIS TWO-BLADED HINGED WIND TURBINES**

K. H. HOHENEMSER (Washington University, St. Louis, MO) and A. H. P. SWIFT (Texas, University, El Paso, TX) ASME, Transactions, Journal of Solar Energy Engineering (ISSN 0199-6231), vol. 106, May 1984, p. 171-176. Research supported by the Solar Energy Research Institute. refs

Hinged two-bladed wind turbines are not necessarily free of disturbing vibrations. The combination of elastic or built-in blade coning with blade flapping about a conventional teeter hinge produces periodic blade angular velocity variations in the blade tip path plane with associated vibrations and dynamic loads. The paper discusses and evaluates various hinge configurations for two-bladed rotors and shows why the conventional teeter hinge leads to nonuniform blade angular velocity in the blade tip path plane. The solution to this problem adopted for two-bladed helicopter rotors, though complex, could be of interest for large wind turbines. A much simpler solution, calling for the suppression of blade flapping by passive blade cyclic pitch variation produced by a strong negative pitch-flap coupling, was found to be practical for upwind tail vane stabilized two-bladed wind turbines. Author

A84-38670**AIRCRAFT ICING IN A CLEAR SKY [OB OBLEDENENII SAMOLETOV V IASNOM NEBE]**

G. N. KOSTIANOI, T. V. RAZORENOVA, and A. I. SHAGIN (Tsentral'naiia Aerologicheskaiia Observatoriia, Leningrad, USSR) Meteorologiya i Gidrologiya (ISSN 0130-2906), June 1984, p. 107-109. In Russian. refs

The possibility of icing of individual parts of an aircraft in a clear sky is demonstrated theoretically in a series of investigations. The investigations take into account conditions of constant low temperature and high relative humidity in order to determine icing effects on an aircraft flying over water on a horizontal flight path in various regions of the USSR. It is shown that the probability of either opaque rime or transparent ice-film formation on the wings of aircraft under these conditions is close to 100 percent. Similar findings also apply to both balloons and airships. I.H.

A84-38774**WIND DETERMINATION ON THE BASIS OF DATA MEASURED DURING THE FLIGHT OF AN AIRLINER [WINDBESTIMMUNG AUS FLUGMESSDATEN EINES LINIENFLUGZEUGES]**

M. SWOLINSKY and P. KRAUSPE (Braunschweig, Technische Universitaet, Brunswick, West Germany) Meteorologische Rundschau (ISSN 0026-1211), vol. 37, June 1984, p. 72-81. In German. refs

Investigations conducted as a consequence of wind-shear related aircraft crashes in the 1970s showed a paucity of statistical data regarding wind shear and vertical winds in the vicinity of airports. Wind measurement projects were, therefore, initiated to obtain the wind data needed for the improvement of flight safety. These projects utilize ground-based measurement systems and suitably equipped aircraft. One project involves the recording of data for the determination of the wind vector along the flight path during the takeoff and landing phase of an airliner of a German airline. The obtained data are to provide a basis for the development of wind models for the analytical representation of shear winds in connection with applications related to flight mechanics and flight control. Attention is given to details concerning the determination of the wind from the measured data, the design of the measuring system on board the Airbus A 300, the implementation of the research program, and measured data. G.R.

N84-27342# Technische Hogeschool, Delft (Netherlands). Luchtvaart-en

AIRFIELD NOISE EVALUATION PROGRAM (ANEP)

F. W. J. VANDEVENTER Dec. 1982 90 p refs In DUTCH (VTH-LR-370) Avail: NTIS HC A05/MF A01

The Airfield Noise Evaluation program (ANEP) for the determination of noise contours around airfields for small aircraft is presented. The ANEP consists of six computer programs, each analyzing a part of the noise load. The structure of ANEP and the sequence of the programs are explained. The possibilities and weaknesses of the program are given. A users guide is presented. The different computer programs are enclosed. Author (ESA)

N84-27343# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FLIGHT TRACK AND AIRCRAFT NOISE MONITORING SYSTEM (FANAMOS)

T. H. M. HAGENBERG and H. J. P. SCHOLTEN 11 Jul. 1983 23 p Presented at Europaische Vereinigung Fluglaermschutzbeauftragter, Schiphol, Netherlands, 16 Sep. 1983 (NLR-MP-83043-U) Avail: NTIS HC A02/MF A01

The Flight track and Aircraft Noise Monitoring System FANAMOS, that automatically monitors the flight tracks of departing and arriving aircraft is described. The actual flight tracks are continuously compared with the prescribed flight tracks, and recorded for later use. With FANAMOS, air traffic authorities can promptly inform aircraft operators in case of significant deviations from the designated standard procedures. The FANAMOS can be installed at any major airport, provided that digitized radar information (from a terminal approach radar) and digitized flight plan information are available. The FANAMOS processes this information to yield an accurate flight path of any SSR-transponder-equipped aircraft. Author (ESA)

N84-27711# Joint Publications Research Service, Arlington, Va. STATUS, FUTURE PLANS FOR AEROFLOT'S METEOROLOGICAL SUPPORT

A. VASILYEV In its USSR Rept.: Transportation (JPRS-UTR-84-009) p 3-4 29 Mar. 1984 Transl. into ENGLISH from Vozdushnyy Transport (Moscow), 12 Jan. 1984 p 3 Avail: NTIS HC A04/MF A01

Forecasts of wind and air temperature on all the basic civil aviation routes, as well as of weather dangerous to aircraft are prepared in chart form 24 hours a day at the Regional Aviation Forecast Laboratory. The forecasts cover the U.S.S.R., Western Europe, Japan, North Africa, and India. Procedural manuals for cockpit personnel and forecasters on meteorological conditions of flights at low altitude, on forecasting turbulence, hail, squalls, icing,

and strong low level wind shear were issued. The automation of forecasting using data from radar observations is proposed.

A.R.H.

N84-28184# Joint Publications Research Service, Arlington, Va.
SPACECRAFT-AIDED AERIAL STUDIES OF ATMOSPHERE'S ELECTROSTATIC ZONES Abstract Only

Y. TREFILOV *In its* USSR Rept.: Earth Sciences (JPRS-UES-84-005) p 76 10 Jul. 1984 Transl. into ENGLISH from Vecherniy Leningrad (USSR), 17 Jan. 1984 p 1

Avail: NTIS HC A05/MF A01

Objectives of an aerial study of electrostatic zones in the atmosphere are briefly discussed. Data from the study will be compared to satellite and ground station data and the resulting information will be used to formulate recommendations for increasing flight safety through electrostatic zones. M.G.

N84-28230*# Barber-Nichols Engineering Co., Arvada, Colo.
CURRENT STATUS OF AN ORGANIC RANKINE CYCLE ENGINE DEVELOPMENT PROGRAM Abstract Only

R. E. BARBER *In* JPL Proc. of the 5th Parabolic Dish Solar Thermal Power Program p 48 1 Mar. 1984

Avail: NTIS HC A15/MF A01 CSCL 10A

The steps taken to achieve improved bearing life in the organic Rankine cycle (ORC) engine being developed for use on solar parabolic dishes are presented. A summary of test results is given. Dynamic tests on the machine shaft and rotors of the ORC engine are also discussed. R.S.F.

N84-28245*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

BRAYTON MODULE DEVELOPMENT OVERVIEW

H. J. HOLBECK *In* JPL Proc. of the 5th Parabolic Dish Solar Thermal Power Program p 110-112 1 Mar. 1984

Avail: NTIS HC A15/MF A01 CSCL 10B

The Advanced Gas Turbine (AGT) and the Subatmospheric Brayton Cycle (SABC) engines are under development. The AGT is developed for automotive applications while the SABC is developed for a gas fired heat pump application. Trade studies of the AGT, the SABC and other existing gas turbines are conducted in combination with various concentrators. The recommendation from these studies is to use the SABC for near term module development while following the AGT development for later advanced application. A preliminary design is completed at the module. M.A.C.

N84-28246*# Sanders Associates, Inc., Nashua, N. H.

NEAR-TERM BRAYTON MODULE STATUS

S. B. DAVIS *In* JPL Proc. of the 5th Parabolic Dish Solar Thermal Power Program p 113-121 1 Mar. 1984

Avail: NTIS HC A15/MF A01 CSCL 10B

The integration of subsystem components and the testing of a Parabolic Dish Module (PDM) to convert solar energy to grid compatible electric power is examined. System components are selected on a basis of current and projected performance efficiencies, technology readiness, future production probabilities and prices, current cost and availability. Potential for a near-term, 8 kW derivative of the PDM is adjudged to be superior to that of a 20 kW system. The PDM is suited to both grid connected and standalone applications, and it may be fired by solar, fossil, or solar/fossil hybrid means. M.A.C.

N84-28247*# AiResearch Mfg. Co., Torrance, Calif.

SUBATMOSPHERIC BRAYTON-CYCLE ENGINE PROGRAM REVIEW

R. L. JOHNSON *In* JPL Proc. of the 5th Parabolic Dish Solar Thermal Power Program p 122-126 1 Mar. 1984

Avail: NTIS HC A15/MF A01 CSCL 10B

A solar energy powered electrical generator utilizing a Subatmospheric Brayton cycle engine is examined. The generator consists of a subatmospheric, Brayton-cycle engine and a permanent magnet (PM) alternator. The electrical power is generated by an alternator driven directly by the Brayton-cycle

engine rotating group. Features that enhance reliability and performance include air foil bearings on both the Brayton-cycle engine rotating group and the PM alternator, an atmospheric-pressure solar receiver and gas-fired trim heater, and a high temperature recuperator. The subatmospheric Brayton-cycle engine design is based on that of the gas fired heat pump engine. M.A.C.

N84-28324# National Center for Atmospheric Research, Boulder, Colo.

DOPPLER WEATHER RADAR APPLICATIONS TO TERMINAL AND ENROUTE AIR TRAFFIC CONTROL

J. WILSON, J. MCCARTHY, R. CARBONE, and T. T. FUJITA (Chicago University, Ill.) *In* WMO Seminar on Radar Meteorol. p 114-122 1984 refs Sponsored by NSF

Avail: NTIS MF A01; print copy available at WMO, Geneva SWFR 21

It is demonstrated that wind shear which is potentially hazardous to aircraft can be encountered if flight paths are based solely on radar reflectivity information. Use of Doppler velocity data can greatly increase flight safety. Single Doppler data from a microburst producing thunderstorm shows an area near the Earth's surface of strong outflow that is only 5km in diameter. The horizontal outflow is confined to the lowest 1km with maximum speeds (32 m/sec) 50 m above ground. A downdraft of at least 10 m/sec is observed to descend to within 1km of the surface. A study of strong low level wind shear events is described. Author (ESA)

N84-28342# Air Force Environmental Technical Applications Center, Scott AFB, Ill.

REVISED UNIFORM SUMMARY OF SURFACE WEATHER OBSERVATIONS (RUSSWO). PARTS A-E: CLARK AFB, PHILIPPINES Final Report

Feb. 1984 408 p Supersedes USAFFETAC/DS-79-104, AD-A079840

(AD-A141228; AD-E850627; AFFTAC/DS-84-013;

USAFETAC/DS-79-104) Avail: NTIS HC A18/MF A01 CSCL 04B

This report is a six part statistical summary of surface weather observations for Clark Air Force Base, Philippines. It contains the following parts: (1) weather conditions, atmospheric phenomena; (2) precipitation, snowfall and snow depth (daily amounts and extreme values); (3) surface winds; (4) ceiling versus visibility; sky cover; (5) psychrometric summaries (daily maximum and minimum temperatures, extreme maximum and minimum temperatures, psychrometric summary of wet bulb temperature depression versus dry bulb temperature, means and standard deviations of dry bulb, wet bulb and dew point temperatures and relative humidity); and (6) pressure summary (means, standard deviations, and observation counts of station pressure and sea level pressure). Data in this report are presented in tabular form in most cases in percentage frequency of occurrence or cumulative percentage frequency of occurring tables. GRA

N84-28346# Lightning and Transients Research Inst., St. Paul, Minn.

AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF AN NEMP (NUCLEAR ELECTROMAGNETIC PULSE SIMULATOR) TYPE FAST RISE LIGHTNING SIMULATOR Final Report, Jul. 1982 - Mar. 1983

J. D. ROBB Wright-Patterson AFB, Ohio AFWAL 15 Mar. 1984 32 p

(Contract F33615-82-C-3403; AF PROJ. 2402)

(AD-A141283; LTRI-765; AFWAL-TR-84-3007) Avail: NTIS HC A03/MF A01 CSCL 04B

Recent lightning phenomena investigations have indicated lightning currents for the high current return phase of lightning strikes to ground of 100 nanoseconds, an order of magnitude faster than the previously accepted value of one to two microseconds. An experimental investigation was undertaken to evaluate the feasibility of using NEMP type generators to provide the faster rise times for lightning testing of aircraft. The program consisted of (1) a theoretical phase to examine the required

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generator parameters, (2) a low level 300 kilovolt experimental phase with a 30 foot long cylinder, six feet in diameter to represent an idealized aircraft under test and (3), a final phase in which a design was developed for testing of full size aircraft at the test current level of 40,000 amperes. Author (GRA)

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MATHEMATICAL AND COMPUTER SCIENCES

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

A84-37226

ASYMPTOTIC METHODS IN MECHANICS [ASIMPTOTICHESKIE METODY V MEKHANIKE]

A. N. PANCHENKOV, ED. Novosibirsk, Izdatel'stvo Nauka, 1983, 176 p. In Russian.

Papers are presented on such topics as ill posed extremum problems in quadrupole wing theory, the extremum problem of a wing with maximum lift coefficient near a screen, optimization of the profile of a plane wing in supersonic and hypersonic flows, and the optimal shape of a body of revolution in transonic flow with constraints on the length and volume. Consideration is also given to the stability of a flight vehicle at a given altitude in the framework of quadrupole wing theory, the longitudinal dynamics of a flight vehicle in a bounded flow, and the approximate integration of unsteady linear systems of differential equations by the method of functional parameters. B.J.

A84-37227

ELEMENTS OF THE THEORY OF A CLASS OF ILL POSED EXTREMUM PROBLEMS [ELEMENTY TEORII ODNOGO KLASSA NEKORREKTNYYKH EKSTREMAL'NYKH ZADACH]

A. N. PANCHENKOV IN: Asymptotic methods in mechanics. Novosibirsk, Izdatel'stvo Nauka, 1983, p. 5-22. In Russian. refs

The present study considers the derivation of differential equations of the necessary extremum condition of certain ill posed problems. Attention is given to problems in which the number of external boundary conditions exceeds the order of these differential equations. Examples include the shape optimization of a symmetric body in a two-dimensional supersonic flow and the problem of a thin airfoil near a screen. An analysis is made of causes of ill posedness with singular perturbations and of ways to solve such problems. B.J.

A84-37492#

COMPUTER-AIDED GENERATION OF DETAILED THERMAL STRUCTURAL MODELS

L. E. FRANK, C. E. SCHUETZ, D. NGUYEN, and F. GHASSEMI (Northrop Aircraft Corp., Hawthorne, CA) American Institute of Aeronautics and Astronautics, Thermophysics Conference, 19th, Snowmass, CO, June 25-28, 1984. 12 p. (AIAA PAPER 84-1766)

Features and capabilities of the menu-driven computer code CAD-CINDA for thermal analysis of structures are outlined. CAD-CINDA input is xyz-coordinates of nodal grid points, with volumetric nodes defined by eight points and surface nodes by four points. The grid points are applied on stored drawings or graphical representations. Graphics are used to define node types, materials, temperatures, heat loads, interface losses, and extra conductance paths. CINDA includes analytical models for conduction, convection, and radiation in both steady-state and transient conditions. Other subroutines handle aircraft and avionics problems involving overall heat balance and temperatures, forced and natural convection, aerothermodynamics, and simultaneous solution of heat transfer and compressible flows. Illustrations are

provided of a six-node problem and an analysis of an aircraft engine bleed air duct. M.S.K.

A84-37942#

AN INVERSE SOLUTION FOR COMPONENT POSITIONING USING HOMOGENEOUS COORDINATE TRANSFORMATIONS

D. P. RAYMER, R. A. MAIER, and M. J. KILLIAN (Rockwell International Corp., Los Angeles, CA) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 541-543.

Previously cited in issue 23, p. 3500, Accession no. A83-48337

A84-38427

A CONTRIBUTION TO THE COMPUTATION OF ROTOR MOMENTS OF INERTIA SUITABLE FOR COMPUTER PROCESSING

H. WITFELD (Hamburg, Hochschule der Bundeswehr, Hamburg, West Germany) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 20, Feb. 1984, p. 227-240.

Algorithms are developed for the computation of moments of inertia for a cylindrical rotor of arbitrary cross section and an axisymmetric rotor of arbitrary longitudinal cross section. The technique proposed permits the reduction of volume integrals to contour integrals along the generating-area boundary, which is modeled as a polygonal path. Only the corner-point coordinates are required as input data. A centrifugal drum and a toroidal rotor are analyzed as examples; and drawings, tables comparing computed and exact results, and a flow chart are provided. Applications to the design of flywheels, turbomachine rotors, and gyroscopes are suggested. T.K.

A84-38550

A CANADIAN AIRPORT TRAFFIC ANALYSIS MODEL

S. G. HAMZAWI (Transport Canada, Ottawa, Canada) Airport Forum (ISSN 0002-2802), April 1984, p. 95, 96, 99, 101.

The design and operating capabilities of the Canadian Airport-Traffic Analysis Model (Hamzawi, 1982) are briefly characterized and illustrated. The model permits the rapid statistical analysis of hourly passenger traffic at terminals for use in service planning and terminal design. A data base comprising the 30 most active airports has been developed for the model. The five modules of the model are described, and printouts of sample analyses are shown. T.K.

A84-38894#

APPLICATIONS OF PROBIT AND LOGIT ANALYSIS TO THE PREDICTION OF THE PROBABILITY OF AN ABORT IN THE AEP MODEL

D. R. BARR (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 7-6-1 to 7-6-6.

Probit and logit computer analysis are used to simulate flight data in which the stimulus is an MTTF while the response is the relative frequency of an abort due to failure of the item. The models give predictions of what the Advanced Evaluation Program (AEP) would experience with respect to the number of aborts. The predictions are regarded as a smoothed version of the AEP output, and are applied to values of the MTBF which were not included in a previous study. It is shown that the probit model performed better for a single failure mode, while the logit model gives a better fit for both last and first failure mode items. I.H.

A84-39306* # National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

COMPUTATIONAL AERODYNAMICS AND ARTIFICIAL INTELLIGENCE

P. KUTLER and U. B. MEHTA (NASA, Ames Research Center, Moffett Field, CA) American Institute of Aeronautics and Astronautics, Fluid Dynamics, Plasma Dynamics, and Lasers Conference, 17th, Snowmass, CO, June 25-27, 1984. 20 p. refs (AIAA PAPER 84-1531)

Some aspects of artificial intelligence are considered and questions are speculated on, including how knowledge-based systems can accelerate the process of acquiring new knowledge in aerodynamics, how computational fluid dynamics may use 'expert' systems and how expert systems may speed the design and development process. The anatomy of an idealized expert system called AERODYNAMICIST is discussed. Resource requirements are examined for using artificial intelligence in computational fluid dynamics and aerodynamics. Considering two of the essentials of computational aerodynamics - reasoning and calculating - it is believed that a substantial part of the reasoning can be achieved with artificial intelligence, with computers being used as reasoning machines to set the stage for calculating. Expert systems will probably be new assets of institutions involved in aeronautics for various tasks of computational aerodynamics.

D.H.

N84-26643# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

MAGNA (MATERIALLY AND GEOMETRICALLY NONLINEAR ANALYSIS) COMPUTER SIMULATION OF BIRD IMPACT ON THE F-15 AIRCRAFT CANOPY

R. E. MCCARTY /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 973-1008 Dec. 1983

(AD-P003230) Avail: NTIS HC A08/MF A01 CSCL 01C

The F-15E aircraft is one of two evolutionary aircraft types which are currently being evaluated by the USAF for future low level, high speed, and attack and interdiction missions. It is a two-place aircraft and is proposed to utilize the windshield/canopy transparency system which has been in production for some years for the TF-15 aircraft. The canopy portion of this transparency system has a high lofted shape and offers considerably more presented frontal area than the canopy for one-place models of the aircraft. As a result of the lofted shape of the TF-15 canopy and the mission of the aircraft, the hazard of transparency bird impact during flight operations is significant. Some proposals to increase the level of bird impact protection for the F-15E canopy have already been aired. The availability of an analysis method which could accurately predict the dynamic structural response of such proposed canopy designs to bird impact loading would be valuable in establishing the merits of each. If the MAGNA nonlinear finite element analysis program could be validated for F-15 transparency analysis it would have significant potential for saving time and costs in the development of improved F-15E transparencies.

GRA

N84-26644# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

SIMULATION OF T-38 AIRCRAFT STUDENT CANOPY RESPONSE TO COCKPIT PRESSURE AND THERMAL LOADS USING MAGNA (MATERIALLY AND GEOMETRICALLY NONLINEAR ANALYSIS)

R. E. MCCARTY and R. A. SMITH /in Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 1009-1039 Dec. 1983

(AD-P003231) Avail: NTIS HC A08/MF A01 CSCL 01C

The linear and nonlinear static response to cockpit pressure and (cold) thermal loads of the forward canopy for the T-38 aircraft has been predicted using the MAGNA (Materially and Geometrically Nonlinear Analysis) finite element computer program. The results obtained are compared to those of earlier analyses and full scale tests. It is concluded that the current canopy design when properly rigged can withstand more than 20 psig pressure, that thermal loads are more critical than cockpit pressure loads, and that

providing more attachment fixity at both forward and aft arches would relieve stress concentrations which occur at the canopy corners. GRA

N84-27461* # National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STABCAR: A PROGRAM FOR FINDING CHARACTERISTIC ROOT SYSTEMS HAVING TRANSCENDENTAL STABILITY MATRICES

W. M. ADAMS, JR., S. H. TIFFANY, J. R. NEWSOM, and E. L. PEELE Jun. 1984 144 p refs

(NASA-TP-2165; L-14861; NAS 1.60:2165) Avail: NTIS HC A07/MF A01 CSCL 09B

STABCAR can be used to determine the characteristic roots of flexible, actively controlled aircraft, including the effects of unsteady aerodynamics. A modal formulation and a transfer-matrix representation of the control system are employed. Operable in either a batch or an interactive mode, STABCAR can provide graphical or tabular output of the variation of the roots with velocity, density, altitude, dynamic pressure or feedback gains. Herein the mathematical model, program structure, input requirements, output capabilities, and a series of sample cases are detailed. STABCAR was written for use on CDC CYBER 175 equipment; modification would be required for operation on other machines. Author

N84-27482# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

A DATA MANAGEMENT AND PRESENTATION TOOL FOR ENGINEERING AND RESEARCH

F. J. HEEREMA and H. A. KREIJKAMP 19 Aug. 1983 14 p refs Presented at the 36th European Control Data Users (ECODU) Conf., Dusseldorf, 12-16 Sep. 1983

(NLR-MP-83044-U) Avail: NTIS HC A02/MF A01

An engineering data management system based on computer aided design techniques was designed and made operational. Database management techniques cope with data transfer. Interactive interrogating of a centralized database, and interactive graphics are applied in the analysis and presentation functions. The system is called the Engineering Data Interactive Presentation and Analysis System. Author (ESA)

N84-27503* # Scientific Research Associates, Inc., Glastonbury, Conn.

SOLUTION OF 3-DIMENSIONAL TIME-DEPENDENT VISCOUS FLOWS. PART 1: INVESTIGATION OF CANDIDATE ALGORITHMS

B. C. WEINBERG and H. MCDONALD Apr. 1979 86 p refs 3 Vol.

(Contract NAS2-10016)

(NASA-CR-166565-PT-1; NAS 1.26:166565-PT-1) Avail: NTIS HC A05/MF A01 CSCL 12A

There is considerable interest in developing a numerical scheme for solving the time dependent viscous compressible three dimensional flow to aid in the design of helicopter rotors. Numerical algorithms are examined to determine their overall suitability for the efficient and routine solution of an appropriate system of partial differential equations. It is concluded that a consistently split time linearized block implicit scheme using either quintic B spline collocation or the generalized operator compact implicit approach to generate a fourth order accurate algorithm is particularly well suited for use on the present problem. High cell Reynolds number behavior leads to favoring the generalized operator compact implicit approach over the quintic B spline collocation method. M.A.C.

15 MATHEMATICAL AND COMPUTER SCIENCES

N84-28456# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

MAGIC (MICROCOMPUTER APPLICATIONS OF GRAPHICS AND INTERACTIVE COMMUNICATIONS). 1: A STUDY OF MANUAL VERSUS VOCAL CONTROL UNDER HEAVY TASK LOADING
D. G. CURRY *In* AF Academy Proc. of the 9th Symp. on Psychol. in the DOD p 435-439 Apr. 1984
(AD-P003320) Avail: NTIS HC A99/MF A01 CSCL 05H

The Microcomputer Applications of Graphics and Interactive Communications study, Phase 1 (MAGIC 1) was designed to compare the effectiveness of a voice activated control system with that of a multifunction control panel utilizing a branching control logic under conditions of heavy manual-visual task loading. Eighteen Air Force personnel were asked to perform fourteen different aircraft subsystem control tasks using each of the control modes while simultaneously performing a complex loading task. Results showed simultaneously performing a complex loading task. Results showed that the subjects demonstrated significantly better performance on three of the five dependent variables when using the voice system, indicating that they were better able to maintain concentration on the loading task with this mode. Analysis of subjective data showed an overwhelming subject preference for the voice control mode. GRA

N84-28516*# Vought Corp., Dallas, Tex.
NEMAR PLOTTING COMPUTER PROGRAM

T. R. MYLER Dec. 1981 68 p refs
(Contract NAS1-15000)
(NASA-CR-165831; NAS 1.26:165831) Avail: NTIS HC A04/MF A01 CSCL 09B

A FORTRAN coded computer program which generates CalComp plots of trajectory parameters is examined. The trajectory parameters are calculated and placed on a data file by the Near Earth Mission Analysis Routine computer program. The plot program accesses the data file and generates the plots as defined by inputs to the plot program. Program theory, user instructions, output definitions, subroutine descriptions and detailed FORTRAN coding information are included. Although this plot program utilizes a random access data file, a data file of the same type and formatted in 102 numbers per record could be generated by any computer program and used by this plot program. M.A.C.

N84-28519# Societe Nationale Industrielle Aerospatiale, Toulouse (France). Div. Avion.

IMPLEMENTATION AND PERFORMANCE OF ALGORITHMS ON A VECTOR CALCULATOR [MISE EN OEUVRE ET PERFORMANCES D'ALGORITHMES SUR UN CALCULATEUR VECTORIEL]

M. VERPRAT and J. M. THOMAS 23 Feb. 1984 8 p refs *In* FRENCH; ENGLISH summary Presented at 1st Gamni Intern. Colloq. on Meth. Vectorielles et Paralleles en Calcul., Paris, Mar. 1983

(SNIAS-832-111-104) Avail: NTIS HC A02/MF A01

The finite element computer program ASELE is examined. The program is used to solve problems of large linear systems as well as the requirements for nonlinear computation and the analysis of computer complementation problems associated with aerospace engineering. M.A.C.

N84-28521# Naval Postgraduate School, Monterey, Calif.
A THREE-DIMENSIONAL TRANSONIC, POTENTIAL FLOW COMPUTER PROGRAM, ITS CONVERSION TO IBM FORTRAN AND UTILIZATION M.S. Thesis

J. PASCHALL, III Dec. 1983 153 p
(AD-A140936) Avail: NTIS HC A08/MF A01 CSCL 09B

This thesis describes the conversion of a computer program from FORTRAN IV for the NOS 1.2 operating system of the CYBER 175 or CDC 6600 computer to FORTRAN IV compatible with the Naval Postgraduate School IBM 3033 system. The converted program, called FL027, calculates the inviscid, three-dimensional transonic potential flow over wings or wing-body combinations. The data input to FL027 is extensive; therefore, an interactive

program was developed to aid the user in building the required input data file. Author (GRA)

N84-28530# National Aerospace Lab., Amsterdam (Netherlands). Stromingen Afdeling.

CURRENT DEVELOPMENT AT NATIONAL AEROSPACE LABORATORY (NLR) AND FOKKER IN COMPUTER AIDED AERODYNAMIC DESIGN

J. T. VANDERKOLK 20 Apr. 1983 33 p refs *In* DUTCH; ENGLISH summary Presented at NVVL/VSV Symp. CAD/CAM, Delft, 6 May 1983
(NLR-MP-83031-U) Avail: NTIS HC A03/MF A01

Developments in the software used by the aerodynamic designer from the viewpoint of applied informatics are summarized. Recent developments in hardware and software initiated the use of computer aided design and computer aided modeling techniques in the aerodynamic design process. Progress in numerical modeling as well as automated pre and postprocessing of data considerably increased the productivity of computational fluid dynamics. Author (ESA)

N84-28537*# Old Dominion Univ., Norfolk, Va. Dept. of Electrical Engineering.

DESIGN OF MULTIVARIABLE FEEDBACK CONTROL SYSTEMS VIA SPECTRAL ASSIGNMENT USING REDUCED-ORDER MODELS AND REDUCED-ORDER OBSERVERS Final Progress Report, 1 Oct. 1982 - 15 Apr. 1984

R. R. MIELKE, L. J. TUNG, and P. I. CARRAWAY, III May 1984 147 p refs

(Contract NSG-1650)
(NASA-CR-173448; NAS 1.26:173448) Avail: NTIS HC A07/MF A01 CSCL 09B

The feasibility of using reduced order models and reduced order observers with eigenvalue/eigenvector assignment procedures is investigated. A review of spectral assignment synthesis procedures is presented. Then, a reduced order model which retains essential system characteristics is formulated. A constant state feedback matrix which assigns desired closed loop eigenvalues and approximates specified closed loop eigenvectors is calculated for the reduced order model. It is shown that the eigenvalue and eigenvector assignments made in the reduced order system are retained when the feedback matrix is implemented about the full order system. In addition, those modes and associated eigenvectors which are not included in the reduced order model remain unchanged in the closed loop full order system. The full state feedback design is then implemented by using a reduced order observer. It is shown that the eigenvalue and eigenvector assignments of the closed loop full order system remain unchanged when a reduced order observer is used. The design procedure is illustrated by an actual design problem. Author

N84-28541# Wisconsin Univ., Madison. Dept. of Mathematics.
CONTROL THEORY OF PARTIAL DIFFERENTIAL EQUATIONS Final Report, 1 Nov. 1981 - 31 Oct. 1982

D. L. RUSSELL 1984 18087 p
(Contract AF-AFOSR-0018-79; AF PROJ. 2304)
(AD-A140945; AFOSR-84-0391TR) Avail: NTIS HC A05/MF A01 CSCL 12A

During the period November 1, 1981 to October 31, 1982, the principal investigator, in co-operation with several research assistants, carried out a program of mathematical research in the general area of control theory of partial differential equations. The program involved two distinct phases: an effort aimed specifically at the development and improvement of control strategies in connection with the wing flutter problem and a more general program in the area of distributed parameter control problems of hyperbolic type. This work resulted in two scientific papers which form the greater part of this report. The first of these, Some Remarks on the Current Status of the Control Theory of Single Space Dimension Hyperbolic Systems, was presented at the NASA JPL Symposium on Control and Stabilization of Large Space Structures, Pasadena, California, July 1982. The second, Admissible Input Elements for Systems in Hilbert Space and a Carleson

Measure Criterion, by L.F. Ho and the principal investigator, is a paper which largely resulted from Dr. Ho's thesis work.

Author (GRA)

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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.

A84-36483#

ACOUSTIC MEASUREMENTS IN HIGH-SPEED SUBSONIC JETS

G. L. MORRISON (Texas A&M University, College Station, TX) and K. W. WHITAKER AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 756, 757.

Previously cited in issue 10, p. 1475, Accession no. A83-25936

A84-36488*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EXPERIMENTS ON SOUND RADIATION FROM A DUCT WITH A CIRCUMFERENTIALLY VARYING LINER

C. R. FULLER and R. J. SILCOX (NASA, Langley Research Center, Acoustics and Noise Reduction Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 22, June 1984, p. 781-785. Research supported by the National Research Council. refs

Previously cited in issue 10, p. 1475, Accession no. A83-25928

A84-37938*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

NOISE TRANSMISSION CHARACTERISTICS OF ADVANCED COMPOSITE STRUCTURAL MATERIALS

L. A. ROUSSOS, C. A. POWELL (NASA, Langley Research Center, Hampton, VA), F. W. GROSVELD (Bionetics Corp., Hampton, VA), and L. R. KOVAL (Missouri-Rolla, University, Rolla, MO) Journal of Aircraft (ISSN 0021-8669), vol. 21, July 1984, p. 528-535. refs

Previously cited in issue 10, p. 1473, Accession no. A83-25915

A84-38091* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

WHY CREDIBLE PROPELLER NOISE MEASUREMENTS ARE POSSIBLE IN THE ACOUSTICALLY UNTREATED NASA LEWIS 8 FT BY 6 FT WIND TUNNEL

J. H. DITTMAR (NASA, Lewis Research Center, Cleveland, OH) Acoustical Society of America, Journal (ISSN 0001-4966), vol. 75, June 1984, p. 1913, 1914. refs

An explanation is presented for the lack of acoustic reflections in noise studies of propfan models in the NASA-Lewis 8 x 6 ft wind tunnel, where trials were run at Mach numbers 0.5-0.85. The highly directional propeller noise, i.e., mainly in the plane of rotation, experiences a convective effect due to the high subsonic axial Mach number. Reflected sounds are carried downstream, out of range of the acoustic sensors in the tunnel. Furthermore, reflected noise is less audible, and therefore does not affect measurements near peak values. It is suggested that some data contamination may occur below Mach 0.6, and that measurements be performed on higher harmonics generated by low level reflected noise.

M.S.K.

A84-38847*# Santa Clara Univ., Calif.

THE CALCULATION OF TRANSONIC ROTOR NOISE

H. R. AGGARWAL (Santa Clara, University, Santa Clara, CA) AIAA Journal (ISSN 0001-1452), vol. 22, July 1984, p. 996-998. refs (Contract NCC2-191)

It is pointed out that an accurate prediction of the high-speed impulsive rotor noise is very difficult since the noise field depends on many complex factors. Schmitz and Yu (1981) have conducted a study with the aim to include local aerodynamic nonlinearities in a calculation regarding the acoustic shock. In the present investigation, the hover case of the model rotor studied by Schmitz and Yu was recomputed without certain implicit assumptions made in the earlier calculation. The obtained results show that the Schmitz-Yu computations are very much base-support area dependent. Attention is given to the quadrupole integral, and the pressure-time curves for the model rotor in hover. G.R.

A84-38882#

SUPPRESSION OF THE ACOUSTIC ENVIRONMENT IN AN IRREGULARLY SHAPED CAVITY WITH AN OPENING EXPOSED TO SUBSONIC FLOW

L. L. SHAW (USAF, Wright-Patterson AFB, OH) IN: Annual Mini-Symposium on Aerospace Science and Technology, 10th, Wright-Patterson AFB, OH, March 20, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 3-3-1 to 3-3-5. refs

A wind tunnel test was performed on an irregularly shaped cavity with an opening exposed to air flow at Mach numbers from 0.65 to 0.80. Methods to suppress the acoustic levels in the cavity consisted of three different leading edge spoilers, three different trailing edge shapes, and internal acoustic treatment. The effect of spoiler porosity was also investigated. The results indicated that all of the spoilers were effective in suppressing the flow induced levels while the trailing edge shape variations, in conjunction with the leading edge spoilers, had very little effect on the levels. The internal acoustic treatment was shown to be very effective in suppressing the levels. Author

A84-39721

AERODYNAMIC NOISE - A REVIEW OF THE CONTRIBUTIONS TO JET NOISE RESEARCH AT THE COLLEGE OF AERONAUTICS, CRANFIELD 1949-1961 (TOGETHER WITH SOME RECENT CONCLUSIONS)

G. M. LILLEY (Southampton, University, Southampton, England) Aeronautical Journal (ISSN 0001-9240), vol. 88, May 1984, p. 213-223. refs

The development of experimental and theoretical techniques for understanding jet noise is traced. Research was spurred by the need to reduce noise if public acceptance of jet-powered aircraft for civil aviation was to be gained. Turbulence was recognized early as the source of jet noise. Corrugated nozzles were devised as a first cut in noise reduction. Microphonic and Schlieren photographic trials were performed in the 1950s to characterize the acoustic emission field. Conclusions drawn from those tests and efforts to numerically model the noise field are outlined. The tests revealed the importance of considering both vortex and enthalpy fields, and showed that Lighthill's acoustic analogy was valid at low Mach numbers. M.S.K.

N84-26588# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.

OVERVIEW OF HUD (HEAD-UP DISPLAY) OPTICAL DESIGNS

R. D. LEE In Aerospace Medical Research Labs. Opt. and Human Performance Evaluation of HUD (Head-Up Display) Systems p 4-10 15 Dec. 1983

(AD-P003157) Avail: NTIS HC A05/MF A01 CSCL 01C

The Head-Up Display (HUD) and the new technologies being applied to it continue to receive great attention by people considering the functioning of fighter and attack aircraft cockpits. The subject has also received its fair share of attention over the last two years at NAECON as well. Berry and Byrd (1981) described the wide field of view (FOV) HUD being developed as part of the Low Altitude Navigation and Targeting Infrared for Night (LANTIRN)

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program. Gard (1982) gave a presentation which described the different roles of diffraction optics as used in HUDS and relatively new optical designs which achieve a wider FOV. This discussion summarizes the material covered by these two papers and serves to form a common basis of understanding of the various HUD technologies. The important features highlighted here figure prominently in the discussions which follow. GRA

N84-26590# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.

OPTICAL INTERACTIONS OF AIRCRAFT WINDSCREENS AND HUDS (HEAD-UP DISPLAYS) PRODUCING DIPLOPIA

L. V. GENCO *In its* Opt. and Human Performance Evaluation of HUD (Head-Up Display) Systems p 20-27 15 Dec. 1983 (AD-P003159) Avail: NTIS HC A05/MF A01 CSCL 01C

The Air Force is in the process of evaluating new, wide field of view heads-up displays (WFOV HUDs) capable of presenting an enhanced array of visual imagery to pilots of modern aircraft. The main findings of this study are: (1) observers are relatively intolerant of negative disparity, (2) longer viewing is more likely to lead to a diplopia effect than very short glances, (3) resistance to disparity appears to be an individual trait, and (4) a large proportion of responses involve suppression of the view from one eye. The overall median negative disparity threshold was 1.2 mrad and the overall positive threshold was 2.6 mrad. These values are recommended as the maximum disparities acceptable for wide-field-of-view Canopy-HUD optical systems. Since the values are so small, we further recommend that the canopy and HUD be treated as a system, with technical interaction between the vendors, and between the vendors and the USAF. The disparity values indicate the net difference between both system components, so optimization may be possible by appropriately matching the optics. GRA

N84-26635# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.

OPTICAL EFFECTS OF F-16 CANOPY-HUD (HEAD-UP DISPLAY) INTEGRATION

H. L. TASK *In* Dayton Univ. Conf. on Aerospace Transparent Mater. and Enclosures p 808-824 Dec. 1983 (AD-P003222) Avail: NTIS HC A08/MF A01 CSCL 01C

The F-16 heads-up display (HUD) provides the pilot with visual information in symbology form that is overlaid on the outside world scene in the forward viewing direction. This super-position of HUD symbology and outside world scene is done by using an optical combiner (beamsplitter) which is part of the HUD optical system. One of the critical items of information that is displayed on the HUD is the aiming reticle that is used for air-to-air and air-to-ground weapon aiming. In order to be effective, it is essential that the aiming reticle be accurately boresighted to the weapon system. This requires a careful integration of the optical characteristics of the HUD and the aircraft canopy. There are several optical parameters that can affect target acquisition and aiming accuracy that involve the canopy, the HUD, and interactions between the two. The primary parameter that affects aiming accuracy is angular deviation due to the windscreen and/or the HUD. GRA

N84-26931# Joint Publications Research Service, Arlington, Va. **MAGNETOHYDRODYNAMIC FLOW PAST NONCONDUCTING WEDGE Abstract Only**

Y. A. PUSHKAR *In its* USSR Rept.: Eng. and Equipment (JPRS-UEQ-84-003) p 33 13 Apr. 1983 Transl. into ENGLISH from Izv. Akad. Nauk SSSR: Mekhan. Zhidkosti i Gaza (Moscow), no. 2, Feb. 1983 p 102-112
Avail: NTIS HC A04/MF A01

The problem of magnetohydrodynamic (MHD) flow past a nonconducting wedge facing the stream at an arbitrary angle of attack is solved by a numerical method for the case of plane-polarization with the magnetic field not parallel to the velocity vector. Only a weak solution, corresponding to slow shock waves, is sought with three dimensionless parameters. Four boundary conditions are established, zero normal velocity component at each

wedge face and equal magnetic field intensity components at both wedge faces, this number of conditions is equal to the number of unknowns and the problem is well conditioned. The solution is plotted in the theta 1, theta 2 plane of wedge angles. The results are useful in the study of processes in MHD machines which include plasma accelerators, quasisteady astrophysical processes, and the Earth's magnetosphere. E.A.K.

N84-27661*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

ACOUSTIC FLIGHT TESTING OF ADVANCED DESIGN PROPELLERS ON A JETSTAR AIRCRAFT

P. LASAGNA and K. MACKALL *In* NASA. Langley Research Center Advan. Aerodyn.: Selected NASA Res. p 1-10 Dec. 1981

Avail: NTIS HC A05/MF A01 CSCL 20A

Advanced turboprop-powered aircraft have the potential to reduce fuel consumption by 15 to 30 percent as compared with an equivalent technology turbofan-powered aircraft. An important obstacle to the use of advanced design propellers is the cabin noise generated at Mach numbers up to .8 and at altitudes up to 35,000 feet. As part of the NASA Aircraft Energy Efficiency Program, the near-field acoustic characteristics on a series of advanced design propellers are investigated. Currently, Dryden Flight Research Center is flight testing a series of propellers on a JetStar airplane. The propellers used in the flight test were previously tested in wind tunnels at the Lewis Research Center. Data are presented showing the narrow band spectra, acoustic wave form, and acoustic contours on the fuselage surface. Additional flights with the SR-3 propeller and other advanced propellers are planned in the future. B.G.

N84-28569*# Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.

NOISE PATH IDENTIFICATION USING FACE-TO-FACE AND SIDE-BY-SIDE MICROPHONE ARRANGEMENTS

M. ATWAL and R. BERNHARD May 1984 28 p refs (Contract NAG1-58)

(NASA-CR-173708; NAS 1.26:173708; HL84-14; REPT-0226-11)
Avail: NTIS HC A03/MF A01 CSCL 20A

In large complex structures, with several major sound transmission paths and high levels of background noise, it can be a complex task to locate and rank the contribution of an individual sound transmission path. The two microphone acoustic intensity techniques are investigated as a tool for path identification. Laboratory tests indicate that, if the intensity transmitted through a particular section of the fuselage is measured in the presence and absence of flanking paths using the face to face and side by side microphone arrangements, then no significant difference exists between the two measured intensities if the face to face microphone arrangement is used. However, if the side by side arrangement is used, then considerable difference exists between the two measured intensities. M.A.C.

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.

A84-39702

THE DESTRUCTION OF KOREAN AIR LINES BOEING 747 OVER THE SEA OF JAPAN, 31 AUGUST 1983 - A BREAK-DOWN OF THE INTERNATIONAL LEGAL ORDER?

P. MARTIN (Frere Cholmeley, London, England) International Journal of Aviation Safety (ISSN 0264-6803), vol. 2, June 1984, p. 15-22.

A general discussion is presented of the effect of the destruction of Korean Airlines flight KE 007 on the understanding of international law as it pertains to the use of force against an intruding civil aircraft. Attention is given to legal precedents where 'aggravating circumstances' were cited by territorial states employing armed force as justification for aggressive defensive measures against civil aircraft. On the basis of evidence uncovered in the ICAO investigation of the incident, it is considered whether Soviet use of force conformed to customary international law and to legal principals established under article 9 of the Chicago Convention of 1944. Observations are made on the various types of liability that might be claimed in civil suits brought by relatives of the victims of the KAL KE 007 tragedy. I.H.

A84-39719

CHANGING PATTERN OF AERONAUTICAL EDUCATION IN THE UK

G. J. HANCOCK (Queen Mary College, London, England) Aeronautical Journal (ISSN 0001-9240), vol. 88, May 1984, p. 200-205. refs

The evolution of aeronautical engineering education (AEE) in the United Kingdom up to the present form is summarized. AEE began in WWI in the form of courses for pilot candidates. An AE diploma was first awarded in 1922, when chairs of AE were being established at various universities. The AEE curriculum then included many mechanical and electrical engineering courses. A postgraduate course was devised after WWII and a significant number of schools began offering undergraduate degrees. The increasing number of topics specifically devoted to AE began to displace machine design courses. Polytechnical universities were formed and led to a large increase in university enrollment in AEE. The individual schools are now biased toward specialty areas such as design, industrial applications, research, transport aerodynamics and civil aeronautics. M.S.K.

N84-27586# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

FY 1985 TECHNICAL OBJECTIVE DOCUMENT

Mar. 1984 75 p Supersedes AFWAL-TR-83-2001

(Contract AF PROJ. 9991)

(AD-A140581; AFWAL-TR-2000; AFWAL-TR-83-2001) Avail:

NTIS HC A04/MF A01 CSCL 21E

This TOD was prepared by the Aero Propulsion Laboratory to provide science and industry with specific technical objectives which the Air Force feels are critical to maintain aerospace superiority in the future. The TOD contains eight technology planning objectives which cover the technical disciplines of air-breathing propulsion, aerospace vehicle power, fire protection, and aircraft and missile fuels and lubrication. GRA

N84-27610# Deputy Chief of Staff for Research Development and Acquisition (Air Force), Washington, D.C.

JUSTIFICATION OF ESTIMATES FOR FISCAL YEAR 1985 SUBMITTED TO CONGRESS FEBRUARY 1984. AIRCRAFT PROCUREMENT, AIR FORCE

Feb. 1984 230 p

(AD-A140837) Avail: NTIS HC A11/MF A01 CSCL 15E

This report includes the Air Force budgetary justification submitted to Congress for Fiscal Year 1985 for construction, procurement, and modification of aircraft and equipment, including armor and armament, specialized ground handling and training devices, spare parts, and accessories; specialized equipment; expansion of public and private plants, Government-owned equipment, and installation in plants, erection of structures, and acquisition of land, and construction; for the foregoing purposes, and such lands and interests therein, may be acquired, and construction prosecuted thereon prior to the approval of title; and construction; reserve plant and Government and contractor-owned equipment layaway; and other expenses; including rents and transportation of things; \$28,676,500,000, to remain available for obligation until September 30, 1987. GRA

N84-28679# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

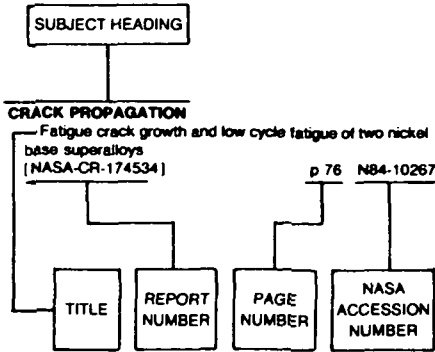
AN ANALYSIS OF NATIONAL AVIATION POLICY WITH RESPECT TO AMERICA'S STRATEGIC AIRLIFT CAPABILITY
Doctoral Thesis

K. N. GOULDIN 1984 185 p

(AD-A141308; AD-E751086; AFIT/CI/NR-84-13D) Avail: NTIS HC A09/MF A01 CSCL 15E

America's national aviation policy has always embodied a commitment to establish and maintain a commercial air transport system responsive to the needs of national defense. Up until 1978, the interests of the airlines tended, for the most part, to parallel those of defense planners. However, since 1978 the airline's domestic operating environment has changed dramatically, raising serious questions regarding the continued policy of relying on the civil sector for the majority of this nation's contingency airlift support. In order to address some of those questions, various aspects of airline operations, the military airlift system, and commercial aircraft manufacturing were examined. The overall findings led to the conclusion that the needs of the civilian air transport industry no longer coincide with those of national defense. Our national aviation policy must be restated in light of these changes if this country is to maintain its position as the free world's primary supplier of military airlift. GRA

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

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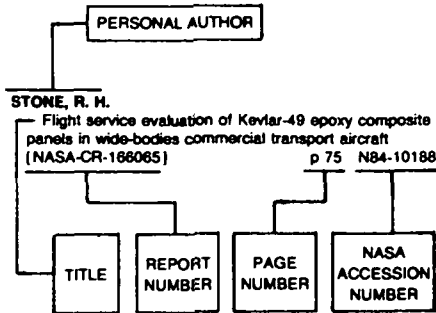
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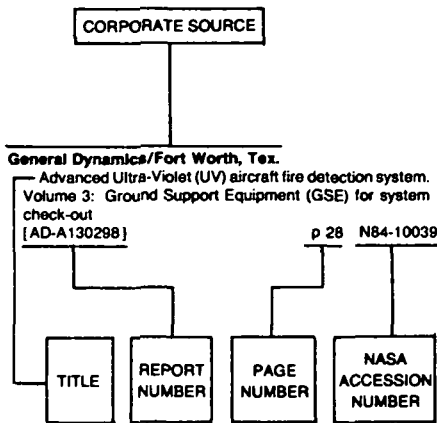
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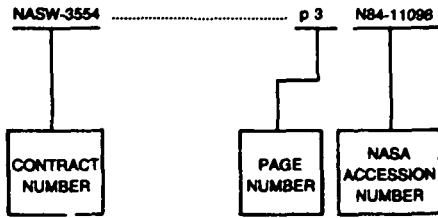
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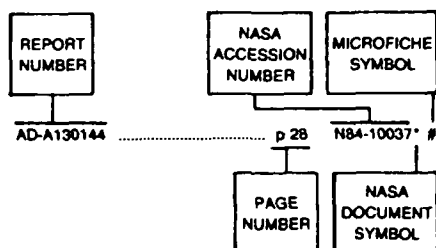


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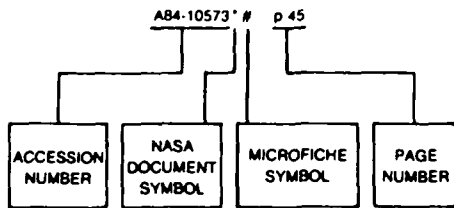
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AIAA PAPER 84-1628	p 706	A84-38017	* #	ESA-TT-895	p 669	N84-27701	#	NAS 1.26:166573	p 674	N84-26679	* #
AIAA PAPER 84-1630	p 651	A84-38019	* #	ESA-TT-886	p 677	N84-27716	#	NAS 1.26:170414	p 689	N84-27724	* #
AIAA PAPER 84-1631	p 651	A84-38020	#	ESA-TT-887	p 702	N84-27742	#	NAS 1.26:172282	p 694	N84-27734	* #
AIAA PAPER 84-1636	p 651	A84-38023	#					NAS 1.26:172338	p 676	N84-26685	* #
AIAA PAPER 84-1640	p 651	A84-38027	#	FAA-CT-83-10	p 674	N84-26680	#	NAS 1.26:172361	p 688	N84-27719	* #
AIAA PAPER 84-1641	p 719	A84-38028	#	FAA-CT-83-43	p 674	N84-26681	#	NAS 1.26:172636	p 666	N84-27678	* #
AIAA PAPER 84-1643	p 719	A84-38030	#	FAA-CT-84-11	p 708	N84-27751	#	NAS 1.26:173448	p 734	N84-28537	* #
AIAA PAPER 84-1644	p 651	A84-38031	* #					NAS 1.26:173639	p 726	N84-27024	* #
AIAA PAPER 84-1645	p 652	A84-38032	* #	FAA-DF-84-001A	p 707	N84-26715	#	NAS 1.26:173644	p 725	N84-26973	* #
AIAA PAPER 84-1646	p 652	A84-38033	#					NAS 1.26:173708	p 736	N84-28569	* #
AIAA PAPER 84-1648	p 719	A84-38034	#	FAA-EE-83-10	p 715	N84-27910	#	NAS 1.26:173721	p 688	N84-27717	* #
AIAA PAPER 84-1656	p 652	A84-38038	* #					NAS 1.26:173723	p 666	N84-27681	* #
AIAA PAPER 84-1657	p 719	A84-38039	* #	FFA-136	p 726	N84-27006	#	NAS 1.26:174624	p 700	N84-26702	* #
AIAA PAPER 84-1658	p 658	A84-39307	#					NAS 1.26:174629	p 729	N84-28089	* #
AIAA PAPER 84-1660	p 652	A84-38040	#	FJSRL-TR-84-0002	p 700	N84-26704	#	NAS 1.26:174642	p 715	N84-27908	* #
AIAA PAPER 84-1662	p 652	A84-38042	* #					NAS 1.26:3252	p 668	N84-27698	* #
AIAA PAPER 84-1663	p 652	A84-38043	* #	FOA-C-53016-H2	p 675	N84-27706	#	NAS 1.26:3290	p 688	N84-27722	* #
AIAA PAPER 84-1664	p 659	A84-39317	#	FOA-C-53017-H2	p 675	N84-27707	#	NAS 1.26:3468	p 688	N84-27720	* #
AIAA PAPER 84-1665	p 653	A84-38044	#	FOA-C-59010-H1	p 675	N84-27708	#	NAS 1.26:3469	p 666	N84-27683	* #
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